**Journal of Community & Communication Research**
**ISSN: 2635-3318**
Volume 6, Number 2, December 2021
Accessible at: https://jccr.sccdr.org.ng

# ANALYSIS OF USAGE AND DETERMINANTS OF CLIMATE SMART AGRICULTURE AMONG FARMERS IN EBONYI STATE, NIGERIA

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**ABSTRACT**
*The realities of climate change abound World over but the brunt is felt more in Africa due to over dependence of the continent on Agriculture. Climate Smart Agriculture is the new dawn helping farmers mitigate and adapt to the negative effects of climate change. The study focused on the usage and determinants of Climate Smart Agriculture in Ebonyi State Nigeria. The objectives were to identify the Climate Smart Agriculture practiced by farmers in the study area; analyze the determinants and level of usage of Climate Smart Agriculture in the study area and challenges encountered in the use of climate Smart Agricultural techniques. The study was carried out in Ebonyi state, Nigeria. Multi stage and random sampling techniques were used in the selection of 90 respondents for the study. Descriptive statistics and Heckman's two-stage selection model were the tools of analysis. It was observed that Climate Smart Agricultural practices like use of resistant varieties, mulching, nitrogen management among others were practiced in the study area. Gender, household size, level of education, income, cooperative membership, credit use had varying degrees of influence on the determinants and level of Climate Smart Agriculture usage among farmers in the study area. Inadequate finance and poor knowledge on the proper application of climate smart agricultural practices were the major challenges in the study area. The study recommended more efforts by extension agents in educating farmers on the proper way of using Climate Smart Agricultural practices to ensure optimum results.*
***Keywords: climate smart agriculture, climate change, Nigeria, Heckman's two-stage selection model***

## INTRODUCTION

The rain fed nature of agriculture in the country has made farmers vulnerable to the negative effects of climate change. The changes in the duration, intensity and timing of rainfall; the intensity and duration of sunlight have left farmers undecided leading to low productivity and indirectly low income and poor standard of living (Dioha & Emodi, 2018; Akande, A. et al.,, 2017; Ebele & Emodi, 2016; Awoyinka, Akinwumi, Okoruwa, & Oni, 2009). Over the years, farmers have coped and adapted to these climate change in different ways; some were effective and others were not. Effective adaptation to climate change requires technology and policy measures to reduce vulnerability and increase the capacity of producers, particularly smallholders' farmers. In addition, given agriculture's role as a major source of greenhouse gas emissions and the high rate of emissions growth experienced with recent conventional intensification strategies, there is a need to look for low emissions growth opportunities and adequate policies (IPCC, 2014). With this in mind, the concept of climate smart agriculture was developed. According to Fanen and Adekola (2014), Agriculture is said to be climate smart when it achieves three main goals: these are (1) sustainably increasing agricultural productivity to support equitable increases in incomes, food security and development; (2) adapting and building resilience to climate change from the farm to national levels; and (3) developing opportunities to reduce GHG emissions from agriculture compared with past trends. The three objectives might not be met all at once, situation and location takes preeminence. In Nigeria and especially south east Nigeria, achieving the first two objectives of climate smart agriculture takes center stage. Climate smart agricultural practices will ensure increased productivity without significant escalation in emissions as a result. Furthermore, the practice will sustainable adaptation practices to climate change in Ebonyi state. Farmers in Ebonyi State are not well informed about climate smart agriculture in terms of resources, knowledge, policies and technologies needed.

The objectives of the study were to; identify the Climate Smart Agriculture practices practiced by farmers in the study area; factors affecting the use and intensity of use of climate smart practices, and finally militating factors to climate smart agriculture use in Ebonyi State.

