Journal of Agriculture, Environmental Resource and Management
ISSN2245-1800(paper) ISSN 2245-2943(online)
4(2)607-613; Dec.2021; pp881-890
www.saerem.com

The Drivers of Adoption of Climate Smart Agriculture (CSA) among Smallholder Crop Farmers in Agroecological Zone D Area of Kogi State, Nigeria: Policy Options for Improved Food Security

[1]Shaibu, U.M., [1]Otaru, A.O., [2]Haruna, M. and [3]David, M.J.
[1]Department of Agricultural Economics and Extension, Kogi State University, Anyigba, Nigeria
[2]Dept of Strategic Space Application, National Space Research & Dev. Agency, Abuja, Nigeria
[3]School of Agricultural Technology, Itakpe, Kogi State Polytechnic
Corresponding E-mail: brave.monday@yahoo.com

ABSTRACT

The adoption of Climate Smart Agriculture (CSA) in meeting the Sustainable Development Goal on zero hunger without damaging the environment cannot be overemphasized. This study assessed the factors that influenced adoption of climate smart agriculture (CSA) among smallholder crop farmers in agroecological zone D area of Kogi State, Nigeria. Primary data obtained through questionnaire administration from one hundred and twenty (120) crop farmers were analysed using descriptive statistics and ordered logit regression model. The major CSA practices adopted by the crop farmers include; early planting (88.3%), minimum tillage (85.8%), mulching (85%), off-farm practices (83.3%), reliance on personal experience to predict weather events (82.5%), application of organic manure (81.7%), planting of covers crops (77.5), and farmer – farmers' knowledge sharing (75.8%). The major drivers of crop farmers' adoption of CSA practices include ag881e, farming experience, cooperative membership, and extension visit. Older crop farmers with high farming experience were less likely to be found in the low adoption category and more likely to fall under the medium and high CSA adoption category; while increased extension visits favour high adoption category. This study advocated for simulation between indigenous knowledge and modern agricultural practices to ensure a smooth transition to CSA in the study location. It is also important for the Kogi State government and the Kogi ADP to develop and execute more elaborate capacity building programmes at the local through extension service delivery on CSA practices.

Keywords: agriculture, climate, food security, knowledge smart, World Bank

INTRODUCTION

Climate Smart Agriculture (CSA) has been presented as an alternative form of agriculture for conserving the environment while addressing the food needs of the world's population (Food and Agriculture Organisation, FAO, 2014). The concept was originally put forth in 2010 by FAO after the Hague Conference on Agriculture, Food Security and Climate Change in 2009 (FAO, 2010; World Bank, 2010). According to FAO (2010), the main aim of CSA is to repackage agriculture in the context of a changing climate, to assure a 'triple win', thus, adaptation, mitigation and development.

CSA has therefore been defined as a form of agriculture that sustainably increases agricultural productivity and incomes; enhances adaptation and building resilience to climate change, reducing or removing Greenhouse Gases (GHGs) where possible, and enhancing the achievement of national food security and the sustainable development goals (FAO, 2014). Collier and Dercon (2014) opine that it is an approach to develop technical, policy and investment conditions to achieve sustainable development and food security.

In a related view, Shea (2014) suggests that CSA is a focus based concept that involves developing new technologies that can help farmers transition from current strategies to more climate-aware practices and encourage farmers to abandon or lessen reliance on methods that increase GHGs. CSA adopts some form of sustainable land management practices that engage farmers in sustainable intensification measures such as agroforestry, conservation tillage, residue management, green manuring and improved water management to improve agricultural performance (DeLonge *et al*., 2016; Palombi and Sessa, 2013). It also enables farmers to use their knowledge and skills more effectively, share information, opt for more efficient pro-environmental technologies and build stronger associations to facilitate effective negotiation of better market prices (Branca *et al*., 2011).

CSA is one of the approaches of adapting and coping with the challenges of climate change. It is important because of its triple potential benefits of improved productivity and high income, reduction or removal of greenhouse gases and improved household food security. Although the government and other stakeholders have promoted a number of CSA practices, some farmers have adopted CSA practices on their farms voluntarily. However, there is a dearth of knowledge on the drivers of the choice and use of the CSA practices.

