

Determinants of choice of Climate Smart Agricultural practices adoption among yam based farming households in Ogun State, Nigeria

Oluwafemi S. Faleye* and Carolyn A. Afolami

Centre of Excellence for Agricultural Development and Sustainable Environment, Federal University of Agriculture Abeokuta, Nigeria.

*Corresponding author. Email: oluwafemifaleye83@gmail.com

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Received 19th March, 2020; Accepted 22nd April, 2020

ABSTRACT: Agriculture is highly vulnerable to the effect of climate change even though is the most weather dependent of human activities. Thus, there is a need for sustainable approach to practice of agriculture in the region. This study examined the determinants of adoption of Climate Smart Agricultural (CSA) practices among yam based farming households in Ogun State, Nigeria. A sample of 160 respondents were selected through multi stage sampling technique from two out of the four Agricultural Development Programme (ADP) zones in the state and data were collected with the use of structured questionnaire, which was also used as an interview guide. Data were analysed using descriptive statistics and multivariate probit model. The findings showed that 89.38% of the yam based farmers were men. Majority (65%) of the farmers were between 41 to 60 years. Also, it was revealed that only 16.3% of the respondents did not have any form of formal education. Mulching was found to be the CSA practice that is mostly adopted in the area with 90.6% of the respondents adopting the practice while mixed farming was the least adopted with 20.6% of the respondents adopting it. Also, it was revealed that on the average, a farmer adopted three out of the five practices considered. Furthermore, the multivariate probit results revealed the following factors that influence adoption of the various CSA practices; radio information, farm size, volume of credit, farming experience, number of contact with extension agent, and membership of cooperative society were positively significant at 1%, 5% and 10 % while sex, age, years of education, use of credit, access to extension service and membership of farmers association were negatively significant at 1%, 5% and 10 %. The study recommended that CSA practices should be introduced to yam based farmers not as a new set of technology but should be diffused to them as an improvement on those indigenous practices they are used to, to enable fast adoption of CSA practice in the area.

Keywords: Agriculture, climate change, Climate Smart Agricultural, yam based farming.

INTRODUCTION

Agriculture is highly vulnerable to the effect of climate change especially considering that it is one of the major human activities that is more dependent on weather patterns. Action Aid Nigeria (2009) ascertains that agriculture suffers from and contributes to undesirable effects of climate change. Many of the current farming practices are detrimental to the environment and constitute major source of anthropogenic greenhouse gas (GHG) emissions; this poses additional challenges to agriculture,

particularly in developing countries (Vermeulen et al., 2012).

The uncontrolled and increasing urbanization, organic and inorganic wastes that left in environment, unintended usage of agricultural lands and wrong agricultural applications are the drivers of environment pollution. Erroneous using of pesticides and chemical fertilizers, irrigation, tillage, plant hormone applications are some of the wrong applications. Also burning of stubble, non-

rotational planting and inappropriate animal wastes are unsustainable in nature (Önder et al., 2011). The impact agricultural practices on the environment varies based on the varieties of practices employed by people around the world.

Agriculture has the potential for any strategy to adapt to climate change and reduce emission particularly in Africa context. Thus, there is a need for sustainable approach to the practice of agriculture in the region (Garrity et al., 2010; Beddington et al., 2011). There has been development and promotion of several initiatives aimed at promoting sustainable agriculture over the last decade (Lichtfouse et al., 2009; Beddington et al., 2012); emphasize has been on agricultural practices that put food security as a goal while also ensuring adaptation and mitigation against climate change.

An approach that employs both adaptation and mitigation is essential for climate change effect as predicted by Intergovernmental Panel on Climate Change [IPCC] (2014b). In describing tensions between maximizing global agricultural productivity, increasing resilience of agricultural systems in the face of climate change and mitigating greenhouse gas (GHG) emissions from agriculture, the term Climate-Smart Agricultural (CSA) development was first used in 2009 (FAO, 2009); the acronym SMART; where S stands for specific, M for measurable, A for achievable, R for reliable and T for time bond (McCarthy et al., 2012). Food and Agriculture Organization (FAO) (2010) describe CSA as a method of agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals. There are three main pillars to any CSA approach: resilience and adapting to climate change; sustainable increased in incomes and agricultural productivity; and either reducing or removing emissions of greenhouse gases. Thus, agriculture is termed to be "climate-smart" when these three objectives are achieves. CSA concept is a good way to merge climate change and agriculture development agendas as one brand (Neufeldt et al., 2013).

