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POVERTY DECOMPOSITION FOR HIGH AND LOW USERS OF CLIMATE SMART AGRICULTURAL TECHNIQUES IN NORTHWEST NIGERIA

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ABSTRACT: *Climate change projections estimate that developing countries who are least prepared for the changes in climate will be the most affected. Meanwhile, the already existing poverty in Nigeria is alarming and climate change threatens food security and poverty to a large extent. It was on this note that the study measured poverty levels for high and low users of climate smart agricultural practices of small holder farming households in North-West Nigeria. The study employed primary data using questionnaire instruments and focus group discussion in the North West region of Nigeria. The FGT Index model, Equally Distributed Equivalent (EDE) FGT, watts index, Sen, Shorrocks and Thon index were employed to decompose the monetary dimensions of poverty while Chakravarty et al (1998) technique, extended watts, extended FGT and Alkire and Foster were employed to decompose the non-monetary dimension. The findings show that poverty rate was higher for low-users of climate smart agricultural practices than for high-users for all dimensions under consideration and for all the decomposition techniques. This implies that farmers should make conscious efforts to practice climate smart agriculture regardless of their poverty status due to the fact that poverty resides more with low-users. It could be as a result of the fact that high-users make their production sustainable by practicing CSA and consequently high yields that might in turn reduce their poverty status. There is need for significant empowerment of the farmers, given that some of the climate smart agricultural practices have cost implications and require extra money to fund.*

KEYWORDS: Poverty, Climate, Agriculture, Northwest, Nigeria,

INTRODUCTION

The earth is warming; this is the unequivocal conclusion of the Fourth Assessment Report of the Inter-governmental Panel on Climate Change (IPCC) in 2007. 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. Smith et al., (2007), 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.

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According to Ahmed et al., (2009) climate change affects poverty in two ways which are: - changes in incomes and changes in the actual cost of living at the poverty line.

Climate-Smart Agriculture (CSA) is defined as agriculture that sustainably increases production and income, resilience as a result, eliminates greenhouse gas emission (mitigation), which heightens the accomplishment of national food security, developmental objectives and reduced poverty, (FAO, 2010). Agriculture is considered to be climate smart when its production is born from adaptation and mitigation practices. . The climate smart agricultural practices considered 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. 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 (Mnkeni and Mutengwa, 2014). Terdoo and Adekola (2014) opined that, though many nations will be expected to embrace climate smart agriculture, its applicability in an African perspective is not very clear, neither has its sustainability been evaluated. Changes in climate and subsequent global warming are posing dangers to food security and consequently increased poverty in numerous developing nations including Nigeria because the agricultural systems are largely rain fed (Bello et al., 2012).

The rising problems associated with climate change are a worldwide phenomenon but developing nations are projected to be the most affected. This is because, the African economy is mainly agricultural rain-fed; basically reliant on the whims of weather, due to lack of ability to cope as a consequence of poverty and low technical development, hence low level of harvest by the farmers (Ziervogel et al., 2006; Jagtap, 2007; Nwafor, 2007 and Onyenechere, 2010). The North West zone remains an agricultural hub for Nigeria with a huge proportion of its population in the agricultural sector (Olapojo, 2012). Nevertheless, it is the poorest zone in Nigeria (National Bureau of Statistics 2013). There is also prevalence of high-income inequality which is increasing income inequality (Action Aid Nigeria, 2009). 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 source of income for many households in North-West Nigeria Obayelu, (2010). Climate plays a significant role in ensuring sustainable agricultural production in many parts of Northern Nigeria.

The relationship between the practices or not of climate smart agriculture and poverty cannot be overemphasized. Presently, drought has affected several parts of Northern Nigeria with agricultural yields varying extensively from year to year and from one locality to another (Abayomi et al., 2001). 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). Furthermore, 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 (Anyanwale, 2007). High rate of poverty makes majority of the population susceptible to climate change and compromises their adaptation capacity (UNDP, 2011).

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Etim and Udofia (2013), revealed that seventy percent (70%) of Africa's deprived households (poor) live in rural areas and depend on agriculture.

