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Adoption of climate smart agricultural practices among smallholder vegetable (*Telfairia occidentalis*) farmers in Obio-Akpor Local Government Area, Rivers State, Nigeria

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ABSTRACT

The paper x-rayed the adoption of climate-smart agricultural practices among smallholder vegetable farmers in Obio-Akpor Local Government Area of Rivers State, Nigeria. Data were collected from 99 respondents with the aid of a structured questionnaire. Descriptive statistics and logit regression analysis were used as the analytical tools. The results on socioeconomic characteristics of the farmers showed that they were mostly 59years old, 50% were married, 83% were males and 16% were females. Most of the farmers had a mean household size of 8 persons, mean farming experience of 18 years, with a mean of 5years spent in school as well as a mean income of ₦163, 091.84. The study identified bush fallowing, crop rotation, weeding, mulching planting of trees as wind breaks, watering, local weather forecasting, zero tillage, cover cropping as the existing/indigenous climate smart agricultural practices in the study area. Results also showed that some farmers have already adopted the indigenous climate smart agricultural practices without even being aware of the term “climate smart agriculture”. The non-climate smart practices include poor fertilizer application, organic manure application, mounds and ridges. The result of the logit regression showed that age, farming experience, marital status and number of farms were significant at 1% (< 0.01). Extension agents and other relevant stakeholders should create awareness and educate farmers on climate-smart agriculture to enable them adopt more of the practices.

Keywords: Climate-smart, vegetable, agricultural practices

INTRODUCTION

The need to increase agricultural productivity and ensure food security in Nigeria for the teeming population has been faced by a myriad of problems like degradation of natural resources and worst hit by the impact of climate change. Climate change is a serious and urgent global issue which is associated with rising demand for

food, feed, fiber, and fuel as well as irreparable damage to the natural resource base (International Assessment of Agricultural Knowledge, Science Technology for Development, 2008). Climate change is such a worrisome issue in the planet as it threatens to aggravate the existing problems confronting mankind. It is clear that climate change is

not only caused by human activities but that the change is more rapid than ever before and more dangerous than earlier thought (Intergovernmental Panel for Climate Change, 2007; International Association of Research Universities, 2009). Climate change is defined as “a change in the state of the climate with observed changes in the mean and variability of climatic properties which persists for a period, either longer or decades (IPCC,2007). It is a change in climate condition over time as a result of natural variability or human activity” (IPCC, 2007). climate change affects about 70% of people in developing countries who reside in rural areas where agriculture is the main source of livelihood (Vermeulen et al. 2012). This was confirmed by studies which showed that climate change has a negative impact on agriculture both in Africa (Building Nigeria’s Response to Climate Change (BNRCC) (2008); Food and Agriculture Organization (2016) and also Nigeria where the farmers rely so much on rainfed agriculture (Onyeneke 2010). This according to Henri-Ukoha and Adesope(2018) exacerbates poverty.

Climate Smart Agriculture is a response to reduce both greenhouse gases (GHG) emissions and the vulnerability of agriculture (Tambi, Mukhebi, Maina and Solomon, 1999). Food and Agriculture Organisation (2010), defined “CSA” as the agriculture adaptation methods that sustainably increases productivity, resilience, reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals. Therefore, CSA practices can be integrated into a single farming system and provide multiple benefits that can improve livelihoods and incomes, for smallholder farmers. CSA seeks to maximize benefits and minimize negative trade-offs across the multiple

objectives which include food security, development, climate variability adaptation, and mitigation (Onoja., Tambi, Bangali, 2015; Maguza-Tembo., Abdi-Khali., Mangisoni and Mkwambisi, 2016).

However, escaping poverty traps in many developing countries depend on the growth and development of the agriculture sector (World Bank, 2008). Agricultural growth and development in the face of the changing climate is not possible without options as merely expanding the area under cultivation to meet the increasing food needs of the growing populations is no longer sufficient. Therefore, research and adoption of certain practices are germane to improvements in agricultural productivity and poverty reduction (World Bank, 2008). Adoption exposes farmers with options and trade-offs which are often influenced by diverse cultures, varying resource base, different objectives, different preferences as well as different socio-economic backgrounds(Tambi, Mukhebi, Maina and Solomon, 1999).

