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Adenike Anike Olayungbo[1]
Obafemi Awolowo University, Ile-Ife, Nigeria

Land Use and Land Cover Change Detection Using Remote Geospatial Techniques: A Case Study of an Urban City in Southwestern, Nigeria

Abstract. Many cities in developing countries are experiencing ecosystem modification and change. Today, about 10 million hectares of the world's forest cover have been converted to other land uses. In Nigeria, there is an estimated increase of 8.75 million ha of cropland and decrease of about 1.71 million ha of forest cover between 1995 to 2020, indicating that Nigeria has been undergoing a wide range of land use and land cover changes. This paper analyses the changes in land use/cover in Ila Orangun, Southwestern, Nigeria from 1986 to 2018, with a view to providing adequate information on the pattern and trend of land use and land cover changes for proper monitoring and effective planning. The study utilized satellite images from Landsat 1986, 2002 and 2018. Remote sensing and Geographical Information System techniques as well as supervised image classification method were used to assess the magnitude of changes in the city over the study period. The results show that 26.36% of forest cover and 44.48% of waterbody were lost between the period of 1986 and 2018. There was a rapid increase in crop land by 365.7% and gradual increase in built-up areas by 103.85% at an annual rate of 3.25%. Forest was the only land cover type that recorded a constant reduction in areal extent. The study concluded that the changes in land use and land cover is a result of anthropogenic activities in the study area.

Key words: land use, land cover, change detection, landsat images, supervised classification, Nigeria

JEL Classification: R14

Introduction

Land use and land cover change detection plays an important role in effective monitoring and assessment of the level of human impact on ecosystems (Liping et al., 2018; Wang et al., 2020) through the use of remote sensing data. Thus, the use of remote sensing data for mapping urban ecosystems is vital to the understanding of the characteristics and structure of urban ecosystems (Fedrigo et al., 2019). Some of the major applications of remote sensing include acquisition, modelling, mapping and classification of spatial data of the earth's surface (Pettorelli et al., 2005; 2014). These spatial data are essentially useful for effective monitoring and management of various land cover features (waterbodies, vegetation, bare surface, soil and rocks) within an urban ecosystem (Pettorelli et al., 2014; Xue and Su, 2017; Fedrigo et al., 2019). Land cover refers to the physical features on the earth surface such as soil, vegetation, wetlands, water bodies, rocks, etc. Land use refers to the various ways by which humans use land, which may be for conservation, settlements, production, recreation or development.

Globally, there has been a continuous conversion of land cover to other land uses. According to the Food and Agriculture Organization (2020), about 10 million hectares (ha)

[1] A.G. Leventis Museum of Natural History, Obafemi Awolowo University, Ile-Ife, Nigeria;
e-mails: aolayungbo@gmail.com, aolayungbo@oauife.edu.ng; https://orcid.org/0000-0002-4064-1852

of the world's forest, which was estimated to be one-third of the total world land cover, was converted mainly to agricultural land and other uses from 2015 to 2020. During this period, Africa had the highest annual rate of forest loss at 3.9 million ha (Food and Agriculture Organization, 2020). With the rapid increase in human population, particularly in many African nations, coupled with continuous land development and high demand for food, the situation is expected to continue. The report of the Forestry outlook Study in Africa (FOSA) on land use trends in Nigeria shows an estimated increase of cropland from 61.9 million ha in 1995 to 70.65 million ha in 2020, while forest cover decreased from 2.65 million ha in 1995 to 938,066.41 ha in 2020 (Aruofor, 2020). This report reveals that Nigeria has been undergoing a wide range of land use and land cover changes, which often lead to ecological imbalance.

Studies have attributed changes in land use and land cover to land development, population growth and urban expansion as a result of urbanization (Orimoogunje, 2014; Nath et al., 2020). Over the ages, particularly since organized human settlements started, human beings have been exploiting the biosphere resources through modification of various land cover to different types of land uses. Prior to the 1970s, ecologists focused mainly on the study of the relationships of organisms to each other and the components of the environment such as soil, light, and temperature, among others. Such studies as those by McIntosh (1974) dwelled on the relationships of flora and fauna in their environments. Many other studies focused on the adaptation and modification of plants and animals to a specific environment, and the distribution and abundance of biodiversity in specific environments, among others (Egerton et al., 2008; Bidlack and Jansky, 2011), with very little focus on land use and land cover changes. The United Nations estimates that about 55 % of the world's population are living in urban areas presently. This is expected to increase to 68 % by 2050 based on population projections (United Nations, 2019). With the rate at which urban populations are increasing in different parts of the world, ecological studies have been focusing on human activities in urban environments in relationship to land use and land cover change for monitoring and policy making (Grove, 1997; Ye et al., 2018; Chen et al., 2020).

Many cities in developing countries such as Nigeria, Liberia and Ghana are experiencing ecosystem modification and land use/cover change as a result of urbanization, population growth and economic development. Economic development often leads to land use and land cover changes which invariably alter the functioning of ecosystems that provide support for humans in all respects, including livelihood. Previous studies (such as Adesina, 2008; Ajala and Olayiwola, 2013; Butt et al., 2015; Ye et al., 2018; Chen et al., 2020) have shown that urban areas are experiencing rapid reduction in total area occupied by natural vegetation, forest and water bodies annually. These changes in land use patterns in different parts of the world have been resulting in ecological imbalance and environmental challenges such as flooding and biodiversity loss, as well as changes in local climate. The ecological imbalance and environmental challenges associated with continuous conversion of natural land cover to other man-made ecosystems, particularly in urban centres, justify the significance of this study. Thus, land use land and cover change detection plays an important role in effective monitoring and assessment of the level of human impacts on ecosystems and its resources. This paper therefore analyses the changes in land use/cover in Ila Orangun, Southwestern, Nigeria from 1986 to 2018. This is with a view to providing adequate information on the pattern and trend of land use/land cover changes over a period of thirty two years for proper monitoring and effective planning.

Materials and methods

Study area

Ila Orangun is situated in Osun state, Southwestern part of Nigeria. Ila Orangun is located approximately between latitudes 8° 2' 13" N and 7° 59' 30" N and longitudes 4° 52' 30" E and 4° 57' 30" E (Figure 1). It has an elevation of about 494 m above sea level. The community has one Local Government Area and eleven wards. According to the National Population Commission (2006), the town has a population of 62,049 but this has been estimated to increase annually by an official annual growth rate of 3.2 percent from 2006 to present (National Population Commission, 2020).

Ila Orangun experiences the Koppen AF humid tropical rainforest climate, which is characterized by high humidity and rainfall (Adejuwon and Jeje, 1976). The climate gives rise to high variety of biological diversity that supports agriculture. The area has two seasons: dry and wet. The wet season starts around March and ends around late October while the dry season is experienced from November to February (Iloeje, 1982; Climate Data, 2018). The average minimum and maximum temperatures in Ila Orangun are 25℃-28℃ and 31℃-32℃, respectively. The area is drained by several rivers which have their source from hills near the city (Ogunfolakan, 2009).

The original type of vegetation found in the Ila Orangun is that of tropical rainforest. However, the present vegetation can be referred to as secondary forest and derived savanna (Tijani and Onodera, 2009; Ogunleke and Oludele, 2013) as a result of land use/land cover changes over the years. The climate supports the growth of valuable cash crops like Cocoa (*Theobroma cacao*) and Kola nut (*Cola* spp.) as well as the production of timber from economic trees like Obeche (*Triplochiton scleroxylon*) and Iroko (*Milicia excelsa*) (Adejuwon and Jeje, 1976; Orimoogunje, 2014). It also favors the cultivation of food crops such as maize (*Zea mays*), yam (*Dioscorea alata*), okro (*Hibiscus esculentus*), cassava (*Manihot esculenta*) and vegetables (*Amaranthus* species) (Adejuwon and Jeje, 1976; Olaniran, 2013). The area has a land mass of approximately 332 square kilometres.

Table 1. Description of land use/land cover classes identified in the study area

Land Use/ /Land Cover Classes	Description
Forest	-Areas covered with matured trees and other green plants that closely grow together (which could be dense, secondary, disturbed or degraded forest).
Crop Land	-Areas of land use for cultivation of crops which include farmland or garden.
Built-up Area	-These are areas covered with buildings (completed or uncompleted) which include residential houses, offices, shops with road networks.
Water Body	-These are areas covered with rivers and reservoirs.
Rock	-Areas covered with exposed rocks

Source: Adapted from Adegboyega (2012).

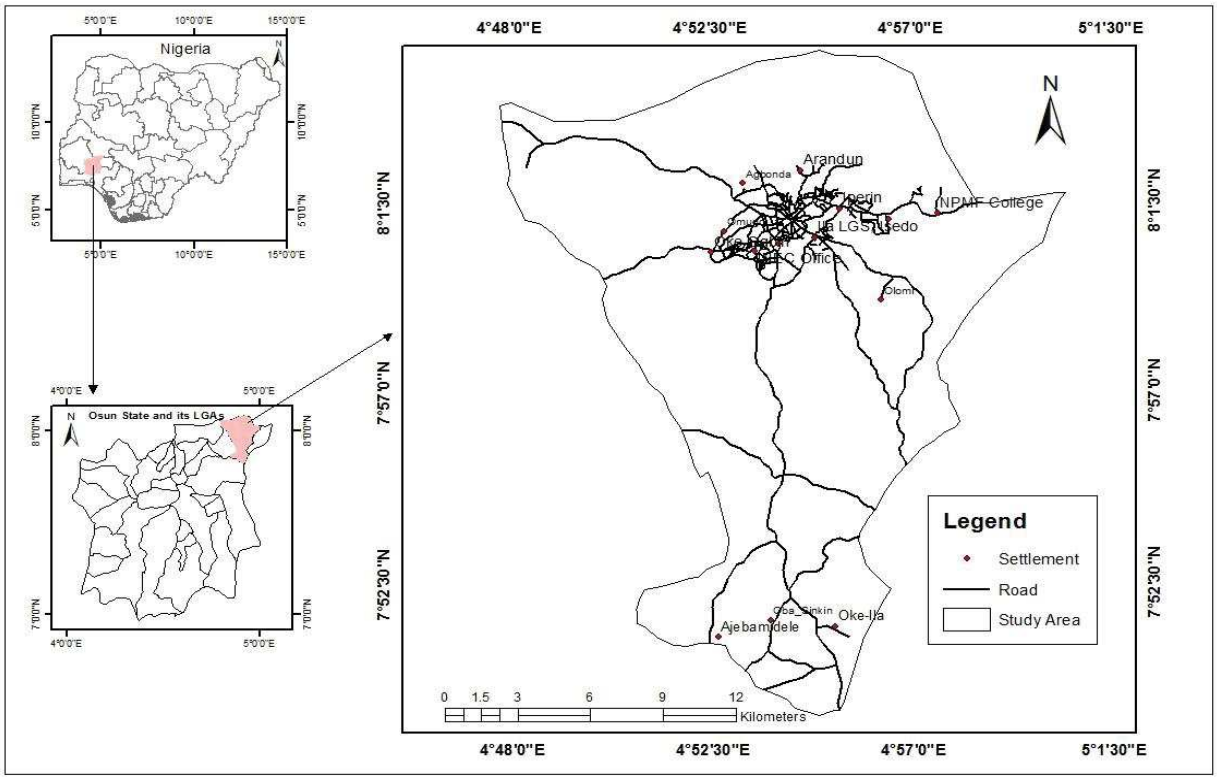

Fig. 1. The study area, Ila Orangun in southwestern, Nigeria

Source: Author's own elaboration.