Pointedly, information on what determines smallholder farmers' decision to engage in CSA practices in the local communities in Nigeria and Kogi State in particular is meagre. Carmona *et al*. (2015) argue that farmers' economic status, personal behaviours and socio-cultural background can influence CSA adoption. Similarly, Van Thanh and Yapwattanaphun (2015) established that extension courses, economic status, education and perception of sustainable agriculture influence the adoption of sustainable agriculture. In order to effectively implement CSA at the sub-national and county (local government) levels, and recoup maximum benefits, it is imperative to uncover the determinants of CSA adoption process. It is against this background that the paper sought to answer the following two questions: (a) What are the socioeconomic characteristics of crop farmers in agroecological zone D (b) What are the CSA practices adopted by smallholder food crop farmers in the study area? (c) What are the factors influencing the adoption of CSA by smallholder crop farmers? Expectedly, the results of the analysis will be inculcated into relevant CSA policies and facilitate attainment of relevant sections of the Sustainable Development Goals (SDGs).

METHODOLOGY

The study area is agroecolgical zone D area of Kogi State, Nigeria. The State is located between Latitude $6^0$30'N and $8^0$5'N and Longitude $5^0$51'E and $8^0$00'E. Kogi state has six (6) operational agricultural zones (A, B, C, D, E, and F) as delineated by the Kogi State Agricultural Development Project (Kogi ADP). Zone D comprises of Idah, Ofu, Ibaji, Olamaboro, and Igala-Mela local government areas with zonal headquarters at Alloma. The zone is well endowed with river valleys and swamp lands for dry season farming. The major crops grown in the zone are cassava, maize, yam, sorghum, rice, millet, cowpea, pigeon pea, groundnut, bambaranut, cocoyam, sweet potato, beniseed, melon, banana, plantain and cotton.

The study employed a quantitative survey research design. Data was sourced from smallholder cassava and maize farmers in the study area. This is because cassava and maize constitute the major food crops produced in the area and are highly affected by climate change (Kogi State ADP, 2018). Cassava and maize farmers were therefore used as a proxy for food crop farmers. For the purpose of this study, the FAO's (2010) definition of smallholder farmers is adopted; smallholder farmers are farmers who farm plots of 2 hectares or less and rely exclusively on family labour. Data collection was done by the researcher and five (5) well trained field assistants. This lasted for two months (July and August, 2021). A multi-stage sampling technique was used to select 120 smallholder cassava and maize farmers from twelve (12) farming communities within the study area.

Data was collected through the administration of a structured questionnaire. The questionnaire was divided into three sections in line with the research questions. Data processing and analyses were done using the Statistical Product for Service Solution (SPSS), version 22 and STATA version 12. Research questions 1 and 2 were achieved using descriptive statistics, while research question 3 was achieved using ordered logit regression model.

The regression model applied is stated below:

$Y_i^* = X_i\beta_i + \varepsilon$

Where Y_i^* is unobserved. What is observable is:

$Y = 0$ if $Y_i^* \leq 0$

$= 1$ if $0 < Y_i^* \leq \mu_1$

$= 2$ if $\mu_1 < Y_i^* \leq \mu$

$= j$ if $Y_i^* \geq \mu_{j-1}$

The μ′s are unknown threshold parameters to be estimated with β. Thresholds parameters determine the estimations for different observed value of y. The observed ordinal variable (dependent variable) takes on values 0 – 2, indexing the extent of adoption (high = 2, moderate = 1, low = 0). Following the number of CSA practices proposed in this study, the dependent variable will be grouped based on the extent of adoption of CSA as:

Extent of Adoption

CSA Adoption Score

High Adoption

> 15

Medium/Moderate Adoption

8 – 15

Low Adoption

< 8

Like the models for binary data, this study is concerned with how changes in the predictors translate into the probability of observing a particular ordinal outcome.