According to (Loevinsohn et al. 2013), adoption is the integration of new technology or approach into existing practices which is proceeded by trial and some form of adaptation. The rate of adoption is defined as “the relative speed with which an innovation is adopted by members of a social system” (Rogers, 2003). Adoption of CSA has become a major consideration to most smallholder farmers in Nigeria. In a study on determinants of climate smart agriculture technology adoption in the drought prone districts of Malawi using a multivariate probit analysis, Maguza-Tembo et al. (2017) observed that gender, age, location, farmer type, level of education, livelihood status/ off-farm participation, land size and source/ownership household income,

household expenditure, anticipated weather pattern, climate variability knowledge/signs, access to credit, all influence the adoption decision of Climate Smart Technologies either positively or negatively. In a study on the status of climate smart agriculture in South East Nigeria, Onyeneke., Nwajiuba., Nwosu., Uwadoka and Aligbe (2016) identified some climate smart practices and suggested that practices that are on ground and familiar with farmers that could enhance and reposition climate-smart agriculture in southeast Nigeria, should be replicated to other parts of Nigeria. However, the area of climate smart agricultural practices in vegetable farming has not been widely researched in the study area leading to a problem which this study intends to address. Against this background, it became imperative : to describe the socio-economic characteristics of vegetable farmers in the study area, ascertain the level of awareness of climate smart agricultural practices by vegetable (*Telfairia occidentalis*) farmers in the study area, describe the existing climate-smart agricultural practices among vegetable farmers in the study area relevant to climate change and to identify the determinants of adoption of climate-smart practices among vegetable farmers in Obio-Akpor Local Government Area. Through this study, ways of improving the adoption level will be identified. This will minimize the vulnerability of the vegetable farmers to the effects of climate change.

MATERIALS AND METHODS

The study population comprised the vegetable farmers in Obio-Akpor Local Government Area. Multi-stage sampling technique used in the selection of the vegetable farmers in the study. In the first stage, nine communities were selected

purposively from 62 communities in the study area. This was to get the communities where the cultivation of vegetable was most predominant. In the second stage, a total of eleven 11 farmers were randomly selected from each of the nine of the communities, giving total of 99 farmers from a list of registered vegetable farmers in the study area. The list was compiled by the Agricultural Development Programme Extension Agent resident in the area.

Data were collected from a primary source using structured questionnaire and oral interview. Data were also obtained through secondary sources such as journals, internet and textbooks.

Data were analyzed using simple descriptive statistical tools such as frequency count, percentages and mean as well as logit regression model.

The Logit model is expressed as:

$$\text{Ln} \left(\frac{y}{1-y} \right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 \dots \beta_n x_n$$

Where:

1 = probability that a farmer will adopt climate-smart agricultural practice
 0 = probability that a farmer will not adopt climate-smart agricultural practice

X₁ = Age (years)
 X₂ = Household size (number of persons)
 X₃ = Level of education (years)
 X₄ = Farming experience (years)
 X₅ = Income of farmers (Naira)
 X₆ = Farm size (Ha)
 X₇ = Number of years
 X₈ = Distance to water source (km)
 X₉ = Marital status (Dummy; 1 = single, 2 = married)
 X₁₀ = Access to Extension services (Dummy; 1 = Yes, No = 0)

- X₁₁ = Exposure to mass media (Dummy; 1 = yes, No = 0, (Number of exposure per annum)
- X₁₂ = Gender (Dummy; 1 = male, 0 = female)
- X₁₃ = Access to credit (Dummy; yes = 1, No = 0)
- X₁₄ = Land ownership (Dummy, 1 = owner, owner = 0)
- e = error term