Yam is a perennial herbaceous vine of the Genus *Dioscorea* that needs support to climb and stem. It requires sandy loam and free draining soil (IITA, 2009) and the underground storage organ are the tubers that provide the carbohydrate for feeding. Yield ranges from 8 to 50 metric tonne per hectare and the maturity period span between 6 to 10 months (Ayanwale et al., 2009).

The sapogenin present in yam called diosgenin is a precursor to many corticoid drugs. Commonly cultivated yam in Nigeria include white yam (*Dioscorea rotundata* *poir*), yellow yam (*Dioscorea cayenensis* *lank*) and water yam (*Dioscorea alata* *lank*) with white yam presenting the highest consumers preference (Ojofeitinmi and Olufokunbi, 1986; Opara, 1999).

In 2008, Nigeria produced about 35 Mt of yam out of 51.4 Mt world production representing 68% of world output

(FAO, 2008). According to the FAO (2013), Nigeria account for about 38 Mt of the 58.75 Mt of the world production of yam. This shows an increase in yam production in Nigeria from 2008 to 2013. Yam is produced in almost every State in the Central and Southern parts of the country and yam remains a major food crop in the household diet and an important source of income for farmers and marketers.

Yam is a major tuber crop in Nigeria economy in terms of quantity and value of production and land brought under its cultivation (Bamire and Amujoyegbe, 2005). Agriculture as the biggest driver of environmental change has ranked it high on political agenda (Smith et al., 2007; Liverman and Kapadia, 2010; Foresight, 2011). About 40 to 50% of the Earth's land surface are agricultural lands (Smith et al., 2007). An estimated value of about three-quarters of tropical deforestation are traced to agricultural activities (Carr, 2004; Skutsch et al., 2007; Wollenberg et al., 2012) and accounts for global anthropogenic emission of about 10 to 12% of the total greenhouse gases (GHGs) in 2005 (Smith et al., 2007).

Some studies have recommended that adoption of CSA technologies can improve input use efficiency, increase crop yield, increase income and reduce emission of GHG (Khatri-Chhetri et al; Sapkota et al., 2014). Yet, the adoption of CSA is still low in Sub Saharan Africa. There has been some positive outcomes of application of CSA in some African countries, namely Northern Cameroon; Yatenga; Egypt; Burkina Faso and the Nile Delta (Branca et al., 2011; FAO, 2010). Also, there is even the recommendation that the adoption of CSA practices in northern Nigeria will improve indigenous agricultural practice as well as encourage the practice of agro-ecological agricultural systems (International Assessment of Agricultural Knowledge, Science, and Technology for Development -IAASTD, 2009). The decision of farmers to use these practices is dependent on various socio economic and institutional factors which needs empirically investigation. This study thus examined the determinants of adoption of CSA practices among yam based farming households in Ogun State, Nigeria.

METHODOLOGY

The study area

This study was conducted in Ogun State, Nigeria. Ogun State was created in 1976 from the former Western State. The State is one of the six South Western states in Nigeria. Ogun State lies within latitude 6°20' South and 7° 58' North in the tropics and longitude 2°40' West and 4°35' East of the Greenwich Meridian with a total land area of 16,762 square kms and an estimated population of 4,054,272 (Ayinde et al., 2015). The State is known for extensively producing food crops like; maize, cassava, yam, cocoyam, soybean among other crops. The physical environment

(soil characteristic and climatic effects), the vegetation type and the availability of markets are all contributory factors that have facilitated the development of the agricultural sector in the State.