Englama and Bamidele (1997) posit that 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 (Canagaraja et al., 1995; World Bank, 1996). This is due to the fact agriculture is still the mainstay of the Nigerian economy. It has continued to employ 72% of the people Ogbalubi and Wokocha (2013),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 impacts of climate change and poverty. Nevertheless, despite this alarming consequences of climate change that seem to worsen with time, the poverty statistics of North West Nigeria is equally very worrisome. The National Bureau of Statistics (NBS) stated that, the typical poverty rate of the States in the North-West geopolitical region remained the highest at 71.4 per cent trailed by North-East 69.1 per cent and North-Central, 60.7 per cent in (NBS 2013). Studies have examined the effect of climate change on farmers' outputs in Nigeria such as Codjoe, Ocansey, Boateng and Ofori, (2013) and Tanko and Muhsinat, (2014). Other authors such as Aigbokhan, (2000), Canagarajah and Thomas, (2001), Oyekale and Oyekale, (2010) have examined the poverty status of farmers in Nigeria as well. The contribution to knowledge with this present study remains the linkage of climate smart agricultural practices and the poverty status of small farming households in North-West Nigeria.

Numerous studies have been done on the subject at National, Regional and State levels such as Ogwumike and Ekpeyong(1996) and Anyanwu(1997) but analysing the impact of climate smart agricultural practices and poverty status among small holder farming households in North West Nigeria is not yet investigated. Ekpoh (2010) 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 research question of this study is: what is the poverty status of high-users and low-users of climate smart agricultural techniques in the Northwest Nigeria?

Concepts and Nature of Poverty in Nigeria

The concept of poverty has no universally agreed definition due to its complex and dynamic and multidimensional scope/nature. Any logical investigation of the concept of poverty is fraught with a number of complications. This is because poverty touches many aspects of the human condition; comprising physical, moral and psychological, that a concise and generally accepted definition is obscure (Blackwood and Lynch, 1994). While an economist would approach the subject from the view point of want, needs and actual demand, the psychologist may look at it from the view point of deprivation, appreciation and personality. But from whatever viewpoint it is perceived, it is obvious that, it is not a desirable situation of life. Streeten, (1979), Ogwumike, (1987) and others have defined poverty in the very broad terms such as not being able to meet basic needs particularly the physical needs (food, housing, clothing, health care, education, energy and transportation) for meaningful life. Besides, it is a multi-dimensional socio-economic and cultural situation that transcends economic explanation and investigation. Ravallion (1991), nevertheless, upholds that although poverty is a multi faceted concept, its features of poor nutritional status, lack of physical assets and incapability to work are adequately well correlated with income and consumption expenditure to allow us concentrate on these two variables. Poverty is a general phenomenon as old as human history in Nigeria, it is a common status which cannot be easily wiped off except available basic needs and resources are acquired and evenly distributed among the citizens to alleviate their poverty which requires some concerted efforts by the government and individuals to shift the status to a more positive direction in nature Olaitan et al., (2000). The National Bureau of Statistics (NBS) 2007, reported that Poverty in Nigeria is basically a rural phenomenon—the bulk of those in poverty are disproportionately situated in the rural parts, where they are primarily involved in agricultural activities and allied accomplishments.

Empirical Evidence

Empirical evidence on related studies include: Terdoo and Adekola, (2014) who assessed the applicability of climate-smart agriculture (CSA) in fighting climate change, desertification and enhancing rural livelihood in an African context. The results showed that climate smart agriculture is strong in aspects such as participation and sustainable use of resources but weak in aspects of reimbursement and equal sharing of benefits and costs. While, Ozor, Urama and Mwangi, (2013) examined climate change vulnerability and the used of indigenous skills for adaptation among smallholder farming communities in Sub-Saharan Africa. The research was based on field surveys and desk studies which were carried out in 2010 in Nigeria, Sierra Leone and Tanzania. The findings revealed that there was a pronounced awareness of climate change among the communities studied with most farmers maintaining that they have been experiencing climate unpredictability and change which have intensified in the recent times. Indigenous coping strategies in the regions include; traditional terracing, tree planting, construction of drainages, irrigation, use of local herbicides and prayers to God. Nevertheless, it remains uncertain on the efficiency of those indigenous technologies in light of additional climate changes.

