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EVALUATION OF CLIMATE SMART INDICATORS INFLUENCING AGRICULTURAL PRACTICES ON SORGHUM ENTERPRISE IN KATSINA AND SOKOTO STATES.

[1]Ekpa D; [1]Tiri G.D and [2]Muntaka.M
[1]Department of Agricultural Economics, Federal University Dutsin-Ma, Katsina State.
E-mail: dekpa@fudutsinma.edu.ng
[2]Department of Agricultural Extension and Rural Development Federal University Dutsin-Ma, Katsina state

ABSTRACT

Presently, the state of poverty in Nigeria is frightening and climate change impends food security and increase poverty. The study was motivated by the increasing consequence of climate change and its impact on farmers in the study area. Farming households changing agricultural practices as a result of global observation of environmental changes. This research established a link that exists between climate smart agricultural practices and poverty in Katsina and Sokoto States. It was based on this that the study wants to evaluate the climate smart indicators influencing agricultural practices on sorghum enterprise in the study area. A multi-stage purposive and random sampling techniques was used to select three hundred (300) farming households in the study area. The objective was therefore, to determine factor influencing indicators of climate smart agricultural practices within sorghum enterprises in the study area. The study employed Principal Component Analysis (PCA), Ordinary Least Square (OLS) of the regression model to analyze the objective of the study housing material was significant at ($P<0.01$) and education was significant at ($P<0.05$). The study reccommends that:'Government, Non-Governmental Organizations and farmer's associations should create a conducive learning environment by developing trainings and farmer friendly programmes such as environmental friendly farming systems to encourage rural household farmers develop interest and adopt climate smart agricultural farming practices. Extension delivery system approach should be down to earth'' to meet the imformation age.

Keywords: Climate, Smart, Agriculture and Sorghum Enterprise.

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 which offers a complete investigation into how climate change is affecting natural and human systems. 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. Assuncao and Chein (2009) evaluated that in Brazil, on average, agricultural productivity per hectare could decline by 18 percent by 2040 as a result of climate change, but that, at the city level, impacts could range from a decrease of 40 percent to an increase of 15 percent.

The development of the agricultural sector is the most efficient poverty reduction measure in countries where the economy is heavily based on agriculture. However, the adverse effects of climate change remain to be a major threat to agriculture (Baley ,2016).The change is already having an impact on agriculture and food security (FAO,2016) and 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. In the developing world, climate change information and adequate response could be regarded as luxury especially at the national level. This is due to the pressing need for basic facilities such as adequate water supply, reliable power, efficient health care, standard educational facilities and sustainable inf rastructure. However, community sensitization/awaren ess and community-based adaptations are important aspects of climate change mainstreaming. Community-focused susceptibility and adaptation valuations are significant tools in sustenance of community established adaptations. True integration and/or training on climate change adaptations strategies at the sub-national level will result in wider ownership of climate response and allow sketch on a wider pool of financial and human resources for execution, while promoting extra extensive dimensions and institutional structure. 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, Kijima et al., (2011). 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, Food for Agricultural Organization (FAO, 2010).
Also Ekpa *et al.* (2017) study revealed that low-users of climate smart agriculture had higher poverty rates and higher poverty severity than high-users of climate smart agricultural practices. And the study shows that high-users of climate smart agriculture reduces the odds of being food poor.

Existing confirmations shows that Nigeria is already overwhelmed with various ecological problems which have been directly connected to the on-going climate change (Adefolalu, 2007; Ikhile, 2007). 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 Federal Ministry of Environment (; Obioha, 2008). Climate change adaptation, particularly at the local or sub-national levels, matter for two reasons: First, the impacts are best felt and understood at the local level; climate change impacts are also observed at the level areas where the vulnerability and adaptive capability are very much specific. Secondly, most adaptation alternatives, for the need of being effective, involves implementation at the local level and fruitful initiatives pioneered at the local level may be replicated and scaled-up nationally.