Sampling technique

Respondents for the study were selected using a multi stage sampling technique. Ogun State has four Agricultural Development Programme (ADP) zones which are Abeokuta, Ilaro, Ikenne and Ijebu-Ode. The first stage of the sampling technique involves the purposive selection two (2) (namely, Abeokuta and Ikenne) out of the four Agricultural Development Programme (ADP) zones in the State. The selection was due to availability of appreciable number of yam famers in these zones. The second stage involved the selection of two (2) blocks out of the six blocks in Abeokuta zone and two (2) blocks out of the four blocks in Ikenne zone giving a total of four (4) blocks. This was followed by the random selection of 2 cells from each block selected from the zones to give 8 cells. The final stage was the random selection of 20 yam farming households in each village that falls within the farming communities selected in the cells. This gives a total of 160 yam farming households that was surveyed in the state for this study.

Source of data and data collection

Primary data were used in this study and they were collected through the administration of well-structured questionnaire and an interview guide. Data were collected on socio-economic variables of age, sex, marital status, size of household and specific climate smart agricultural practices (of intercropping, cover cropping, mulching, etc.).The questionnaire was filled by the literate respondents while the interview guide was read and interpreted for the illiterate respondents and their responses were recorded instantly.

Data analysis techniques

Descriptive statistics and multivariate probit regression were used to analyse data. Descriptive statistics, such as frequency distribution, means and percentages were used to describe the socio-economic characteristics of age, sex, marital status, size of household of adopters and non-adopters of CSA practices.

For this study, Climate Smart Agriculture practices was considered as application of relevant practices applicable to yam production in the study area. These are; mixed cropping (intercropping), crop rotation, zero or reduced tillage, mixed farming and mulching. The position of Afolami et al. (2015) on adoption was adopted for this study; a farmer is an adopter if he or she has planted one the improved variety of cassava in the previous planting season and still has it on the farm as at the time of the survey. For this study, a farmer was classified as an

adopter of CSA practice if he or she has used at least one of the afore mentioned practices in at least one planting season prior to the onset of this study or even during the duration of the study. This is in line with NIAEM (2007) that defined adoption as the use of a recommended practice on a continuous basis. Adoption variable is defined as 1 if a farmer is an adopter of a CSA practice and 0 if a farmer is non adopter. This study adopted multivariate probit regression model to examine the factors that determine the farmers' decision to adopt CSA practices so as to take into account the multiple practices, and the possible simultaneity of the decision making.

Estimation procedures: Multivariate Probit Model

In Climate Smart Agriculture Practices, there are several practices that make up the technology, thus, the use of a multivariate (instead of univariate) model to take into consideration the multiple practices, and the simultaneity of the decision making process of the farmers. Consequently, a multivariate probit model was used in this study to examine the adoption decision by yam based farmers. The multivariate probit model estimated the choice of Climate Smart Agriculture Practices related to each of the yam based farmers corresponds to a binary choice (yes/no) equation and the choices are modeled jointly, taken into account the correlation among disturbances (Table 1). There is an improvement in model estimates from the multivariate specification over those from univariate specifications when the error correlations are significantly different from zero. Otherwise, the results from the two modeling frameworks would need to be compared. Hence, if a farmer adopt j practice, j equations each describing a latent dependent variable that corresponds to the observed binary outcome for each practices would be needed to be estimated simultaneously. Thus, a system of simultaneous probit models were constructed for zero tillage, mulching, mixed farming, mixed cropping and crop rotation.

The multivariate probit regression model is usually described in terms of correlated multivariate normal distribution of the latent variables that are manifested as discrete variables through a threshold specification and hence allows the flexible modeling structure and easy interpretation of parameters (Balía and Jones, 2004).

