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# Poverty Status of Climate Smart Agricultural Farmers in North West Nigeria.-Application of Foster Greer and Thorbecke Model

**Ekpa D.[1,*], Oladele O. I.[2], Akinyemi M.[1]**

[1]Department of Agricultural Economics and Extension, Federal University Dutsin-Ma, Katsina State, Nigeria
[2]Department of Agricultural Economics and Extension, North-West University Mafikeng, South Africa
*Corresponding author: ekpadaniel3322@gmail.com, dekpa@fudutsinma.edu.ng

**Abstract** This research established a link that exists between climate smart agricultural practices and poverty in North-West geopolitical zone of Nigeria. The study was motivated by the increasing consequence of climate change and its impact on poverty status among farmers in the study area. Farming households changing agricultural practices as a result of global observation of climatic and environmental changes. It was based on this that the study examines the impact of climate smart agricultural practices on poverty status among farmers in North West Nigeria. A multi-stage sampling techniques was used to select two hundred and ninety four (294) farming households in the study area who provide the relevant primary data information for the study through a set of pre-tested structured questionnaires. The objective was to decompose poverty status for high-users and low-users of climate smart agricultural techniques in the study area. Foster Greer and Thorberk model, Watt's index, Sen, Shorrocks and Thon index were used to ascertain the objective. Poverty head count according to the FGT index for the total population is 35.89% for absolute poverty and 9.12% for relative poverty. This means that the average climate smart agriculture farmers had about 36% deprivation of basic human needs such as food, safe drinking water, health, shelter, education and information. On the other hand, for the absolute poverty of 9%. It means the average climate smart agricultural farmers had 9% deprivation to maintain the average standard of living. It connotes that the average climate smart agricultural farmers had 33% deprivation of food and 13% deprivation of average standard of living. Analysis of health poverty reveals that the absolute poverty is 42.38% and relative poverty 27.64%. It implies that the average climate smart agricultural farmers were deprived of health by 42% and by average standard of living by 28%. Further, analysis on education poverty reveals the absolute poverty and relative poverty value of 47.10% and 28.26%. This signifies that about 47% of the climate smart agricultural farmers were deprived of basic education and about 28% of climate smart agriculture farmers were deprived of average standard of living. The study concludes that poverty is evident in the study area. It therefore reccommends that Government, Non-Governmental Organizations and farmer associations should create a conducive knowledge exchang enviroment to encourage the low-users of climate smart agriculture to improve on their performance. Spouses especially should develop interest in climate smart agricultural farming. women empowerment programme can be embarked upoun by government and private individual. Policy on formal education should be enriched and developed in the curriculm to meet the climate smart agricultural challenges.

***Keywords:*** *climate-smart-agriculture, poverty, North-West, Nigeria*

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## 1. Introduction

Climate change equally leaves many more people vulnerable to poverty. [21], estimated that above half of the world's population as well as most of the productive lands and urban areas are situated in coastal and delta regions where the climate related disasters are prominent. These areas are predominantly found where the highest number of the deprived households live, especially in Sub-Saharan Africa. Therefore consequences of climate change such as submerging, droughts, landslides amongst others, will not only reduce farm yields for many, but will also leave them vulnerable to poverty in the short, medium or long term. It is therefore imperative to design policies as well as enforce practices that adapt to the current observed changing climate. This has led to a growing concern about the likely consequences of climate change on poverty, economic growth, ecosystem services, livelihood prospects, as well as overall human development [32], anticipated that the poorest populations in developing countries are expected to bear the brunt of the impacts of climate change, with costs on individuals (e.g. livelihood, agriculture or water) estimated to exceed billions of dollars in some countries. Direct and indirect effects of climate change on poverty are enormous. According to [4], climate change affects poverty in two ways which are: - changes in incomes and changes in the actual cost of living at the poverty line. Agriculture must therefore incorporate climate change effects to ensure sustainability. The use of high resilient varieties is another exercise that could advance or increase income hence poverty is been reduce by households, increasing their efficiency, [21]. Climate-Smart Agriculture (CSA) is defined as agriculture that sustainably increases production and income, resilience as a result, eliminates greenhouse gases emission (mitigation), which heightens the accomplishment of national food security, developmental objectives and reduced poverty [15]. Agriculture is considered to be climate smart when it achieves three main goals: (i) The sustainable increase in agricultural production and income, (ii) The acclimatizing and building resilience to climate alteration and (iii) The reduction or eliminating greenhouse gas (GHG) emission, [13], Climate smart farming promotes the transformation of agricultural systems and agricultural policies to increase food production to enhance food security, and ensure that food is affordable (low input-cost) hence reducing poverty while preserving the environment and ensuring resilience to a changing climate [22]. Existing confirmations shows that Nigeria is already overwhelmed with various ecological problems which have been directly connected to the on-going climate change [2]. The Southern ecological zone of Nigeria mostly known for high rainwater is currently confronted by abnormality in the rainfall pattern, also Guinea Savannah under going slowly increasing temperature, while the Northern zone faces the menace of desert encroachment at a very wanton rate per year induced by fast reduction in the volume of surface water, vegetation (flora) and wildlife (fauna) resources [14].