In Africa, climate-smart agriculture offers multiple benefits in line with attainment of the goals of :- sustainable increase in reliability and productivity of agricultural systems, increase in smallholder farmers' resilience and adaptation to effects of climate change and reduction in greenhouse gas emissions from agricultural practices (Naess, 2011). Fanen and Adekola, (2014) opined that, although, many nations are projected to embrace CSA, its demonstration in an African perspective is not yet so, neither has its sustainability been evaluated. The use of climate smart adaptation (mulching ,intercropping ,conservation agriculture, agro-forestry , improved grazing etc.) in the local environment can be influence positively or negatively by both social, political, environment and economic factors, however , this information is not well documented in literature, It is against this background that this research was undertaken to contribute to this information gap by ascertaining the factors influencing indicators/use of climate smart agricultural practices on sorghum enterprise among farmers in Katsina and Sokoto States, North-West ,Nigeria.

Changes in climate and subsequent global warming are posing dangers to food security and consequently increased poverty in numerous developing nations including Nigeria because of the agricultural systems are largely rain fed. (Bello et al., 2012). Climate is a long-term average weather conditions that directly or indirectly affects agricultural production. Climate determines the choice of what plant to cultivate, how to cultivate it, the yields of crops to keep. 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 (Fanen and Adekola,2014).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). 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 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 impact of climate change and poverty. Nevertheless, despite this alarming consequence of climate change that seems 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). The United nation (UN) has lamented the spate of nutrition crisis in North-West ,Nigeria saying 70% of the Northwest regions population live below the poverty line ,they describe the situation as worrisome (United Nation,2022). Numerous studies have been done on the subject at National, Regional and State levels such as (Anyanwu (1997) and (Ojoko *et.al*, 2017) while Ekpoh (2010) assessed the effect of climate change and adaptation on agriculture by rural farmers in North-Western, Nigeria, but analysis of the factors influencing indicators of climate smart agricultural practices on sorghum enterprise is not yet investigated in the study area. Sorghum is widely cultivated in the study and happens to be a staple food crop. Hence this study is looking at factor influencing indicators of climate smart agricultural practices on sorghum enterprise in Katsina and Sokoto States.

OBJECTIVE

To evaluate climate smart indicators influencing agricultural practices on sorghum enterprise in the study area.

RESEARCH METHODOLOGY

The study area are Katsina and Sokoto States. These two States are in the North-West region which 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 (NPC, 2006). 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 (Draper and Maureen 2009). It is therefore evident that changing climates (increasing droughts or floods) will influence agricultural productivity and imperative to examine the factors influencing indicators of climate smart agriculture practices on sorghum enterprise among farmers in the study area. The main source of livelihood of the people in this zone is 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 condition makes the farmers to cultivate a variety 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.

DATA COLLECTION 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 (NBS, 2013), 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). The United nation (UN) has lamented the spate of nutrition crisis in North-West ,Nigeria saying 70% of the Northwest regions population live below the poverty line ,they describe the situation as worrisome (United Nation,2022). The second stages involved a random selection of three (3) Local Government Areas from each of the three agricultural zones in Katsina State. And random selection of three (3) Local Government Areas from three (3) out of the four agricultural zones in Sokoto State, making a total of six (6) Local Government Areas in all. The third stages involved random selection of ten (10) communities from each Local Government Areas to bring the total to sixty (60) Communities. Lastly, five (5) farming households were randomly selected from each of the communities to give a total of three hundred (300) respondents.