Data collection

Data used for the study are Landsat images which were obtained freely from the United States Geological Survey (USGS) archive. Based on the available data, the study utilized satellite images from Landsat 1986, 2002 and 2018. Thus, Landsat Thematic Mapper (TM) 1986, Enhanced Thematic Mapper (ETM) 2002 and Landsat 8 OLI/TIRS located on Path 190 and Row 055 were utilized for this study (Table 1). This was with a view to obtaining useful information on the changes in land use patterns within the study area for adequate monitoring and planning. Landsat datasets were selected for this study, due to the fact that they are highly suitable for studies on land use/land cover change detection, give a time series of data on an area and also have good spatial resolution (Oyinloye et al., 2010; Boyle et al., 2014).

Image processing and classification

The Geographical Information System (GIS) software that was utilized for this study includes Earth Resources Data Analysis System (ERDAS) IMAGINE 9.2 and Aeronautical Reconnaissance Coverage Geographic Information System (ARCGIS) 10.2 versions. Subset images were created from the landsat images (1986, 2002 and 2018) using the administrative

boundary of the study area as a shapefile. This task was performed in order to select the pixels i.e. Area of Interest (AOI), that are within the geographic boundary of the study area. The areal extent and geographic co-ordinates of the subset images were described in order to aid the performance of various integrated analytical operations for change detection. The appropriate band combination from the multispectral satellite images were selected to create a colour composite that was specifically tailored to facilitate the identification of the features of interest in the GIS environment.

Table 2. Characteristics of the Dataset for the Ile-Ife and Ila Orangun

Data Type	Date of capture	Spatial Resolution	Landsat Scene	Location	
				on WRS	Source
Landsat Imagery	17 Dec., 1986	30 m	TM	P190R055	USGS
Landsat Imagery	01 Jan., 2002	30 m	ETM+	P190R055	USGS
Landsat Imagery	03 Jan., 2018	30 m	Landsat 8	P190R055	USGS

Source: USGS denotes United States Geological Survey.

A supervised classification method was employed because it aids the selection of pixels that represent land use features that are useful for the study (Oyinloye and Oloukoi, 2013; Boyle et al., 2014; Madaan and Sharma, 2012). Ground control points with coordinates of known locations were obtained using GPS to enhance the validity of the classified map during reconnaissance survey. The purpose of performing this task was to confirm the accuracy of the spatial information from remotely-sensed images (1986, 2002 and 2018) through a process known as ground truth (Ramzi, 2015). The same symbols were assigned to classes of similar group attribute data. The classification scheme which represents the tropical terrestrial biomes as described by Costanza et al. (1997) was chosen because it corresponds to the rainforest ecological zone of Nigeria. Based on this classification, five classes (forest, cropland, waterbody, built-up and rock) were identified from the multi-date satellite images (1986, 2002 and 2018).

Data Analysis

The thematic raster layers were quantified using ERDAS IMAGINE statistical tool. From the classified multi-date images acquired, land use/land cover (LULC) layers were digitized for change detection (such as trend, magnitude and rate of the change) using the formula which is expressed as:

$$\Delta LULC = LULC_2 - LULC_1 \quad (1)$$

Where:
$\Delta LULC$ is the land use/land cover change;
$LULC_2$ is the current area extent of a particular land use/land cover type;
$LULC_1$ is the previous area extent of a particular land use/land cover type.

In addition, Average Rate of change (*ARC*) of a particular land use/ land cover type was calculated using the formula which is expressed as:

$$ARC = \Delta LULC / T \quad (2)$$

Where:
ARC is the Average Rate of Change;
T is the total number of years.

Lastly, the annual rate of changes in various land cover types was determined using the formula:

$$LUDI = [(U_b - U_a) / U_b\ T] \times 100 \quad (3)$$

Where:
LUDI is the annual rate of change;
U_b and U_a represents the extent of urban expansion at time '*a*' and '*b*';
T is the length of time in years from time '*a*' to time '*b*'.

Results and discussion

Land use/cover change

The main land use in the study area included arable farming, residential and institutional. The land use/land cover areal extent of Ila Orangun for 1986, 2002 and 2018 is presented in Table 3. The study area covered an estimated area of 33,224.6 hectares. As presented in Figure 2 and Table 2, forest occupied (89.56%) represents the most extensive land use/cover type in 1986. The built-up area (5.2%) represents the second largest land use/cover type, followed by crop land (4.81%), rock (0.34%) and water body (0.09%) in 1986. However, by the year 2018, there were changes in the areal extent occupied by all the land use/cover types.

Table 3. Land Use/Land Cover Areal Extent of Ila Orangun between 1986 and 2018, in ha

Land use/Cover Classes	1986		2002		2018	
	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)
Forest	29755.95	89.56	28357.20	85.35	21911.6	65.95
Crop Land	1598.10	4.81	2624.74	7.90	7442.3	22.40
Built-up Area	1727.68	5.20	2093.15	6.30	3521.8	10.60
Waterbody	29.90	0.09	13.29	0.04	16.6	0.050
bare surface	112.97	0.34	136.22	0.41	332.3	1.00
Total	33224.60	100.00	33224.60	100.00	33224.6	100.00

Source: Author's Computation, 2021.

The results of the trend/magnitude and rate of change for the classified land use/cover of Ila Orangun between 1986 and 2018 are presented in Table 4. The positive values of the magnitude of change and annual rate of change implies an increase in land use/cover from the previous year of study while the negative values of magnitude of change and annual rate of change implies a reduction in land use/land cover from the previous year of study. During the period between 2002 and 2018, forest was the only land cover type that recorded

a reduction in areal extent. The trend of land use/cover changes in Ila Orangun from 1986 to 2018 implies that part of forest area has been converted and lost to crop land, built-up area and rock annually (Figure 2 and Table 4). The results show that part of the areas that were formerly occupied by forest between 1986 and 2002 have been reduced more than three times the areal extent between 2002 and 2018.

Table 4. Analysis of the changes in Land Use/Land Cover in Ila Orangun between 1986 and 2018

Land use/ /Cover classes	Magnitude of change						Annual rate of change	
	1986-2002		2002-2018		1986-2018			
	area, in ha	%	area, in ha	%	area, in ha	%	ha/yr.	%
Forest	-1398.75	-4.7	-6445.6	-22.73	-7844.35	-26.36	-245.16	-0.82
Crop land	1026.64	64.24	4817.56	162	5844.2	365.7	182.63	11.43
Built-up area	365.47	21.2	1428.65	125.31	1794.12	103.85	56.07	3.25
Waterbody	-16.61	-55.55	3.31	24.3	-13.3	-44.48	-0.42	-1.39
Rock	23.25	20.58	196.08	143.94	219.33	194.15	6.85	6.07

Source: Author's Computation, 2021.

The results from the analysis of the land use/cover areal extent from 1986 to 2018 reveal that forest constitutes the most extensive type of land use/land cover by accounting for 65.95% of the total areal extent in 2018. However, the value in 2018 indicates a continuous and drastic decline in forest cover from 89.56% to 65.95% over a period of thirty-two years, mainly due to anthropogenic factors such as logging activities and urbanization, coupled with other urban development and continuous increase in crop land, built-up and rock areas as shown in Table 3. One of the possible reasons for continuous logging activities in Ila Orangun is as a result of the climatic condition which supports dense vegetation.

A comparison of the magnitude of change in the land use/cover indicates that while forest cover was decreasing continuously, cropland, built-up area and rock were increasing annually between 1986 and 2018 (Table 4). However, there were fluctuations (i.e. increase and decrease) in the trend and rate of change recorded in the areal extent occupied by water body during these periods (Tables 3 and 4). More specially, the results of the magnitude of change show that crop land, built-up area and rock increased by 365.7%, 103.85% and 194.15% at an annual rate of 11.43%, 3.25% and 6.07% per annum, respectively, between 1986 and 2018. The rate at which land use/land cover was converted to crop land was very rapid when compared to other land use/cover types over the study period. The study noted that the majority of the residents in Ila Orangun are predominantly subsistence farmers who engage in the cultivation of arable crops such as yam, maize, cassava and vegetables as a means for survival and livelihood. This is evident in the rapid trend by which crop land gained more areal extent than other land cover types in the study area from 1986 to 2018. The areal extent occupied by cropland by the year 2018 was more than double its initial size in 1986.

