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Assessing the extent of adoption of the climate smart agriculture practices by farmers in Delta State, Nigeria

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ABSTRACT

Globally, climate change is an issue of concern as included in the SDGs. Its effect on Nigeria, an agrarian nation with an average nominal GDP of 40% from agriculture, can be worrisome as agricultural harvest largely depends on adequacy of natural resources. Change in weather pattern, rainfall often leads to the experience of food insecurity. As a result, in Delta State, Nigeria, the outcomes of climate change put livelihoods at a major threat. Therefore, it is imperative to improve the farming practices through the adoption of Climate-Smart Agriculture (CSA). Climate smart agriculture (CSA) practices suggest effective ways and strategies towards food security of a nation. Therefore, this study investigated the extend of CSA adoption by farmers in Delta State, Nigeria. A multistage sampling technique was adopted for the study and data from 276 farmers were obtained with a structured questionnaire. Descriptive statistics was used as the estimation technique. The analysis of the quantitative data disclosed that: Intercropping (74.6%) was the most adopted CSA by respondents; and 47.1 % of the respondents understand the importance of CSA. The results showed that the extent of adoption of CSA practices was on a small scale and quite low as farmers mostly adopted intercropping. It was therefore recommended that awareness on the importance of CSA with technical assistance should be provided to farmers in order to promote CSA practices. Also, government agencies and cooperate organizations should leverage on current global SDG drive, and provides enabling environment and incentives for a wider scale adaptation of CSA.

Keywords: *Climate Smart Agriculture (CSA), farmers, farming practices, food security, Sustainable Development Goal (SDG), Delta state*

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INTRODUCTION

Climate change has continued to alter the balance and viability of the ecosystem (Etim and Ndaeyo, 2020). Aside from affecting natural capitals like aquatic and terrestrial availability, its effects are also evident on the productive ecosystems though the drastic shift in elements of weather conditions (Onyekwe *et al*., 2021). Notably, it has led to reduction in crop yields, increase in pests and weeds, reduction in agricultural sustainability, loss of agricultural biodiversity and increased food insecurity (Fisheries Integration of Society and Habitats -FISH, 2016). Onyeagocha *et al*. (2018) reported that rainfall and temperature have been shown to have statistically significant effects on agriculture more than other elements of weather**.** This suggests that climate could determine what is to be planted, when it is to be planted, incidences of pests and diseases, pollination, length of growing season, and eventual agricultural outputs. The changing climate affects plants and animals which are main source of food for human.

Agriculture is made up of four sub-activities, namely: crop production, livestock, forestry and fishing and no section is spared from the surge of climate change (Etim *et al*., 2020). As a result of the enormous strain placed on population growth and the issue of the warming of the earth, and on food production and its security, there is need to embrace more sustainable concept, such as Climate Smart Agriculture (Etim *et al*., 2020; Waaswa *et al*., 2021). Additionally, this is consistent with Sustainable Development Goals (SDGs), especially Goals 1, 2, 3 and 13; that buttresses on: ending poverty in all its forms everywhere; ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture by 2030; ensure that all people of all ages live healthy lives and promote well-being; and taking urgent action to

combat climate change and its impacts (Ogbodo *et al*., 2019) respectively. These goals, which form a set of 17 goals was enacted in 2015 by the United Nations (UN) requires urgent action in order to meet the timeline of 2030, especially in countries of the world, such as Nigeria - categorized as developing (Ejemeyovwi *et al*., 2017).

Agriculture is a critical tool for long-term eradication of food insecurity and pivotal to sustainable development. However, agricultural productivity has remained low and stagnant in recent decades, particularly in small-holder production environments like Nigeria (FAO 2014). Due to shifting rainfall patterns and the increased frequency of extreme events such as droughts and floods, productivity has begun to decline in many cases (Lipper *et al*., 2014). These are common indices of experiences of climate change.

Climate change is an evolving concern globally; IPCC (2018) reported that like other regions in the world, Nigeria has had her fair share in climatic change in recent past that had resulted to instances such as flood and drought because of seasonal aberrations. In Nigeria, Olugbire (2021) reported the flood incidence, which took place between August 2012 to October 2012 and was recorded as the worst in 4 decades. It becomes worrisome for Nigeria that is agrarian, and derives an average nominal GDP of about 40 percent from agriculture, with 70 percent of her population relying on agriculture for their livelihood (Olorunfemi *et al*., 2020; Berg *et al*., 2013), yet, still depending majorly on rain-fed agricultural system to nourish a food insecure nation (Ejemeyovwi *et al*., 2017; Ogbodo *et al*., 2019).