The North West zone remains an agricultural hub for Nigeria with a huge proportion of its population in the agricultural sector [29]. Nevertheless, it is the poorest zone in Nigeria. [23] There is also prevalent of high-income inequality which is increasing income inequality [3]. Farming in northern Nigeria is mainly rural, with about 80 percent of the farmers involved in rain-fed agriculture and subsistence in nature. Farming is the major sources of income for many household in North-West Nigeria [25]. Climate plays a significant role in ensuring sustainable agricultural production in many parts of Northern Nigeria. In addition low level of improved agricultural technology compels wide use of traditional farming system. The latest discrepancies in the climate and weather of the region have taken severe toll on crop production with some crop yields now declining [30]. The climate smart agricultural practices introduced were; usage of organic manure, agro-forestry, conservation agriculture, the usage of improved varieties and breeds, integrated crop/livestock management as well as irrigation for small-holder farmers. This was in response to the consequences of the poor production associated with low agricultural output and high incidence of poverty among farmers in North-West Nigeria.

Presently, drought has affected several parts of Northern Nigeria with agricultural yields varying extensively from year to year and from one locality to another (1). The restraints posed by climate change on agriculture in this region range from prominent seasonality of precipitation which may be shorter periods of rainfall or irregular rains, (which limits crop production to short periods of three to five months) to severe and repeated droughts (which dislocate the usual pattern of seasonal water availability). Furthermost, of the droughts likewise unveil such characteristics as fictional onset of the rains, late onset of the rains, prominent breaks through the rainy season, and early termination of the rains; leading to severe alterations in the pattern of seasonal rainfall dissemination [5]. High rate of poverty makes majority of the population susceptible to climate change and compromises their adaptation capacity [12], revealed that seventy percent (70%) of Africa's deprived households (poor) live in rural areas and depend on agriculture. [6], have revealed hat the majority of the rural dwellers are engaged in farming activities. The implication of this is that, a greater percentage of the rural poor are farmers. Hence, most of the poverty deliberations and considerations in Nigeria are linked with agriculture [17]. This is due to the fact that agriculture, is still the mainstay of the Nigerian economy. It has continued to employ 72% of the people [27], despite its decreased role in providing foreign exchange income to the government. But these farmers, due to their low productivity coupled with inadequate access to capital, transportation, storage and processing facilities are usually exposed to negative impact of climate change and poverty. Numerous studies have been done on the subject at National, Regional and State levels such as [28], but analysing the impact of climate smart agriculture practices and poverty status among small holder farming households in North West Nigeria is not yet investigated. [11] assessed the effect of climate change and adaptation on agriculture by rural farmers in North-Western Nigeria. This study is looking at climate smart agricultural practices and poverty status among small holder farming households in North-West Nigeria.The objective of this work is to decompose poverty status for high-users and low-users of climate smart agricultural techniques in the study area.