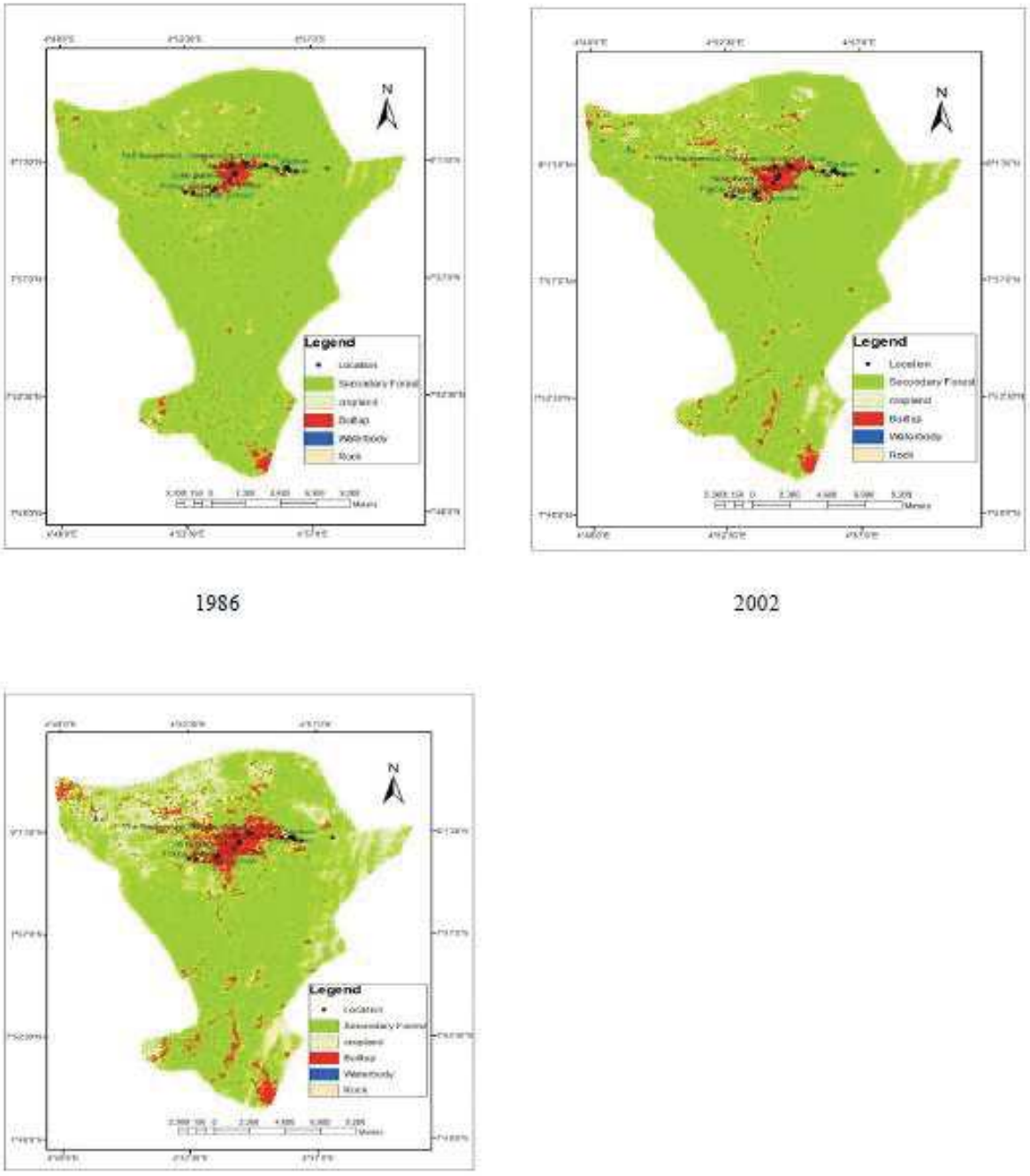

Fig. 2. Land Use/Land Cover Maps of Ila Orangun 1986, 2002 and 2018

Source: Author's own elaboration.

The changes can be attributed to urban development such as expansion of urban settlements, road expansion, population increase, urbanisation, transformation of natural areas to residential and commercial areas, as well as conversion of natural forest to farm land. These results are similar to the findings by Aguda et al. (2013), Ajala and Olayiwola (2014) and Oyinloye and Oloukoi (2013) on changes in land use/cover in urban areas of Nigeria as caused by urbanisation and conversion of vegetation areas to farmlands, roads and built-up areas over the years.

Implication of land use/cover change

Although, forest remained the most dominant of all the land use/cover types in Ila Orangun from 1986 to 2018, there had been a continuous decrease in the areal extent occupied by forest over the period of thirty-two years. A reduction in forest cover suggests the impacts of human activities such as farming, commercial logging and timber extraction, land development for buildings and road construction within the study area. Notably, the rate of deforestation between 1986 and 2002 was rapid, which is an indication that the flora and fauna as well as the ecosystem services supplied to the area has been greatly altered. The environmental effects of rapid forest decline in Ila Orangun include: forest degradation, loss of biodiversity, and reduction in forest carbon sequestration rates, which contributes to local and global climate change. The findings of this study support the observation of FAO (2020) that Nigeria's rainforest vegetation is declining rapidly with loss of genetic diversity of both flora and fauna species due to poor monitoring and management strategies.

The continuous increase in the trend by which land use/land cover classes are converted to built-up areas suggests a continuous demand for more buildings by the growing population within the study area. Likewise, Ajala and Olayiwola (2013) attributed increase in built-up area to increase in spatial extent as a result of population growth, physical growth and development. The results of the trend in cropland (1986-2018), suggest that farming is a predominant occupation in Ila Orangun. The results showed a higher rate of conversion of land cover to cropland than other classes of land cover. During the course of ground truthing activities and reconnaissance survey, it was revealed that many of the farmers are subsistence farmers who practice bush burning and shifting cultivation with the use of local farm tools. Such practices contribute to the alteration of ecosystems and cause ecological imbalance, which is regarded as unsustainable by the FAO (2020). Also, Boratyńska and Huseynov (2017) noted that such agricultural practices need to be improved through provision of modern technologies and improvement of agricultural infrastructure in order to improve food production and achieve sustainable development (Huseynov, 2020). The trend of the changes in the patterns of land use/cover in the Ila Orangun shows that there is need for the adoption of adequate monitoring policies and effective management strategies for ecological balance and sustainability.

Conclusions

Uncontrolled Land use activities are known to cause ecological instability and pose great threat to global food security. This study examined the changes in the pattern of land use and land cover in an urban city in southwestern, Nigeria from 1986 to 2018. It aimed at detecting the extent and rate of changes in land use pattern over a period of thirty two year for proper monitoring and effective planning.

Based on the results of this study, it can be concluded that the pattern of land use/cover in Ila Orangun has changed significantly over the past thirty-two years. The application of RS and GIS for change detection reflects a continuous and drastic decline in forest extent in the study area, which is an indication of disturbance of the ecosystem and depletion of its resources. The rapid expansion of cropland and built-up areas is a reflection of continuous uncontrolled anthropogenic activities due to population increases and urbanisation. With the results obtained from LULC analysis, it is evident that Ila Orangun lacks proper land use

planning and management since there is no official area designated for land development and farming. The practice of shifting cultivation and bush burning by subsistence farmers coupled with continuous rapid increase in cropland areal extent reveals that there is no proper monitoring or strict compliance with the utilization of land that is only designated for farming. The study concludes that the trend of LULC change in the area constitute a major threat to sustainable livelihood, food security and global climate protection.

From the findings of this research, the study recommends that there is need to create a database with regular updates on the changes of land use/land cover. This will provide a baseline for data retrieval which can help monitor the pattern, trend and changes of land use/land cover types for necessary actions. Since forest cover has been identified as a major land cover type that is vulnerable to anthropogenic activities, there is need to monitor land use activities for effective management. And since the majority of people living in Ila Orangun engaged in subsistence farming, there should be drastic measures to curb unsustainable farming practices in the study area. This will reduce ecosystem degradation, ecological resource depletion and ecosystem service deterioration while enhancing sustainable utilization of ecological resources.

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Mary Cris F. Pleños[1]
Visayas State University, Philippines

The Determinants of Fish Catch: A Quantile Regression Approach

Abstract. The goal of this study is to use quantile regression (QR) to find predictors of fishers' catch and compare it with OLS regression. The heterogeneous association across the different quantiles of the catch distribution was investigated using QR analysis. The findings reveal that the effect changes depending on where a fisher is in the catch distribution. In the OLS, there are several non-significant predictors that appear to be significant in quantile regression. By OLS regression, demographic variables have little effect on fishers' catch; but, in quantile regression, marital status, fishing hours, and use of motorized boats appeared to have a relatively high impact at the top of the distribution.

Key words: quantile regression, fishers, catch

JEL Classification: C14, Q22

Introduction

According to Food and Agriculture Organizations in the United Nations (2021), the Philippines ranked among the major fish producing countries in the world with a total production of 3.1 million tons of fish, crustaceans, mollusks and other aquatic animals. As cited in Oxford Business Group (2021), the Philippine agriculture and fisheries accounts for 10% of the country's GDP.

In 2019, the production volume of fisheries across the Philippines was approximately 4.4 million metric tons. In the same period, the overall production value of fishing in the country was approximately 281.7 billion Philippine pesos (Statista, 2021). The total volume of fisheries production was registered at 978.62 thousand metric tons in the first quarter of 2021 (PSA, 2021). There are 9 million registered small-scale fishers and their families rely on marine waters to provide income and food. About 85% of Filipino fishers are coastal, small-scale fishers, and catch nearly half of the Philippines' fish (RARE, 2021).

In 2016 as reported by Philippine Statistics Authority or PSA, fishing is an important source of livelihood for Filipinos, fish being the country's second staple food next to rice. On average, every Filipino consumes daily about 98.6 grams of fish and fish products.

Studies related to empirical evidence on examining relationships between variables are essential specifically on determinants of fishers' catch and knowing the nature of its impact, either negatively or positively. The goal of this study is to use quantile regression to find significant predictors of fish catch and compare them to the standard least square model. The impact of fishing and socioeconomic factors on the catch of fishers was investigated.

[1] National Abaca Research Center, Visayas State Univeristy;
e-mail: mc.plenos@vsu.edu.ph; https://orcid.org/0000-0002-8378-2663

Literature Review

Regression has been developed to quantify the relationship between dependent variable (response) and independent variables (predictor). Demena (2011) uses OLS regression to identify the determinants that affect the utilization of fishery resources to enhance the scanty artisanal fish catch level. Birhanu (2015) uses linear regression to detect the factors that influenced the fish production in Lake Ziway, Ethiopia. Ratna et al. (2018) determine the factors that affect the income of fishers in Lhokseumawe of West Center of Indonesia. The method used for data analysis is multiple linear regressions with the linear-log mode. Zella & Mpemba (2017) use linear regression to identify the determinants of fishing income in Coastal Households of the Indian Ocean. A number of studies have applied the standard regression or ordinary least squares (OLS) to identifying the significant factors on fishers' catch and income since it is the most common statistical method when examining the factors affecting the response variable.