RESULTS

Socio-economic Characteristics of the Respondents

The socio-economic characteristics of the vegetable farmers showed that 28% of the farmers were within the age of 61-70 years, while 4.0% of them were within the age of 81 years and above, with a mean of 59.17. The result also indicate that 38.38% of the vegetable famers are within the household size of 7-9 persons, while 1.0% of the vegetable farmers fall within the range of 14 and above persons, with a mean household of 8 persons. The levels of education of the vegetable farmers showed that 38.38% of the farmers acquired secondary education and are within the range of 7-12 years spent in secondary school while 10% of the farmers have acquired tertiary education with a mean of 5.4. About 52.53% of the farmers has income with below ₦100, 000 naira, while 4.0% are within ₦500,000 – ₦800,000 with mean income of ₦163, 091.84. The result also showed that 38.38% of the farmers have farming experience of 1-10 years, while 4.0% have farming experience within 41-50 years and above with mean of 18. The result also indicate that 45.45% of farmers have a farm size within and below 0.5 hectares, while 4.04% of farmers have farm size within 2.1-3.0 hectares, with their mean of 0.75 hectares.

The result on farm size showed that 39.39% of farmers cultivated 3-4 farms, while 1% of farmers had 7-8 farms and above, with mean of 4. The result showed that 70.71% of farmers had their farms and house close within 0.6-1.0km, while 3.0% of farmers have their farms away from their houses within 2.1-3.0km. The distance of the farms to market showed that 80% of farm have their farms distant from market within 0.6-1.0km, while 1% of farmers have their farms distant from market within 2km and above with mean of 1km. The result also showed that majority of the farmers are married at 50%, while 2% are single 6% are divorced, 38% are widows and widowers, and 3% are separated. Also from Table, 22% of the farmers have access to extension services, while 77% of the farmers do not have access to extension services. The result on access to media showed that 56% of farmers have access to mass media, while 43% are not exposed to mass media. Table 1 also indicates that 83% of the farmers are males while 16% are females. Also from the results, majority of the farmers do not have access to credit facilities while 24% of the farmers had access to credit facilities.

Awareness of Climate Smart Agriculture

The result on awareness of climate smart agricultural practices in the area is presented in Table 2 above. The table showed that 99% of the vegetable farmers are aware of agricultural practices that boost productivity. Also, 36% of the vegetable farmers carryout practices that reduce or remove Green House Gases (mitigation). Table 2 also showed that 52% of the vegetable farmers carryout practices that helps them to withstand the shocks arising from climate change impacts (resilience) and at the same time adapt to the effect of extreme weather events (adaptation). Meanwhile, only 14% of the vegetable farmers are aware that the integration of productivity, mitigation and

adaptation/resilience are climate smart agricultural practices in the study area.

Table 1. Distribution of Vegetable Farmers According to Socio-economic characteristics

Variables	Frequency	Percentage	Mean
Age (Years)			
30-40	10	10.10	59.17
41-50	20	20.20	
51-60	24	24.24	
61-70	28	28.28	
71-80	13	13.13	
81 and above	4	4.04	
Household Size (Number)			
1-3	10	10.10	8
4-6	25	25.25	
7-9	38	38.38	
10-13	25	25.25	
14 and above	1	1.01	
Level of Education (Years)			
0 (No formal education)	18	18.18	5.4
1-6	33	33.33	
7-12	38	38.38	
13 and above	10	10.10	
Farming Experience (Years)			
1-10	38	38.38	18 yrs
11-20	30	30.30	
21-30	15	16.16	
31-40	11	11.11	
41-50	4	4.04	
Income (Naira)			
Below 100,000	52	52.53	163,091.84
101-300	35	35.35	
301-500	8	8.08	
501-800	4	4.04	
Farm Size (Hectares)			
Below 0.5	45	45.45	0.75
0.51-1.0	30	30.30	
1.1-1.5	11	11.11	
1.51-2.0	9	9.09	
2.1-3.0	4	4.04	
Number of Farms			
1-2	33	33.33	4.0