## 2. Materials and Method

The study area is North-Western (NW) geopolitical zone of Nigeria. This comprises of seven States namely: Katsina, Kano, Kaduna, Kebbi, Jigawa, Sokoto and Zamfara States. The region is located between latitude $9^0 10^1$N and $13^0 50^1$N and longitude $3^0 35^1$E and $9^0 00^1$E and covers about 168,719 $km^2$ of the country's total land mass. The zone is blessed with population of 35,786,944 million [24]. North-West zone is categorized by abundant diminutive grasses of about 1.5 – 2m and few stunted trees hardly above 15m. It is by far the most densely human inhabited zone of Northern Nigeria. The agricultural sector forms the basis of the overall development thrust of the zone. The flora of Northern Nigeria is principally marginal or short grass savannah. This region is described by a relatively hot climate with seasonal rainfall and a marked dry season [10]. The soils in the northern region of Nigeria are characterized as reddish brown or brown soils of the semi-arid and arid areas and are known as tropical ferruginous soils which are made up of about 85%

sand with PH values that varied between 6.0 and 7.0 [18]. It is therefore evident that changing climates (increasing droughts or floods) will influence agricultural productivity and imperative to examine the impact of climate smart agriculture practices on poverty status among farmers in North-West Nigeria. The main source of livelihood of the people in this zone was agriculture. Although variation occurs among the States**,** off-farm activities include trading, tailoring, bricklaying and carpeting among others. Farming practices used in the States include shifting cultivation, mixed farming, mixed cropping and pastoral farming. The climate makes the farmers to cultivate a very widespread of crops such as cereal, legumes and vegetables. Livestock such as cattle, goats, sheep, and poultry farm like chicken, turkey, pigeon and ostriches etc are produced and the livestock are reared extensively.

## 2.1. Data and Sampling Procedure

A multi-stage sampling procedure was employed for the collection of data from the rural farming households. The first stage involved a purposive selection of Katsina and Sokoto States due to high prevalence rate of poverty [23]. The second stages involved a random selection of three Local Government Areas from each of the three agricultural zones in Katsina State. And random selection of three Local Government Areas from three out of the four agricultural zones in Sokoto State, making a total of six Local Government Areas in all. The third stages involved random selection of ten communities from each Local Government Areas to bring the total to sixty Communities. Lastly, five farming households were randomly selected from each of the communities to give a total of three hundred respondents.

## 2.2. Analytical Method

The analysis was carried out using FGT Index model, watts index, Sen, Shorrocks and Thon index, [9]. Alkire and Foster decomposition methods for monetary and non-monetary dimensions of poverty was used. These models have varying computations and were therefore used to see if the results will be consistent across all the methods. The most popular of them is however the Foster, Greer and Thorbecke model which is widely known as the FGT poverty measurement technique that examines the proportion of poor people amongst farmers who are high-users of climate smart agriculture and those who are low-users of climate smart agriculture as well as the poverty gap and the severity of poverty.

The study employs four indices as monetary dimensions; food expenditure dimension, health expenditure dimension, education expenditure dimension and percapita expenditure (total household expenditure divided by household size). The study again employed PCA to generate a composite variable for the asset dimension which stands as the only non-monetary dimension employed by in the study. The FGT Index model, Equally Distributed Equivalent (EDE) FGT, watts index, Sen, Shorrocks and Thon index are employed to decompose the monetary dimensions of poverty while Chakravarty technique, extended watts, extended FGT and Alkire and Foster were employed to decompose the non-monetary dimension. FGT and EDE-FGT will not only decompose absolute poverty but also relative poverty at the mean for the monetary dimensions while Alkire and Foster will do same for the non-monetary dimension –asset.

Poverty decompositions methods necessitate the use of poverty lines. A poverty line has been defined as the least or the cut-off standard beneath which an individual or family is labelled as poor [6]. According to [8], there is no certified poverty line in Nigeria and as such numerous earlier studies have used poverty lines which are proportions of the average per capita expenditure, in this study per capita expenditure which is deliberated more suitable in past studies because of its consistent (reliable) and does not change over a period of time when compared to income was embraced. Therefore, the poverty line was well-defined as the two-thirds (2/3) of the mean value for each of the dimensions. This is in line with [33] who characterized farm households into poor and non-poor groups using the two-third mean per capita expenditure as the bench mark. This arbitrary poverty line is not too bias considering that the focus of this study is in comparing the poverty rates between high-user and low-users of CSA. For each dimension, they are grouped into two categories poor and non-poor on the bases of the poverty line. These decomposition methods are discussed below:

The most popular decomposition method - Foster, Greer and Thorbecke (FGT) poverty index was used to determine poverty levels among the respondents. The FGT index is given as

$$FGT_{\alpha} = \frac{1}{N}\sum_{i=1}^{H}\left(\frac{z-y_i}{z}\right)^{\alpha} \quad (1)$$

Where:

N = Total number of respondents i.e household sampled

H = Number of respondents below the poverty line i.e poor people

z = The poverty line or threshold

$y_i$ = Per Capita Household Expenditure of the $i^{th}$ respondent

α = Non-negative poverty aversion parameter (0, 1 or 2).

That is $y_i = (y_1, y_2, \ldots, y_n)$ which represents the income vector of the farmers both high-users and low-users of climate smart agriculture with incomes sorted in collective order of magnitude. Z is the poverty line which can be used to decide the level of poverty status of the high-users and low-users of climate smart agriculture, q is the number of poor individuals, N is the total number of individuals in the population under study, α is a weighting parameter that can be regarded as a measure of poverty aversion and is the most important because it is the index that makes this formula vary in measuring headcount, poverty gap and the severity of poverty. The FGT index takes on the values 0, 1 and 2 for headcount, poverty gap and severity respectively. The head count index is advantageous in that it is simple to construct and easy to understand.

Meanwhile EDE FGT is estimated as:

$$\text{EDE P} = \left[\frac{1}{N}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right)^{\alpha}\right]^{\frac{1}{\alpha}} \equiv \left(\text{P}^{\frac{1}{\alpha}}\right); \text{for } \alpha > 0. \quad (2)$$

EDE FGT is the Equally Distributed Equivalent form of FGT. EDE FGT applies only when α =1 and α = 2. This means that is does not measure head count as is the case with the FGT index.

The Watts index is the first distribution-sensitive poverty measure was proposed in 1968 by World Bank Institute. Watts' discrete version takes the form

$$W = \frac{1}{N}\sum_{i=1}^{q}\left[\ln(z) - \ln(y_i)\right] \quad (3)$$

where the N individuals in the population are indexed in ascending order of income (or expenditure), and the sum is taken over by the q individuals whose income (or expenditure) $y_i$ falls below the poverty line z.

While the Sen Index has been modified by others, and perhaps the most compelling version is the Sen Shorrocks-Thon (SST) index, defined as

$$P_{SST} = P_0 P_1^{P}(1+\hat{G}^{P}) \quad (4)$$

which is the product of the headcount index, the poverty gap index (applied to the poor only), and a term with the Gini coefficient of the poverty gap ratios (i.e. of the Gn's) for the whole population. This Gini coefficient typically is close to 1, indicating great inequality in the incidence of poverty gaps.

The non-monetary dimension of poverty was decomposed using multidimensional methods which include; Chakravarty et al index, extended watts, extended FGT and Alkire and Foster. The general form of an additive multidimensional poverty index is:

$$P(X,Z) = \frac{\sum_{i=1}^{n} w_i\, p(X_i, Z)}{\sum_{i=1}^{n} w_i} \quad (5)$$

Where P ($X_i$, Z) is individual i's poverty function {with vector of attributes Xi,=($x_{i,1}$,….,$x_{i,j}$) of poverty lines Z= ($z_1$,….,$z_j$)} determining i's contribution to total poverty P (X, Z). Therefore, the following computations represent the decomposition measures:

Chakravarty et al index;

$$P(X_i, Z) = \sum_{j=1}^{J}\left(\frac{z_j - x_{i,j}}{z_j}\right)_+^{\alpha}. \quad (6)$$

Extended Watts Index;

$$P(X_i, Z) = \sum_{j=1}^{J}\alpha_j \ln\left(\frac{z_j}{\min(z_j; x_{i,j})}\right). \quad (7)$$

Multiplicative and extended FGT;

$$P(X_i, Z) = \prod_{j=1}^{J}\left(\frac{z_j - x_{i,j}}{z_j}\right)_+^{\alpha j}. \quad (8)$$