Linear regression is expressed as a linear function of a set of independent or predictor variables. It assesses how the mean of a conditional distribution changes with respect to some characteristics. This method assumes that the coefficients or covariates are the same across the population (Weisberg, 2013). This approach is less informative if the influence of independent variables varies across the distribution of response variable. This model is a parametric method that requires assumptions. The linear regression has the following assumptions (Berry, 1993): (1) There should be a linear and additive relationship between dependent (response) variable and independent (predictor) variable(s). (2) There should be no correlation between the residual (error) terms. (3) The independent variables should not be correlated. (4) The error terms must have constant variance (homoscedasticity). (5) The error terms must be normally distributed. However, normality and homoscedasticity are seldom met. Failure to meet at least one of the assumptions will lead to performing a quantile regression analysis, otherwise it will result in unreliable results and misleading policy inferences.

Quantile regression is a semiparametric alternative to OLS regression. It is an econometric regression model in which a specified conditional quantile (or percentile) of the outcome variable is expressed as a linear function of subject characteristics (Koenker & Bassett, 1987). QR analysis has the ability to estimate quantile-specific effects that describe the impact of covariates not only on the center but on the tails of the outcome distribution (Bernd, 2001). Linear regression is sensitive to outliers (Draper & Smith, 2014) while QR is robust to outliers (Waldmann, 2018). It provides a richer characterization of data allowing to consider the impact of a covariate on the entire distribution of response variable, not merely its conditional mean.

Methodology

The Data

Small-scale fishers account for around 800,000 people in the Philippines. This study includes cross-sectional data from 266 fishers in Leyte, Philippines, who were randomly selected from 15 fishing sites in five different municipalities. Since the allowable margin of error used by most surveys is normally between 4% and 8%, the sample size in the study was

calculated with a 6% margin of error and a 95% confidence interval. A pre-tested survey questionnaire was used to collect data from October 2018 to December 2019.

Variable Description

Daily fisher catch is quantified in kilos, and the detected predictors are classified as either demographic or fishing variables. Years are used to describe demographic attributes such as age and education. The overall number of family members is indicated by the household size, while marital status is represented by a dummy variable (1 = married, 0 = not married). Income of spouse is represented by a dummy variable (1 = has income, 0 = none). A dummy variable (1 = has income, 0 = no income) is used to indicate the spouse's income. A dummy variable (1 = yes, 0 = no) represents fishing as a primary source of income. Total number of hours per fishing session is used to describe fishing characteristics such as fishing hours and travel time from the coast to the fishing location. Membership in an organization (1 = member, 0 = non-member), presence of fishing companions (1 = with, 0 = without), and use of a motorized boat (1 = motorized, 0 = non-motorized) were all represented by a dummy variable.

Quantile regression approach

Quantile regression models the quantiles of the response variable conditional on the covariates (Koenker & Bassett, 1987). Ordinary Least Squares (OLS) regression models are commonly used in studies to determine the factors that influence fish catch. Such an approach would only reflect the impact of socioeconomic and fishing variables on the mean of the conditional distribution of catch, and would not allow for the influence to change across the catch distribution. As a result, the quantile regression analysis gives a solution to this issue. For this method to work, the dependent variable must have enough variance across quantiles for statistically significant returns to be estimated for each quantile. Quantiles provide a more accurate view of the distribution in the presence of outliers.

Research results

Descriptive analysis

Demographic and fishing characteristics were the two categories of the variables in this study. Fisher's catch ranged from 0.375 to 11.5 kg per fishing day. Fishers are 45 years old on average and have completed seven years of education. A fisher's household has an average of five individuals. Around 80% of the fishers were married, with about 30% of their spouses contributing to the family's financial requirements. Approximately 94 percent of fishers said that fishing is their primary source of income. Approximately 40% of the population became members in a fisher organization. They fish for 6.4 hours and traveled 1.4 hours from the beach to the fishing area. Food, gasoline, and other fishing paraphernalia are included in the average amount spent on fishing activities, which is PHP 279.80 (USD 5.76). Fishers utilize motorized boats to capture fish in about 36% of cases, while 66% of fishermen have fishing partners.

Table 1. Descriptive analysis of the data

Variable	Mean	Std. Deviation	Min	Max
Demographic characteristics				
Catch (kg)	2.860902	1.584132	0.375	11.5
Age (years)	45.37594	13.54634	15	89
Education (years)	6.947368	3.078387	0	20
Marital status (married fishers)	0.800752	0.400188	0	1
Household size	5.030075	2.147187	1	13
Spouse has income	0.304511	0.461068	0	1
Fishing characteristics				
Fishing as primary income	0.93985	0.238213	0	1
Membership in fishers' organization	0.369811	0.483667	0	1
Fishing hours	6.433835	3.497193	1	16
Travel time from shoreline to fishing area (hours)	1.40782	1.030522	0	6
Daily fishing cost (in PHP)	279.8045	304.635	5	1690
Daily fishing cost (in USD)	5.76	6.27	0.10	34.79
Use of motorized boat	0.362264	0.481564	0	1
Presence of companion in fishing	0.656604	0.475741	0	1

Note: 1 USD = 48.58 PHP

Source: Authors' own calculation and analysis (2021).

Quantile Regression Analysis

The effects of demographic and fishing factors on fishers' catch are presented in this section using OLS and quantile regression estimations. A quantile regression model was constructed at the 0.10, 0.25, 0.50, 0.75, and 0.90 quantiles to explore the differential effects at different points in the conditional distribution of fish catch (see Table 2).

Prior to model estimate, the OLS assumptions were checked to ensure that the findings were reliable. The errors were determined to be non-normal using the Shapiro-Wilk test, indicating that a standard linear regression or OLS model is not suggested for this investigation. As a result, quantile regression was used, which does not require any modeling assumptions.

According to OLS estimates, the model is significant at 5% (p-value = 0.0262), and the demographic and fishing characteristics account for around 8.69% of the variation in the fishers' catch. Only fishing hours and the usage of motorized boats had statistical relevance in predicting fishers' catch. Fishing hours have a beneficial impact on fishers' catch and are considerable at 1%. This amounts to a 0.087562 kg increase in catch per hour spent fishing. Furthermore, fishers who use motorized boats catch 0.432674 kg more than fishers who use non-powered boats. Demographic features, on the other hand, have no statistical significance in the dependent variable, hence they had no effect on the catch of the fishers.

Table 2. Comparison of OLS and quantile regression for catch determinants at 0.10, 0.25, 0.50, 0.75 and 0.90 quantiles

Specification	OLS	Quantile				
		0.10	0.25	0.50	0.75	0.90
Demographic characteristics						
Age	-0.00087 (0.007569)	-0.00094 (0.006747)	-0.01042 (0.007084)	-0.00667 (0.009443)	-0.01062 (0.009937)	-0.00578 (0.013735)
Years of education	0.039765 (0.031757)	0.065875* (0.028308)	0.038695 (0.029725)	0.038706 (0.03962)	0.056756 (0.041693)	0.021885 (0.057632)
Marital status (married fishers)	0.180538 (0.265456)	-0.18273 (0.236627)	0.181636 (0.248466)	0.231238 (0.331183)	0.777166** (0.348504)	1.014505** (0.481741)
Household size	0.028588 (0.045624)	0.066671 (0.040669)	0.057874 (0.042704)	0.064155 (0.05692)	0.043288 (0.059897)	-0.03932 (0.082797)
Spouse has income	0.066998 (0.215989)	0.035061 (0.192532)	0.074648 (0.202165)	0.140551 (0.269467)	0.270923 (0.283561)	-0.2249 (0.391969)
Fishing characteristics						
Fishing as primary income	0.220734 (0.406848)	0.341417 (0.362664)	0.23477 (0.380809)	-0.26048 (0.507583)	0.154351 (0.534131)	0.497464 (0.738334)
Membership in organization	0.125686 (0.206074)	0.079657 (0.183694)	-0.13576 (0.192884)	0.271734 (0.035323)	0.356353 (0.270544)	0.063815 (0.373976)
Fishing hours	0.087562*** (0.028313)	0.046272** (0.025238)	0.049644* (0.026501)	0.048634 (0.035323)	0.108271*** (0.037171)	0.114476** (0.051382)
Travel time	0.161485 (0.10093)	0.041766 (0.089969)	0.056024 (0.09447)	0.095279 (0.12592)	0.215399 (0.132506)	0.537905*** (0.183164)
Daily fishing cost	0.000382 (0.000353)	0.000294 (0.000315)	0.000552* (0.00033)	0.00066 (0.00044)	0.000317 (0.000463)	-0.00012 (0.000641)
Use of motorized boat	0.432674* (0.229901)	0.153 (0.204933)	0.465165** (0.215187)	0.310622 (0.286824)	0.307725 (0.301826)	0.927242** (0.417216)
Presence of companion in fishing	-0.1223 (0.207726)	0.001475 (0.185166)	-0.20374 (0.19443)	-0.20403 (0.259158)	0.01628 (0.272712)	0.001793 (0.376973)
Constant	1.099226 (0.69985)	-0.26535 (0.623845)	0.789814 (0.655057)	1.664907 (0.87313)	1.448477 (0.918798)	2.084147 (1.270063)

Note: *** significant at 1%, ** significant at 5% and * significant at 10%

Source: Authors' own calculation and analysis (2021).

The OLS equation was then re-estimated in quantile regression form to see how much of an impact explanatory factors might have throughout the fishers' catch distribution. The quantile regression results point to some significant changes in the catch distribution at various periods.

With the exception of the 0.50 quantile or median, where it appears to be insignificantly different from zero, fishing hours were shown to be significant across quantiles, which is consistent with the outcome of the OLS estimate. Hours spent per fishing day is considered fishing effort in this study (Clark, 2013). Fishing effort is one of the important aspects to consider for effective planning of regulatory measures and development programs in fisheries (Purcell, 2020).

However, near the higher end of the conditional distribution, the impact of fishing hours on catch is rather large. Years of education, daily fishing costs, and the use of motorized

boats were found to have a substantial impact on fishers' catch in the lowest portion of the distribution. Married fishers, trip duration, and the use of motorized boats are all significant predictors of catch toward the higher end of the conditional distribution. Married fishers had a significant effect on the 0.75 quantiles, but a much higher effect on the 0.90 quantile. The use of motorized boats was more beneficial at the top of the catch distribution than in the lower quartile. At the 0.50 quantile, both demographic and fishing characteristics were insignificantly different from zero.

