Journal of Research in Forestry, Wildlife & Environment Vol. 11(3) September, 2019
http://www.ajol.info/index.php/jrfwe
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E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Olugbire et al., 2019

CLIMATE CHANGE ADAPTATION THROUGH CONSERVATION AGRICULTURE: EVIDENCE FROM SMALLHOLDER FARMERS IN ONDO STATE, NIGERIA

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ABSTRACT

This study identifies the factors influencing the adoption of CA among smallholder farmers in Ondo State, Nigeria. To determine the factors influencing the adoption of CA among smallholder farmers, Tobit regression model was used. From the regression results, minimum tillage, crop rotation, mulching, cost of planting materials, cost of equipment's are all positively significant at 1% and a unit increase in them will increase the adoption of CA practices in the study area. The primary occupation of the respondents is positively significant at 5% and a unit increase in primary occupation of the respondentsincreases the rate of adopting CA practices by 0.0570868. Age of the respondents is negatively significant at 10% and this implies that a unit increase in age decreases the rate of adopting CA by 0.0018808. Also, household size is positively significant at 10% and a unit increase in households' size increase the level of adoption of conservation agriculture by 0.0079891. This paper therefore recommends that policies addressing the 3 core principles of CA practices (minimum tillage, crop rotation and mulching) should be re-emphasized so as to improve the food production involve in agricultural value chain activities. Young ones should be encouraged to involve in farming practices especially CA activities. And lastly, cost of equipment and planting materials should be subsidized for farmers so as to foster improved farming, increased food production and hence aid commercialization among smallholder farmers.

Key words: Conservation agriculture, agricultural value chain and smallholder farmers

INTRODUCTION

According to FAO (2013), Conservation Agriculture is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. Conservation Agriculture (CA) is increasingly promoted in Africa as an alternative for coping with the need to increase food production on the basis of more sustainable farming practices. CA is specifically seen as a way to address the problems of soil degradation resulting from agricultural practices that deplete the organic matter and nutrient content of the soil. It aims at higher crop yields and lower production costs. Yet, success with adopting CA on farms in Africa has been limited (Kassam*et al*., 2009). Conservation Agriculture (CA) is increasingly seen as an effective technology to increase farmers' resilience to climatic variability and address soil degradation resulting from agricultural practices that deplete the organic matter and nutrient content of the soil, aiming at higher crop productivity with lower production costs. However, the adoption of conservation agriculture (CA) by smallholder farmers in Africa has been limited so far (Giller*et al*., 2009).The low output/low yield associated with conventional agriculture or non-adoption of CA among smallholder farmers has limited their involvement in agricultural

value chain activities because much of their production is sufficient for their household with low market accessibility. However, Roger Norton(2014) opinedvalue chain as a set of linked activities that work to add value to a product; it consists of actors and actions that improve a product while linking commodity producers to processors and markets. Value chains work best when their actors cooperate to produce higher-quality products and generate more income for all participants along the chain, as opposed to the simplest kinds of value chains, in which producers and buyers exchange only price information — often in an adversarial mode. Value chains differ from supply chains, which refer to logistics: the transport, storage and procedural steps for getting a product from its production site to the consumer.

IFAD (2011) opined that at the national and sub-Saharan African regional level, efforts are being intensified to promote the technology despite concerns raised about its suitability within the smallholder farming context. Some of these concerns include: the potential decrease in yields due to poor adaptation of CA; increased labour requirements when herbicides are not used; competing uses of mulch for soil cover and livestock feed;and the potential redistribution of farmlabour, placing even more demands onwomen's time. It has also been noted that weak input supply chains in most countries are a major hurdle for smallholder farmers in the proper application of the technology. The critical issue however, is not whether CA works – even strong critics (Giller*et al*., 2009) agree that it works – the question is whether it is the best approach for smallholder farmers in sub-Saharan Africa given the context within which they operate.

Involvement of smallholder farmers in Agricultural food chain

Smallholders live in rural areas of developing countries and they are distinguished by the relatively small amounts of agricultural land that they cultivate. The size of farm considered "small" depends on the quality of local agricultural resources and the specific economic context. In general, smallholder farms are defined as operating two hectares or less (World Bank, 2003). There are approximately 2.5 billion people living on 500 million smallholder farms in developing countries, with the majority living on less than $2 per day (IFAD, 201 3). Based on estimates from Food and Agriculture Organization of the United Nations (FAO) data, the majority of small farms are located in Asia (87 percent), with the next largest number found in Africa (8 percent). There are approximately 33 million smallholder farms in Africa, comprising 80 percent of all African farms (Nagayets 2005).