Given that I_j^0 represent the latent response associated with j th practice for $j = 1, \dots, J$ and I_j is the binary response outcome associated with the same practice. $I_j = 1$ if the yam based farmer adopts the practice and 0 otherwise. Hence the multivariate probit regression model can be specified as linear combinations of stochastic and deterministic as follows (Young, et al., 2006):

$$\begin{aligned}
 I_1^0 &= X' \beta_1 + \varepsilon_1 & \text{for } I_1 & (I_1^0 > 0) \\
 I_1^0 &= X' \beta_2 + \varepsilon_2 & \text{for } I_2 & (I_1^0 > 0) \\
 I_1^0 &= X' \beta_j + \varepsilon_j & \text{for } I_j & (I_1^0 > 0) \dots \dots \dots (1)
 \end{aligned}$$

Table 1. Description of the variables used in the Multivariate Probit Model.

Variables (Xi)	Definition	Signs of apriori Expectation
Sex	Sex of household head, 1 male and 0 otherwise	+
Age of Household head	Age in years	±
Household size	Number of persons living under the same roof	+
Years of education	Number of years of formal education of household head	+
Major occupation	1 if major occupation is farming and 0 otherwise	+
Ownership of farm land	1 if farmer owns a farm land and 0 otherwise	+
Access to radio	1 if farmer access to agricultural information through radio, 0 otherwise	+
Farm size	Total area of land cultivated by farmers in Hectare	+
Total revenue on yam	Total annual revenue in naira	+
Use of credit	1 if a farmer uses credit and 0 otherwise	+
Volume of Credit	Value in Naira	+
Years of farming experience	Number of years of experience in farming	+
Access to extension service	1 if a farmer have access to extension service, 0 otherwise	+
Frequency of extension contact	Number of contacts farmers had with extension agent in the previous cropping season	+
Membership of association	1 if a member of farmers' association and 0 otherwise	+
Membership of cooperative society	1 if a member of farmers' cooperative society and 0 Otherwise	+

$x = (1, x_1, \dots, x_n)$ is a vector of 'n' independent variables which remain the same for all the CSA practices considered (i.e. the deterministic component) and $\beta_j = (\beta_{j0}, \beta_{j1}, \dots, \beta_{jn})$ is a corresponding vector of parameters. ε_j is the error term which may be thought of as consisting of unobservable factors which explain the marginal probability of choice of type j practice.

RESULTS AND DISCUSSION

Socioeconomic characteristics of yam based farmers

Information on the socio economic characteristics of yam based farmers in the study area were analysed using descriptive statistics (frequency distributions and percentages) as shown in Tables 2a and b. Table 2a shows that majority (89.38%) of the yam based farmers were males and 10.63% were females. The domination by male farmers could be linked to males having greater access to farm land than their females' farmers. Also, the tedious nature of yam farming could be responsible for this. This is against the findings of Adisa and Okunmadewa (2005), Akinagbe et al. (2008) and Nsoanya and Nenna (2011) who concluded that women are the backbone of agricultural sector and agricultural production in African. The result also shows that majority (85.0%) of the farmers were married, 2.5% were single, 2.5% were separated while 9.4% were widowed and 0.6% were divorced. The domination of farmers by married men and women invariably contributed to increase in farm labour provided by household size (Torimiro, 2005).

The years of education of the farmers shows that only 16.25% had never been to school while the remaining had one form of education or the other. The average years of schooling was 7 years. This supports the assertions of Ozor and Madukwe (2005) that the majority of the farmers had one form of education or the other, and thus it is an advantage for adoption of innovation, since education enhances the adoption of improved agricultural technologies.

Majority of the farmers (73.75%) had farming as their primary occupation while only 26.25% did not. A good proportion of the respondents, (66.25%) also had yam farming experience of about 20 years or less. The age distribution of the yam based farmers revealed that majority (65.00%) were aged between 41 to 60 years with an average age of 50 years. This implies that majority of the farmers are old, with the disadvantage of not adopting innovations that can enhance farm productivity. The household size was relatively high; with 34.38% of the farmers having household size of 1 to 4 members and 50.00% have 5 to 8 members each while 15.63% had household members that are above 8. The mean household size was 6 people with a standard deviation of 3 people. This implies that farmers in the study area have a large household size. This supports the findings of Teklewold et al. (2006), Tizale (2007), Onubuogu et al. (2013) and Esiobu et al. (2014) that labour availability is dependent on large household size and thus makes adaptation to climate change easy by reducing the cost of hired labour. Majority of the farmers (84.37%) had access to agricultural information via the radio. A good proportion of the yam based farmers (60.63%) had their own personal land used for agriculture.