Conclusions

The classic OLS regression methodology was frequently employed in previous studies on examining the determinants of fishers' catch without first examining the assumptions. The findings of quantile regression demonstrate that the catch distribution differs at different places. Some fishing and demographic factors may matter at different points in the conditional contribution of catch. There appear to be significant differences between different phases of the catch. With OLS regression, insignificant variables appear to be significant at quantile regression, with their marginal effect on catch rates rising as quantiles rise.

In developing policies for fishers, the differences must be considered. Because the number of hours spent in fishing activity appears to be significant, with a growing marginal effect at larger quantiles, the local government must protect these fishers by providing training for safety measures while fishing. The local government must promote the usage of motorized boats because they appear to have a bigger marginal effect at higher quantiles. If one is not available, the LGU must help fishers to obtain one by providing financial assistance through loans.

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S.D. Dilini Rathnachandra[1], S.H. Pushpa Malkanthi[2]
Sabaragamuwa University of Sri Lanka

Female Farmers' Agricultural Information Needs and Food Production: A Case Study of Imbulpe ds Division in Sri Lanka

Abstract. The study was conducted to find out female farmers' agricultural information needs and their impact on food production, in the Imbulpe DS Division in Sri Lanka. Of the female farmers in the area, 238 were taken as the sample for the study from seven selected Grama Niladhari (GN) divisions in the area. Female farmers were selected by using a simple random sampling method from these purposively selected GN divisions. A pre-tested, interviewer-administered questionnaire survey was used as the primary data collection method from March to July 2019. Data analysis was done by using descriptive statistics and chi-square analysis. The result revealed that the majority (62.6%) of respondents were middle aged (40-59 years), married, and belonged to families with 4-5 members. Most respondents (64.3 %) had studied up to junior secondary education level. Their average farm land size is 0.84 acres and they have farming experience of about 15 years. Most of the respondents mentioned that they had obtained higher levels of information needs about improved crop varieties. In addition, female farmers reported that they moderately need information on application of agrochemicals, improved market systems and modern farming technologies. Extension agents and other female farmers act as their major sources of agricultural information and ICT equipment acts as the least important agricultural information source in this area. Moreover, there is a significant positive association between the agricultural information needs and food production. Therefore, providing necessary agricultural information and enhanced utilization of ICT tools for agricultural information sources, and encouraging female farmers to participate in farming societies will lead to enhanced food production in this area.

Key words: agricultural information, Imbulpe, information needs, Sri Lanka, women farmers

JEL Classification: Q1, Q16

Introduction

Women constitute nearly half of the global population. They are the co-builders of civilization. Yet they are underprivileged in many countries around the world, especially in developing countries (World Bank, 2021; Rahman et al., 2007).

Nowadays, gender equity or female empowerment is considered as the key to achieving sustainable development of a particular country (United Nations-UN, 2020; UNDP, 2017; Khan et al., 2017). In many countries, female contributions are often invisible when assessing the social development of the country. That is the root cause for evaluating the contribution of women for the development of a country through their agricultural information need and food production (FAO, 2011; UN, 2010).

The performance of agricultural activities such as planting, weeding, harvesting and post-harvest activities by women have increased to the same level as farming activities of

[1] Graduate, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, P.O. Box 02, Belihuloya, Sri Lanka; e-mail: dilinirathnachandr92@gmail.com; https://orcid.org/0000-0002-6889-9193; Corresponding Author
[2] Senior Lecturer, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, P.O. Box 02, Belihuloya, Sri Lanka; e-mail: malkanthi09@gmail.com; https://orcid.org/0000-0002-2438-9976

men, due to the movement of men's labor from agriculture to the urban sector (International Labor Organization-ILO, 2018; Ibharhokanrhowa, 2016; Malkanthi, 2016). Rural women dominate in the agricultural sector in developing countries. In developed nations, farming operations are mechanized and women's involvement is considerably low (Ibharhokanrhowa, 2016).

As agriculture modernized, male activities considerably increased and overall labor requirements significantly decreased. Men highly upgraded their level of education and access to technical knowledge as well as to agricultural information (FAO, 2018). An improved information and knowledge flow in the agricultural sector are key components to improving small-scale agricultural production and linking increased production to the agricultural markets. This leads to improvements in yield, rural livelihoods, food quality, food security and national economies. However, only a certain amount of agricultural information is available to rural farmers, despite the large body of knowledge available in research institutions, universities, public offices and libraries. This situation is largely attributed to the weak linkages between research, extension, not-for-profit and non-profit organizations, libraries etc.

Most of the developing countries suffer from gender inequality, which is a key factor to be addressed under the sustainable development goals. Gender inequality increases the knowledge barrier for female farmers (Rathnachandra & Malkanthi, 2020; Mojaki & Keregero, 2019). In Sri Lanka, the share of employed women is only 18% of the total population. Among them, about 80% of the economically active women come from the rural sector. (Madurawala, 2018; Annual labor force reports, 2017). Female contribution to agriculture-related activities is gradually increasing in the national economy of Sri Lanka. The majority of rural women contribute their efforts to the agricultural sector rather than the industrial sector (Annual Labor Force Reports, 2017).

The Imbulpe DS Division is basically dominated by the agriculture sector rather than the industrial or service sector, and women conduct farming activities more or less similar to men (Census and Statistics of Agriculture base report-Rathnapura District, 2013/14). Therefore, most of the women are engaged in agricultural-related activities in this area. Imbulpe DS Division has 50 GN divisions under administrative distribution in Sabaragamuwa Province. A considerable level of agricultural knowledge and experience is available in the Sabaragamuwa university and the Agrarian Service Center of the study area. Therefore, the agricultural information gap can be overcome by establishing proper linkages between female farmers and agricultural information sources in a timely manner. In addition, agricultural information needs should be properly assessed to effectively disseminate agricultural information within the study area. Doing so would have considerable impact on the food production of female farmers. However, no proper studies have been conducted to identify the agricultural information needs and food production of rural female farmers in this area.

Agricultural information can help to empower female farmers and increase their production capacity. Thus, this study was aimed at the agricultural information needs of rural female farmers in the Imbulpe DS division, in hopes of identifying its impact on their food production. The study also aims to identify the sources of agricultural information and to assess the impact of agricultural information needs on food production in this area.

Research methodology

Imbulpe DS Division is a rural farming area situated in the Rathnapura district in Sabaragamuwa province of Sri Lanka. In this region, a considerable percentage of men have moved to urban areas searching for jobs. Therefore, most of the women are carrying out agricultural activities. The area is located close to the Sabaragamuwa University of Sri Lanka, which conducts some agricultural extension activities and awareness programs from time to time. This study is also the result of a situation analysis of the area before conducting an agricultural extension program.

Out of the fifty GN divisions of the Imbulpe DS division, seven GN divisions were purposely select for the study, namely: Halpe, Seelogama, Kinchigune, Puwakgahawela and Muttettuwegama, Imbulpe and Karagastalawa. These GN divisions represent higher numbers of women farmers who are registered under the regional Agrarian Service Center than is found in other GN divisions. 238 female farmers were randomly selected from those seven GN divisions as the sample. A pre-tested, interviewer-administered questionnaire survey was used as the primary data collection method from March to July 2019.

Data analysis was conducted using descriptive statistics and chi-square analysis. Results revealed that a list of possible areas of agricultural information needs of the female farmers had been identified through the pilot study. Then, female farmers mentioned their agricultural information needs based on a prepared list of information needs. The level of agricultural information needs were indicated by ranking them as high (3), moderate (2) and low (1). These categories were based on the studies of Ikwuakam et al (2016) and Okwu and Umoru (2019). The weighted average was calculated to identify the levels and types of agricultural information needed by female farmers in this area. In addition, the sources of agricultural information were analyzed by ranking the provided list of agricultural information sources based on the findings of the pilot study. Results of the Chi-square analysis showed the impact of agricultural information needs on food production in Imbulpe DS division. Food production increment capacity was measured by categorizing it in a yes (1) and no (0) manner, for the subject of further data analysis.

Results and discussion

Socio-economic factors of the respondents

Important socio-economic factors of female farmers are presented in Table 1. The age most women farmers (62.6%) was between 40-59 years. It is clear that most of the women farmers represent the economically active age range and there is a considerable potential to enhance their agricultural information as a way to increase their levels of agricultural production. Furthermore, 90.3% of respondents were married and most of them (64.3%) had received Junior Secondary education (GCE Ordinary level) as their level of education. Therefore, based on the findings of the FAO (2014), they have the ability to access and adopt new technologies that can improve their agricultural production, credit facilities and also reduce their agricultural information needs.

Table 1. Socio-economic factors of respondents (n = 238)

Factor	Category	Frequency	Percentage (%)
Age	20-39 Years	40	16.8
	40-59 Years	149	62.6
	> 60 Years	49	20.6
Marital status	Single	09	3.8
	Married	215	90.3
	Widowed	14	5.9
Educational level	No Primary education	08	3.4
	Primary education	68	28.6
	Junior secondary education (O/L)	153	64.3
	Senior secondary education (A/L)	09	3.8
Monthly income (LKR)	Less than 20,000	61	25.6
	20,001 – 40,000	156	65.5
	40,001 – 60,000	21	8.8
Number of family members	less than 4	79	33.2
	4 – 5	128	53.8
	more than 5	31	13.0

Source: Field survey, March to July 2019.

The majority of the respondents reported that they have 4-5 members within their families. Moreover, 0.84 acre was recorded as their average size of farm land, and the average duration of farming experience is about 15 years. While 65.5% of female farmers have received LKR 20,001 – 40,000 as the monthly income, 25.6% of them reported their monthly income as below LKR 20,000. Thus, a low level of monthly income shows the importance of agricultural information needs within the study area.

Agricultural information needs of female farmers in the area

According to the findings of Table 2, most respondents (57.7%) reported that they need information about improved crop varieties. They also need information on the application of agrochemicals (55.3%), improved market systems (47%) and irrigation systems (45.1%).

Table 2. Areas of agricultural information needs by the respondents (n = 238)

Areas of information need	Frequency	Percentage (%)
Irrigation methods	114	45.1
Suitable storage facilities	54	22.5
Application of agrochemicals	140	55.3
Improved livestock varieties	44	18.6
Modern farming technologies	80	33.6
New cropping systems	30	12.7
Improved crop varieties	146	57.7
Improved market systems	112	47.0

Source: Field survey, March to July 2019.