Kenyan Green Bean Value Chain

(J.E. Austin Associates, inc) reported to the world bank that in the 2000s, as the power of the supermarkets continued to drive the market, many supermarkets began to pursue market segmentation and branding strategies which increased the demand for higher quality standards, different varieties, and organic or "safer "produce. A number of exporters have invested heavily in growing their own high-quality certified vegetables to take advantage of the increased market opportunities for high-quality produce. The effect of these trends has been a much shorter supply chain, a greater degree of vertical integration, fewer active players, and production and exporting on a much grander scale. By the early 2000s, seven of the largest food retailing chains accounted for 76 percent of fresh fruit and vegetable sales and 70 to 90 percent of fresh produce imports from Africa. 63 As of 2004, the total Kenyan vegetable export trade was worth USD 139m, and the country ranked second in Africa in fresh exports vegetables. The industry employs 45,000 to 60,000 people, of whom an estimated 60 percent are women, in commercial farms, processing, and logistics operations; another 7,000 are smallholders. Employees typically earn just under USD 2 per day, while smallholders are reportedly able to earn the equivalent of USD 7 per day.

Impacts of CA on production output of smallholder farmers

The result table below depicts the impact of conservation agriculture on production output of smallholder farmers by comparing the input allocations for CA and conventional farming alongside with the yield (Mazvimavi K*etal.*, 2012)

Rising population has forced farmers to abandon traditional practices that left the land fallow for several years, and to cultivate ever-smaller plots. Intensive tilling and hoeing year after year can produce a hardpan in the soil. That restricts root

growth and stunts plants. Rainwater pounds the bare soil, forming a surface crust that the water cannot penetrate. It runs off, taking the valuable topsoil with it. Erosion in some places is so severe that there is little soil left. To get a good yield, farmers often apply more and more fertilizer. With less moisture in the soil, plants are more vulnerable to drought. They start to wilt after a few days without rain. Conservation agriculture enables farmers to reverse this trend. It prevents hard-pans from forming, protects the soil, increases soil moisture, and restores soil fertility, so stabilizing yields and improving production over the long term, thereby improving yields (FAO,2013).

Factors influencing adoption of CA among smallholder farmers

The main barriers to conservation agriculture adoption continue to be, knowledge on how to do it (know how), mindset (tradition, prejudice), inadequate policies as commodity based subsidies (EU, US), availability of adequate machines (many countries of the world) and availability of suitable herbicides to facilitate weed management (especially in developing countries). These barriers must be overcome not only by farmers but also by researchers, extension workers, university professors, politicians and all stakeholders involved in the farming industry if a greater adoption is aimed to be achieved. The widespread adoption of No-tillage under a great range of different conditions on more than a 100 million ha worldwide shows, that the system can be made to work and function, it is only a matter of a firm determination to do so, after recognizing the superiority of this system in relation to unsustainable intensive tillage practices (Rolf *et al*., 2009).Despite the impact of CA in achieving the Millennium Development goals, higher profitability and better productivity of CA on crops and significant effort that has gone in promoting CA in sub-Saharan Africa, yet, the adoption has been limited. This study therefore explores the factors that determine the adoption of CA among the farming households in Ondo state.

MATERIALS AND METHODS

Study Area

This study was carried out in Akure North and South Local Government Area (LGA) of Ondo State, Nigeria. Akure South is a local government area in Ondo state, Nigeria and its headquarter is in the town Akure. It has an area of 331km^2 and a population of 353,211 at2006 census. The postal code of the area is 340. Akure North is also a local government in state. Its headquarters is in the town of Iju/Itaogbolu. It has an area of 660km^2 and a population of 131,587 at the 2006 census. The postal code of the area is also 340.

Population of the study, Sampling procedure and sample size

All the farming households in Akure North and Akure South local Government Area of Ondo state constituted the population of the study.Two stage sampling technique was employed to select the representative sample for the study. In the first stage, 10 villages were randomly selected from identified villages in the study area, 5 villages were selected from Akure North and 5 villages were selected from Akure South. The second stage was random selection of 12 registered farming household from each of the selected villages to arrive at 120 respondents proposed for the study.