β= a vector of estimated parameter

Ɛ = the error term

Xi = individual farmers variables to be considered in the study and these include (based on existing studies and conceptual framework of this study);

X_1 = age (years)

X_2 = farming experience (years)

X_3 = farm size (hectares)

X_4 = education (years)

X_5 = membership of association (member = 1; non-member = 0)

X_6 = access to credit (access = 1, no-access = 0)

X_7 = extension services (number of extension visit per farming season)

X_8 = household size (number)

X_9 = farm income (₦)

$Ɛ_i$ = error term

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Crop Farmers

The distribution of respondents according to selected socioeconomic characteristics is presented in Table 1.

Table 1: Distribution of crop farmers according to socioeconomic characteristics

Socioeconomic Characteristics	Frequency	Percentage
Sex		
Male	83	69.2
Female	37	30.8
Age		
25 – 36	33	27.5
37 – 46	46	38.3
47 – 56	33	27.5
57 – 66	08	6.7
Marital Status		
Married	107	89.2
Single	09	7.5
Divorced	0	0
Widowed/widower	04	3.3
Household Size		
1 – 5	23	19.2

6 – 10	56	46.6
11 – 15	26	21.7
16 – 20	15	12.5
Educational Qualification		
No formal education	32	26.7
Primary education	30	25.0
Secondary education	33	27.5
Tertiary education	25	20.8
Other Occupation		
Processing of farm produce	32	26.7
Trading	52	43.3
Civil service	33	27.5
Artisanship	03	2.5
Farm size		
0.1 – 1	61	50.8
1.1 – 2.0	59	49.2
Annual Income (Naira)		
Below 100,000	28	23.4
50,000 – 250,000	55	45.8
Above 250,000	37	30.8

Field Survey, 2021

Table 1 shows that most (69.2%) of the respondents were males and 93.3% were in the age range of 25 – 56 years. The findings on gender is a common practice in most African households where male assumes the headship position. The reported age range in this study will favour the adoption of CSA practices as the respondents are energetic and ready to adopt innovation. The result further shows that majority (89.2%) of the respondents were married with a modal family size of 6 – 10 members. In terms of literacy, 26.7% of the crop farmers had no formal education; this may also favour adoption of agricultural innovation such as the CSA practices.

Climate Smart Agriculture (CSA) Practices

The CSA practices adopted by crop farmers in the study area is presented in Table 2 and summarized in Figure 1. The various practices were adopted from the World Bank's climate smart village model. As shown in Table 2, majority (82.5%) of the crop farmers relied on their own personal experience to predict weather events, 40% depended on radio/television to access weather information, 17.5% and 16.7% of the farmers were trained on weather information by relevant organization such as NGOs and through community centres and/or extension agents, respectively. The low adoption of crop insurance agrees with the position of Shaibu *et al*. (2020) who reported low level of adoption of agricultural insurance scheme among crop farmers in Kogi State. Mulching (85%), early planting (88.3%), and planting of covers crops (77.5) were the major water smart practices adopted by the crop farmers. The carbon smart practices adopted by the respondents include; minimum tillage (85.8%), application of organic manure (81.7%), and mixed cropping (71.7%). Planting of leguminous crops (69.2%) and precision fertilization (42.5%) were the major Nitrogen smart, while compost of residue after planting (55%) was the energy smart practices adopted by most of the crop farmers. In terms of knowledge smart practices, crop farmers in the study area adopted off-farm practices (83.3%), farmer – farmers' knowledge sharing (75.8%), membership of association (71.7%), and seed banking (65.8).