Studies of Onyekwe *et al*., (2021) and Onyeneke (2019), collaboratively stated that Nigeria suffers from diminishing food production which in turn leads to diminishing revenue because the country solely relays on rain-fed agriculture even through it is a major source of revenue. The resulting effect of climatic change being experienced as demanded for an intentional shift in farming system as several crops are already at their heat tolerance threshold (Intergovernmental Panel on Climate Change - IPCC, 2018). Ali *et al*., (2020) proposed that farmers should implement farming strategies effective of solving the concerns of adverse climatic change and its linked implications, such as CSA.

CSA comprises of those farming practice that would lessen greenhouse gas (GHG) emission which adversely impacts farm produce while sustainably increasing productivity. CSA can be seen in management practices in livestock, crop, soil and water to mention but a few (Ali, 2020). CSA can also be an agricultural management principle that serves as a defence mechanism against climatic events. Crop management, livestock management, soil and water management, agro-forestry, integrated food energy systems, infrastructure, and access to climate information are some of the CSA interventions (Ogbodo, 2019).

Climate-smart agriculture (CSA) comprises of techniques that make farming more sustainable and resilient to climate change. They are farming methods employed by farmers to achieve soil moisture conservation, enhance soil fertility, stabilize farm produce and livelihoods as well as achieve food security for the nation. The CSA model is designed to improve the convergence of agricultural development and climate responsiveness. Under a changing environment and rising food demand, it attempts to achieve food security and widen development goals. According to Waaswa *et al*., (2021), CSA presents the answer to the question of climate change while addressing food security. It thereby offers more effective ways to farming and also helps in solving the adverse climatic change and its linked implications (Ali *et al*., 2020).

According to Onoja (2019), agriculture is the backbone of Delta State economy, agriculture is practiced for commerce and consumption (Onoja *et al*., 2019). Crops largely grown for commerce and consumption are Cassava and other arable crops (Obi, 2010). Delta State is an oil-producing state of Nigeria, yet majority of the 'Deltans' are farmers, and agriculture serves as the major occupation in the state. Farmers in the state produce more than 80 percent of food consumed in the state. Ironically, agriculture contributes to climate change, accounting for 13 to 14 percent of greenhouse gas (GHG) emission (Oyewole, 2015). The Niger Delta region, where Delta State is situated, is known for its rich blend of valleys, and its less than six meters above sea level, with the presence of numerous creeks and water bodies; making it highly vulnerable to flood, which is a severe threat to croplands. Onyeagocha *et al*., (2018) reported that rainfall and temperature has been shown to have statistically significant effect on agriculture apart from other elements of weather. Just like in the case of flood, research has shown that extreme climate aberrations impact the livelihood in Delta state (Obi, 2010) and CSA is the tomorrow of agricultural sustainability in such instances. Records documented shows that CSA is an adapted coping strategy practiced in Delta state, Nigeria (Onoja *et al*., 2019).

Studies on the level of awareness and adoption of CSA practices in different regions of the economy persist (Mashi *et al*., 2022; Onyekwe *et al*., 2021). Although, academic interests have increased on CSA in Africa based on the growing population in the continent and the need to improve agricultural productivity; nevertheless, very few studies have investigated the extent of awareness and appropriation of CSA practiced among farming households in Delta State, Nigeria. The study therefore seeks to assess the extent of adoption of CSA practices among farming households in Delta State, Nigeria. The study was restricted to crop farmers because of time constraints in effectively covering other agricultural practices. The contribution of this study is its approach of scaling the CSA practices. The adoption of CSA practices was scaled into three categories including large scale, medium scale and small scale. The study contributed to the literature by profiling the practices of CSA adopted by farmers in

Delta State.

Research questions

The following research questions were formulated in order to guide this study within the context of the main objective of assessing the extent of adoption of the climate-smart agriculture practices by farmers in Delta State, Nigeria:

1. What is the level of adoption of CSA in Delta State, Nigeria?
2. What are the CSA practices engaged by farmers in Delta State, Nigeria?
3. What is the impact of CSA on farmers' effectiveness in Delta State, Nigeria?
4. What are the challenges to the adoption of CSA by farmers in Delta State, Nigeria?