## METHODOLOGY

### *Study area*

The study area is Ebonyi State, Nigeria. It was created as a State on 1st October, 1996. It is situated in the South Eastern part of Nigeria. It is made up of 13 Local Government Areas (LGAs). The State is divided into three agricultural zones: Ebonyi Central, North and South, which also serves as the three agricultural zones. Each of these zones is made up of four Local Government Areas except Ebonyi South that has five L.G.As. The State has an estimated population of about 2.9 million people (National Population Commission (NPC), 2016). The State is bounded in the North by Benue State; in the south by Abia State and in the west by Enugu State. The occupation of most people living in the rural areas of the state is farming, with about 60-80 percent of them practicing small-scale farming. Ebonyi State is known for its production of rice. yam, cassava, cocoyam, potatoes, vegetables, etc in commercial quantities.

### *Sampling Procedure*

The respondents were selected via multi stage and random sampling procedures. First, from the three agricultural zones, two L.G. As were purposively selected to give a total of six L.G.As; these areas have profuse number of farmers. The second stage involved a random selection of 15 farmers from each of the already selected areas. This gave a total of 90 respondents.

### *Method of Data Analysis*

In order to achieve the objectives of this research, simple descriptive statistics such as means, tables and frequencies and Heckman's two-stage selectivity model were used to analyze the primary data obtained for the study. The first and third objectives were analyzed using descriptive statistics and Heckman's two-stage selectivity model was used to analyze the second objective.

### *Model specification*

#### Heckman's two-stage selection model

Heckman's two-stage selection model was used to examine the direction of causality between the determinants of climate smart agriculture users and non- users. The model had two dependent variables – the dichotomous ($Y_1$) and continuous ($Y_2$). The specification was as follows:

$$Y^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + e_1 \qquad (1)$$

Where,

$Y^*$ = $Y_1$ and $Y_2$

$Y_1$ = Probability of climate smart agriculture usage (1= usage, 0=otherwise)

$Y_2$ = intensity of climate smart agriculture practice (number of CSA used by the farmers)

$X_1$ = gender (male=1 and female=0)

$X_2$ = household size of the farmers measured in numbers

$X_3$ = experience of the farmers measured in years

$X_4$ = level of education of the farmers measured in years

$X_5$ = size of the farmers' labor force

$X_6$ = income (Naira)

$X_7$ = exposure to extension workers (number of visits)

$X_8$ = credit access (amount in Naira)

$X_9$ = risk orientation (risk averse =0 and otherwise=1)

$X_{10}$ = cooperative membership (member= 1, otherwise=0)

$b_i$ = the parameter

$e_i$ = the error term

## RESULTS AND DISCUSSION

Results of farmers' usage of climate smart agricultural technique in Ebonyi State are presented in Table 1. The climate smart practices were grouped into six categories of predominant climate smart practices in southeast Nigeria (Nwajiuba, Tambi, & Bangali, 2015). Results from Table 1 showed that residue soil cover was the best practice in the study with 23.3% of the respondent practicing the act of not leaving the farm bare void of vegetation. (Awoyinka, Akinwumi, Okoruwa, & Oni, 2009) shared similar result. This practice prevents erosion and leaching. It also adds, retain soil moisture and provides a conducive environment for soil organisms to operate. Minimal soil disturbance which involves little tillage was used by 8.9% of the respondents while zero tillage where the farmer plants directly was practiced by 4.4% of the respondents. Crop rotation and inter play of planting heavy feeders alongside shallow feeders was used by 7.7% of the farmers.

Majority of the respondents (55.6%) used organic manure to complement and improve the soil nutrients. Mulching was used by 31.1% of the respondents to retain moisture and add to the nutrient of the soil. Integrated crop management tries to find a balance between organic and inorganic use of fertilizers led to 15.6% of the farmers to use inorganic fertilizer moderately an according to the needs of the plants. Only 10% of the respondents were able to allow their farm land to fallow and replenish lost nutrients. Land is a scarce resource in the study area and only a few respondents can afford to leave the farm bare for a period of time. The use of organic manure goes a long to positively affect GHG emissions (Sansoulet, Cabidoche, & Cattan, 2007) Farmers in the study area who practiced organic agriculture used different approaches to get the manure for their farms. Cover crops and green manure was used by 21.7% of the respondents to enrich their soil. This is followed by 14.4% of the respondents who prepared compost manure to help enrich the soil. Crop rotation which ensures heavy feeders and shallow feeders are in cooperated to ensure an even use of the soil nutrients by the crops and nitrogen management were practiced by 7.7% and 15% of the famers respectively.

