Factors Influencing the Adoption of Climate Smart Agricultural Technologies Among Root Crop Farming Households in Nigeria

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Abstract
The variability and change in climatic factors has impacted greatly on food production in Nigeria. The adoption of climate smart agricultural (CSA) approach by root crop farmers is critical to sustainable food production in the face of climate change impacts. The study identified CSA technologies adopted by root crop farmers as well as examined socio economic factors that influence the adoption these technologies among smallholder root crop farmers in Nigeria. The data obtained were analyzed using descriptive statistic and Tobit regression analysis. The CSA technologies adopted by the root crop farmers in the study area include use of irrigation (12.62%), having diversity of production streams through livestock ownership (51.54%), crop rotation (87.03%) and use of improved crop variety (19.45%). Agricultural climate smart adaptation decisions were influenced by farm size, age, access to credit, level of education and ownership of means of transport. Based on the result, it was recommended that financing institutions should enhance access to credit to rural households for those who need them most and minimize financial exclusiveness. Also, educational campaign and awareness on climate smart agricultural activities should be embarked on so as to uplift the consciousness of root crop farmers on CSA technologies. More so improved root crop varieties are required for sustainable food production and food security in Nigeria.
Keywords: Root crop, climate smart, Production, and Smallholder.

Introduction

The productivity trend in agriculture needs to be adjusted in other to feed the rapidly growing and urbanizing populations that is predominantly located in Sub Saharan Africa. The yield gap required to be filled varies across locations due to production efficiency and changes in consumption pattern but expectation was estimated to be between 25 and 70 %. [1]. The expected rise in food productivity will be happening under limited land, intense climate variability and change. A better approach to agricultural production need to be adopted in other to overcome the problem of limited scarce resources [2]. With utmost consideration given to the changes in atmospheric weather conditions, with special interest to the reduction to greenhouse gas(GHG) emissions. The atmospheric concentration of GHG was projected to be duple by 2030, thereby leading to a more global warming [3]. The present climatic conditions will globally not be favorable to agricultural production especially in developing countries were rural farming household are the major producers. The smallholder agricultural production systems should be equipped to improve the production capacity, in other to sustain the food demand of the growing populace [4]. In the face of these obstacles, different adaptive approaches such as Climate Smart Agricultural Approach have been established and endorsed as a panacea to improving farm productivity and boost food security in SSA [5]. The application of Climate smart agricultural technologies will encourage the adoption of most impactful practices that will increase food production while mitigating climate change. This consist of reduction in greenhouse gas emissions, growing of soil fertility and carbon sequestration, tackle resilience to climate to change, and a better use of the natural environmental services [6,7] According to the Food and Agricultural Organization (FAO) CSA is defined as the agricultural approaches that sustainably increase productivity, resilience, mitigation and improves achievement of national food security and development goals [8]. The application of CSA comprises of various activities, for example mulching, intercropping, crop rotation, water harvesting, irrigation, integrated nutrient management, agroforestry and conservation tillage [9]. The effects of climate variability and change is taking a great toll on rural farming households in SSS, due to inadequate adaptation measures [10,11]. CSA has gained the approval of having the capability of bringing proper mitigation- adaptation progress outcomes which has drawn the attention of policy and development practitioners, but this can be achieved through a cautious blends of different CSA activities, rather than a single CSA activity [12]. In spite of the possible gains of CSA, its practices in less developed economies are not accomplishing their complete budding because of low adoption level [13]. low adoption decision of CSA technologies could hinge on institutional limitation, farm and farmer characteristics, in addition to how the activity appear in themselves [14,15]. The role of farm and farmer characteristics concerning the adoption of CSA has been examined by some researchers in many regions and on different crops [16,17], but as to how it influences the adoption decision of root crop farming households in Nigeria requires thoughtful attention. This study thereby sought to fill the knowledge gap by evaluating the factors responsible in influencing the adoption decision of climate smart agricultural technologies of root crop farmers in Nigeria. specifically, by examining the socio-economic characteristics of the respondents in the study area; to identify climate smart agricultural technologies adopted in the study area and to determine factors influencing root crop farmers decision to adopt CSA technologies.

2. Materials and Methods

Study area

The study was done in Nigeria. The Federal Republic of Nigeria is in West Africa between latitudes 4^0 to 14^0 North and between longitudes 2^02^1 and 14^030^1 East. To the North, the country is bounded by Niger Republic (1497km) and Chad (853km) to the West by Benin Republic (773km) to the East by the Cameroon Republic (1690km) and to the South by Atlantic Ocean. Nigeria has a population of over 200 million people [18], with diverse biophysical characteristics, ethnic nationalities (more than 250), agro-ecological zones and socio-economic conditions. Farming is the predominant occupation of the people; about half of the working population is engaged in agriculture majority of who are small holder farmers. Cassava, yam, sweet potato, sorghum, maize, millet and rice are among the major food and cereal crops in Nigeria [19]. The environmental challenges facing the country include excessive flooding, desertification, soil degradation, rapid deforestation.