Table 2a. Respondents' distribution by socioeconomic characteristics.

Variable	Frequency (n=160)	Percentage (%)	Mean	Standard deviation
Sex of household head (dummy variable)				
Male	143	89.38		
Female	17	10.63		
Age of household head (Continuous variable in years)				
≤20	0	0.00		
21-40	30	18.75	50	10
41-60	104	65.00		
61-80	26	16.25		
Marital status (Categorical variable)				
Single	4	2.5		
Married	136	85.0		
Divorced	1	0.6		
Separated	4	2.5		
Widow	15	9.4		
Household size (Continuous variable)				
1-4	55	34.38		
5-8	80	50.00	6	3
Above 8	25	15.63		
Years of education (Continuous variable)				
0	26	16.25		
1-6	62	38.75	7.28	4.88
7-12	53	33.13		
Above 12	19	11.88		
Major occupation (dummy variable)				
Farming	118	73.75		
Otherwise	42	26.25		
Ownership of farmland (dummy variable)				
Owns a land	97	60.63		
Otherwise	63	39.38		
Access to agricultural information through radio (dummy variable)				
Have access	135	84.37		
Otherwise	25	15.63		
Farming experience (Continuous variable in Years)				
≤10	31	19.40		
11-20	75	46.90	18.49	8.88
21-30	36	22.50		
Above 30	18	11.30		
Farm size (Continuous variable in Hectares)				
≤1.0	104	65.00		
1.1-2.0	40	25.00	1.09	0.90
Above 2.0	16	10.00		

Source: Field Survey Data, 2017.

Table 2b. Minimum and maximum values of continuous variables in socio economic characteristics.

Variable	Unit	Minimum	Maximum
Age of Household Head	Years	27	73
Household Size	Number of persons	2	15
Years of Education	Years	0	21
Farming Experience	Years	5	50
Farm Size	Hectares	0.2	6.53

Source: Field Survey Data, 2017.

Table 3. Distribution of related constraints encountered in yam production by the farmers.

Constraints	Frequency	Percentage (%)
Decreased Yield	123	76.9
Pest and disease infestation	41	25.6
Short season length	31	19.4
Flooding of farm lands	32	20.0
Increased use of fertilizer	12	7.5
Reduced rainfall	6	3.8
Rotten of yam tubers due to high temperature	10	6.3
Late emergence of yam seedling	2	1.3
Total	257**	

**Multiple Responses recorded (Source: Field Survey Data, 2017).

Climate related constraints encountered in yam production

Climate change pose a lot of constraints to farmers in the study area. Table 3 reveals that majority (76.9%) of the respondents identified decrease in yield as climate related constraints encountered in yam production while 25.6% identified pest and disease infestation as a constraint and 19.4% indicated short season length compared to what they have in previous years. Twenty percent of respondents had their farm land flooded due to excessive rainfall in the previous farming season, 7.5% of the respondents indicated that climate change has brought about increased use of fertilizer to replenishing the soil fertility and 3.8% indicated that there has been a reduction in rainfall pattern. Rotten yam tubers due to high temperature was identified as a constraint by 6.3% of the respondents while just 1.3% indicated late emergence of yam sett as a constraint. This constraint has in one way or the other informed the yam farmers to seek better ways to manage their production in the face of ever changing climate. The constraints generally faced by yam farmers in the study area also corroborate the findings of Ademola and Oyesola (2012) reported low yield, stunted growth, high sunlight intensity, pests and diseases and prolonged dry seasons as constraints to yam farmers' productivity.