ANALYTICAL METHOD

The objective was to be analysed with the aid of multiple regression methods using the Ordinary Least Square (OLS) estimation techniques. However, in line with the classical linear theorem, certain assumptions must be verified to ensure consistency and robustness. The assumptions that pertain more to cross sectional analysis like this one include multicollinearity and heteroscedasticity. Multicollinearity is examined with the aid of the Variance Inflation Factor (VIF) while the heteroscedasticity is automatically catered for by the Stata software using the robust option when regressing. To determine the factor influencing indicators of climate smart agricultural practices within sorghum enterprises. Socioeconomic variables are regressed against composite dependent variables the use of climate smart agricultural techniques in sorghum enterprise. Six major types of CSAP were studied and they are: the practice of using organic manure, agro-forestry, conservation agriculture, integrated crops and livestock management, the use of improved varieties/hybrid of crops/animals and the use of irrigation for smallholder farmers

The Principal Component Analysis (PCA) was used to compute the composite dependent variables that will be estimated with a multiple regression model. The principal components analysis was used to generate the composite variable for the use of climate smart agriculture for the sorghum enterprises.

The principal component analysis as specified by Ifelunini *et al*., (2013) is presented thus: Given variables (Xs represent the various factors used to develop sorghum composite index) X1,…, Xp measured in n farmers, while Z1,…,Zp are the principal components which are uncorrelated linear combinations of the original variable, X1,…, Xp, given as;

$$Z_1 = \alpha_{11}X_1 + \alpha_{12}X_2 + \ldots + \alpha_{1p}X_p$$
$$Z_2 = \alpha_{21}X_1 + \alpha_{22}X_2 + \ldots + \alpha_{2p}X_p$$

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$Zp = \alpha_{p1}X_1 + \alpha_{p2}X_2 + \ldots + \alpha_{pp}X_{pz}$

This matrix of equations can be expressed as z =Ax, where z= (Z_1,…,Zp),x= (X_1,…, Xp) and A is the matrix of coefficients. The coefficients of the first principal component, α11… α1p, are chosen in such a way that the variance of Z_1 is maximized subject to the constraint $\alpha 2_{11}, \ldots, \alpha_{21}p = 1$. There five composite variables are derived using the PCA that are regressed against the socio economic variables; age, dummy for gender (dgen), dummy for education (deduc), dummy for marital status (dmats), dummy for religion (drel), households size (hhsize), farmsize (fsize), experience (exp), ownership (own), dummy for landacquisition (dlaq), dummy for type of labour (tlab), dummy for membership of association (dmas), dummy for transportation type (dtt), dummy for housingmaterial (dhmat), dummy for communication kits (dcom), number of extension contacts (nec), access to credit (acc), lack of time (lot), state dummy (dstate) and total household expenditure (thexp).

The multiple regression model is specified thus:

$$Y = \beta_0 + \sum_{i=1}^{20} \beta_i X_i + \varepsilon_\iota \qquad \ldots\ldots(1)$$

Where Y represents the dependent variables (index of composite variables of sorghum climate smart), β_0 represents the intercept, β_i the coefficients of the independent variables, X_i the independent variables listed above and ε_ι the stochastic or error term.

The model to be estimated will be that with a composite variable for sorghum as dependent variable (csasorghum). The equation to be estimated and a priori expectation are shown below:

$$\text{Index of csasorghum}_i = \beta_0 + \beta_1 age_i + \beta_2 dgen_i + \beta_3 deduc_i + \beta_4 dmats_i + \beta_5 drel_i + \beta_6 hhsize_i + \beta_7 fsize_i + \beta_8 exp_i + \beta_9 own_i + \beta_{10} dlaq_i + \beta_{11} tlab_i + \beta_{12} dmas_i + \beta_{13} dtt_i + \beta_{14} dhmat_i + \beta_{15} dcom_i + \beta_{16} nec_i + \beta_{17} acc_i + \beta_{18} lot_i + \beta_{19} dstate_i + \beta_{20} thexp_i + \varepsilon_i \quad \ldots\ldots(2)$$

Table 1: A priori Expectation for Regression Model Based on factors influencing the use of Climate Smart Agriculture with Sorghum Enterprise.