**Table 1: Usage of Climate Smart Agricultural Practices by farmers in Ebonyi State**

| Climate smart agricultural practices | Frequency | Percentage |
|---|---|---|
| **Conservation agriculture** | | |
| Residue soil cover | 21 | 23.3 |
| Minimal soil disturbance | 8 | 8.9 |
| Zero tillage (direct seedling) | 4 | 4.4 |
| Crop rotation | 7 | 7.7 |
| Strip cropping | 0 | 0 |
| **Integrated crop management (ICM)** | | |
| Mulching | 28 | 31.1 |
| Fallowing | 9 | 10 |
| Application of manure | 50 | 55.6 |
| Moderate use of inorganic manure | 14 | 15.5 |
| **Organic agriculture** | | |
| Cover crops and green manure | 19 | 21.7 |
| Crop rotation | 7 | 7.7 |
| Nitrogen management | 9 | 10 |
| Use of compost | 13 | 14.4 |
| **Agriculture water management system** | | |
| Run-off water Harvesting | 90 | 100 |
| Stream diversion | 5 | 5.5 |
| Irrigation | 21 | 23.3 |
| Diversion of ditches and drainage | 11 | 12.2 |
| **Adapted crop varieties** | | |
| disease/pest resistant varieties | 38 | 42.2 |
| High yielding crop varieties | 31 | 34.4 |
| **Indigenous knowledge (IK)** | | |
| Early planting | 43 | 47.7 |
| Late planting | 41 | 45.6 |
| Use of natural pest enemies | 6 | 6.7 |
| Pest and weed management | 4 | 4.4 |

Source: Field survey data, 2019; multiple responses recorded

Access to water in Ebonyi state is quite hard due to the nature of their soil. This makes rain water indispensable in their farming activities. All the respondents acknowledged harvesting of rain water in the farm was a major source of agriculture water management in the area. Irrigation was used by 23.3% of the respondent to augment the rain water. Stream diversion and diversion of ditches and drainage was used by 5.5% and 12.2% of the respondents ensured water supply to their farm by water tankers.

Furthermore, the use of adapted crop varieties which has been improved to adapt to climate change were common place in the study area 42.2% of the respondents planted with disease/pest resistant varieties while 34.4% cultivated high yielding crop varieties. These plants varieties help increase yield and income of the farmers. This in turn helps improve the standard of living of the farmer.

Indigenous knowledge used by farmers to combat climate change still takes the vanguard in climate smart practices in the study area. Early planting and late planting were used by 47.7%

and 45.6% of the respondents in the study area. Changing of planting dates can help in reducing yield instability by twerking the relationship between the flowering of some crops and temperature. (Sparks, Jeffree, & Jeffree, 2000; Dioha & Emodi, 2018) Use of natural pest enemies and scare crows to scare off respondents were used by 6.7% of the respondents and traditional weed management approaches were used by 4.4% of the farmers.

***Determinants of the climate smart agriculture use by farmers in Ebonyi State***

Heckman's two-stage selection model was used to examine the factors affecting the decision to adopt CSA as well as the factors affecting the intensity of adoption. The dependent variable in the two models are (1) a dichotomous outcome that assigns unity to adoption and zero to non-adoption and (2) the number of CSA adopted by an individual farmer. The chi-square of the models was statistically different from zero