Literature review

According to Olorunfemi, *et al*., (2020), climate-smart agriculture could be organic farming practices such as mulching, crop rotation, minimum tillage, cover cropping, and composting. In addition to organic farming practices, climate-smart agriculture techniques include agroforestry, enhanced grazing, and improved water management (FAO, 2018; Ogbodo, 2019). These practices can mitigate the effects of climate aberration by improving the quality of the soil, air, water, and the overall landscape for farming that is sustainable. Mekonnen (2016) also identified that CSA is hinged on three (3) key components: adaptation and resilience of climate change; minimizing and checking on greenhouse gases; and stabilizing increase in agricultural production. This tends to increase agricultural outputs and incomes on a long-term basis. For smallholder farmers in developing nations, the gap between the yields they achieve on their farms and the maximum yields that is technically feasible is quite large; therefore, improving productivity as well as cutting costs through improved resource-use efficiency are imperative ways to attain agrarian growth (FAO, 2014; World Bank, 2016).

Studies have shown the links between the adoption of CSA and food security (Adebisi *et al*., 2022; Bazzana *et al*., 2021; Lipper *et al*., 2014; World Bank, 2016). Other research has variously explored the impact of climate-smart agriculture on poverty (Tesfaye *et al*., 2020); Implications of disseminating CSA initiatives on scaling up (Olorunfemi *et al*., 2020) among others. The World Bank (2016) study on "Climate-smart agriculture: successes in Africa" highlighted the successful implementations of climate-smart agricultural practices on the continent. The World Bank and partner organizations engaged in successful implementations of CSA projects in selected African countries such as Kenya, Uganda, Tanzania, Ethiopia, Zambia, Morocco, and other 13 West African countries to support both crop and livestock farmers and also ensure that the agricultural sector remains sustainable for future generations (World Bank, 2016). Bashir and Schilizzi (2013) investigated the determinants of rural household food security in Africa and Asia regions of which more than 80% of the populace are undernourished. Using 40 peer-reviewed studies (20 studies from each region), the study applied a meta-analysis technique to achieve the stated objectives. Three fundamental parts of food security were examined comprising of food availability, food accessibility and food utilization. The analysis showed that food availability is the most prioritized research areas taken after by food accessibility whereas food utilization is the least prioritized research areas in both regions.

According to Onyeneke, (2019), the researcher highlighted that achieving sustainable agricultural techniques must be done without neglecting the costs and constraints of such adaptation measure. This requires the skills of the agriculturist to determine the criteria for assessing environmental, social and economic production systems. The most efficient adaptation measure will differ even within countries, given the considerable variance in agro-ecologies and farming, livestock, and fishing systems. The work of Onoja *et al* (2019) revealed that the adoption of CSA hones has significant variation in the profits of farming systems in Delta State, Nigeria. In a nutshell, climate smart technology aims to make existing technology available to farmers while also creating up-to-date technologies, such as drought- or flood-tolerant crops, to meet the demands of a warming climate (Oyewole, 2015).

Etim and Ndaeyo (2020) estimated the factors affecting the adoption of climate-smart practices in rice production in Akwa-Ibom State, Nigeria. Data were drawn from a primary data source using questionnaires and they were analyzed using descriptive statistics and univariate probit model. The identified factors affecting rice farmers' willingness to adopt CSA practices include education, family size, farm income and access to information on climate change. Hence, rice agriculturists are more likely to embrace CSA practices considering the positive and significant effect of the identified factors. Olorunfemi *et al* (2020) emphasized the important role extension agents play in the dissemination of CSA activities which are influenced by their educational qualification, years of experience, training in CSA and the numbers of community covered. Hence, the need to train more extension agents so as to scale up agricultural productivity.

Adebisi *et al* (2022) studied the impact of CSA practices on food security among agricultural households in Kwara State, Nigeria. The research employed the use of questionnaire to gather responses among farming households in the sampled area and the results were analyzed using descriptive statistics and logistic regression. The findings showed that about 59% of the farming households are food secured while others are food insecure. Although, 53.3% of the users operates CSA on a medium scale, 30% operates on high scale and 16.7% operates on a low scale in Kwara State.