However, they were less interested in information about improved livestock varieties (18.6%) and suitable storage facilities (22.5%). This is because most of the female farmers were engaged in small-scale farming rather than large-scale industrial farming operations. They had a moderate level of education and literacy and poor awareness about using ICT equipment to access agricultural information.

Level of agricultural information needs of female farmers

Information about the level of agricultural information needed by female farmers in the study area are shown in Table 3.

Table 3. Level of agricultural information needed by respondents (n = 238)

Areas of information need	Yes						No	
	High		Moderate		Low			
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Irrigation methods	66	57.9	35	30.7	13	11.4	123	51.6
Suitable storage facilities	8	14.8	22	40.7	24	44.4	184	77.3
Application of agrochemicals	85	52.1	64	39.3	14	8.6	75	31.5
Improved livestock varieties	22	27.5	30	37.5	28	35	103	66.4
Modern farming technologies	78	51.7	59	39.1	14	9.3	87	36.6
New cropping systems	76	58.5	38	29.2	16	12.3	108	45.4
Improved crop varieties	91	62.3	41	28.1	14	9.6	92	38.7
Improved market systems	70	55.1	43	33.9	14	11.0	111	46.6

Categorizations based on the Ikwuakam et al., 2016

Source: Field survey March to July 2019.

As per the results of Table 3, 62.3% of the female farmers indicated a high level of need for agricultural information on improved crop varieties, and a moderate level of agricultural information needs regarding the application of agrochemicals (39.3%), improved livestock varieties (37.5%), modern farming technologies (39.1%) and improved market systems (33.9%) in the study area. Suitable storage facilities (44.4%) obtained a lower level of agricultural information needs. The rest of the responses indicated that information on irrigation methods, suitable storage facilities and improved livestock varieties was rarely of interest for the female farmers of Imbulpe DS division.

Sources of agricultural information for the respondents

The sources of agricultural information that are used by female farmers are presented in Table 4.

Table 4. Sources of agricultural information used by female farmers n = 238

Source	Frequency	Percentage (%)
Extension agent	114	47.9
ICT equipment (phones, internet etc.)	12	05.1
Contact farmers	37	15.5
Other female farmers	69	29.0
Other sources	06	2.1

Source: Field survey, March to July 2019.

Based on the findings of Table 4, most of the female farmers indicated that extension agents (47.9%) and other women farmers (29%) were their major sources of agricultural information. Agricultural information sources, contact farmers and ICT equipment were less important sources of information. Newspapers, farming societies and other family members were shown as the other sources of agricultural information. While use of ICT is low, they have higher levels of contact with the extension agents of the area. Another special feature is that a female extension agent is working in this area. And also, based on the study of Tharani et al. (2016), own farming experiences and other family members were shown as the agricultural information sources of the Vavunia district in Sri Lanka. Extension agents and ICT equipment usage was not used for gaining agricultural information in Vavunia district. Because of the impact of civil war in the north province of Sri Lanka, female farmers were less aware of the other information sources of agriculture. In addition, radio, field days, demonstrations, training programs and progressive farmers were mentioned as the conspicuous information sources of Batticaloa district in Sri Lanka (Geretharan and Sugirtharan, 2019).

Table 5. Comparison of level of education of female farmers and sources of agricultural information (n = 238)

Specification		Extension agent		ICT equipment		Contact farmers		Fellow women farmers		Other sources	
		f*	%	f	%	f	%	f	%	f	%
Educational level	No Primary education	0	0	0	0	2	0.84	6	2.5	0	0
	Primary education	0	0	0	0	24	10.1	38	15.9	6	2.5
	Junior secondary education (O/L)	107	44.9	10	4.2	11	4.6	25	10.5	0	0
	Senior secondary education (A/L)	6	2.5	2	0.84	0	0	0	0	0	0

* - f = frequency, % = percentage

Source: Field survey, March to July 2019.

As per the results of Table 5, extension agents and ICT equipment were seen as the information source of female farmers who are educated up to senior secondary education. Basically, extension agents, ICT equipment, contact farmers and other female farmers were used as the information source of women farmers educated up to jounior secondary level. When the respondents did not have an adequate level of education, ICT equipment was not used as an agricultural information source.

Table 6. Chi-square analysis of the impact of level of education of female farmers and sources of agricultural information

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	472.958[a]	20	.000
Likelihood Ratio	473.754	20	.000
N of Valid Cases	300		
a. 17 cells (56.7%) have expected count less than 5. The minimum expected count is. 16.			

Symmetric Measures[c]			
		Value	Approximate Significance
Nominal by Nominal	Phi	1.256	.000
	Cramer's V	.628	.000
	Contingency Coefficient	.782	.000
No. of Valid Cases		300	
c. Correlation statistics are available for numeric data only.			

Source: Authors' own calculations.

As per the results of Table 6, the Cramer's V value of 0.628 shows a moderate level of positive relationship among two variables with statistical significance at 5% significance level. p value is less than 0.05. Therefore, it can be concluded that a statistically significant positive association exists between the level of education of female farmers and sources of agricultural information.

Impact of agricultural information on food production

The impact of agricultural information needs on food production of female farmers was analyzed through chi-square analysis. The relevant results are shown in Tables 7 and 8.

Here, the dependent variable is food production and agricultural information needs was the independent variable. Food production increment capacity was measured in the categorical manner and agricultural information needs were measured through the ranking scale of their needs as low, moderate and high.

Table 7. Comparison between food production and agricultural information needs

Specification		Has your food production increased		
		No	Yes	Total
Agricultural information neediness	Low	15	8	23
	Moderate	19	52	71
	High	46	98	144
	Total	80	158	300

Source: Field survey, March to July 2019.

Comparison between respondents' agricultural information needs and food production is shown in Table 7. These findings revealed that most respondents had a higher level of agricultural information needs for the increment of food production. This is because they use the latest information, such as information about improved crop varieties, application of agrochemicals, new cropping systems, and irrigation systems in order to increase food production. However, they showed a lower level of interest regarding information about improved livestock varieties and suitable storage facilities. The low level of agricultural information needs and zero increment of food production that was found according to the survey statistics shows that there exists a very difficult situation. The low level of education, literacy and use of ICT equipment for agricultural activities results in a lack of proper dispersion of agricultural innovations and modern farming technologies to the rural women.

Table 8. Chi-square analysis of the impact of agricultural information needs of women farmers and food production

Specification	Chi-Square Tests		
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	301.012[a]	6	.000
Likelihood Ratio	306.515	6	.000
N of Valid Cases	300		

a. 1 cells (8.3%) have expected count less than 5. The minimum expected count is 4.75.

Specification		Symmetric Measures	
		Value	Approximate Significance
Nominal by Nominal	Phi	1.002	.000
	Cramer's V	.708	.000
N of Valid Cases		300	

Source: Authors' own calculations.

As per the results of Table 8, the Cramer's V value of 0.708 shows a strong positive relationship among two variables with statistical significance at 5% significance level. p value is less than 0.05. Therefore, a statistically significant positive association exists between agricultural information needs and the level of food production. Makawia, 2018 has reported that there is an impact of agricultural information needs on food production based on the study of sesame producers in Morogoro district in Tanzania. And also, Ikwuakam et al., 2016 findings showed that agricultural information needs has an effect on sesame production according to the study of information needs of sesame farming households in selected agricultural zones of Katsina state, Nigeria.

Conclusion

Most of the respondents noted that they need information about improved crop varieties. In addition, they reported that application of agrochemicals, improved market systems and modern farming technologies related information are more significant for them. But they showed less interest regarding information related to improved livestock varieties and suitable storage facilities. This is likely because the majority of female farmers are engaged in small-scale farming rather than industrial farming operations.

Most of the female farmers have indicated that extension agents and other women are their major sources of agricultural information. In addition, contact farmers provide a considerable level of agricultural information. ICT equipment serves as the least important agricultural information source in this area. Newspapers, husbands, farming societies and other family members were shown as the other sources of agricultural information. A moderately positive correlation was obtained between the level of education of female

farmers and sources of agricultural information. In addition, there is a statistically significant positive association between the agricultural information needs and food production in this area.

Recommendations

Based on the findings of the study, the following recommendations can be made in order to improve the situation of female farmers in the region:

- Enhancing female farmer participation in workshops and training programs related to the application of agrochemicals, improved market systems and modern farming technologies to fulfill the agricultural information needs of the women farmers.
- Persuading women farmers to gain required agricultural information through use of ICT equipment and also the contact farmers for the build-up of basic skills and abilities to increase their food production.
- Encouraging female farmers to participate in farming societies and allowing them to discuss their farming issues by sharing their farming experiences.
- Persuading female farmers to utilize novel farming practices that are not solely based on traditional farming methods.

Limitations of the research method

- The level of agricultural information needs was determined through the categories of the study of Ikwuakam et al (2016) as high, moderate and low. This measure was obtained in a categorical basis that prevents further in-depth analysis.
- The Imbulpe area consists of 50 GN divisions according to the administrative distribution. However, only seven GN divisions were selected, based on the higher representation of female farmers than in the other GN divisions of the study area.
- Food production increment was determined by a categarical manner. Therefore, this provides only a rough idea about the agricultural information needs and food production in Imbulpe DS division.

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Samuel Kaase Upev[1], Justice Inyanda Onu[2], Shuaibu Iliya Mshelia[3], Amurtiya Michael[4]
Moddibo Adama University of Technology, Yola, Nigeria

Poverty and its Alleviating Strategies among Rural Farming Households in Benue State, Nigeria

Abstract. The study analysed rural farming households' poverty status and alleviating strategies in Benue State, Nigeria. The specific objectives of the study were to: describes the rural household heads' socio-economic characteristics; determine the poverty status of the respondents and its determinants; and identify poverty alleviating strategies of the respondents. Data for the study was collected from 420 respondents selected using a multi-stage sampling technique. Data collected were analysed using descriptive statistics, the Foster-Greer-Thorbecke poverty measurement index, and the Binary Logistic regression model. The findings of the study revealed a very high incidence of poverty (70%), having a gap of 0.34, and severity of 0.17. Poverty in the area is positively associated with the age of the household head and household size, while gender, educational level, off-farm activity, membership of a group, farm size, and land ownership are negatively associated with poverty. The common poverty alleviation strategies identified were agricultural wage labour (48.6%), rental services (45.0%), and transportation business (36.7%). Therefore, it was recommended that the government and other stakeholders should initiate sustainable social protection schemes that can assist rural residents in alleviating poverty until their condition improves.