**Table 2. Determinants of adoption of CSA practices and number of CSA practiced by farmers in Ebonyi state**

| | **Decision to adopt CSA (Model 1)** | | | **Number of CSA adopted (Model 2)** | | |
|---|---|---|---|---|---|---|
| | **Coeff.** | **Std. err** | **Coeff.** | **Coeff.** | **Std. err** | **Coeff.** |
| Constant | 0.757 | 0.318 | 2.380** | 0.434 | 0.121 | 3.590*** |
| Gender | -0.702 | 0.334 | -2.102** | -0.760 | 0.582 | -1.306 |
| Household size | 0.376 | 0.138 | 2.725** | 0.649 | 0.319 | 2.034** |
| Farming experience | -0.108 | 0.131 | -0.824 | 0.368 | 0.251 | 1.466 |
| Level of education | 0.087 | 0.034 | 2.559** | 0.623 | 0.134 | 4.649*** |
| Labour | -0.641 | 0.839 | -1.607 | -0.262 | 0.101 | -2.594** |
| Income | 0.158 | 0.067 | 2.358** | 0.786 | 0.307 | 2.560** |
| Extension visit | 0.672 | 0.101 | 1.709* | 0.173 | 0.065 | 2.661** |
| Credit use | 0.439 | 0.129 | 3.403*** | -0.879 | 0.961 | -0.915 |
| Cooperative membership | 0.435 | 0.105 | 4.143*** | 0.224 | 0.575 | 0.389 |
| Risk | -0.983 | 0.446 | -2.202** | -0.494 | 0.202 | -2.445** |
| Wald chi2 (10) | 35.663 | | | | | |
| Log likelihood | -66.383 | | | | | |
| lambda | 54321.78 | 1344.162 | 40.413 | | | |

Source: Field survey data, 2019

Gender was negative to adoption of CSA at 5% level of significant. This implies that women in Ebonyi State adopted CSA more than their male counterparts. Women in Ebonyi state were hardworking and more involved in farming; this increased their use and adoption of CSA practices to increase their harvest and improve their income. (Nhemachena & Hassan, 2007)stated that female headed households are more likely to take up climate change adaptation methods than men headed households.

Household size was positive to adoption and intensity of usage of CSA practices at 5% significance level respectively. Household size is seen as proxy for cheap labour. Households with large household size stand a better chance of adopting and practicing CSA because there is enough manpower to do the needed farm work as farming activities is manually done and labour intensive in the state.

Level of education was positively related to adoption and intensity of CSA use at 5% and 1% respectively. The more enlighten a farmer is, the more chances the farmer might adopt climate smart practices and increase the intensity of CSA use. Education helps the farmer grasp the concept of climate change and its effects. Farmers are enlightened on ways there farming activities contribute to climate change, offering new ideas to help combat and mitigate the effects of climate change, the findings are in line with the results of (Onubuogu & Esiobu, 2014) who opined that educated farmers have more knowledge of climate change and are already aware of various techniques and management practices that could be employed to combat the negative impact of climate change in the area.

Labour was negatively related to the number of CSA practiced by farmers. Most farmers reduce the number of CSA practices because of the labour involved. Agriculture in the country is still rudimental with crude implements; this have made farming labour intensive and increase the cost of production. thus, this might affect farmers using CSA intensively as they try to produce within budget.

The decision to use CSA practices was positively influenced by income of the farmers at 5% for farmers Ebonyi state while the intensity of use had the same levels of significance and also positive. This implies that the probability of choosing to use CSA practices was informed by increasing incomes. It also holds that the more income received by a farming household, the higher the use of climate smart agriculture technologies. Part of the added income would be used to offset the cost involved in adopting any of the CSA technologies. According to (Ogbanje, 2015), the more income a farm household generates, the more the tendency of channeling it into other productive activities such as purchase of improved varieties and adoption of technologies.

The probability of using CSA was positively related to extension contacts at 10% level of significance for Ebonyi state while the intensity of use was positive 5%. This result implies that farmers who had contacts with extension agents were better informed about the benefits of using Climate smart agricultural practices than farmers who had no knowledge about the technology. Since extension agents are saddled with the responsibility of transmitting information and innovative ideas to the local farmers, the use of CSA is also to be taught by them, especially using on-the-farm demonstration. This is very desirable because extension services provide trainings that help the farmer understand and evaluate the improved technologies at their disposal. Additionally, it is also believed that that good extension programs and contact with farmers are key factors in adoption which would also enlighten the farmers and create better awareness for the potential gains of improved technologies in crop production (Nwaru, 2004; Odomenem & Obinne, 2010).

