World Journal of Agricultural Research, 2017, Vol. 5, No. 5, 273-278
Available online at http://pubs.sciepub.com/wjar/5/5/4
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DOI:10.12691/wjar-5-5-4

Evaluation of Factors Influencing Indicators of Climate Smart Agricultural Practice on Crop in North-West Nigeria

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Abstract The current state of poverty in Nigeria is alarming and climate change threatens food security and increases poverty directly and indirectly. This research established a link that exists between climate smart agricultural practices and poverty status of small household farmers in North-West geopolitical zone of Nigeria; and based on this, examined climate smart agricultural practices and poverty status of small holder farming households in the zone. The specific objective of the study was to determine factors influencing indicators of climate smart agricultural practices on crop enterprise in the study area. Multi-stage, purposive and random sampling techniques were used to select three hundred (300) farming households in the study area, and using a set of pre-tested structured questionnaires, relevant data were collected. The study employed Ordinary Least Square (OLS), regression models to ascertain the objective. The regression analysis of maize enterprise shows that age, gender, marital status and household size were significant ($p < 0.10$), with age positively significant inferring that a unit increase in age will result in corresponding increase in the practice of climate smart agriculture for maize enterprise by 0.0264; also, the results showed that many more male farmers used climate smart agriculture in the maize enterprise than their female counterparts by 0.6001. Education, housing materials, lack of time and State option were significant ($p < 0.01$). The study concludes that crop production is greatly influenced by climate Smart Agriculture in the study area. The results suggest that those who had informal education (Arabic education) had significantly lower indices of climate smart agriculture for maize production than their counterparts who had formal education primary, secondary and tertiary. Housing material was also negatively significant ($p < 0.01$), meaning that the farmers with mud/thatched and mud/zinc houses had significantly lower usage of climate smart agriculture in the production of maize when compare with those with brick/zinc and concrete block zinc houses. The study concludes that socio economic variables influenced climate Smart Agriculture in the study area. It therefore recommends that women be encouraged to develop interest in climate smart agricultural farming activities through women empowerment programmes instituted by government and private bodies because men dominate the climate smart agricultural practices in the study area; Government, Non-Governmental Organizations and farmer associations should create a conducive learning environment to encourage the farmers of climate smart agriculture in the study area to embrace formal education which can improve their performance rapidly; and finally, policy on informal education should be enriched and developed in the curriculum to meet the current climate smart agricultural challenges.

Keywords: *climate, smart, agriculture and poverty in north-west Nigeria*

Cite This Article: Ekpa, D., Oyekale, A.S., and Oladele, O.I, "Evaluation of Factors Influencing Indicators of Climate Smart Agricultural Practice on Crop in North-West Nigeria." *World Journal of Agricultural Research*, vol. 5, no. 5 (2017): 273-278. doi: 10.12691/wjar-5-5-4.

1. 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 [1], 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. Smith *et al.*, [2] 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 Ahmed, Diffenbaugh and Hertel, [3] climate change affects poverty in two ways which are: changes in incomes and changes in the actual cost of living at the poverty line. The influence of a food price rise on earnings depends on the income sources for a given family group. If earnings rise more rapidly than the cost of living for households at the poverty line in a given stratum, then the poverty headcount will fall and vice versa [3]. IFRC (2000) 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 numbers of the deprived households live, especially in Sub-Saharan Africa. Therefore, consequences of climate change such as submerging, droughts and 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 infrastructure. However, community sensitization/awareness 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 adaptation strategies at the sub-national level will result in wider ownership of climate response and allow sketches 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 and hybrids are other exercises that could advance or increase income hence poverty is being reduced by households and also increasing their efficiency [4]. As a result, the Africa Climate-Smart Agriculture Alliance which instituted Africa's Heads of State and Government Organization [5] hasten to put together ten (10) essential member associates across governments, research institutions and civic society establishments. These members include: the African Union; New Partnership for Africa's Development (NEPAD); Agency (the convener of the Alliance); CARE; Catholic Relief Services; Concern Worldwide; Oxfam and World Vision; the Forum for Agriculture Research in Africa (FARA); the Food; Agriculture and Natural Resource Policy Analysis Network (FANRPAN); Climate Change; Agriculture and Food Security Research Program (CCAFS); and the Food and Agricultural Organization of the United Nations (FAO). The Africa Climate-Smart Agriculture Alliance promotes an approach on climate-smart agriculture that remains applicable to the African framework and was aimed at sustaining rapid scaling up of climate-smart agricultural practices across Africa by at least six (6) million farming households by 2021. This will contribute to the African Union-NEPAD's broader goal of supporting 25 million farm households by 2025 [6]. Climate-Smart Agriculture (CSA) is defined as agricultural practices that sustainably increases productivity, income and build resilience to climate change. As a result, eliminates greenhouse gas emission (mitigation) or adapts to changing climate, which heightens the accomplishment of national food security, developmental objectives and reduced poverty, [7]. 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 elimination of greenhouse gas (GHG) emission, [8]. Climate smart agricultural 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). Existing confirmation shows that Nigeria is already overwhelmed with various ecological problems which have been directly connected to the on-going climate change [9,10]. The Southern ecological zone of Nigeria mostly known for high rainwater is currently confronted by abnormality in the rainfall pattern. Also Guinea Savannah is under going slowly increasing temperatures, 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 [11,12]. 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. Second, most adaptation alternatives, for the need of being effective, involve implementation at the local level and fruitful initiatives pioneered at the local level and may be replicated and scaled-up nationally. It is on this note that this research work seeks to ascertain factor influencing indicators of climate smart agricultural practices on crop enterprise in the study area. The Nigerian story presents a contradiction because the country is rich, but the individuals are poor. This study seeks to determine the factors influencing indicators of climate smart agricultural practices on maize crop enterprise in the study area.