Furthermore, educational attainment, access to extension visits, farm size, off-farm income and CSA practices were found to positively and significantly contribute to food security of the farming households. The work of Bazzana *et al* (2021) examined the impact of CSA on food security in Ethiopia. The study applied an agent-based modelling approach to investigate the adoption of CSA practices among rural farmer in Ethiopia as well as understand future adaptation dynamics to consider with the world-changing dynamics. Considering the social and ecological pressures in terms of community network, environmental externalities and climate change, the study assessed farmers' adoption of CSA techniques in the short and long term in rural Ethiopia. It further utilized four dimensions of food security (availability, self-sufficiency, stability and food insecurity severity). The findings revealed that the adoption of the conservation practices of CSA (represented by crop rotation; crop residue management; minimum tillage) have positive and increasing effects on crop yields and economic returns/gains in agricultural production. However, the Water and Soil Management Actions (WSA) are not often appropriate for agriculturists with intention to achieve more food productivity quickly because it can be expensive and take a long time to see a return on investment. While the study focused on the Ethiopian economy, it is essential to look at what applies in the Nigerian economy and specific areas due to the heterogeneity of the country

Review of empirical issues

Floods, according to Ogbodo *et al* (2019), are the world's most recurrent, broad, devastating, and frequent natural dangers. Increased intensity and frequency of flooding, storms, and drought can serve as limitation to food security and agricultural productivity, according to empirical studies (FAO, 2007). Nigeria is not immune to floods and has had several; the most devastating and worst of which occurred in August-October 2012, when rivers overflowed their banks and submerged hundreds of kilometres of urban and rural territory. The floods affected over 7,705,378 Nigerians, resulting in 2,157,419 internally displaced persons (IDPs), 363 deaths, and more than 618,000 damaged homes (Ogbodo *et al*, 2019), affecting food security and making the effort to achieve Goals 1 and 2 of the Sustainable Development Goals appear feeble, as a significant portion of farmland was affected. Food productivity and sustainability are increasingly threatened by the rising frequency and intensity of diverse abiotic stresses such as flood and drought, according to a study done by Mottaleb *et al*. (2017). Under changing climatic scenarios, with the effect of mitigation in place for sustained food production can ensure the attainment of food security. Adejoro (2017) studied on climate change impact on Poultry industry in Nigeria, observed that excessive drought has significant effects on the storage of raw feed materials both in terms of quality and its efficacy. It was noted that mycotoxins could spur the contamination during storage that posits toxic effect on livestock after consumption. Climate change has a secondary influence on animal husbandry, according to this study.

Review of theoretical issues

Diffusion of innovation (DOI) theory

By this theory, the rate of adoption and utilization of any innovation depends on the farmer's awareness and perception of the concept. Henri-Ukoha and Adesope (2018) discovered that in Nigeria, an extension agent's position in the organization, as well as years of experience and involvement in extension service, alongside the level of interface with farmers determines the level of their knowledge and competency in disseminating climate change adaptation strategies. Adejoro (2017) collaborating this added age, gender, educational level, and job location as factors that influence the level of innovation. He advocated for the implementation of a sustainable educational and training policy for extension agents on climate smart related organic agricultural practices in order to improve their knowledge and competence, as well as retraining on the changing nature and dynamics of climatic fluctuation to avoid knowledge and competency gaps. (Olorunfemi *et al*. 2020). There seem to be a gap in information diffusion, since most of the farmers averagely educated with a minimum of secondary school certificate, yet were not adequately knowledge about CSA. Should there be better diffusion of climate compatible innovation, Delta state will be better food secured.

Agency theory

This theory can also be thought of as what a person is free to accomplish and achieve in pursuit of whatever aims or values he or she considers significant according to World Bank, 2005. One might ask, are farmers in Delta state willing to adapt CSA as against the conventional measures that is becoming detrimental to the environment and their economic sustenance?

METHODOLOGY

Study area

The study was carried out in Delta State, Nigeria. Ofuoku and Okompu (2020) study revealed that Delta State an agrarian state with 80% of the population found in the rural area, and agriculture is the prominent sources of livelihood in the state (Figure 1). The State lies within the latitude 5º00´and 6º45´East of the equator and longitude 5º00´ and 6º30´North, and it has a total land area of 16,842 km^2. Literature is not clear on the number of farmers in the research area. The main occupation of the populace in the state is farming. This study focused on crop farming