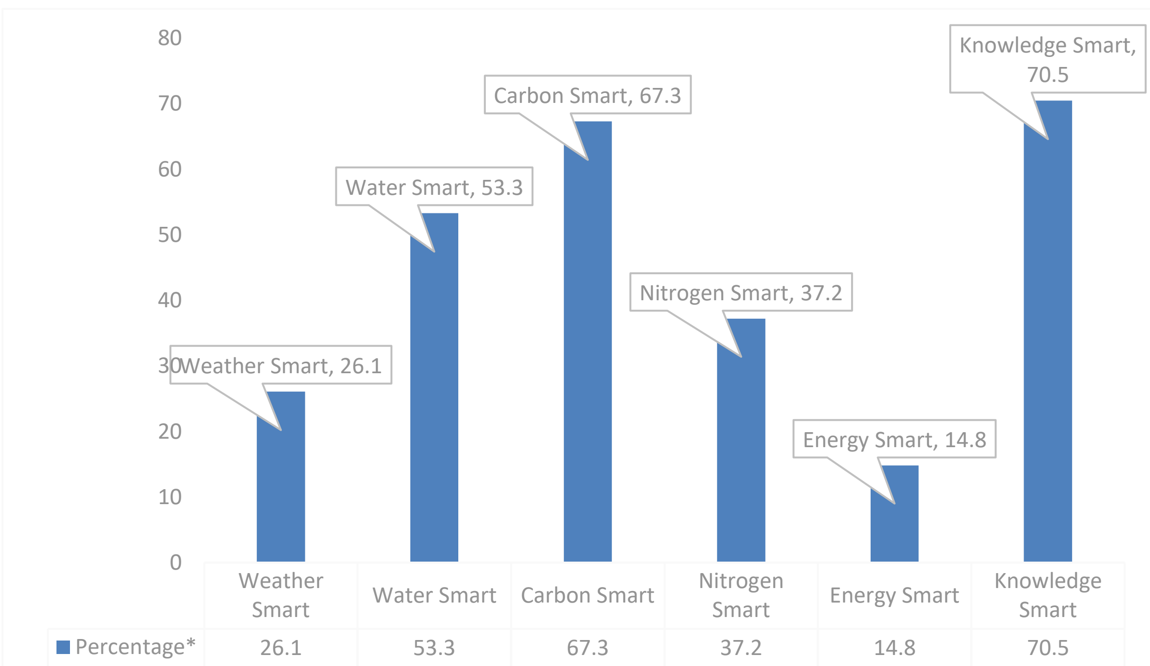
Summarily, Figure 1 shows the order of adoption of CSA practices by crop farmers to include; knowledge smart (70.5%), carbon smart (67.3%), water smart (53.3%), nitrogen smart (37.2%), weather smart (26.1%), and energy smart (14.8%).

Table 2: CSA practices adopted by crop farmers

CSA Practices	Freq.*	Percentage
A. Weather Smart		
Use personal experience to predict weather events	99	82.5
Usage of radio/TV for weather information	48	40.0
Training on weather information by relevant organization	21	17.5
Weather information through community centre/agents	20	16.7
Take crop insurance to protect my farm	0	0
Use of internet to access weather information	0	0
Sub-Total	**188**	**26.1**
B. Water Smart		
Engage in mulching	102	85.0
Control of irrigation water	08	6.7
Early planting to meet with rain	106	88.3
Planting of cover crops to maintain soil moisture	93	77.5
Harvest and store rain water to be used on my farm	11	9.2
Sub-Total	**320**	**53.3**
C. Carbon Smart		
Minimum tillage	103	85.8
Organic manuring	98	81.7
Mixed cropping	86	71.7
Afforestation	46	38.3
Crop rotation	71	59.2
Sub – Total	**404**	**67.3**
D. Nitrogen Smart		
Planting of leguminous crops		

Precision fertilization (avoid over fertilization)	83	69.2
Soil testing before fertilizer/manure application	51	42.5
Sub – Total	0	0
	134	**37.2**
E. Energy Smart		
Use of less fuel consuming vehicles on the farm	0	0
Compost of residue after planting	66	55.0
Conversion of residue to bioenergy	05	4.2
Use of solar equipment in farming	0	0
Sub – Total	**71**	**14.8**
F. Knowledge Smart		
Farmer-farmer knowledge sharing	91	75.8
Member of farmer association/group	86	71.7
Seed banking (store seeds for next season)	79	65.8
Off-farm activities	100	83.3
Access information on market prices	67	55.8
Sub – Total	**423**	**70.5**

Source: Field Survey, 2021 *** = multiple responses**
NOTE: Questions/statements adopted from the World Bank climate smart village model



Source: Field Survey, 2021 * percentage obtained through multiple responses

Drivers of Crop Farmers' Adoption of CSA

Estimates of the ordered binary logit model on factors that influence the adoption of CSA practices by crop farmers are presented in Table 3.