Meanwhile, Ekpoh, (2010) evaluated adaptation to the effect of climatic variations on agriculture by rural farmers in North-Western Nigeria. The study used regression models which relate climate data to crop yields to show that rainfall has a positive relationship with crop yields in the region and explained over 70 percent of the variations in the yields of sorghum, millet and maize, all of which were significant at the 0.05 level. Evaporation also had a significant but opposite relationship with crop yields. Other climatic features in the experiment provided minimal levels of explanation. The farm surveys establish that rural farmers in North-Western Nigeria were quite innovative when it came to adapting to drought. The study concluded that the effects of climatic variations on crop yields in North-Western Nigeria can be considerable, especially under drought conditions. However, while Ekpoh concentrated on the effects of climatic variations on crop yields in North-Western Nigeria, the study examined the relationship between climate smart agriculture and poverty in the same region.

Then Ajani, Mgbenka and Okeke, (2013) examined strategies for climate change adaptation among farmers in Sub-Saharan Africa. The study used observations and reviews of associated literatures on adaptation strategies in the areas. The adaptation approaches include (i) water and land resources usage as indigenous adaptation methods. (ii) Land tenure issues and adaptation to climate change in Sub-Saharan Africa. (iii) climate-proof crops (iv) pest control measures (v) climate change and rural

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farmers. Some of the current climate change literature evaluates issues of vulnerability and adaptation including the tasks and opportunities. It was revealed that indigenous knowledge practices have been employed magnificently in adapting to climate change effects among farmers in Sub-Saharan Africa. There is the need consequently to integrate this local acquaintance into formal adaptation policies. Institutional funding is also needed in the form of information on cropping patterns; credit; crop insurance and government subsidized seeds. In the event of a dry season or drought, institutional support should be provided frequently in the form of a loan waiver in order to help the farmers cope with the impacts of climate change. Institutional support, as well as increased access to education, information and technology and sustainable agricultural development might improve the overall resilience of smallholder farmers and reinforce their efforts to withstand the overall impacts of changes in climate variability and long-term climate change. However, as with the case of Ekpoh, it differs from the study under consideration.

RESEARCH DESIGN AND METHODOLOGY

The study area is North-West (NW) geopolitical zone of Nigeria. This zone comprises of seven (7) States namely: Katsina, Kano, Kaduna, Kebbi, Jigawa, Sokoto and Zamfara States. The agricultural sector forms the basis of the overall development thrust of the zone. The region is described as a relatively hot climate with seasonal rainfall and a marked dry season (Draper and Maureen 2009). It is evident that changing climates (increasing droughts or floods) will influence agricultural productivity and therefore makes it imperative to examine the impact of climate smart agricultural practices on poverty status among farmers in North-West Nigeria. The climate makes the farmers to cultivate a very widespread variety of crops such as cereals, 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.The population of this study includes all farmers in North-West Zone of Nigeria.

A multi-stage sampling procedure was employed for the collection of data from the rural farming households. The first stages involved a purposive selection of Katsina and Sokoto States due to high prevalence of poverty (NBS 2016). The second stages involved a random selection of six (6) Local Government Areas from fifty seven (57) Local Government Areas of the two States. The third phase involved the random selection of twelve (12) villages from each of the six Local Government Areas making one hundred and thirteen (113) villages in all. The final step was a random selection of three hundred (300) farming households from the one thousand and eighty (1,080) farming households in the study area to give a total of three hundred (300) respondents. Primary data for the study was collected through a well-structured pretested questionnaire. The questionnaires were developed based on the objectives of the study and literature. There were four sections in the questionnaire.