Method of data collection and Measurement of variable

Data for the study was collected through the use of a well-structured questionnaire which was developed based on the objectives of the study. Dependent variable (Y) and independent variables (X_{is}) was used for this study. Dependent variable (Y) was adoption of CA practices which took on values of 1 and 0 while independent variables (X_{is}) was selected socio-economic characteristics of the respondents as well as the farming practices employed.

Data analysis and Models specification

Descriptive statistics such as frequency count and percentages was used to describe data on selected socio-economic characteristics of the respondents while tobit regression model was used as inferential statistics tools to test the formulated hypothesis. Household decision to adopt CA will depend on a number of factors like land holding size, access to extension services and information, household characteristics (such as age of household head, and gender), availability of labour and unobservable factors explained by the stochastic term, ε. This study will use the tobit model to assess the determinants of CA adoption. We will assumed a latent variable Yi* representing adoption or non- adoption. Where adoption means the process by which a particular farmer is exposed to, considers and finally practices an innovation. Independent variables Xi will be

regarded as factors that affect CA adoption and β will be a -vector of parameters. Then the decision to adopt a technology will be specified as follows:

Tobit Model Specification

$Y_i^* = \beta X_i + e_i$

$Y_i^* = 0$, if $Y_i = 0$

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

Where Y_i^* is the observed dependent variable (adoption index)

β is a vector of unknown parameters;

X_i is the vector of independent variables; where i = 1, 2.....n;

RESULTS AND DISCUSSION

Descriptive Statistics of Secondary Socio-Economic Characteristics of Respondents

Using descriptive statistics, the primary and secondary socio-economic characteristics were analysed and presented in tables 1 and 2. Results from table 1 show that the mean age of the respondents is 48years, majority of the household head (76.04%) are literate, many of them are married (about 76.04%), they have an average household size of 7members which makes them have access to family labour, majority of the respondents engage in farming activities as their primary occupation (about 72.92%). About 66.67% of the respondents have access to labour, 83.33% practice minimum tillage, 34.38% practice crop rotation, 32.29% practice mulching. 65.63% source for their input by purchase while 29.17% have access to government subsidy on inputs.

Table 1: Descriptive Statistics of Primary Socio-economic Characteristics

Variables	Frequency	Percentages
Gender		
Male	72	75
Female	24	25
Age		
≤ 30	13	13.5
31 – 40	19	19.79
41 – 50	24	25.00
51 – 60	26	27.09
61 – 70	13	13.54
Above 70	1	1.04
Mean age	47.9	
Level of education		
No formal Education	23	23.96
Primary Education	36	37.5
Secondary Education	24	25
Tertiary Education	13	13.54
Mean	6.9	
Marital status		
Single	7	7.29
Married	73	76.04
Widowed	10	10.42
Divorced	6	6.25
Households size		
1-5	29	30.21
6-10	47	48.96
11-15	18	18.75
Above 15	2	2.08
Mean household size	7	
Total	**96**	**100**

2: Descriptive Statistics of Secondary Socio-Economic Characteristics

Variables	Frequency	Percentages
Primary occupation		
Farming	70	72.92
Non-Farming	26	27.08
Secondary occupation		
None	23	23.96
Farming	16	16.67
Non-Farming	57	59.37
Access to Labour		
Yes	64	66.67
No	32	33.33
Minimum tillage practices		
Yes	80	83.33
No	16	16.67
Crop Rotation practices		
Yes	33	34.38
No	63	65.63
Mulching practices		
Yes	31	32.29
No	65	67.71
Cost of planting materials(₦)		
≤ 10,000	38	39.58
10,001 – 20,000	36	37.50
20,001 – 30,000	13	13.55
30,001 – 40,000	4	4.16
› 40,000	5	5.21
Cost of equipment(₦)		
≤ 3000	83	86.46
3,001 – 6,000	9	9.37
6,001 – 9,000	3	3.13
› 9000	1	1.04
Source of input by purchase		
Yes	63	65.63
No	33	34.38
Source of input by NGO		
Yes	4	4.17
No	92	95.83
Source of input by governmental subsidy		
Yes	28	29.17
No	68	70.83

Determinants of conservation agricultural practices among farming households

The results in table 3 show the conclusive inferences on the exact quantitative relationship between the adoption index and socio-economic characteristics. Each slope coefficient in the equation is a partial slope coefficient and it measures the change in the estimated tobit for a given change in the value of the given regressor (holding other regressor constant). The coefficient

shows variable with positive and negative values. Variables with negative values imply a negative relationship between the explanatory variables and the dependent variables. Variables with positive values imply a positive relationship between the explanatory variables and the dependent variables. Among the 11 variables, only 8 variables were significant.