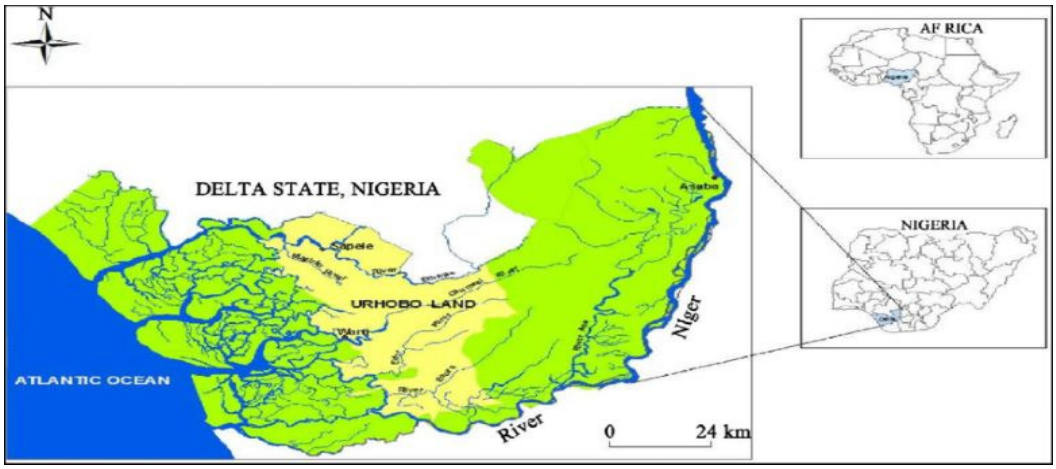

Figure 1: Map of the three Agricultural zones in Delta state

Table 1: Sample distribution

Selected Local Government Areas	Frequency	Percentage
Isoko North	102	37.0
Ndokwa West	102	37.0
Warri South	72	26.0
Total	276	100.0

(Source: Researcher, 2023)

households that could make use of climate-smart agricultural practices.

Ethical approval and consent

In order to prevent bias, respondents were made aware that their participation in the study was voluntary and that all information collected would be treated with the utmost confidentiality. Additionally, respondents were fully informed that the study was only being conducted for academic purposes and that the researchers would follow all protocols, including permission from the Departmental Ethics Committee to conduct this research.

Sampling procedure

Delta State was purposefully selected because it's majorly an agrarian state. A descriptive and cross-sectional survey research design was adopted for the study. A multistage sampling procedure was used in the selection of respondents. In the first stage, Delta was purposively selected to be predominantly agrarian economy. The second stage involves the purposive selection of three (3) agricultural zones because of its agricultural strata. The third stage was selection of each stratified agricultural zone whereby one (1) Local Government Area (LGA) was selected with a purposive sampling. The selected LGAs were based on their agrarian activities, making the total selected LGAs, 3. In the fourth stage, 4 agricultural villages were then selected randomly from the 3 sampled LGAs to give a total of 12 agricultural villages. Lastly, in the fifth stage, 25 farmers were randomly selected across the 12 agricultural communities. This was based on the justification by Gay and Airasan, (2003) in educational research: competencies for analysis and application, that a rule of thumb to realize a sufficient sample size regarding a descriptive survey is to ensure that it is made up of 10% to 20% of the population under study. Thus, a total number of 300 respondents was selected as the sample size. However, the total number of respondents' questionnaire retrieved was 276. Table 1 depicts the sample distribution of the respondents by the selected LGAs.

Analytical techniques

Descriptive statistics such as mean, standard deviation, frequency, and percentage, was used to profile the demographic characteristics of respondents and the CSA practices adopted by farming households in the study area.

Variables description

The adoption of CSA was measured using related parameter as stated in Adebisi *et al.* (2022). Respondents were asked if they 'frequently use', 'occasionally use', 'rarely use' and 'do not use' several CSA practices such as: intercropping, mulching, crop rotation, planting of improved varieties, mono cropping, agro forestry, mixed cropping, row planting, minimum tillage. Each of the four-point Likert scale was then used to generate the use of CSA index as described in the equation:

$$\text{Adoption of CSA Index}_i = \frac{[(N_1 \times 3) + (N_2 \times 2) + (N_3 \times 1) + (N_4 \times 0)]}{M}$$

where:
N_1 = Number of farming households that frequently use a CSA practice
N_2 = Number of farming households that occasionally use a CSA practice
N_3 = Number of farming households that rarely use a CSA practice
N_4 = Number of farming households that did not use a CSA practice
M = Total number of respondents (n)
The adoption of CSA was later grouped based on the criteria low, moderate and high to reveal the level of its adoption.