Credit use was only significant for the probability of using CSA technology at 1% for Ebonyi state and was not significant for the intensity of use. This implies that credit only affected the decision to use the technology and may not have played any significant role in determining the level and intensity of use of the CSA practices. This finding agrees with (Iheke & Nwaru, 2014; Odomenem & Obinne, 2010; Nwaru, 2004) who asserted that farmers spend more on innovation adoption with credit than without credit because credit afforded the farmers the opportunity for more access to farm inputs.

Cooperative membership was positively signed in relation to the probability of using CSA for farmers in Ebonyi state at 1% level of significance implying that farmers who are cooperative members are more likely to use CSA than non-cooperators. This is because cooperative societies are good sources of quality inputs, labour, credit, information and organized marketing of agricultural products. This agrees with the opinion of (Odomenem & Obinne, 2010; Mwangi & Kariuki, 2015) that involvement in cooperative organizations helps farmers to adopt innovations.

The coefficient of risk was negative in the first and second models at 5% for Ebonyi state. This result implies that farmers who are averse to risk were less-likely to use CSA.

***Challenges encountered in the use of climate Smart Agricultural techniques***

Table 3 presents the challenges faced by farmers in using CSA in the study area. Poor policy framework was identified by 81.1% of the respondents as one of the challenges encountered in the use of climate smart agriculture in the state. It was observed that there was no written policy document climate smart agriculture in the state. There is no guide on what is expected from the farmers and roles played by government in ensuring CSA practices; this leaves the farmers to their own fate.

**Table 3: challenges of climate smart agriculture use in the study area**

| Challenges | Frequency | Percentage |
|---|---|---|
| Poor policy frameworks | 73 | 81.1 |
| Inadequate financing | 81 | 90 |
| Lack of data and information | 53 | 58.9 |
| Poor knowledge of the practice | 80 | 88.9 |
| Poor government support | 65 | 72.2 |

Field survey 2019, multiple responses recorded

The lack of an existing link of CSA with any government document translates to no budgetary allocation for it. This means no provisions of funds to the practice. This comes as no surprise as 90% of the respondents complained about inadequate financing of CSA from the government. This have discouraged farmers who might have practiced CSA if funds were available. This assertion was confirmed by (Terdoo & Adekola, 2014).

Further, 58.9% of the respondents admitted that lack of data and information on CSA is frustrating, this leads to misinformation, wrong application and poor gauge to the effects of CSA use in the farm. Due to lack of data and misinformation on CSA; 88.9% respondents admitted having poor knowledge of CSA practices. This problem is not peculiar to Ebonyi state; many farmers are doing it wrong with CSA as a result of poor information dissemination. This defeats the objectives of the practice. Finally, 72.2% of the respondents believed that poor government support of CSA affects its use. Government support in terms funds, subsidies, research and information dissemination have been poor.

## CONCLUSION AND RECOMMENDATIONS

The effects of climate change are hitting hard, due to the over dependence on agriculture and poor coping capacities, its imparts are felt hard in Nigeria and other African countries. Agriculture in Ebonyi state is rain fed and weather dependent which leaves the farmers at the mercy of climatic conditions. Climate smart Agriculture is not new to farmers in Ebonyi state as most farmers practiced CSA. The following recommendations will help farmers tackle the challenges listed by famers in the state:

i. Government should make policies, rollout programs and orientation campaigns that will train extension workers on the new trends on climate smart agriculture and also provide the needed resource which will enable these extension workers spread the new trends to people in the hinterlands;
ii. Increased sensitization campaign on reality of climate change and the need to adopt climate smart practices towards reduction of adverse effect of climate change should be intensified;
iii. Government should provide incentives, subsidies, financial assistance and enabling
iv. policy environment towards adoption of good CSA practices. this will increase the chances of more farmers willing to improve their productivity using CSA.
v. Farmers should be taught proper ways of keeping records in their farms as this will help provide data needed to make policies, measure success rates and progress of programs and assist framers in getting aid from government and non-government agencies.

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