Table 3: Estimates of Ordered Logit on the Drivers of CSA among Crop Farmers

Variables	Coefficients	Marginal Effects		
		Low Adoption	Medium Adoption	High Adoption
Age	0.06 (0.03)**	-0.01 (0.003)**	0.05 (0.002)**	0.011 (0.005)**
Farming exp.	0.23 (0.05)***	-0.02 (0.01)***	0.019 (0.004)***	0.041 (0.008)***
Farm size	0.03 (0.07)	-0.002 (0.007)	-0.003 (0.006)	0.005 (0.013)
Education	0.03 (0.07)	0.003 (0.007)	0.003 (0.006)	0.006 (0.013)
Cooperative mem.	2.26 (1.09)**	-0.21 (0.10)**	-0.188 (0.0914)**	0.401 (0.183)**
Credit access	0.91 (0.53)	-0.08 (0.05)	-0.076 (0.044)	0.162 (0.091)
Extension visit	1.01 (0.31)***	-0.09 (0.03)***	-0.084 (0.024)***	0.179 (0.047)***
Household size	-0.08 (0.09)	0.01 (0.01)	0.007 (0.007)	-0.015 (0.016)
Income	3e-06 (9e-06)	2e-07 (8e-07)	2e-07 (7e-07)	5e-07 (1e-06)
Log likelihood = -92.60; LR Chi^2 = 45.11***; Pseudo R^2 = 0.20				

Source: Field Survey, 2021 *** and ** = significant at 1% and 5% level, respectively. Figures in parentheses are standard errors.

The Chi square statistics of 45.11 was statistically significant ($p < 0.01$). This implies that, the included explanatory variables have influence on crop farmers' adoption of CSA practices. Furthermore, Pseudo R^2 of 0.20 is an indication that the variables included in the model accounted for 20% of the factors responsible for variations in the probability of crop farmers adopting CSA practices. Estimates of the marginal effects at the various ordered levels indicate the effects of one unit change in an exogenous variable on the probability that a crop farmer operates at a particular level. The adoption level of the respondents was based on the CSA adoption score. Farmers who had an adoption score below eight (8) were considered to have low level of adoption; respondents with 8 – 15 had medium adoption level, while farmers who had above fifteen (15) adoption score were adjudged to fall in the high adoption category. From the result presented in Table 3; age, farming experience, cooperative membership, and extension visit significantly influenced the adoption score of crop farmers in the study area. By implication, these variables increases or decreases the probability of farmers having high adoption score.

Table 3 shows that the coefficients of age and farming experience were significant across the three levels at 5% and 1% level of significance, respectively. It was negatively signed at level 1 (low adoption) and positively signed at levels 2 and 3. By implication, older food crop farmers with high farming experience are less likely to be found in the low adoption category. The higher the age and farming experience, the more likely crop farmers fall under the medium and high CSA adoption category. Pointedly, a one year increase in age and farming experience will reduce the likelihood of crop farmers belonging to the low CSA adoption category by 0.01 and 0.02, respectively. Further, a one year increase in age and farming experience will increase the likelihood to be in the medium adoption level by 0.05 and 0.019, respectively. Also, a one year increase in age and farming experience will increase the likelihood of crop farmers to be in the high adoption category by 0.01 and 0.04 respectively.

The estimate on extension visits shows that an increase in the number of extension visits will increase the likelihood of crop farmers' adoption of CSA practices. The marginal effects indicates that higher number of extension visits will reduce the likelihood of crop farmers been found in levels 1 and 2, but favours the high adoption category. Specifically, an increase in extension visits will reduce the probability of crop farmers belonging to the low and medium adoption category by 0.09 and 0.08 times. Additionally, an increase in extension visits will increase the likelihood of crop farmers belonging to the high adoption category by 0.18 times. Agricultural institutions such as the Agricultural Development Project (ADP) play significant role in creating awareness on innovation adoption. Famers need support at various levels to be able to embrace CSA. The agricultural extension agents play pivotal role in such situation as they provide training, education, demonstration, monitoring and evaluation to ensure that farmers adopt CSA practices. This finding supports other views (Nyanga *et al*., 2016; Aggarwal *et al*., 2013; and Palombi and Sessa, 2013) on socio-cultural and institutional determinants of CSA adoption.