RESULTS AND DISCUSSION

Demographic characteristics of the respondents

The results in (Table 2) revealed that women were mostly involved in crop farming than men as more than half (54.7%) of the respondents were female. In respect to religion, majority of the of the respondents (91.7%) were Christians. This indicates that Christianity is the predominant religion of the study area. A total of 79.6% of the farmers had secondary and post-secondary education. This suggest that the population relatively moderate level of educational attainment, with secondary education being the benchmark. This is also in line with findings of Mia *et al*. (2023) that 67.2% member of the farming community, who are using CSA, had secondary and post-secondary education. This implies that most of these farmers were literate and this could enhance the possibility of using climate smart agricultural practices. The average household size of farmers was 5 members which is an indication the farming household is fairly large and could enhance the farming activities. The average age of the farmers was about 48 years. This indicates that most farmers were economically active. However, youth were not actively involved, with about 7% of the respondents within the age range of 30 and below. Furthermore, the farming experience stood at 24 years. This implies that most respondents have been engaged in farming as their primary occupation for a long period and that could enhance their risk management in production. Farmers gain the ability to cope with severe climatic circumstances and adaptive strategies as a result of their farming expertise. Farmers' farming experience improves their knowledge and awareness of climatic events and conditions, as well as their ability to adjust to changing climates in a positive way. Majority of respondents (78.3%) did not belong to any farmer association indicating a less interaction or exchange of innovation among these farmers and their resources can be hardly pooled to foster production growth. The average monthly income of farmers was about ₦53, 000 while an average farmers cultivated two types of crops on their farms. This implies that they engaged in multiple cropping than mono-cropping which was a means of generating more income as well as enhancing management of income risk in agriculture. The average farm size cultivated was 12.9 hectares which indicates large scale farming by the farmers in the Delta state, Nigeria. The results showed a diversity of educational background. However, the population have a relatively moderate level of educational attainment, with secondary education being the benchmark. The result shows a relatively low level affiliation to farming groups (21.70percent).

Adoption of climate smart agricultural practices

The extent of adoption of CSA practices in the study area is very low, as only 11.6% are users of CSA practices (Table 3). The results in Table 3 further revealed that most of the respondents (88.4%) were not aware and did not adopt CSA practices. Furthermore, about 52.9% of the respondents did not understand the importance of such practices. This suggests the need to create more awareness and enlightenment on the use and adoption of CSA practices for achieving food security and enhancing agricultural sustainability.

Climate smart agricultural (CSA) practices

Table 4 revealed that intercropping (74.6%) was the most predominant CSA practices engaged among crop farmers in Delta State, Nigeria followed by cover cropping (30.4%) as well as minimum tillage (23.6%). The least of the CSA practiced by the crop farmers were Growing Crops and Trees (7.6%), Composting (7.2%) and Irrigation (6.9%). %). Intercropping serves as an adaptation measure to reduce risk of total crop failure, nitrogen fixation for leguminous crops, and reduces pest and or disease infestation (Onyeneke, 2019). Minimum tillage is a soil conversation practice. Soil conservation methods aid in the prevention of unanticipated climatic changes. It is also an adaptive approach that raises soil fertility, hence increasing farmer productivity.

Other agricultural practices

In addition to the agricultural practices listed in (Table 4), the practices listed in (Table 5) were used by farmers in Delta State, and their frequency distribution shows how common they are. A good number (10.9 percent) of the farmers practice Shifting Cultivation, while 4.1 percent also practice ridging and bed making.

Impact of CSA on farmers' effectiveness

Table 6 presents the influences of CSA practices on the livelihood of farmers. The majority (88.8 percent) of the

Table 2: Demographic characteristics of the respondents.

Variables considered	Frequency	Percentage (%)	Mean ± SD / Mode
Gender			
Female	151	54.70	
Male	125	45.30	0.55 ± 0.50
Total	276	100.0	
Religion			
Christianity	253	91.70	
Traditional	22	8.00	1.08 ± 0.31
Others	1	0.40	
Total	276	100.0	
Educational level			
No formal education	28	10.10	
Primary	56	20.30	
Secondary	107	38.80	2.31 ± 0.91
Post-secondary	85	30.80	
Total	276	100.0	
Household size			
1-5	140	50.72	
6-10	132	47.83	
>10	4	1.45	5.5 ± 2.1
Total	276	100.0	
Age (years)			
21-30	20	7.25	
31-40	65	23.55	
41-50	80	28.99	
51-60	60	21.74	47.8 ± 11.9
>60	51	18.48	
Total	276	100.0	
Farming experience (years)			
1-10	75	27.17	
11-20	43	15.58	
21-30	54	19.57	
31-40	52	18.84	23.9 ± 15.6
41-50	52	18.84	
Total	276	100.0	
Membership of farming group			
Member	60	21.70	0.22 ± 0.41
Non-member	216	78.30	

(Source: Researcher, 2023)

Table 3. Climate Smart Agriculture Awareness and Perception (n=276).