Variables	Coding System	Category	Expected Sign
Age	Number in years	continuous	-/+
Gender	1 if male, 0 if not	dummy	-/+
Educational level	1 educated in Arabic, 0 if not	dummy	-
Marital status	1 if married, 0 if not	dummy	+
Religion	1 if Christian, 0 otherwise	dummy	-/+
Household size	Number of siblings	continuous	+
Farm size	Number in hectares	continuous	-
Experience	Number in years	continuous	+
Ownership of farm land	1 if yes, 0 if not	dummy	+
Land acquisition	I if inherit, 0 if not	dummy	-/+
Type of labour	1 family, 0 if not	dummy	-/+
Membership of association	1 if yes, 0 if not	dummy	+
Means of transportation	1 if animal, 0 if not	dummy	-/+
Housing material	1 if mud, 0 if not	dummy	-/+
Communication kit used	1 if TV, GSM or video and 0 if radio	dummy	+
Extension contacts	Number of contacts	Continuous	+
Access to credit	1 if access, 0 if not	dummy	+
Lack of time	1 if farmer lacks time for CSA, 0 if not	dummy	+
State dummy	1 if Katsina state, 0 if Sokoto	dummy	-/+
Household expenditure	Total expenditure	continuous	+

RESULTS AND DISCUSSION

This section presents the result on the factors influencing the use of climate smart agricultural techniques on sorghum enterprises using the principal component analysis (PCA) and the multiple regression models through ordinary least square (OLS) estimation techniques. The principal components analysis was used to generate the composite variable for the use of climate smart agriculture for the sorghum enterprise. After which these composite variables were employed as dependent variables in order to investigate the factor influencing indicators of climate smart agricultural practices on sorghum enterprise in Katsina and Sokoto States respectively. The F-statistics was significant at (P<0.05), hence the model is fitted. The R^2 of 0.0867 implies that the explanatory variable can only account for 8.70% in the sorghum enterprise. In addition, the Variance Inflation Factor (VIF) value of 1.52 shows that there is no serious multicollinearity among the independent variables. The Ordinary Least Square (OLS) estimation results on Table 2 show that education, farm size and housing material were significant (p< 0.05).This will likely affects farmers' adoption of climate smart agricultural practices in the study area. This implies that respondents who had informal education had significantly lower indices of climate smart agriculture for sorghum production by 0.152724 than their counterparts who had formal education. These results corroborates with apriori expectation and is a pointer to the importance of formal education. This finding is affirmed by Okpachu et al. (2014) who emphasized that education could have a positive impact on the farmers if the curriculum is enriched and applicable to their farming activities. Also, Ayinde et al. (2010) found that education level of farmers has a significant influence on adoption and the finding of Daniel et al (2021) found that levels of education play an important and prominent role in economic development and skill acquisition. It enhances one's ability to understand and apply new ideas, technological innovations as well as his or her ability to plan and take risk.

Table 2: OLS Regression Result of Sorghum Enterprise

Sorghum CSA Enterprise	Coefficient	Standard error	t-value	P-value	Tolerance
Age	-.0033532	.0128667	-0.26	0.795	0.3846
Gender	.374837	.3812064	0.98	0.326	0.4948
Education	-.152724	.0776972	-1.97	0.050**	0.8864
Marital	-.5625115	.4265004	-1.32	0.188	0.5442
Religion	-.118351	.276596	-0.43	0.669	0.8153
Households	-.0042876	.0282198	-0.15	0.879	0.6000
Farm-size	-.058918	.0238867	-2.47	0.014**	0.7545
Experience	.0090153	.0121938	0.74	0.460	0.4197
Ownership	-.1548924	.4692801	-0.33	0.742	0.5329
Land acquisition	.0329311	.4313515	0.08	0.939	0.6650
Labour	-.1803822	.1917326	-0.94	0.348	0.9388
Membership	.0960629	.169133	0.57	0.571	0.6304
Transportation	-.0862034	.2165393	-0.40	0.691	0.8688
Housing material	-.5706555	.1919158	-2.97	0.003***	0.7829
Communication	.0489703	.1536928	0.32	0.750	0.8080
Extension contact	-.0473868	.0567902	-0.83	0.405	0.9525
Access to credit	-.2207313	.1567902	-1.41	0.159	0.6865
Lack of time	-.0930056	.1473308	-0.63	0.528	0.8660
State	.099974	.1601718	0.62	0.533	0.6911
Expenditure	-18600000	581,000,000	-0.32	0.749	0.7650
Constants	1.244299	.7860683	1.58	0.115	
Number of Obs:	294				
F (20, 273)	1.64				
Prob> F	0.0442				
R-Squared	0.0867				
Root MSE	1.1403				