CONCLUSION AND POLICY OPTIONS

The findings of this study confirms the role of CSA in promoting climate change adaptation, mitigation, food security and sustainable development. Based on the World Bank categorization of CSA practices (weather, water, carbon, nitrogen, energy and knowledge practices), the CSA practices implemented by most of the farmers included knowledge smart, carbon smart, and water smart. The major determinants of CSA adoption were age, farming experience, and extension visits.

Based on findings from this study, the following policy options are recommended:

1. Local and international organisations should help to strengthen farmers' indigenous knowledge to align with modern agricultural practices. This will ensure a smooth transition to the application of climate smart agricultural technologies.
2. Extension agents and relevant stakeholders should educate crop farmers on the use of modern smart practices such as mobile phones to access weather information, access to weather information on the internet, agricultural insurance uptake, and relevant soil testing before fertilization
3. For easy adoption of CSA practices with their up-scaling at all levels, variables such as age, years spent farming, and access to regular extension services

should be properly integrated in CSA programming.

REFERENCES

Aggarwal, P., Zougmoré, R., and Kinyangi, J. (2013). Climate-Smart Villages: A community approach to sustainable agricultural development. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Retrieved from www.ccafs.cgiar.org

Carmona, I., Griffith, D. M., Soriano, M. A., Murillo, J. M., Madejón, E., and Gómez-Macpherson, H. (2015). What do farmers mean when they say they practice conservation agriculture? A comprehensive case study from southern Spain. *Agriculture, Ecosystems & Environment*, 213, 164-177.

DeLonge, M. S., Miles, A., and Carlisle, L. (2016). Investing in the transition to sustainable agriculture. *Environmental Science & Policy*, 55, 266-273.

Food and Agriculture Organisation. (2010). The state of food insecurity in the world 2010. Retrieved from www.fao.org/docrep

Food and Agriculture Organisation. (2013). FAO statistical year book 2013. Retrieved from www.fao. org/docrep

Food and Agriculture Organisation. (2014). The state of food and agriculture (SOFA) 2014. Retrieved from www.fao.org/3/a-i4040e.pdf

Nyanga, A., Kessler, A., and Tenge, A. (2016). Key socio-economic factors influencing sustainable land management investments in the West Usambara Highlands, Tanzania. *Land Use Policy*, 51, 260-266.

Palombi, L., and Sessa, R. (2013). Climate-smart agriculture: sourcebook. Food and Agriculture Organization of the United Nations (FAO).

Shaibu, U.M; Ibitoye, S.J.; Oyibo, F.O.; Emeje, C. and Shaibu, D.O**.** (2020). Assessment of Crop Farmers' Willingness to Take (WTT) Agricultural Insurance Scheme in Kogi State, Nigeria: Application of Turnbull Estimator. *Revista E- Agronegocios*, 6(1). https: DOI: https://doi.org/10.18845/rea.v6i1.4937. E-Agribusiness Magazine of the Center for Research in Agricultural Economics and Agribusiness Development (CIEDA) of the University of Costa Rica.

Shea, E. C. (2014). Adaptive management: The cornerstone of climate-smart agriculture. *Journal of Soil and Water Conservation*, 69(6), 198A-199A.

Van Thanh, N., and Yapwattanaphun, C. (2015). Banana farmers' adoption of sustainable agriculture practices in the Vietnam Uplands: The Case of Quang Tri Province. *Agriculture and Agricultural Science Procedia*, 5, 67-74.

World Bank (2010). Development and climate change. Retrieved from siteresources. worldbank.org/INTWDR2010/.../WDR10 on Monday January 4, 2016 at 07: 59am.