Adoption and Perception of CSA	Frequency	Percentage (%)
Have you adopted climate-smart agricultural practices like intercropping, crop rotation, cover cropping, minimum tillage or any listed?		
Yes	32	11.60
No	244	88.40
Do you understand the importance of CSA?		
Yes	130	47.10
No	146	52.90

(Source: Researcher, 2023)

farmers agreed that CSA had helped them use their input better, 10.5 percent of the farmers are indifferent about this. Also, 85.1 percent agreed that Climate Smart Agriculture (CSA) makes them cultivate better, while 12 percent of them are indifferent. Again, 81.2 percent of the farmers believed that CSA made them have more harvests. Most of the farmers (68.5 percent) agreed that CSA helped them deploy labour more effectively, while 25 percent were indifferent. A little over half (52.5 percent) of the farmers agreed that they cultivated improved varieties as a result of CSA, only 24.3 percent disagreed, while 23.2 percent did not know whether it helped them or not.

CSA also helps farmers make better and productive farming decisions. This is also reflected in Table 6 that the majority (73.9 percent) of the farmers were in favour of it, while a relatively insignificant part (4.3 percent) were not in favour. Farmers were rather undecided than to disagree that CSA helped to increase productivity. However, the majority (50.4 percent) of the farmers did not know whether CSA had helped them in increasing their professional network. Furthermore, 30.1 percent agreed that CSA could expand professional network, while 19.6 percent disagreed. A great portion, (78.3 percent) of the farmers agreed that CSA had increased their income, a very few (2.5 percent) disagreed and only 19.2 percent were indifferent. It also appears that CSA reduces post-harvest loss, as 71 percent of the farmers had reduced post-harvest loss due to CSA adaptation it. Basically, these outcomes show that CSA has a broad range of benefits for farmers. As indicated in (Table 7), the majority (89.1

Table 4: Distribution of climate smart agricultural practices.

CSA Practices	Frequency	Percentage (%)
Intercropping		
Yes	206	74.6
No	70	25.4
Mono-cropping		
Yes	56	20.3
No	220	79.7
Crop Rotation		
Yes	44	15.9
No	232	84.1
New Crop Varieties		
Yes	58	21.0
No	218	79.0
Cover Cropping		
Yes	84	30.4
No	192	69.6
Growing Crops and Trees		
Yes	21	7.6
No	255	92.4
Minimum Tillage		
Yes	65	23.6
No	211	76.4
Mulching		
Yes	61	22.1
No	215	77.9
Row Planting		
Yes	63	22.8
No	213	77.2
Irrigation		
Yes	19	6.9
No	257	93.1
Composting		
Yes	20	7.2
No	256	92.8

(Source: Researcher, 2023)

Table 5: Frequency distribution table of other agricultural practices

Agricultural Practices	Frequency	Percent
Beds making	2	0.7
Fertilizer application	3	1.2
Manure application and ridging	1	0.4
Those listed in the research instrument	225	81.5
Planting early maturing varieties	2	0.8
Planting melon (egusi) as cover crop	1	0.4
Ridging and beds	11	4.1
Shifting cultivation	30	10.9
Use of early maturing varieties	1	0.4
Total	276	100.0

(Source: Researcher, 2023)

Table 6: Effects of CSA practices on the respondents' livelihood.

Items	Levels	Frequency	Percentage
I use my inputs better	Agree	245	88.8
	Disagree	2	0.7
	Don't know	29	10.5
I cultivate better than before	Agree	235	85.1
	Disagree	8	2.9
	Don't know	33	12.0
I have more harvest than before	Agree	224	81.2
	Disagree	7	2.5
	Don't know	45	16.3
I deploy farm labour better	Agree	189	68.5
	Disagree	18	6.5
	Don't know	69	25.0

Table 6: Contd.

I cultivate improved varieties	Agree	145	52.5
	Disagree	67	24.3
	Don't know	64	23.2
I make better farming decision	Agree	204	73.9
	Disagree	12	4.3
	Don't know	60	21.7
My professional network has increased	Agree	83	30.1
	Disagree	54	19.6
	Don't know	139	50.4
I have more farm income	Agree	216	78.3
	Disagree	7	2.5
	Don't know	53	19.2
I record less post-harvest losses	Agree	196	71.0
	Disagree	5	1.8
	Don't know	75	27.2

(Source: Researcher, 2023)

Table 7: Climate smart agriculture: recommendation and level of engagement.