The objective was analysed using FGT Index model, watts index, Sen, Shorrocks and Thon index, Chakravarty et al (1998) and Alkire and Foster decomposition methods for monetary and non-monetary dimensions of poverty. 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 (1984) 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 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 et al (1998) 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 decomposition 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 (Anyanwu, 1997). According to (FOS, 1999) and (Canagarajah and Thomas, 2002), 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 consistency (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 Durojaiye, 1995 and World Bank, 1996 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-users 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

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

where:

N = Total number of respondents i.e households 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

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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 when α equals 0,1 and 2 respectively. 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:

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

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

The Watts index is the first distribution-sensitive poverty measure, proposed in 1968 by Watts (World Bank Institute, 2005). Watts' discrete version takes the form

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

where the N individuals in the population are indexed in ascending order of income (or expenditure), and the sum is taken over 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 SenShorrocks-Thon(SST) index, defined as

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

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 (1998) index, extended watts, extended FGT and Alkire and Foster. The general form of an additive multidimensional poverty index is:

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

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:

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Chakravarty et al (1998) index;

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

Extended Watts Index;

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

Multiplicative and extended FGT;

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

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 = H x A……………………………………………………………………...(9)

where: $H = \frac{q}{n}$ ……(10)

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:

$$q = \sum_{i=1}^{n} w_i p_k (y_i; z) \quad \text{……(11)}$$

RESULTS AND DISCUSSIONS

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 EDGE 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) above. This arbitrary poverty line is not completely bias as the focus is to compare poverty between low-users and high-users of climate smart agricultural

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practices. The poverty rates for high-users and low-users of climate smart agriculture are therefore discussed below:

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, food expenditure, health expenditure and education expenditure. Expenditure is often used to proxy 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 categories of expenditure to ascertain the income dimension of poverty and they are discussed below:

Poverty Rates for High-users and Low-users of CSA for Per capita expenditure

Per capita expenditure represents total expenditure per head of each household and is 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 is higher for low-users of climate smart agriculture than high-users, despite the fact that these varying techniques of measurements have different formulations. According to the FGT index, poverty head count for the total population is 35.89% for absolute poverty and 9.12% for relative poverty. When disaggregated, low-users record 37.36% for absolute and 10.23% for relative poverty as against 35.41% for absolute and 8.76% for relative poverty for high-users of climate smart agriculture. This trend is similar with the watts index that records 13.12% poverty head count for low-users as against 10.22% poverty head count for high-users. Similarly, Sen, Shorrocks and Thon index show 17.52% poverty head count for low users and 14.59% poverty head count for high users.

This trend could be explained in two ways; First, poor farmers are unable to practice climate smart agriculture due to the extra costs that is involved with it. 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. Either ways, there is need for credit facilities to assist farmers sustain CSA cost and increased sensitization especially with empirical evidence as such to show that poverty resides more with low-users of climate smart agriculture. Poverty gap and severity as shown for FGT and EDGE FGT follows the same trend as the poverty head count, therefore implying that low-users of CSA are worse off than high-users. This further buttresses the need for conscious efforts to be made to enforce the practice of climate smart agriculture, principally as a means of alleviating poverty.

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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

Poverty Rates for High-users and Low-users of CSA for Food Expenditure

The second case is that of Food expenditure wherein we consider only a portion of household expenditure –expenditure on food per head. The results for food dimension of poverty show the same trend with that of percapita expenditure. It shows a wider gap between low-users and high-users, with low-users having consistently higher poverty head count than high-users. Also, poverty gaps and poverty severity for food dimension follows the same trend with equally higher gaps than those of per capita expenditure.

This again shows that low-users of CSA have higher poverty rates than the high-users for food expenditure and per capita expenditure. This is the same for both absolute and relative poverty measurements of FGT and EDGE FGT. Poverty head count for food expenditure for the whole population according to FGT is 32.84% which is less than that of per capita expenditure, but the low-users have higher poverty head counts than that of percapita expenditure and the high-users have lower poverty head counts than that of per capita expenditure.

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Table 2: Poverty Measurements of Food 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	0.420155	0.166450	0.094390	1631.64
	High-user CSA	0.298379	0.079430	0.037786	1631.64
	Total Population	0.328370	0.100862	0.051726	1631.64
FGT Relative Index	Low -user CSA	0.178295	0.079972	0.044431	993.41
	High-user CSA	0.098784	0.035594	0.020157	1152.03
	Total Population	0.128675	0.048499	0.027527	1112.96
EDE-FGT absolute Index	Low -user CSA		0.166450	0.307229	1631.64
	High-user CSA		0.079430	0.194387	1631.64
	Total Population		0.100862	0.227435	1631.64
EDE-FGT Relative Index	Low -user CSA		0.079972	0.210787	993.41
	High-user CSA		0.035594	0.141974	1152.03
	Total Population		0.048499	0.165914	1112.96
Watts Index	Low -user CSA	0.269623			1631.64
	High-user CSA	0.118305			1631.64
	Total Population	0.155571			1631.64
Sen, Shorrocks and Thon index	Low -user CSA	0.289108			1631.64
	High-user CSA	0.146277			1631.64
	Total Population	0.183441			1631.64