Sampling technique

A total of 360 farming households were chosen from the three states of different agro climate namely Abia, Ebonyi and Benue in Nigeria. A multi-stage random sampling technique was adopted in selecting respondents. First, a purposive selection of one local government area (LGA) each was selected from three senatorial zones. Secondly two farming communities were randomly selected from each of the selected LGA, twenty (20) farmers were randomly selected from each the selected communities, giving us a total of 360 respondents. Data were collected on a number of household variables including demographics, socio economic variable, land use and ownership, climate change impacts and responses. Only 293 households were used in the analysis; 67 households were dropped because of incomplete and/or inconsistent data.

Analytical techniques

Objectives (i) and (ii) which are to examine the socio-economic characteristics of the respondents and identify climate smart agricultural technologies adopted in the study area were analyzed with descriptive statistics such as frequencies, means and percentages; objective (iii) which is to determine the factors that influence root crop farmers' decision to adopt CSA technologies was achieved using Tobit regression model.

Specifications of model

For objective (iii) which is to determine the factors that influence root crop farmers' decision to adopt CSA technologies was analyzed with Tobit regression model.

The model is specified explicitly as

Y= f (X1, X2, X3, X4, X5, X6, X7, X8) +e
Where,
Y= Adoption decision (adopted= 1, not adopted =0)
X1 = Age of the farmer (years)
X2 = Farming experience (years)
X3 = Level of Education (Years of formal schooling)
X4 = Household size (Number of people feeding from the same pot)
X5= Access to credit (Dummy Yes= 1, No=0)
X6 = Farm size (hectare)
X7 = Contact with Extension agent
X8 = ownership of means of transport (Dummy Yes = 1, No = 0)
E = error term.

3.Results

3.1Socio –Economic Characteristics of the Root Crops Farming Households in the Study area

The result of socio-economic characteristics of the root crops farmers in the study area is presented in table 1. The result shows that 40.61% and 59.39% respectively constitute the proportion of female and male farmers in the study area. The result further shows that about 66.55% of the farmers are within the age bracket of between 30-49 years, while about 9.02% are above 60 years. More so, greater percentage has more than 20 years of farming (61.77%) with about 61.43% having a household size of about 5-8 persons.

Table 1: Distribution of respondents on socio economic characteristics of Root Crop Farmers (N=293)

Variable	Frequency	percentage
Gender		
Female	119	40.61
Male	174	59.39
Age		
< 20	4	1.37
20-29	24	8.19
30-39	100	34.13
40-49	95	32.42
50-59	42	14.33
60-69	21	7.17
70-79	5	1.71
80-89	2	0.68
Farming Experience		

0-9	80	27.30
10-19	131	44.71
20-29	50	17.06
30-39	21	7.17
40-49	10	3.41
50-59	1	0.34
Household size		
1-4	55	18.77
5-8	180	61.43
9-12	47	16.04
>13	11	3.75
Level of Education		
0-6	69	23.55
7-12	100	34.13
>13	124	42.32
Farm size		
<1	8	2.73
1-4	210	71.67
5-8	50	17.06
9-12	7	2.39
13-16	1	0.34
>17	8	2.73
Access to credit		
Access	133	45.39
Non-Access	160	54.61
Contact with Extension Agent		
Contact	190	64.85
No Contact	103	35.15
Membership to cooperatives		
Members	183	62.46
Non-Members	110	37.54

Source: Field survey 2020.

The result from the table also shows that about 58 % of the farmers had more than 6 years of primary education. Majority (71.67%) of the respondents have farm size of between 1- 4 hectares while about 54 % could have access to credit facilities. It was also established from the table that about 64.85and 62.46 % respectively of the respondents had contact with Extension agents and belonged to one cooperative organization or the other.

3.2 Climate smart agricultural technologies practiced among Root Crop Farmers in Nigeria.

The study identified some climate smart agricultural technologies adopted by the farmers to combat climate change impacts and meet their food security needs. The various climate smart technologies identified that root crop farmers adopted in the study area are shown in Table 2. Moreover, most of these activities have been put into practice over decades ago, but it was observed that the use of these approaches has been on the increase in the recent years due to prolonged droughts and floods incidence that have been worsened by variability in climate and weather. The major CSA technology used by root crop farmers included use of irrigation, crop rotation, diversity of production through livestock ownership and use of improved crop variety.

Table 2: Distribution of identified Climate Smart agricultural technologies practiced among Root Crop Farmers in Nigeria.