According to Levine, Muwonge and Batana (2012), the multidimensional index by Alkire and Foster is made up of two components: the poverty headcount, H, and an adjustment measure, "A" that represents the number of deprivations suffered, on average, by the poor.

$$MPI = HxA$$

where:

$$H = \frac{q}{n} \quad (9)$$

Which is simply the total number of poor, q , divided by the total population, n . Since we are using data from a representative household survey, and since we want to adjust for variations in household size the study applies a weight $w_i$= $s_i h_i$ where $s_i$ is the sample weight and $h_i$ the household size. $w_i$ could be normalized so that $\sum_{i=1}^{n} w_i = n$.

Therefore the total population of poor is given as:

$$q = \sum_{i=1}^{n} w_i\, p_k(y_i; z). \quad (10)$$

## 3. Results and Discussion

This chapter presents the result on poverty rates for high-users and low-users of climate smart agriculture. The study employs both income and non-income dimensions of poverty as well as absolute and relative poverty for Foster Greer and Thorbecke (FGT) index and Alkire and Foster. The income dimensions includes overall percapita expenditure as well as expenditure on food, health and education, while the non-income poverty employed was the asset dimension of poverty. The asset dimension is a composite variable that was derived through principal component analysis of the type of housing material, means of communication and type of transportation gadget. Poverty was equally decomposed via several techniques namely; Chakravarty et al [28], Extended Watts, Extended FGT and Alkire and Foster (absolute and relative) for the non-income dimension and then FGT (absolute and Relative), EDE-FGT (absolute and Relative), Watts Index and the Sen, Shorrocks and Thon index for the income dimensions of poverty.

The results all show the head count of poverty {P(0)}, poverty gap {P(1)} and the poverty severity {P(2)} in each decomposition technique that applies. It is worth noting that while some of the techniques measure only poverty head count, others such as the FGT and EDE FGT measure the poverty gap and severity as well. The poverty line in each case is two-third of the mean of each dimension as discussed in chapter three (3). This arbitrary poverty line is not completely bias as the focus is to compare poverty between high-users and low-users of climate smart agricultural practices. The poverty rates for high-users and low-users of climate smart agriculture are therefore discussed below:

### 3.1. Poverty Rates for High-users and Low-users of CSA – Income Dimension

Several forms of expenditure shall be used to ascertain the income dimension of poverty; per capita expenditure which comprises of food expenditure and health expenditure.

Expenditure is often used as a proxy to income for two key reasons; First, experience has shown over time that individuals are more comfortable and hence more likely to be truthful about their expenditures than their incomes and secondly, expenditure captures all streams of income other than just the salary that is usually thought of when posed with the question of inquiring income. It is on this note therefore that this study employs various portions of expenditure to ascertain the income dimension of poverty and they are discussed:

### 3.2. Poverty Rates for High-users and Low-users of CSA for Percapita Expenditure

Table 1 shows the total expenditure per head of each household which was calculated as total household expenditure divided by household size. Per capita expenditure therefore represents overall expenditure per head in the household. The results for all the six measurements of poverty show that poverty head count was higher for low-users of climate smart agriculture than high-users, despite the fact that these varying techniques of measurements have different formulations. Poverty head count according to the FGT index for the total population was 35.89% for absolute poverty and 9.13% for relative poverty. Whereas, low-users and high-users of climate smart agriculture were deprived of basic human needs such as food and health care services 37% and 35% respectively. However, in the case of FGT absolute poverty index, when disaggregated, the low-users of climate smart agricultural farmers were absolutely 2% poorer than high-users of climate smart agricultural farmers. This was in line with the work of Sanusi et al. (2013) that majority of farming households do not have all year round sustained income that can guarantee and sustain their basic necessity of life. Also the FGT relative poverty values of 10.23% and 8.76% for low-users and high-users of climate smart agricultural practices respectively, imply that 10.23% and 8.76% of low-user and high-users of climate smart agriculture were poor. In the case of FGT relative poverty index, when disaggregated, the low-users of climate smart agricultural farmers were relatively 2% poorer than high-users of climate smart agricultural farmers. This is in support of [28] that the major cause of poverty in Nigeria was the reluctance of the farmers to adopt new farming techniques that will enhance their productivity. And this also corroborates the work of [31] that the archaic farming methods of rural farmers makes them to be vulnerable to poverty and that the situation needs government intervention for them to escape the scourge of poverty.