Respondents' distribution by adoption of CSA practices

The adoption of the CSA practices varies from one farmer

to the other in type and number of practices. Table 4 revealed that only 5.6% of the sampled respondents were actually non-adopters of CSA practices in the study areas, while the majority (94.4%) were adopters. Majority (68.8%) of the farmers adopted zero tillage and 31.3% of the farmers did not. In the same vein, 9.4% did not adopt mulching while majority (90.6%) did. It was also observed that minority (20.6%) of the respondents adopted mixed farming in the study area, as shown in Table 4, while 79.4% did not adopt mixed farming, and this may be due to inability to secure start-up capital due to large capital requirement for commercial livestock farming. This corroborate Oluwasusi (2013) that found out that minority (14.2%) of yam farmers in Ekiti State engaged in mixed farming.

Majority (71.3%) of the respondents adopted mixed cropping while 28.8% did not adopt mixed cropping. It implies that the respondents practiced mixed cropping to guarantee all-year-round production to insure the farmers against total crop failure. This finding is similar to that of Oluwasusi (2013) who found that majority (84.1%) of yam farmers in Ekiti State engaged in mixed cropping. Also, 54.4% adopted crop rotation while 45.6% did not.

Table 5 shows that on the average, a farmer adopted three of all the five CSA practices considered, while 5.6% adopted one practice, 13.8% adopted two practices, 34.4% adopted three practices and 33.8% adopted four practices. Just 6.9% adopted all the five practices. No agricultural technology will have an impact either directly or indirectly unless farmers adopt it (Meinzen-Dick et al., 2004).

Table 4. Respondents' distribution by adoption of CSA practices.

CSA practices	Frequency	Percentage (%)
Adoption zero tillage		
Yes	110	68.8
No	50	31.3
Adoption of mulching		
Yes	145	90.6
No	15	9.4
Adoption of mixed farming		
Yes	33	20.6
No	127	79.4
Adoption of mixed cropping		
Yes	114	71.3
No	46	28.8
Adoption of crop rotation		
Yes	87	54.4
No	73	45.6

Source: Field survey data, 2017.

Table 5. Respondents' distribution by number of CSA practices adopted.

Number CSA Practice adopted	Frequency	Percentage (%)	Cumulative percentage (%)
0	9	5.6	5.6
1	9	5.6	11.2
2	22	13.8	25.0
3	55	34.4	59.4
4	54	33.8	93.2
5	11	6.9	100.0
Total	160	100	
Mean	3		
Standard Deviation	1.22		
Maximum	5		
Minimum	0		

Source: Field Survey Data, 2017.

Determinants of choice of Climate Smart Agricultural practices adoption

The various determinant of the CSA practices used by the yam based farmers are discussed below as shown in Table 6. The socio economic and institutional factors that affected the decision of a farmer to use a practices varies from one practice to the other as indicated in the table 6.

Coefficients of age and sex were negative and significant ($p < 0.1$) in adoption of mixed cropping. This indicate that as age of the yam based farmers increase, the probability of adopting mixed cropping among the yam

based farmers decreases. Findings have shown that age has a negative relationship with adoption of technology. This relationship is also supported by Mauceri et al. (2005) and Adesina and Zinnah (1993) that there is an increase in risk aversion and reduction in long-term investment in the farm among farmers as they grow old. Also, the sex of the farmers increases the probability of the farmer to use mixed cropping.

The coefficient of household size was positive and significant ($p < 0.05$) for adoption of mixed cropping. This implies that an increase in household size among the yam

Table 6. Determinants of choice of Climate Smart Agricultural practices adoption.