Source: Authors Computation

Poverty Rates for High-users and Low-users of CSA for Health expenditure

The health dimension represents household expenditure on health per head; that is, household expenditure on health divided by household size. Noteworthy is the fact that all the measurement techniques for decomposition show higher rates for poverty count, poverty gap and poverty severity for the total population, low-user and high-users of climate smart practice. Yet again, poverty head count, poverty gap and severity is higher for low-users of climate smart agriculture than high-users of climate smart agriculture. This shows that beyond the general expenditure, low-users have lower welfare status for not only per capita expenditure as a whole, but also for food and health dimensions of poverty. Hence our point of increasing awareness and capacity of farmers to encourage CSA practice cannot be overemphasized. This is shown on Table 3 below:

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Table 3: Poverty Measurements of Health 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	0.575194	0.300446	0.190549	963.25
	High-user CSA	0.374367	0.158742	0.094102	963.25
	Total Population	0.423826	0.193641	0.117855	963.25
FGT Relative Index	Low -user CSA	0.381395	0.165081	0.090070	556.90
	High-user CSA	0.237082	0.097823	0.56515	669.71
	Total Population	0.276441	0.117745	0.067759	641.92
EDE-FGT absolute Index	Low -user CSA		0.300446	0.436520	963.25
	High-user CSA		0.158742	0.306760	963.25
	Total Population		0.193641	0.343300	963.25
EDE-FGT Relative Index	Low -user CSA		0.165081	0.300117	556.90
	High-user CSA		0.097823	0.237729	669.71
	Total Population		0.117745	0.260305	641.92
Watts Index	Low -user CSA	0.502067			963.25
	High-user CSA	0.258867			963.25
	Total Population	0.318573			963.25
Sen, Shorrocks and Thon index	Low -user CSA	0.473424			963.25
	High-user CSA	0.279593			963.25
	Total Population	0.332447			963.25

Source: Authors Computation

Poverty Rates for High-users and Low-users of CSA for Education Expenditure

Finally, the last option considered under the income dimension of poverty is that of education expenditure per head. The estimates for education dimension are much similar with those of the health dimension which are both higher than those of the food expenditure and per capita expenditure. Overall poverty head count for education dimension for FGT is 47.07 which is higher than that of health of 42.6641, nevertheless low users for education dimension record 57.98%, 40.00%, 58.25% and 52.67% poverty head count for FGT absolute index, FGT relative index, Watts index and Sen, Shorrocks and Thon index respectively. While, those for health are 57.52%, 38.14%, 50.21% and 47.34% poverty head count for FGT absolute index, FGT relative index, Watts index and Sen, Shorrocks and Thon index respectively. These were generally higher poverty head counts than those of the high-users of climate smart agriculture. This trend again applies both for poverty gap and poverty severity.

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Table 4: Poverty Measurements of Education 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	0.579845	0.332507	0.238793	1118.27
	High-user CSA	0.435157	0.175997	0.105829	1118.27
	Total Population	0.470790	0.214542	0.138575	1118.27
FGT Relative Index	Low -user CSA	0.400000	0.251167	0.133001	581.86
	High-user CSA	0.252280	0.102687	0.069962	806.76
	Total Population	0.282551	0.139254	0.090729	751.37
EDE-FGT absolute Index	Low -user CSA		0.332507	0.488665	1118.27
	High-user CSA		0.175997	0.325313	1118.27
	Total Population		0.214542	0.372256	1118.27
EDE-FGT Relative Index	Low -user CSA		0.204423	0.364693	581.86
	High-user CSA		0.112513	0.264502	806.76
	Total Population		0.139254	0.301212	751.37
Watts Index	Low -user CSA	0.582582			1118.27
	High-user CSA	0.294484			1118.27
	Total Population	0.363979			1118.27
Sen, Shorrocks and Thon index	Low -user CSA	0.526739			1118.27
	High-user CSA	0.305897			1118.27
	Total Population	0.365606			1118.27