This trend could be explained in two ways; first, poor farmers are unable to practice climate smart agriculture due to the extra costs such as irrigation, organic manure and procurement of high quality hybrids. On the other hand, the avoidance of climate smart agriculture could further impoverish farmers since climate smart agricultural practices are the only sustainable means of farming in this era of climate change. Poverty depth and severity as shown for FGT and EDE FGT follows the same trend as the poverty head count, therefore implying that low-users of climate smart agriculture are worse off than high-users. This further buttresses the need for conscious efforts to be made to enforce the practice of climate smart agricultural activities, principally as a means of alleviating poverty.

**Table 1. Poverty Measurements of Percapita Expenditure for low and high-users of CSA**

| Measurement Technique | Population | P(0) | P(1) | P(2) | Poverty line |
|---|---|---|---|---|---|
| FGT absolute Index | Low -user CSA | 0.373643 | 0.099800 | 0.037848 | 9611.11 |
| | High-user CSA | 0.354103 | 0.081763 | 0.028111 | 9611.11 |
| | Total Population | 0.358916 | 0.086205 | 0.030509 | 9611.11 |
| FGT Relative Index | Low -user CSA | 0.102326 | 0.024100 | 0.011050 | 6520.62 |
| | High-user CSA | 0.087639 | 0.018310 | 0.005462 | 6504.63 |
| | Total Population | 0.091256 | 0.019732 | 0.006838 | 6508.57 |
| EDE-FGT absolute Index | Low -user CSA | | 0.099800 | 0.194547 | 9611.11 |
| | High-user CSA | | 0.081763 | 0.167664 | 9611.11 |
| | Total Population | | 0.086205 | 0.174669 | 9611.11 |
| EDE-FGT Relative Index | Low -user CSA | | 0.024100 | 0.105120 | 6520.62 |
| | High-user CSA | | 0.018310 | 0.073906 | 6504.63 |
| | Total Population | | 0.019732 | 0.082693 | 6508.57 |
| Watts Index | Low -user CSA | 0.131235 | | | 9611.11 |
| | High-user CSA | 0.102211 | | | 9611.11 |
| | Total Population | 0.109359 | | | 9611.11 |
| Sen, Shorrocks and Thon index | Low -user CSA | 0.175211 | | | 9611.11 |
| | High-user CSA | 0.145868 | | | 9611.11 |
| | Total Population | 0.153232 | | | 9611.11 |

Source: Authors Computation.

## 4. Conclusion

The study was motivated by the increasing consequence of climate change and its impact on poverty status of farmers in the study area. The already existing poverty in Nigeria was alarming and climate change threatens food security and increase poverty directly and indirectly. It was based on this that the broad objective is therefore to examine the climate smart agricultural practices and poverty status of small holder farming households in North-West Nigeria. What are the poverty status of those who are high-users and low-users of climate smart agricultural techniques in the study area? The study employed [17] Foster, Greer and Thorbecke, [9] Chakravarty et al (1998), Extended Watts, Extended FGT and Alkire and Foster, FGT, EDE-FGT (absolute and Relative), Watts Index and the Sen, Shorrocks and Thon index The study employed several decomposition techniques and the study shows that for all the monetary dimension (per capita expenditure, food, health and education) the results show that low-users of climate smart agriculture had higher poverty rates and higher poverty severity than high-users of climate smart agriculture. And the study shows that high-users of climate smart agriculture reduces the odds of being food poor. The study therefore recommends that massive campaigns be made by government, civil societies and the media to create awareness about climate smart agriculture and to proffer indigenous solutions that address the significant constraints being faced. There is equally need to boost the role of financial institutions in terms of the volume and frequency of credit given out and to reduce or eliminate their interest rate for the farmers, especially for those that practice climate smart agriculture.

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