3-4	39	39.39	
5-6	20	20.20	
7-8	6	6.06	
9 and above	1	1.01	
Distance to Farm (km)			
0.1-0.5	9	9.09	1.04
0.6-1.0	70	70.71	
1.1.-1.5	8	8.08	
1.6-2.0	9	9.09	
2.1-3.0	3	3.03	
Distance to Market (km)			
0.1-0.5	3	3.03	1.04
0.6-1.0	79	79.8	
1.1-1.5	13	13.13	
1.6-2.0	3	3.03	
2.1 and above	1	1.01	
Marital Status			
Single	2	2.02	
Married	50	50.50	
Divorce	6	6.06	
Widow/widower	38	38.38	
Separated	3	3.03	
Access to Extension Services			
No	77	77.7	
Yes	22	22.22	
Exposure to Mass Media (Per Annum)			
No	43	43.43	
Yes	56	56.56	
Gender			
Female	16	16.16	
Male	83	83.83	
Access to Credit			
Yes	13	13.13	
No	86	86.86	
Total	99	100	

Source: Field Survey, 2018.

Table 2. Awareness of Climate-Smart Agriculture by Vegetable Farmers in the Study Area

Practices	*Frequency	Percentage (%)
Productivity	99	99.99
Mitigation	36	36.36
Adaptation/Resilience	52	52.52
CSA	14	14.14

Source: Field Survey, 2018; *Multiple responses recorded

The perceived existing/indigenous climate smart agricultural practices in the study area

The result on the perceived existing climate smart agricultural practices is shown in Table 3 below. From the results, reduced burning of residue, zero tillage, mulching, mixed cropping, application of wood ash, planting of trees to serve as wind breaks, local weather forecasting, weeding,

watering, bush fallowing, crop rotation and cover cropping are the perceived existing/indigenous climate smart agricultural practices practiced by the vegetable farmers in the study area. Meanwhile, tillage, fertilizer application, use of organic manure are practiced in the area but are not perceived climate smart practices.

Table 3. The perceived existing climate-smart agriculture practices in the study area

Practices	Productivity	Resilience/Adaptation	Mitigation
Reduced burning residue	++	+	++
Zero-tillage/No tillage	+++	+	++
Mounds/ridges	+++	++	-
Mulching	++	+++	++
Mixed cropping	+	++	++
Application of wood ash	+++	+	+++
Planting of trees to serve as wind break	+++	++	++
Local weather forecasting	+	+	+
Weeding	++	+	+
Watering	+	+	+
Fertilizer application	+	+	-
Bush fallowing	+	+	+
Organic manure application	+	+	-
Crop rotation	+	+	+
Cover cropping	+++	++	-

Source: Field survey, 2018.

+++ Indicate the practices boost productivity, enhance resilience/adaptation and remove Green House Gases (mitigation) simultaneously.(+++) (++) (+).

+ Indicates that these practices raise productivity or enhance resilience/adaptation or mitigate climate change effects, but not as much as (++) (+++). i.e. less

++ Shows that these practices either raise productivity and enhance resilience/adaptation but may not mitigate climate change effects and vice versa.

- Indicates that these practices are not smart because they do not boost productivity, resilience/adaptation and mitigation.

Determinants of Adoption of Climate-Smart Agricultural Practices.

The results of the logit regression on determinants of adoption of climate-smart

agriculture in the study area as presented in Table 4. The likelihood chi-square of 33.70 is significant at 1% (< 0.01).Also from the table, age, farming experience, number of

farms and marital status of farmers are positive and significant at 1% (<0.01) while level of education, distance to water source

and exposure to mass media are positive and significant at 10% (<0.10).