Technologies	Frequency	percentage
Use of Irrigation	37	12.62
Crop rotation	255	81.03
Diversity of production (livestock ownership)	151	51.54
Use of improved crop variety	57	19.45

Computed from field survey 2020, multiple responses.

The result in table 2 shows that about 81% of farmers in the study area practice crop rotation while approximately 13% used irrigation. Most of the farmers diversified their production by having other enterprise like livestock in order to spread the risks and challenges presented by climate variability and change. Nineteen percent of the farming households grew improved crop varieties.

3.3 Determinants of factors influencing root crop farmers' decision to Adopt Climate Smart Agricultural Technologies in the Area of Study

The Tobit regression estimate of the determinants of factors influencing root crop farmers decision to adopt CSA technologies are presented on Table 3. The result shows that the coefficients of age, level of education, farm size, access to credit and ownership to a means of transport significantly influenced the decision to adopt CSA. The coefficient of age has a 95% probability level in influencing farmers adoption decision while coefficients of level of education, access to credit, farm size and ownership of a means of transport exerted 90% level of probability respectively on farmers' CSA adoption decision.

Table 3. Tobit Regression Estimates for Determinants of factors influencing root crop farmers' decision to Adopt Climate Smart Agricultural Technologies in Nigeria.

Variables	Coefficients	Standard Error	T	P>t
Age	.0064	.0023	2.81	0.005**
sex	-.0154	.0402	-0.38	0.701
Farming exp.	-.0003	.0029	-0.11	0.912
Level of education	.0113	.0068	1.67	0.096*
Household size	.0009	.0075	0.12	0.908
Access to credit	-.0873	.0437	-2.00	0.047*
Farm size	.0047	.0027	1.73	0.085*
Contact with EA	.0163	.0429	0.38	0.704
Owns a means of transport	.0939	.0560	1.68	0.097*
Cons	-.0411	0.1002	-0.41	0.683
Log likelihood = -110.432				
LR chi 2= 28.80***				
Pseudo R2 = 0.1154				

Note **, * 5%, and 10% significance level respectively.

4.0 Discussions

4.1 Socio economic characteristics and CSA Adoption.

The socio-economic characteristic of different farming households in an agricultural location can give insight into adoption of CSA technologies among its inhabitants. The distribution of respondents according to gender shows that both gender is well represented in root crop production in the study location. Although the disclosure to climate variations to men and women in any given location may be the same, but it is widely acknowledged that there is diverse gender-based differences in vulnerability and consequently adaptation and adaptive capacity [20]. As it was reported by [21] that men and women decision to adapt to climate change may vary due to variances that exit in their ability to access productive resources, employment and extension services support. [22] in their study conducted in Lushoto, Tanzania found out that there is variation in interests between men and women for CSA. Women prefers the practice of intercropping, while men adopt the use of composting, agroforestry scheme and fetching of the feeding materials as CSA approach. There is an indication that the level of engagement of women in adaptation activities is more, because of their having better understanding of what is happening in their immediate surrounding and their useful involvement in climate sensitive work like agricultural activities [23]. Nevertheless, there is also contraindication reported by [24] in their study stating that some CSA activities like tillage conversation can lead increase in weed density and causing more weeding frequencies, an activity regularly done by female gender in Sub Saharan Africa. In addition, the ability of women to adopt CSA technologies is hindered by social norms and structures like land owing to property rights and access to information [25]. Age corelates with maturity which is an implication of an individual's ability to make wise decisions as regards to agricultural activities. Majority of the respondents are within their productive age. Farmers within the middle age and younger are mostly open to new ideas and easily adopts new technologies. [26], reported that young and middle ages household heads are most industrious and interested in new technologies. [27], in their study found out that at above 45 years, age is negatively correlated with the adoption of small scale irrigation farming. Household size of majority of respondents were made up of more than 12 persons. It has been observed that large household size increases the likelihood of adopting CSA practices. [28], in their study found out that household size affects climate change adaptation positively in southern Nigeria. The educational attainment helps in equipping farmers with the required skills and knowledge needed to implement suggested technologies on their farms. The respondents were educated as more than 70% had more than six years of primary education. [26], reported that level of education of a farmer plays a substantial impact on the decision to practice the CSA. Farmers who are highly educated will have greater opportunity of making good choices along with speedily adopting new technologies in farming. The size of farm could have a direct influence on the adoption of CSA technologies. More than 70% of the respondents have median farm size 2.5 hectares. According to [30], they reported that a positive relationship exists between farm size and CSA technologies. They also stated that the early adopters of technologies belong to large farm owners. Participating in CSA activities among smallholder farmers is also hindered by land fragmentation, which makes it difficult to gain from the economies of scale. The study of [31], reported that increasing farm size by one- hectare increases the chances of carrying out CSA technologies such as conservation agriculture, change in the planting date, and crop diversification. The decision to adopt CSA technologies comes with a price in terms of purchasing drought tolerant varieties and irrigation equipment. Almost half of the respondent have access to credit and this may directly and significantly encourage the practice of CSA [32]. More so, having access to credit can encourage investment in CSA related money-making ventures, influence farmers' role in social networks, builds the ability to manage shocks of climate events and fortifies farmers' resilience level. Extension agents should be among the reliable sources of new information providers on CSA technologies that can increase agricultural productivity and income of farmers. More than 60 % of the respondents had contact with extension agents indicating that extension contact increases the probability of adopting CSA. Farmers who had regular extension agent contacts have better chances to be aware of climate change and also of the various practices that can help them to adapt. The respondents were seen belonging to one cooperative organization or the other. These native organizations perform important role in the practice of CSA technologies because their members are usually local people who come together and gather funds that may be required to access and adopt a given CSA technology. According to [21], they reported that collective action is important in facilitating the adoption of CSA technologies. It also enables risk merging and allow people to build assets that help them in resisting climate change shocks.