Source: Authors Computation from Computer Printout of Regression Analysis
Note: *, ** and *** means 1%, 5% and 10% level of significant respectively

Farm size was significant ($p<0.05$). This means that the farmers with small farm size had their indices of climate smart agriculture being lower by 0.058918 when compared with those who owned large farm size. This was because the more agricultural farm size occupied by a farmer, the more the need to use more resources to facilitate the adoption of climate smart agricultural practice hence this result was negatively significant due to the fact that the lesser the farm size the more effective the available resources for climate smart agricultural practices. Although, we found this to be in contrast with the finding of Nambuya *et al.*, (2005) who reported that adoption of improved varieties is positively correlated to farm size and that most farms with small land holding were not sowing improved varieties.

Housing material parameter was significant ($p<0.01$). This means that the farmers with mud/thatched and mud/zinc houses had their indices of climate smart agriculture being lower by 0.5707 when compared with those who owned brick/zinc and concrete block zinc houses. According to Stephen (2010) on different management practices and approaches that can contribute to improving productivity and economic sustainability, quality of housing materials was discovered to promote good environment and enhance productivity of the farmers. The farmers in the study area lived in mud/thatched buildings as a result of their poverty level. This has a consequence on their commitment to climate smart agricultural practices in the study area.

Table 3: Multi-Collinearity Test of Variables

Variable	VIF	Tolerance	Eigenvalue
Age	2.60	0.3846	13.6796
Gender	2.02	0.4948	1.3705
Education	1.13	0.8864	1.0070
Marital	1.84	0.5442	0.9167
Religion	1.23	0.8153	0.7666
Households	1.67	0.6000	0.6502
Farmsize	1.33	0.7545	0.4881
Experience	2.38	0.4197	0.4179
Ownership	1.88	0.5329	0.3874
Land acquisition	1.50	0.6650	0.3274
Labour	1.07	0.9388	0.2417
Membership	1.59	0.6304	0.2287
Transportation	1.15	0.8688	0.1257
Housing material	1.28	0.7829	0.0988
Communication	1.24	0.8080	0.0913
Extension contact	1.05	0.9525	0.0728
Access to credit	1.46	0.6865	0.0524
Lack of time	1.15	0.8660	0.0355
State	1.45	0.6911	0.0227
Expenditure	1.31	0.7650	0.0123
			0.0067
Mean VIF	1.52		

Source: Authors' computation from the Computer printout of Multicollinearity Test

CONCLUSION AND RECOMMENDATIONS

The study was motivated by the increasing consequence of climate change and its impact on crops production 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. The specific research question that has been addressed is: What are the factors influencing the indicators of climate smart agricultural practices on sorghum enterprises in Sokoto and Katsina? We conclude that farmer's level of education, farm size and housing type are they main factors influencing farmers' indicators of climate smart agricultural practices in the study area assuming other factors remain unchanged. We also found that the state, ownership of means of communication, available labour experience and farmers experience of climate smart agricultural practices were positive but statistically insignificant.

The study reccommends that:'Government, Non-Governmental Organizations and farmer's associations should create a conducive learning environment by developing trainings on environmental friendly farming systems to encourage rural household farmers to develop interest and adopt climate smart agricultural practices. Moreso, extension delivery system approach should be down to earth'' to meet the imformation age.

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