Table 3: Result of logit regression analysis on determinants of the adoption of climate-smart agricultural practices in the study area

Variables	Coefficients	Standard Error	T-ratios
Age	1.003057	0.032536	3.0829*
Household size	0.9293239	0.952177	0.9760
Level of education	0.9362251	0.0549969	1.708***
Farming experience	0.9891434	0.0278246	35.5492*
Income (naira)	1.000002	2.09006	0.4785
Farm size (ha)	4.553874	3.266806	1.3940
Number of farms	0.8765262	0.1569401	5.5851*
Distance to water (km)	0.4031771	0.2459782	1.6390***
Marital status	0.6694484	0.2329474	2.8738*
Access to Extension Services	0.1558921	0.1419666	1.0981
Exposure to mass media	3.4933888	2.468507	1.4153***
Gender	3.961658	3.699513	1.0708
Access to credit	0.4680191	0.373148	1.2543
Land Ownership	0.229258	0.1479193	0.022
Constants	23.97125	51.62853	0.4643
Logistic Regression chi-square	= 33.70		
Number of observations	= 99		

Source: Field Survey, 2018

*1% level of significance, **5% level, ***10% level of significance

DISCUSSION

There appears to be the dominance of middle aged vegetable farmers in the study area. This suggests that the vegetable farmers are energetic, hence are able to carry out practices and adopt climate-smart agriculture (Henri-Ukoha and Osuji, 2017).

The mean household size of 8 persons showed that the vegetable farmers have large household sizes. This has implications for availability of farm hands which will enhance productivity and carry out more climate-smart practices. The mean number of years spent in school indicated as 5.4 showed the farmers acquired education. Education exposes farmers to technologies and innovations that would enable farmers

adopt climate-smart agricultural practices. A mean income of ₦163, 091.84 is an indication that most of the vegetable farmers have low income which might limit their ability to purchase technologies. This could limit their ability to adopt climate-smart agriculture. A mean farming experience of 18 years indicates that the vegetable farmers are well experienced. This suggests that they possess substantial wealth of experience which could increase their ability to carry out climate-smart practices. A mean farm size of 0.75 hectares indicates that they are smallholder farmers. This could be attributed to the land tenure system practice in the study area. This may also be due to approaching development and urbanization where lands are sold off and much attention

is not given agriculture. Farmers with smaller farm size will find it difficult to carry out practices that enhance productivity, resilience adaptation and mitigate climate change effects and adoption of climate smart agriculture will be low. This is in line with findings of Nwajiuba, Emmanuel and Solomon (2015). A mean number of 4 farmers show that the farmers have few farms. Table 1 also showed that majority (70.71%) of the farmers have farms that are located to water bodies within 0.6 to 1.0km. This implies that farmers whose farms are close to their houses are able to carry out climate smart practices, this will make it easy for them to harvest water for the farm. A mean distance of 1km from the farms indicates they have distant farms. This is possible when there is water in the household, closeness of farm to house will make it easy for adequate monitoring of farm, convey of produce from farm to markets (Onyeneke et al. 2016). Majority (80%) of the farmers are married. This indicates that farmers who are married are likely to adopt climate-smart agriculture. This might be due to the fact that they will get access to credit support from their spouse to concentrate more on agricultural activities. About 77% of the farmers do not have access to agricultural extension services. This implies that most of them may not be exposed to climate-smart agricultural practices which makes it difficult for them to adopt. Contacts or visits with extension agents provides opportunity for transfer of skills, knowledge, technology and information which will facilitate the adoption of climate-smart agricultural practices.

Majority(56%) of the farmers are exposed to mass media. This implies that they have

higher chances of being exposed to vital information that will enable them adopt climate-smart agricultural practices. Majority(83%) of the farmers are males, implying that they are more and carryout agricultural practices more than females. Majority (66%) of the farmers do not have access to credit facilities. This indicates that most of the farmers may not be able to afford inputs and other technologies necessary for the adoption of climate smart agricultural practices.

Table 2 showed that 99% of the vegetable farmers are aware of agricultural practices that boost productivity. This suggests that they know the practices that will enable farmers have higher productivity (productivity). Also from the results, 36% of the vegetable farmers carryout practices that reduce or remove Green House Gases (mitigation). Table 2 also showed that 52% of the vegetable farmers carryout practices that helps them to withstand the shocks arising from climate change impacts (resilience) and at the same time adapt to the effect of extreme weather events (adaptation). Meanwhile, only 14% of the vegetable farmers are aware that the integration of productivity, mitigation and adaptation/resilience are climate smart agricultural practices in the study area. These are in line with findings of Chidiebere-Mark et al. (2017) who observed that most farmers are not aware of climate-smart agriculture but are already practicing it. Farmers who are aware of changes in climatic conditions have higher changes of adopting practices that make them more resilient (Madison, 2006). Raising awareness of changes in climatic conditions and practices that are climate-smart to avert the effects of change in climate would have

greater impact in increasing their willingness to adopt. Climate-smart agriculture is a platform where the triple possibility of simultaneously increasing productivity, enhancing resilience (adaptation) and mitigating green house emissions becomes possible (Nwajiuba et al. 2015).