4.2 Climate Smart agricultural technologies.

This study identified climate smart agricultural technologies that are practiced in the study area. The use of irrigation (12.62%) was the least adopted CSA technology practiced by the root crop farmers surveyed because Nigeria agricultural sector is particularly sensitive to climate extremes due to the reliance of her on rain-fed subsistence agriculture [33]. [34], in their study reported that low adoption level of irrigation could be attributed to the need for more capital and low potential for irrigation in South East Nigeria. The adoption of crop rotation (81.03%) as a CSA technology was high among root crop farmers in the study. Crop rotation could serve well as a CSA technology because it decreases the risk of serious pest and disease outbursts, control erosion, handle soil fertility, and balance nutrient removal from the soil among others [35]. About half of the household surveyed engaged in diversity of production by rearing livestock. The ownership of livestock as a means of alternative income generation activity acts as a source of income to augment their earning from crop production. This could also be a risk management approach which is line with the findings of [36], in their study reported that the engagement in off-farm activities by farmers in southeastern Nigeria is done as a risk management strategy as well as climate change adaptation approach. The adoption of improved crop variety as a CSA technology approach was low (19.45%) among the respondents. Improved crop varieties are usually high-quality planting materials with the potential for better yield, tolerant to drought, flood as well as pests and diseases [37]. Low varietal turnover and the poor acceptance of new varieties has been observed in Sub Saharan Africa attributed to the insufficient priority given to farmers, high seed and transport cost and also limited supply [38].

4.3 Determinants of factors influencing root crop farmers decision to Adopt Climate Smart Agricultural Technologies in the Area of Study

The coefficient of age has a positive and significant influence on farmers decision to adopt CSA technology. This implies that a unit increase in the respondent age will bring about a 0.64% change in the probability of the farmer decision to adopt CSA. This corroborates with the findings of [39], in their study reported that farmers age positively influences the choice of different CSA practices such as minimum tillage, integrated pest management, site specific integrated nutrient management, and crop insurance. The coefficient for level of education of the farmers was also found to be positive and significant, implying that a unit increase in education attainment of root crop farmers in the study area will bring about 1.13% chance of adopting CSA technology. The educational qualification of farming households will enhance the capability to acquire, develop, and practice information pertinent to the adoption of new technology. Similar result was gotten from [40,41]. The coefficient for access to credit is negative and significant implying that a unit decrease having access to credit will reduce the likelihood of adopting CSA and this is against a priori expectation. While evidence of effectiveness of access to credit to mitigate impact of climate change are reported but most rural farm households about 96% of those seeking credit are unable to do so due to financial exclusiveness [42]. The size of the farm cultivated by the respondents were positively related to decision to adopt CSA. The result showed that a unit increase in area of land cultivated by the farmers will increase the likelihood of adopting CSA by 0.47%. The findings of [43] supported the result as they stated that households with relatively big farm sizes were more likely to take up more adaptation strategies when compared with farmers with small farm sizes. The Possession of means of transport also was significant. In contrast [44] in their study reported that possession of animal as a means of transport to negatively influence the decision of farming household to adapt to climate change in Uganda

5.0 Conclusion

The study examined factors influencing the Adoption of Climate Smart Agricultural Technologies Among Root Crop Farming Households in south-eastern and north central states of Nigeria. The study identified the use of irrigation, crop rotation, diversity of production, and use of improved crop variety as major climate smart agricultural technological approach adopted by root crop farmers in the study area. The research further shows that root crop farmers adoption decision was influenced by age, access to credit, farm size, level of education and ownership of transport. Based on the result, it was recommended that financing institutions should enhance access to credit to rural households for those who need them most and minimize financial exclusiveness. Also, educational campaign and awareness on climate smart agricultural activities should be embarked on so as to uplift the consciousness of root crop farmers on CSA technologies.

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