Key words: poverty, alleviating strategies, rural, farming household, Nigeria

JEL Classification: R2

Introduction

In recent years, poverty and Nigeria have become synonymous owing to the nation's status of having the world's highest number of people living in extreme poverty (World Poverty Clock, 2020). Extreme poverty implies a situation whereby a person expends below $1.90 USD a day in meeting basic needs. Currently, the nation has about 86.9 million people living in that condition. This unfortunate situation which has perpetuated as the world's leading development challenge has received tremendous global attention, making it topmost on the sustainable development goals (SDGs) scale of preference (World Bank, 2015; 2017). In other parts of the globe, substantial progress was made due to the quality of efforts from affected nations and other development partners (Beegle, 2016). However, in Nigeria, poverty across all indices of measurement has increased with both increases in population and the nation's economic status

[1] MSc; Department of Agricultural Economics and Extension, Moddibo Adama University, Yola, Nigeria; e-mail: samupev1973@gmail.com
[2] Professor; Department of Agricultural Economics and Extension, Moddibo Adama University, Yola, Nigeria; e-mail: justiceonu@gmail.com
[3] Professor; Department of Agricultural Economics and Extension, Moddibo Adama University, Yola, Nigeria; e-mail: simshelia@mautech.edu.ng
[4] PhD; Department of Agricultural Economics and Extension, Moddibo Adama University, Yola, Nigeria; e-mail: michaelamurtiya@yahoo.com; https://orcid.org/0000-0001-5273-9999

(Ucha, 2010; British Council Nigeria, 2012; Abur et al., 2013; Action Aid Nigeria, 2015; Taiwo & Agwu 2016; Wossen et al., 2019; Adepoju, 2019; Oladeebo et al., 2017).

As a consequence of the manifestation of this dehumanising condition, a large proportion of nations have been living in some extremely traumatizing situations that range from food insecurity, unemployment, poor health status resulting in low life expectancy and high infant mortality, poor quality of education, and conflicts/social vices among others (Ayegba, 2015; Amnesty International, 2018; Owakoyi, 2019). Since the Nigeria's inception, various governments have demonstrated commitment towards poverty eradication (Anyebe, 2014; Williams, 2016). Hence, outcomes of the various regions of the country could be attributed to the discrepancies in the distribution of poor people in the country. Nigeria is made up of six geopolitical regions, with both the North and the South having three regions each. However, in terms of the distribution of poor people, the situation is much more severe in the Northern regions compared to the Southern regions (National Bureau of Statistics, NBS, 2020). Similarly, even across the three northern regions, poverty is least in Northcentral compared to the Northeast and Northwest.

Benue State is one of the most notable states in the Northcentral region of the country owing to its strategic position of being one of the links between the Northern and Southern regions, population size, and abundance of agricultural and mineral resources (Samuels et al., 2011). The State has an estimated population of about 5,741,800 people, (NBS, 2019), and has favourable climatic conditions, and fertile soil which is conducive for the production of a variety of crops and livestock. Common crops grown in the area include tubers like yam and cassava, cereals like maize, rice, and sorghum, and also legumes like groundnut, soya bean, and Beni-seed. Similarly, tree crops like orange, banana, pineapple, cashew, etc. are also produced in large quantities. The state is located deep in the guinea savannah region, hence, it is rich in livestock like cattle, sheep, goats, and pigs which add to the rich fishery resources in the State (Benue State Agricultural and Rural Development Authority, BNARDA, 2012). Despite its agricultural potentials, poverty has remained pervasive in the state. The poverty headcount rate is 32.9% while the poverty gap is index 8.4% – all more than the national averages (NBS, 2020). Similarly, in tandem with the submission of the Oxford Poverty and Human Development Initiative, OPHI, (2017), the State has about 59.2% of its population experiencing various dimensions of poverty with an additional 18.2% living near (vulnerable) multidimensional poverty. In the same vein, poverty perception among the populace has remained high with about 54.6% of the populace considering themselves to be poor (Samuels et al., 2011). In the last decade, the State has made headlines across various news media as a result of the farmer/herder conflict that has complicated the poor status of most of its rural residents (Ikwuba, 2011; Saakuma, 2017; Amnesty International, 2018; NBS, 2019; Ogah et al., 2019). This is in addition to other climatic and economic risk factors like poor soil quality, the incidence of pests and diseases, climate change, and inflation among others (Anyebe, 2014; Williams, 2016).

Poverty studies in the region over the years have concentrated on its determinants (Etim and Udoh, 2013; Abu and Soom, 2016; Omotesho et al., 2016; Adepoju, 2019; Nwibo et al., 2019). However, the assessment of poverty-alleviating strategies has not been prominent in these studies. These strategies are deliberate measures taken to overcome or cushion the effects of poverty on the individual or household (Maniriho and Nilsson, 2018). In light of this, therefore, this study assessed poverty and its alleviating strategies among rural farming households in Benue State, Nigeria. This study sought to specifically: describe the respondents' socioeconomic characteristics; ascertain the prevalence of poverty and its determinants in the study area; and also, identify the respondents' poverty alleviation strategies.

Methodology

Benue State is composed of 23 Local Government Areas, covering a landmass of 34,059 square kilometres and delineated into three agricultural zones (BNARDA, 2004). A total of 420 rural household heads from 20 communities spread across 10 Local Government Areas were selected using a simple random sampling technique. The respondents were selected from the list of registered rural farm families (413, 159) obtained from families from the Benue State Agricultural and Rural Development Authority. A semi-structured questionnaire was administered to the selected respondents who are household heads. The study was conducted over a span of three months (September--December, 2019). In the collection of the data, five research assistants were employed to handle four communities each. The assistants were selected due to their familiarity with the terrains of the study area, and experience in data collection using the local language of the people.

The respondents' socioeconomic characteristics and poverty alleviating strategies were assessed using descriptive statistics. The Foster-Greer-Thorbecke (FGT) model was used in analysing the respondents' poverty status. The poverty indices measured were the incidence, depth, and severity. The FGT measure for the i^{th} subgroup ($P_{\alpha i}$) is given below;

$$P_{\alpha i} = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-y}{z}\right) \quad \propto \tag{1}$$

Where:
$P_{\alpha i}$ = Measure of poverty;
Z = Poverty line;
y = per capital expenditure (PCE) of the i^{th} household;
q = the number of poor households below the poverty line;
n = the total number of sampled rural farming households;
α = the poverty aversion parameter that takes a value of 0, 1, 2 for incidence, depth, and severity respectively.

The study used the total per capita expenditure as a measure of the standard of living of the rural farming households. The poverty line was $1.90 USD which was equivalent to N = 665 based on the prevailing official exchange rate by the Central Bank of Nigeria. Households' total expenditure is the sum of cash expenditure on the consumption of goods and services.

Also, factors influencing the respondents' poverty status were identified using the Binary Logit regression model. The Binary logit regression model is specified explicitly as:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 \ldots\ldots\ldots\ldots + \beta_{12}X_{12} + U \tag{2}$$

Where:
Y = Poverty status (1 = non-poor, 0 = poor);
β_0 = Constant;
X_1 = Age (years);
X_2 = Gender (male = 1: female = 0);
X_3 = Marital status (married = 1, otherwise = 0).
X_4 = Household size (Number of people);
X_5 = Educational Level (Number of years spent in school);

X_6 = Off-Farm Activity (Yes = 1, No = 0);
X_7 = Membership of self-help group (Yes = 1: No = 0);
X_8 = Assistance from any poverty alleviation programme (Yes = 1: No = 0);
X_9 = Receive Remittance from relatives (Estimated monetary value in ₦);
X_{10} = Farm size (ha);
X_{11} = Access to Formal Credit (1 = can access, 0 = otherwise);
X_{12} = Land ownership (Yes = 1, No = 0);
U = Error term.

Results and Discussion

Socio-Economic Characteristics of the Respondents

People's social and economic characteristics have a great influence on their poverty status (Danaan, 2018). In this study, the respondents' socioeconomic characteristics are presented in Table 1. Findings of the study revealed that the mean age of the household heads was 43.6 years and they are mostly (78.8%) males, married (82.9%), and having an average household size of eight people. This finding suggests that the bulk of the respondents were not advanced in age and could be able to adopt strategies that can enable them to alleviate poverty. Similarly, having persons of the male gender being dominant in the distribution of the household heads could not be unconnected to the largely patriarchal setting of most African rural areas giving most authority, control, and ultimate decision-making across social institutions to men (Bammeke, 2007; Akanle and Ejiade, 2012). In terms of educational attainment, the majority (89.8%) at some point attended formal schools. Literacy level plays a significant role in determining poverty status or means of combating it (Owuor et al., 2007).

Similarly, farming is another significant determinant of rural poverty in Nigeria (Shehu et al., 2010). In this study, the average farm size was 2.7 hectares, implying that the majority of the respondents are small-scale farmers who may not be able to depend solely on farming for sustenance (Arene et al., 2010; Akinsuyi, 2011). This is because the rapid increase in population in the area substantially promotes the fragmentation of landholdings leading to a decrease in farm size and subsequently income from farming activities. Also, this study indicated that the majority (88.6%) of the respondents belong to one form of a self-help group or another. This high participation in self-help activities is common among rural farmers because of the absence or difficulty of assessing available government and other financial institutions' loanable funds (Ezekiel, 2014).

Table 1. Socio-Economic Characteristics of the Respondents (N = 420)

Variable	Frequency	Percentage
Age (Years)		
<30	34	8.1
30-39	97	23.1
40-49	129	30.7
50-59	114	27.1
60 and above	46	8.1
Mean	46.3	
Sex		
Female	85	20.2
Male	335	79.8
Marital Status		
Married	348	82.9
Single	42	10.0
Divorced	19	4.5
Widowed	11	2.6
Household Size (People)		
1-5	100	35.5
6-10	149	70.0
11-15	86	20.5
>15	77	18.3
Mean	8	
Education Status		
Non-Formal Education	43	10.2
Primary	74	17.6
Secondary	180	42.9
Tertiary	123	29.3
Farm Size (Ha)		
<1	98	23.3
1-2	110	26.2
3-4	116	27.6
5-6	70	16.7
>6	26	6.2
Mean	2.39	
Membership of Self-help Group		
Non-Member	48	11.4
Member	372	88.6

Source: Field Survey, 2019.