Source: Authors Computation

Poverty Rates for High-users and Low-users of CSA for Non Income Dimension –Asset

To ascertain the non-income dimension of poverty, a composite variable was generated from the possession of housing materials as well as means of communication and transportation used, using principal components analysis. The composite variable was then summarised and two-third of its mean designed as poverty line. The poverty line was then used to generate a dummy variable for asset poverty and non-asset poverty. The results are shown on Table 6.5 below.

Decomposition Methods such as Chakravarty et al (1998) and the Extended Watts, decomposed poverty for α= 0, 1 and 2 unlike the others that only measure poverty head count. Tsui (2002), Chakravarty et al. (1998) and Bourguignon and Chakravarty (1999) suggested several functional forms for multidimensional poverty indices. Bourguignon and Chakravarty (2002) also examined the shapes of its poverty contours taking into account the idea of substitutability or complementarity between attributes, an important issue in multivariate measurement.

The asset dimension again shows that low-users of climate smart agriculture have higher poverty head counts than high-users of poverty. Low-users of poverty record 53.5%, 47.4%, 53.5%, 53.5% and 28.1 % for Chakravarty et al (1998), Extended Watts, Extended FGT, Alkire and Foster Absolute and Alkire and Foster – Relative, respectively as against 44.7%, 38.5%, 44.7%, 44.7% and 28.1% for Chakravarty et al (1998), Extended Watts, Extended FGT, Alkire and Foster Absolute and Alkire and Foster – Relative respectively. Thus, poverty head count is higher with low-users than high-

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users when asset dimension is taken into consideration. Poverty severity as well as poverty gap show the same trend as is the case with all others illustrated above.

Table 5: Poverty Measurements of Asset Dimension for low and high-users of CSA

Measurement Technique	Population	P(0)	P(1)	P(2)
Chakravarty et al (1998)	Low -user CSA	0.535	0.310	0.186
	High-user CSA	0.447	0.252	0.151
	Population	0.469	0.267	0.159
Extended Watts	Low -user CSA	0.474	0.474	0.474
	High-user CSA	0.385	0.385	0.385
	Population	0.407	0.407	0.407
Extended FGT	Low -user CSA	0.535		
	High-user CSA	0.447		
	Population	0.469		
Alkire and Foster - Absolute	Low -user CSA	0.535		
	High-user CSA	0.447		
	Population	0.469		
Alkire and Foster - Relative	Low -user CSA	0.281		
	High-user CSA	0.719		

Source: Authors Computation

CONCLUSIONS

The study was motivated by the increasing popularity of climate change consequences being witnessed all over the world. Projections show that developing countries who are least prepared for the changes in climate will be the most affected. The already existing poverty in Nigeria is alarming and climate change threatens food security and poverty to a large extent. It was on this note that the study measured poverty levels for high and low users of climate smart agricultural practices of small holder farming households in North-West Nigeria. The findings show that poverty rate was higher for low-users of climate smart agricultural practices than for high-users for all dimensions under consideration and for all the decomposition techniques. This implies that farmers should make conscious efforts to practice climate smart agriculture regardless of their poverty status due to the fact that poverty resides more with low-users. It could be as a result of the fact that high-users make their production sustainable by practicing CSA and consequently high yields that might in turn reduce their poverty status.

There is need for significant empowerment of the farmers. Some of the climate smart agricultural practices have cost implications and require extra money to fund it. Insufficient credit facilities will not encourage farmers to practice climate smart agriculture as some of them can barely afford seeds and tools more or less of hybrid seeds and other forms of climate smart agricultural practice. The consequences to climate change affect all and sundry and has been alleged to increase poverty levels. It is therefore only logical to practice climate smart agriculture so as to be sustainably increasing productivity, income and build resilience to climate change, reduce or eliminate green-house gas emission which enhances achievement of national food security and reduce poverty.

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