	Levels	Frequency	Percentage
Recommend CSA to another farmer	No	18	6.5
	Yes	258	93.5
Scale of deploying CSA	Large	2	0.7
	Medium	28	10.1
	Small	246	89.1

(Source: Researcher, 2023)

Table 8. Challenges impacting on current state of climate smart practice by respondents.

Challenges to CSA	Levels	Frequency	Percentage
Cost	Agree	276	100.0
	Disagree	0	0.0
	Don't Know	0	0.0
Cultural affinity	Agree	13	4.7
	Disagree	210	76.1
	Don't know	53	19.2
Education (awareness/information)	Agree	174	63.0
	Disagree	98	35.5
	Don't know	4	1.4
Source of input	Agree	184	66.7
	Disagree	92	33.3
	Don't Know	0	0.0
Time	Agree	135	48.9
	Disagree	129	46.7
	Don't know	12	4.3
Others	Bad Climate	1	0.4
	Bad Climate and Inadequate Fertilizer	1	0.4
	Inadequate Fertilizer	2	0.7
	Inadequate Fertilizers and Labour	1	0.4
	Inadequate Labour	3	1.1
	Insecurity	2	0.7
	Old Age	4	1.4

(Source: Researcher, 2023)

percent) of the farmers were still practicing CSA on a small scale, corroborating the study of Onyeagocha *et al*. (2018). However, the outcome reveals that almost all (precisely 93.5%) of them were likely to recommend CSA to their colleagues. This is apparently due to the benefits they derived from the practices.

Challenges to the adoption of CSA by farmers in Delta state, Nigeria

Table 8 shows that cost (100 percent), source of input (66.7 percent), and education (awareness/information) (63.0 percent) were all serious challenges to CSA adoption.

Table 9: Descriptive Statistics (ratio scale)

Parameters	N	Minimum	Maximum	Mean
Average annual yield (annual production) Kg/Bag	276	200	60000	5597.01
Proportion of yield sold to the market (percentage)	276	0.0	100.0	61.960
Portion of yield consumed directly (percentage)	276	0	100	34.67
Household monthly income (in naira)	276	62	920004	79801.51
Distance from home to farm? (in Km)	276	0.2000	50.0000	5.567210
Time it takes to walk from home to farm (in minutes)	276	0	300	79.80
Distance between the farm and market (in Km)	276	0.5000	50.0000	4.929348
Proportion of yield consumed or gets to your table (in percentage)	276	0.0000	100.0000	35.020290
Amount realized from crop sales last year after taking out cost (in naira)	276	0	1500000	272003.62
Amount spent on food monthly in household? (in naira)	276	35	150000	50810.28
Valid N (listwise)	276			

(Source: Researcher, 2023)

Nevertheless, the majority (76.1 percent) of the farmers agreed that cultural affinity did not affect the practice of CSA. Other factors that affect CSA practice are listed in (Table 9). Earlier, descriptive statistics were computed from categorical scale questions, while this descriptive is computed from questions in ratio scale.

Conclusion

The adoption of Climate Smart Agriculture (CSA) practices in Delta State faces significant challenges, including low awareness, limited access to resources, and insufficient funding. While practices like intercropping and minimum tillage demonstrate potential for improving soil health and productivity, their small-scale implementation limits broader impact on food security. Women play a vital role in enhancing climate resilience through their contributions to agriculture, yet their efforts remain under-supported. The lack of farmer participation in agricultural groups further restricts access to CSA knowledge and extension services, hindering adaptive capacity. Farmers in the region, with an average of 15 years of experience, possess the potential to address climate challenges, but unlocking this potential requires targeted support. Addressing barriers through increased awareness campaigns, strengthened farmer networks, improved extension services, and access to funding and inputs is essential. By implementing these measures, Delta State can advance CSA adoption, fostering sustainable agriculture and enhancing resilience to climate change.

Recommendations

(a) A prolific creation of awareness on the importance of CSA in necessitating food security be instituted.
(b) Provision of technical assistance and support for farmers transitioning to CSA and ensure guidance and expertise are offered to them.
(c) Development of policies that incentivize the adoption of sustainable agriculture practices such as subsidies, extension services or tax incentives.
(d) Public-private partnership of government, non-profit organizations should leverage on current global SDGs goals drive to provide an enabling environment and incentives for a wider scale adaptation of climate-smart agriculture.
(e) Governments can provide CSA technologies to support farmers in order to achieve national food security and reduce their poverty levels.

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