Poverty Status of the Respondents

The distribution of the respondents' poverty status is presented in Table 2, and the result indicated a very high poverty incidence among the majority (70%) of the respondents. This implies that poverty in the area at the time of the study far outweighed the national average. It also implies that poverty is increasing at a faster pace in the area. This finding lends credence to the submission of OPHI (2017) and NBS (2020) who reported a high incidence of poverty in the area. The result also presented the respondents' poverty gap index (P1) which provides information on the difference between the poor's income or expenditure and the score was 0.34. This indicates that an average poor farming household head would require 34% of the poverty line to get out of poverty. Similarly, the poverty gap among the poor was 0.15 indicating that the poverty severity of the rural farming households was 15%. This result means that rural farming households need about 15% increases in per capita expenditure to push them away from severe poverty. This finding agrees with that of Anyanwu (2013) which stated that poverty in Nigeria is largely a rural phenomenon.

Table 2. Respondents' Poverty Status

Indices	Measure
Poverty Incidence (P_o)	0.70
Poverty Gap (P_1)	0.34
Poverty Severity (P_2)	0.17
Poverty Line	1.90 USD

Source: Field Survey, 2019.

Determinants of Poverty among the Rural Farming Households

The result of the binary logistic regression identifying the factors influencing poverty in the area is presented in Table 3. The model has a pseudo R2 of 0.545 which implies that 54.5% of the variation in the poverty status of the respondents could be explained by the independent variables used. The LR statistics was 277.5963 and is statistically significant at a 1% probability level, and this indicated model fitness. The result indicated that only eight predictors were statistically significant at different levels of significance. Consistent with a priori expectation and findings from previous studies, age (X1) and household size (X4) had a significantly negative relationship with the probability of being non-poor at 1% and 5% levels respectively. This indicates that the likelihood of experiencing poverty in different dimensions increases with advancement in age and vice versa. This is expected as the younger farmers tend to be more productive and can move away from poverty, implying that their likelihood of being poor also decreases. This finding agrees with the Life-cycle Hypothesis theory that poverty is relatively high at young ages, decreases during middle age, and then increases again at old age (Rodriguez, 2002; Gang et al., 2004). In the context of household size, several studies (Gang et al., 2002; Bokosi, 2006; Anyanwu and Erhijakpor, 2010) lay credence to the findings of this study that a larger household size increases the likelihood of poverty due to the high chances of having more dependents who can drain

resources in meeting their basic needs of food, clothing, school fees, medical bills, etc. Large household size is common among rural farmers in the study area because of the absence of well-developed social security systems and low savings. Fertility rates particularly among the poor are high in order for the parents to have some economic support from the children when they reach old age. Across most rural contexts in Nigeria, poverty status is being influenced by gender as in other climes (Bastos et al., 2009). Based on the result presented, gender (X2) has a significant (at 5%) influence on the status of poverty of the respondents. This finding implies that households headed by females tend to be more likely to be in poverty compared to the households headed by males.

Table 3. Determinants of Poverty among Rural Households

Variable	Coefficient	Std. Error	Z-statistic
Age (X_1)	-0.108555	0.022468	-4.827610***
Gender (X_2)	1.660414	0.791889	2.096776**
Marital Status (X_3)	-0.656489	1.109656	-0.591615
Household Size (X_4)	-0.225853	0.092540	-2.440605**
Educational Level (X_5)	0.146993	0.039296	3.740666***
Off-farm Activity (X_6)	0.249593	0.143033	1.745010*
Membership of Group (X_7)	0.486366	0.131819	3.689634***
Access to Social Protection (X_8)	1.02E-07	2.45E-06	0.041620*
Received Remittance (X_9)	2.93E-06	1.93E-06	1.518180
Farm Size (X_{10})	2.043940	0.371258	5.505445***
Access to Credit (X_{11})	-0.000577	0.425491	-0.001356
Land Ownership (X_{12})	1.131277	0.414148	2.731575**
Constant	-0.482072	1.778125	-0.271113

***, **, * Significant at 1, 5 and 10%, respectively

Source: Field Survey, 2019.

Years of formal education (X5) were also positively signed and significant at 1%. This suggests that an increase in the level of education may reduce the chances of being poor and vice versa. This is because education increases the stock of human capital, which in turn increases labour productivity and wages. The study also revealed that undertaking off-farm activities (X6) showed a positive and statistically significant (at 10%) relationship with the likelihood of being non-poor in the study area. The result presents a direct positive relationship between the number of off-farm activities and the possibility of being non-poor. Off-farm activities help the rural poor to complement yield and income from agriculture to meet the social welfare needs of their families. This finding lends credence to the submission of Obinna and Onu (2017) who reported that rural residents engage in off-farm activities to supplement income to reduce the risk associated with income generated solely from

agricultural activities. The finding of the study also revealed that the coefficient of the self-help group (X7) was positive and significant at a 1% probability level. This suggests that respondents who belong to such groups may be less likely to be poor compared to non-members. This is because such groups utilize members with increased social capital who can then be relied upon to access productive resources. As opined by Apata et al. (2009) and Alimi (2012), farming is a significant determinant of poverty in rural areas in Nigeria. Similarly, the study also established that farm size (X10) showed a positive and statistically significant (at 1%) relationship with being non-poor in the study area. This means that the larger the farm size the lower would be the likelihood of being poor ceteris paribus. This finding collaborates with that of Etim and Udoh (2013) who concluded that an increase in cultivable farmland with a subsequent increase in output will decrease poverty. Also, this study established that land ownership (X12) has a positive and statistically significant (1%) relationship with the possibility of being non-poor in the study area. This is as expected since owning will reduce the production cost of the farmer and increase the profit margin.

Poverty Alleviation Strategies Adopted by the Rural Farmers

Poverty alleviating strategies are the deliberate actions adopted by households to help them reduce the negative effect of poverty (Maniriho and Nilsson, 2018). The distribution of the respondents' poverty alleviation strategies is presented in Table 4. The finding of the study indicated that the provision of agricultural wage labour is the most (48.6%) common strategy in the study area. Similarly, households in the area provide rental services (45%) for canopies, chairs, generating sets, and farming/building tools. Engaging in the transportation business (using motorcycle/okada, tricycle/Keke NAPEP, bus service) was also common with a participation rate of 36.7%. Across various parts of Nigeria, engaging actively in politics is a means of gaining a livelihood, and in this study also, 31.7% of the respondents consider it to be their poverty alleviation strategy. Other strategies identified include; sale of part of farm produce before harvesting time (29.5%), collecting farm inputs from middlemen/farmers on credit to pay during harvesting season (19.8%), and the sales of part of landed property (10.5%). This finding implies that the majority of the respondents adopt a range of strategies within their capacity, relying heavily on their social capital to access resources. As revealed by Alkire et al. (2014), instead of emphasizing specialisation within these existing portfolios, upgrading them to increase income could be a more realistic approach that will be more appropriate for poverty reduction.

Table 4. Respondents' Various Poverty Alleviation Strategies

Strategies	Frequency	Percentage	Ranking
Agriculture wage labour	204	48.6	1st
Sales of part of farm produce before harvesting	124	29.5	5th
Sales of part of landed property	44	10.5	7th
Transportation business	154	36.7	3rd
Rental services	189	45.0	2nd
Active participation in politics	133	31.7	4th
Collecting farm inputs from middlemen on credit to pay during harvesting season	83	19.8	6th
Seasonal Migration	3	0.7	8th

*Multiple Responses.

Source: Field Survey, 2019.

Conclusions and Recommendations

Poverty of all forms is pervasive in Benue state, especially among rural farmers who constitute the bulk of the state's populace. The findings from the study revealed that the rural parts of the State have a poverty incidence of about 70%. This outcome has a dire socio-economic consequence on the sustainable and inclusive growth of the state. The study established that household head's age, gender, household size, years of formal education, households' off-farm activities, membership of self-help groups, household farm size, and land ownership are the factors influencing poverty in the area. In order to reduce the negative impact of poverty in the area, various poverty alleviation strategies were adopted by the respondents. These strategies were community-based, relying mostly on the social capital of the person concerned. But, considering the socio-economic status of the respondents, their social capital base may not be effective enough to facilitate the adoption of a poverty reduction strategy that can safeguard their economic future sustainably. Based on the findings of the study, the following are recommended:

i. The government and other stakeholders should initiate sustainable social protection schemes that can assist rural residents in alleviating poverty until their condition improves. The need for social production is to facilitate empowerment so the beneficiaries can seize opportunities both on-farm and off-farm and be productive. This will promote inclusion and reduce inequality for long-term sustainable growth of individuals and households.
ii. The government should make farm inputs available to the farmers at affordable prices since this will enhance production, which can in turn increase income from the farming activities on which their livelihood is heavily reliant. Agriculture is the main livelihood of the people, and it can positively influence their poverty status if it is productively carried out. Currently, the inflation rate is very high and most farmers

cannot afford to procure the needed farm inputs at the prevailing price due to poverty. Hence, the government should ensure that subsidised farm inputs are purchased by small-scale farmers only. This can enable farmers to become more productive and increase farm size.

iii. Self-Help Groups in the area should be supported with capacity-building and access to capital for them to be viable and support their members. The role of self-help groups among farmers, especially those in rural areas cannot be overemphasised. Generally, lack of capital is the major limitation to agricultural productivity in Nigeria. However, farmers are prominent among the financially excluded segment of the nation's population. Therefore, membership of an active self-help group can empower farmers by facilitating access to capital from individuals and financial institutions or organisations. The groups also facilitate farmers' access to education, health, and sanitation, among others. This will substantially ease poverty reduction in the area.

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Katedra Ekonomii Międzynarodowej i Agrobiznesu
ul. Nowoursynowska 166, 02-787 Warszawa
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e-mail: problemy_rs@sggw.edu.pl

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Warsaw University of Life Sciences – SGGW
Institute of Economics and Finance
Department of International Economics and Agribusiness
166 Nowoursynowska St.
02-787 Warsaw, Poland
Phone: +48 22 5934103, +48 22 5934102, fax.: +48 22 5934101
e-mail: problemy_rs@sggw.edu.pl

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