2. Materials and Methods

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 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 49,564,917.44 million [13]. North-West zone is characterized 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. Katsina State is divided for administrative purpose into three agricultural zones namely: Ajiwa, Funtua and Dutsinma zones, while Sokoto State is divided for administrative purpose into four agricultural zones namely: Tambuwa, Sokoto, Isa and Gwadabawa zones. This region is described by a relatively hot climate, with seasonal rainfall and a marked dry season [14]. It is therefore evident that changing climates (increasing droughts or floods) will influence agricultural productivity. The main source of livelihood of the people in this zone is agriculture. 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 farming etc are carried out and the livestock are reared extensively

2.1. 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 [15]. 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.

2.2. Analytical Method

The objective was to ascertain 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 was to examine with the aid of the Variance Inflation Factor (VIF) while the heteroscedasticity was automatically catered for by the Stata software using the robust option when regressing. To determine the factor influencing indicators of climate smart agricultural practices on maize crop enterprises. Socioeconomic variables are regressed against composite dependent variable the use of climate smart agricultural techniques in maize crop enterprises. 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 maize crop enterprise. The principal component analysis as specified by Ifelunini et al., [16] was presented thus: Given variables (Xs represent the various factors used to develop composite indices for maize crop) $X_1,\ldots, Xp$ measured in *n* farmers, while $Z_1,\ldots,Zp$ are the principal components which are uncorrelated linear combinations of the original variable, $X_1,\ldots, Xp$, given as;

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

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

This matrix of equations can be expressed as z = Ax, where $z = (Z_1\ldots Zp)$, $x = (X_1\ldots Xp)$ and A is the matrix of coefficients. The coefficients of the first principal component, $\alpha_{11}\ldots \alpha_1p$, are chosen in such a way that the variance of Z_1 is maximized subject to the constraint $\alpha 2_{11}\ldots \alpha_{21}p = 1$. The five composite variables are derived using the Principal Composite Analysis (PCA) that are regressed against the socio economic variables; age (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), dummy ownership (down), dummy for landacquisition (dlaq), dummy for type of labour (dtlab), 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), dummy access to credit (dacc), dummy lack of time (dlot), dummy State (dstate) and total household expenditure (thexp).

The multiple regression model is specified thus:

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

Where Y represents the dependent variable (the composite variables for the dependent models), 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.

3. Empirical Results and Discussion

This presents the results on the investigation of the factors influencing the use of climate smart agricultural techniques on maize crop enterprise using the Principal Component Analysis (PCA) and the multiple regression models through the use of Ordinary Least Square (OLS) estimation techniques. The principal components analysis was used to generate the composite variables for the use of climate smart agriculture for the maize crop enterprises. Thereafter, this composite variable was employed as dependent variable in order to investigate the factors or determinants for the maize crop. The composites are made up of the six forms of climate smart agricultural practices under consideration for the maize crop, and they include: use of organic manure, agro-forestry, agricultural conservation, irrigation, integrated crop/livestock management and use of improved hybrids.