The result on the perceived existing climate smart agricultural practices is shown in Table 3. From the results, reduced burning of residue, zero tillage, mulching, mixed cropping, application of wood ash, planting of trees to serve as wind breaks, local weather forecasting, weeding, watering, bush fallowing, crop rotation and cover cropping are the perceived existing/indigenous climate smart agricultural practices adopted by the vegetable farmers in the study area. They are climate-smart agricultural practices because they raise productivity, enhance resilience (adoption) and at the same time produce positive mitigation benefits. This in line with findings of (Agele., Iremiren and Ojeniye, 2000). Table 3 also shows that tillage, fertilizer application, use of organic manure are practiced in the area but are not perceived climate smart practices. During tillage operations especially with tractor, fuel is burnt releasing carbon dioxide into the atmosphere, carbon is also released into the atmosphere. Poor fertilizer management leads to the release of nitrous oxides, poorly managed organic manure can lead to the release of green house gases in the atmosphere. That is why they are not climate smart agricultural practices. They are practices that boost productivity, enhance resilience but in turn lead to the emission of greenhouses gases which contributes to global warming (Henri-Ukoha., Ugwuja and Uhuegbulam, 2017).

The results of the logit regression on determinants of climate-smart agriculture in the study area are presented in Table 4. A likelihood chi-square of 33.70 is significant at 1% (< 0.01) indicating that the model had good fit to the data. Age is significant at 1% (< 0.01). This implies that the more the older the farmers, the more experience they have about smart practices and changes in climate. This will increase the likelihood of adopting climate-smart agriculture.

Farming experience is significant at 1% (< 0.01). This indicates that a unit increase in farming experience increases the likelihood of adopting smart practices, experienced farmers have more knowledge about changes in climatic conditions.

Number of farms is significant at 1% (< 0.01). This implies that a unit increase in the number of farms cultivated increases the likelihood of adopting climate smart agriculture. Farmers will be able to carry out practices such as shifting cultivation and crop rotations.

Marital status of farmers is significant at 1% (< 0.01). This implies that farmers who are married will be willing to adopt climate smart agriculture as they will gain support from their spouse and children, it also indicates the availability of farm hand. A positive and significant level of education implies that the more education a farmer acquires, the more the likelihood of adopting climate smart agricultural practices.

Distance to water which was positive and significant at 10% (< 0.01) suggests that the closer the farm is to source of water, the higher the likelihood of adopting climate smart agricultural practices. This is consistent with Onyeneke et al. (2016). A positive and significant value of exposure to mass media at 10percent implies that the exposed the farmer is to information on climate smart agriculture, the more the

likelihood of adopting it *ceteris paribus*. Exposure to information affords the farmer the privilege of getting the right mix of information properties for a particular technology which influences his adoption behavior (Maguza-Tembo et.al, 2017).

CONCLUSION AND RECOMMENDATIONS

From the findings, the smallholder vegetable farmers are educated, experienced farmers that have large households. They are not aware of climate smart agriculture but they have adopted some that are indigenous to them. Age, farming experience, number of farms and marital status are important determinants of climate smart agricultural practices in the study area. Based on the findings, extension agents should educate them well on the what they are already doing to encourage them to do more. They should also expose farmers to more practical climate-smart practices so that they will be willing to adopt more. The land use act should be revisited to enable farmers acquire more farmlands. Again, farmers should be encouraged to utilize the various credit options made available to them by government and relevant stakeholders.

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