Parameters	Zero tillage		Mulching		Mixed farming		Mixed cropping		Crop rotation	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
SX	0.000217	0.394978	-0.194714	0.491013	-0.060632	0.456204	-0.815940***	0.482021	-0.134769	0.353768
AG	0.025991	0.016619	-0.007660	0.018054	-0.024984	0.016204	-0.030800***	0.018031	-0.008038	0.014422
HHS	0.072190	0.051372	0.068748	0.062190	0.068621	0.048833	0.115861**	0.054749	0.050377	0.044811
YRSE	0.030139	0.029217	-0.011104	0.032326	-0.054600***	0.031423	-0.031626	0.030457	0.027453	0.026198
MJROCP	-0.145494	0.265755	0.170163	0.337783	0.281430	0.336152	-0.222964	0.306443	0.179631	0.267139
OWNL	0.390407	0.243126	0.076752	0.305280	-0.054186	0.259528	-0.523939***	0.269341	0.300424	0.220794
RDINF	1.123913*	0.351582	0.608592	0.383590	0.921824**	0.439905	0.270265	0.394706	0.198045	0.350212
FARMS	-0.098464	0.174633	0.056185	0.151596	0.321719***	0.195157	0.295293	0.183986	0.147365	0.150607
YRVN	1.34e-07	6.81e-07	-7.57e-07	6.87e-07	-1.07e-06	6.58e-07	2.23e-08	9.65e-07	-8.12e-07	5.92e-07
UCRDT	0.193675	0.322488	-0.437624	0.493569	0.333377	0.370470	-1.092661**	0.444057	-0.282944	0.310254
CRDTV	-8.54e-07	1.77e-06	7.32e-06	5.03e-06	-3.58e-07	1.70e-06	7.30e-06**	3.29e-06	8.73e-07	1.79e-06
FARME	0.011483	0.0186844	0.0467487***	0.026350	-0.001137	0.020186	0.026741	0.022015	0.033308***	0.019372
AEXAT	-0.313509	0.441980	-0.271734	0.556309	-0.046454	0.500408	-1.787753*	0.557163	0.264134	0.465081
NCEXAT	-0.052656	0.161615	0.121107	0.210888	0.331079**	0.167336	1.006831*	0.284233	-0.058077	0.162869
MEMAS	-0.397916***	0.234542	-0.173033	0.278473	0.235317	0.259047	-0.079044	0.277085	0.469414**	0.223941
MEMCO	0.002669	0.253279	0.869474**	0.386646	0.022533	0.272660	0.486269	0.297633	0.240740	0.250386
CONST	-1.739776***	0.987083	0.0132265	1.061363	-1.201752	1.066562	1.767613***	1.075004	-0.820761	0.854513

*Significant at 1%, **Significant at 5%, ***Significant at 10%, Sex (SX), Age (AG), Household Size (HHS), and Years of Education (YRSE) Ownership of land (OWNL) Farm Size (FARMS) Yam Revenue (YRVN) Use of Credit (UCRDT) Credit Volume (CRDTV) Farming experience (FARME) Access to Extension Agent (AEXAT) No of Contact with Agent (NCEXAT) Constant (CONST) Major Occupation (MJROCP) Radio Information (RDINF) Membership of Association (MEMAS) Membership of Cooperative Society (MEMCO).

based farmers would increase the probability of choosing mixed cropping among the sampled yam based farmers. Labour availability is measured using size of a household. It is a determinant in adoption process, in that constraint of labour availability can be relaxed by larger household size when introducing a new agricultural technology (Mignouna et al., 2011; Bonabana- Wabbi 2002).

The coefficient of years of formal education was negative and significant ($p < 0.1$) for adoption of mixed farming. This implies that the probability of choosing mixed farming among the yam based farmers decrease as farmers' years of formal education increases. This could be possible as young educated farmers seek white collar jobs as

a means of diversifying their income rather than diversifying into livestock production and, this affects the decision to adopt mixed farming.

The coefficient of ownership of farm land was negative and significant ($p < 0.1$) for the adoption of mixed cropping. This implies that an increase in ownership of farm land among the farmers would decrease the probability of choosing mixed cropping. This is expected as farmers own more land, they could always plant other crops on different piece of land instead of engaging in mixed cropping.

The coefficient of access to agricultural information through the radio was positive and significant for zero tillage and mixed farming

($p < 0.01$) and ($p < 0.1$) respectively. This is an indication that an increase in access to agricultural information through the radio among the yam based farmers would increase the probability of choosing zero tillage and mixed farming CSA practices options among the yam based farmers.