3.1. Factors Influencing Climate Smart Agricultural Practices for the Maize Enterprise

The linear regression was done to evaluate the influence of the socio economic factors on maize enterprise using climate smart agriculture. The overall model was significant ($p < 0.01$). This implies that the model is well fitted. The R-square value of 0.2119 was obtained. This shows that 21.19% of the dependent variable was being explained by the explanatory (independent) variables. In addition, the multi-collinearity test indicated that the mean Variance Inflation Factor (VIF) was 1.52. This implies that the model is void of any serious multicollinearity problem. The study employed the use of the 'robust' option (using Stata) which ensured that results were void of heteroscedasticity. Table 1 shows the result of maize enterprise. Nine variables were significant: Age, gender, marital status and household were significant ($p < 0.10$), with age positively significant inferring that a unit increase in age will result in corresponding increase in the practice of climate smart agricultural indices on maize enterprise by 0.0264. This was contrary to apriori expectation and suggests that the climate smart agricultural practices of maize enterprise might have been used by these farmers for a very long time and so experience tend to give the older farmers an edge over the younger ones. The results are contrary to the findings of Akinyemi *et al.*, [17] which discovered that farmers' agricultural participation is inversely related to their age. The older the farmers, the less active they tend to be in their involvement in agricultural activities. Also, the results showed that many more male farmers used climate smart agriculture in the maize enterprise than their female counterparts by 0.6001. Also, married farmers (monogamy and polygamy) were significantly higher in terms of the use of climate smart agriculture for maize enterprise than their counterparts (divorced, widowed and singled). The results corroborate the work of Zitha [18], who found out that married farmers tend to have a stability advantage and supportive assistance from their spouses which can be used to boost their farming activities. The work of Judy [19], emphasized the dominance of agricultural activities by men in Sub-Saharan countries especially in the production of cash crops. Education, housing materials, and lack of time were negatively significant ($p < 0.01$). The results suggest that those who had informal education (Arabic education) had significantly lower indices of climate smart agriculture for maize production than their counterparts who had formal education primary, secondary and tertiary. This is contrary to apriori expectation and also opposed to the findings of Isaac [20], which asserted that education promotes agricultural activities both among the peasant and commercial farmers. Meanwhile, the farmers with mud/thatched and mud/zinc houses had significantly lower usage of climate smart agriculture in the production of maize when compare with those with brick/zinc and concrete block zinc houses. The study showed a significant and negative relationship between respondents who professed the lack of time, and those who did not in terms of climate smart agricultural practices for the production of maize. The results suggest that those who lack time to practice climate smart agriculture had significantly lower indices of climate smart agriculture for maize enterprise than their counter parts who had enough time. Furthermore, Communication was significant ($p < 0.05$). It connotes that the use of climate smart agriculture for maize enterprise by respondents who were communicated by handsets Global System for Mobile (GSM) was significantly lower by 0.2949 than those who were informed by radios, televisions and videos. This result contradicts the apriori expectation but it shows that the farmers were not getting supportive information that will enhance climate smart agricultural activities in the study area through phones. This buttresses the assertion of Okediji [21], who posit that, network problems and poor road networking imposed difficulties to farmers' use of handsets as a means of communication among the rural communities.

Table 1. Ordinary Least Square (OLS) Regression Result of Maize Enterprise

Maize CSA enterprise	Coefficient	Standard error	t-value	P-value	Tolerance
Age	.0263797	.0138967	1.90	0.059***	0.3846
Gender	.600618	.3175352	1.89	0.060***	0.4948
Education	-.2403243	.0913511	-2.63	0.009*	0.8864
Marital	.6383875	.3534255	1.81	0.072***	0.5442
Religion	-.0795656	.2310621	-0.34	0.732	0.8153
Households	-.0568359	.0310621	-1.83	0.068***	0.6000
Farmsize	.0328947	.0248263	1.32	0.186	0.7545
Experience	-.0106109	.0149105	-0.71	0.559	0.4197
Ownership	-.1908068	.3258319	-0.59	0.559	0.5329
Landacquisition	.2637486	.3132237	0.84	0.400	0.6650
Labour	-.0025226	.2715146	-0.01	0.993	0.9388
Membership	0.331398	.1720026	0.19	0.847	0.6304
Transportation	.0549571	.2182468	0.25	0.801	0.8688
Housingmaterial	-.7796276	.2003394	-3.89	0.000*	0.7829
Communication	-.294856	.144532	-2.04	0.042**	0.8080
Extension contact	-.0107841	.0637598	-0.17	0.866	0.9525
Access to credit	.0086644	.1592249	0.05	0.957	0.6865
Lack of time	-.1461511	.1614057	0.91	0.000*	0.8660
State	.7709275	.1785835	4.32	0.000*	0.6911
Expenditure	-2.97e-06	6.23e-06	-0.48	0.634	0.7650
Constants	-1.684111	.6080197	-2.77	0.006	
Number of Obs:	294				
F (20, 273)	4.14				
Prob> F	0.0000				
R-Squared	0.2119				
Root MSE	1.1509				

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

Table 2. Multi-Collinearity Test of Variables

Variable	VIF	Tolerance	Eigen Value
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 Multi collinearity Test.

4. Conclusion and Recommendation

The study was motivated by the increasing consequence of climate change and its impact on agriculture and 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 was therefore to evaluate factors influencing indicators of climate smart agricultural practices on maize crop enterprise in North-West Nigeria. The specific research question then addressed what are the factors influencing the indicators of climate smart agricultural practices on maize crops enterprises? The study employed principal component analysis, ordinary least square regression analysis to address this research question. The study showed that age ($p < 0.10$), gender ($p < 0.10$), education ($p < 0.01$), marital status ($p < 0.10$), households ($p < 0.10$), housing material ($p< 0.01$), communication ($p < 0.05$), lack of time ($p < 0.01$) and State ($p < 0.01$) were significant determinants of the use of climate smart agricultural practices in the maize enterprise. Based on the outcome, the study recommended that: Women especially should develop interest in climate smart agricultural farming activities, through women empowerment programmes instituted by government and private bodies because men dominate the climate smart agricultural practices in the study area. Government, Non-Governmental Organizations and farmer associations should create a conducive learning environment to encourage the farmers of climate smart agriculture in the study area to embrace formal education which can improve on their performance rapidly. Policy on informal education should be enriched and developed in the curriculum to meet the current climate smart agricultural challenges.

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