Age of the respondent has a negative and significant relationship which implies that, a unit increase in age decreases the rate of adopting conservation agriculture and this is in line with the a priori expectation that as aging increases, the efficiency of the farmers to work reduces. Also the households' size of the respondent has a positive and significant relationship which implies that, a unit increase in households size increases the level of adoption of conservation agriculture which agrees with the apriori expectation that increase in households' size increases the availability of family labour for farm activities. The primary occupation of the respondent has a positive relationship and is significant which implies that, a unit increase in primary occupation of the respondent will increase the rate of adopting conservation agricultural practices.Since majority of the respondent has their primary occupation to be farming as identified in the socio-economic characteristics, this will therefore enhance the adoption of conservation agricultural practices and this accompany the a priori expectation as identified in the literature.

The minimum tillage practices also has a positive and significant relationship which implies that, a unit increase in minimum tillage practices increases the adoption of conservation agriculture by 0.23 and in accordance with the apriori expectation as identified in the literature, minimum tillage is one of the major components of conservation agricultural practices and majority of the farming households in the sample population practices it as identified in the socio-economic characteristics of the respondents. Likewise the crop rotation practices also has a positive relationship which implies that a unit increase in crop rotation practices increases the adoption of conservation agriculture by 0.17. Mulching also being one of the conservation agricultural practices has a positive relationship and is significant at 1%. All of these practices facilitate the adoption of conservation agriculture.

Furthermore, cost of planting material and cost of equipment has a positive and significant relationship implying that a unit increase in the cost of planting material and cost of equipment increases the adoption of conservation agriculture. According to the literature, conservation agriculture requires investment on equipment and planting material and the more these inputs are added the greater the yield increase is expected to be.

Table 3: Determinants of adoption of conservation agricultural practices among farming households

Adoption index	Coefficient	Standard Error	Z
Constant	0.1785296	0.0803976	2.22
Age	-0.0018808	0.0011258	-1.67***
Years spent in school	0.0000278	0.002256	0.01
Households size	0.0079891	0.0040767	1.96***
Primary occupation	0.0570868	0.0256513	2.23**
Farm size available	0.0013959	0.0081978	0.17
Frequency of extension visit	-0.0211508	0.0164334	-1.29
Minimum tillage	0.2324292	0.0341666	6.80*
Crop rotation	0.1747119	0.0233693	7.48*
Mulching	0.1697304	0.0226834	7.48*
Cost of planting material	1.87e-06	6.90e-07	2.72*
Cost of equipment	0.0000153	4.30e-06	3.57*

Pseudo R^2 = 0.2607; Number of obs = 96; LR chi^2 (11) = 101.07; Prob> chi2 = 0.0000; *Significant at 1%, ** Significant at 5%, *** Significant at 10%.

CONCLUSION

This study concludes that the factors driving adoption of CA practices among the farming households in the study area are: age, household's size, primary occupation, minimum tillage, crop rotation, mulching, cost of planting materials, and cost of equipment. Hence, it is very necessary to develop a suitable policyfor the adoption of conservation agricultural practices among rural farmers in the study area.

Recommendations

Based on the findings of the study, the following recommendations are hereby suggested:

Since age has a negative effect on the adoption of conservation agriculture, young ones should be encouraged to involve in farming practices especially conservation agricultural activities.Household's size has positive effect on the adoption of CA, therefore family labour should be maximally used where possible in the practice of conservation agriculture.Primary occupation which is farming should be expanded among farming households since this is a major determinant of adopting conservation agriculture.Minimum tillage, crop rotation and mulching have a positive effect on the adoption of conservation agriculture therefore these practices should be encouraged so as to enhance increased crop production involved in value chain activities.

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