The coefficient of farm size was positive and significant ($p < 0.1$) for adoption of mixed farming. This implies that the probability of choosing mixed farming is increased among the farmers as farm size increases. Studies have shown a positive relationship between adoption of agricultural technology and farm size (Gabre-Madhin and Haggblade, 2001; Ahmed and Bagchi, 2004; Uaiene et al., 2009; Mignouna et al., 2011). Yam

based farmers with large farm size are likely to adopt mixed farming as they can make provision for livestock farming thus, increasing the adoption of mixed farming.

The coefficient of use of credit was negative and significant ($p < 0.05$) for the adoption of mixed cropping. This implies that an increase in access to credit among the yam based farmers would decrease the probability of choosing mixed cropping. Thus, an increase in use of credit would make the yam farmer specialize (sole cropping) as opposed to mixed cropping.

The coefficient of volume of credit was positive and significant ($p < 0.05$) for the adoption of mixed cropping. The implication of this is that an increase in volume of credit among the farmers would increase the probability of choosing mixed cropping.

The coefficient of years farming experience was positive and significant ($p < 0.1$) for the adoption of mulching and crop rotation. Thus, an increase in years of farming experience will increase the probability of adopting mulching among the yam farmers. This is expected as farmers' years of experience increases, they tend to know more about various ways of improving their farming activities.

The coefficient of access to extension services was negative and significant ($p < 0.01$) for the adoption of mixed cropping. This is an indication that an increase in access to extension services among the farmers would decrease the probability of choosing mixed cropping.

The coefficient of number of contacts with extension agents was positive and significant ($p < 0.01$) for the adoption of mixed cropping and mixed farming. This is an indication that an increase in number of contacts with extension agents among the farmers would increase the probability of choosing mixed cropping and mixed farming. Information about the existence, effective use and benefit of new technology are usually provided to farmers through extension service agents. The influence of extension service agents can prevent the negative implication lack of formal education can have on decision to adopt some technologies by farmers (Yaron et al., 1992; Bonabana-Wabbi 2002).

The coefficient of membership of association was negative and significant ($p < 0.1$) for the adoption of zero tillage while it was positive and significant ($p < 0.05$) for the adoption of crop rotation. This implies that a decrease in membership of association among the yam based farmers would increase the probability of choosing zero tillage while increase in membership of farmers association increases the probability of adopting crop rotation. This is expected as farmers association enable farmers to share knowledge on various practices that can help to improve their enterprise.

The coefficient of membership of cooperative society was positive and significant ($p < 0.05$) for the adoption of mulching. This implies that an increase in membership of cooperative society among the yam based farmers would increase the probability of choosing mulching. This is expected as mulching is a major practice that is required for yam production and it is labour intensive which requires

some funding. Therefore, availability of more funds from cooperative society will help the farmers in adopting mulching.

Conclusion and recommendation

Yam based farming in the study area is dominated by male farmers by 89.38%. It was revealed that only 16.25% of the yam based farmers have no formal education which shows low level of illiteracy. Mulching was the most adopted practice in the area by 90.6% while mixed farming was the least adopted with 20.6% of the respondents adopting it. On the average, yam farmer adopts three practices out of the five practices considered. The finding from the study shows that various socio-economic, institutional, economics variable affects the adoption of CSA practices in the area. The factors influencing the choice of farmers in adoption though varies from practices to the other. The study therefore recommends;

1. That various stakeholders like Ministry of Agriculture, Research Institute and agriculture entrepreneurs should promote transmission of agriculture information on CSA practices through radio in the area since access to agricultural information through the radio is important in getting the farmers to adopt CSA practices.
2. There is need to improve the diffusion of Climate Smart Agricultural practices innovations in the study area and its environs if researchers are convinced that they are actually improved and rewarding practices.
3. CSA practices should be recommended to yam based farmers not as a new set of technology but should be diffused to them as an improvement on those indigenous practices they are used to, to enable fast adoption of CSA practice in the area.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

ACKNOWLEDGEMENTS

The authors appreciate the Centre of Excellence in Agricultural Development and Sustainable Environment (CEADESE), Federal University of Agriculture, Abeokuta for the financial support. Also, our profound gratitude goes to the respondents and enumerators for their time and cooperation in the various interview and discussion held in the course of this research.

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