SOIL CONSERVATION TECHNIQUES FOR CLIMATE CHANGE ADAPTATION AMONG ARABLE CROP FARMERS IN SOUTHWEST NIGERIA

Fapojuwo O.E*., Olawoye, J.E.** and Fabusoro E.***
*Department of Agricultural Administration, University of Agriculture, Abeokuta
Corresponding *E-mail: obabirekemi@yahoo.com*
**Department of Agricultural Extension and Rural Development, University of Ibadan, Ibadan, Nigeria
E-mail: jeolawoye@yahoo.com
***Department of Agricultural Extension and Rural Development, University of Agriculture, Abeokuta
E-mail: efabusoro@gmail.com

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Abstract

Agriculture places a heavy burden on the land and environment in the process of providing food for man, and climate factors in agricultural production is having its toll on soil fertility in rural Nigeria. The study explored farmers' awareness and practice on soil conservation techniques for climate change adaptation in southwest Nigeria. In the event of reducing yield, flooding and increasing soil temperature, farmers have resorted to adaptive strategies to reduce the effect of climate change. A sample of 102 arable crop farmers producing major staple crops, were selected and interviewed. Majority (81.4 %) of the people is male and 54.9 % fell within the age category of 31-50 years. Over half (80.6 %) of the farmers had formal education. Also, 60.8% of the farmers cultivated about 1-3 ha of land and had about 10years of farming experience. The common climate adaptation strategies among the farmers were mulching, green and farmyard manuring, cover crops and mixed cropping, which have direct effect on soil nutrient. Other strategies to mitigate the effect of flooding such as terracing and contouring were seldom used. Farmers' opinion towards climate adaptation strategies is that no significant yield increase was achieved and the techniques were not cost-effective. Also, the techniques require technical know-how, which they lacked. Major constraints to farmers' use of the climate adaptation strategies were pressure on land, lack of knowledge on soil conservation techniques, inadequate information and education on use of soil conservation techniques and insecure land tenure system. Significant relationships ($p<0.05$) existed between use of the strategies and educational level ($\chi 2 = 15.603$) and age ($r=0.217$). There is the need for increased knowledge on climatic adaptation and educational orientation for technical know-how. Strengthening agricultural extension services will make farmers more informed and knowledgeable about climate change impact on agricultural production and the adaptation strategies to use.

Introduction

Soil conservation technique is the application of processes to the solution of soil management problems. The conservation of soil implies utilisation without waste so as to make possible a continuous high level of crop production while improving environmental quality. Soil conversation, in practice refers to the protection of all surface deposits, not merely the near-surface, organic layers that are subject to present-day weathering (Schwab *et al*, 1993). Some of the methods used to maintain soil fertility include the following: shifting cultivation, land rotation, crop rotation, mixed cropping, planting of cover crops and use of manure.

It is therefore obvious that crop growth is impossible without moisture and irrigation is necessary to ensure crop growth and development whenever and wherever there is enough water for crop growth. Therefore, application of irrigation helps to avert crop losses in areas subjected to incidence

of drought (Ayoade, 2005). Food crop farmers in South Western Nigeria provide the bulk of arable crops that are consumed locally, as well as major food crop supplies to other regions in the country. The local farmers are experiencing climate change even though they have not considered its deeper implications. This is evidenced in the late arrival of rain, the drying-up of stream and small rivers that usually flow year-round, the seasonal shifting of the “Mango rains” and of the fruiting period in some parts of Oyo State such as Ogbomosho area, and the gradual disappearance of flood-recession cropping in riverine areas of Ondo State are among the effects of climate disturbances in some communities of South-Western Nigeria (BNRCC, 2008 cited in Apata *et al* 2009). Arable crop farmers have become increasingly interested in reducing tillage to reduce soil erosion and increase plant-available water. The amount of surface residue and surface roughness both have an effect. Crop residue management technologies have been developed to leave more of the harvest residues, leaves, roots on or near the surface. Conservation tillage represents any tillage system that reduces soil and/or water loss compared with clean tillage, in which all residues are incorporated into the soil (Havlin *et al*, 2005).

One of the leading causes of prime land loss is poorly planned urban and industrial development. Land suited for agriculture is often not considered for such development because of higher costs. Land for agriculture cannot compete with these more intensive uses. Many private and government agencies are concerned with agricultural land preservation, which greatly affects the long-range potential to produce food and fibre. Continued increases in yield may be threatened by soil erosion, air pollution, regulatory constraints, the increasing cost of fertilizers, water, fuel, and other resources inputs, and less productive newly cultivated land in to climatic changes (Schwab *et al*, 1993). Changes in climate can be expected to have significant impacts on farm yields and product quality as a result of changes in temperatures, moisture, air and soil (IPCC, 2001). There is however no universally applicable measure for adapting agriculture to climate change, hence there should be sufficient flexibility to deploy the adaptation measures most appropriate and suitable for each local situations particularly Sub Saharan African countries whose economies are highly dependent on natural resources and rain fed agriculture, and generally have very low level adaptive capacities and strategies (Adebayo *et al*, 2011, Yohe and Tol, 2002 and Spore, 2008).

Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC TAR, 2001a and UNDP, 2005). Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in climatic conditions (UK CIP, 2003). It follows that changes in the mean conditions that define those environments can actually be experienced most noticeably through changes in the nature and/or frequency of variable conditions that materialize across short time scales and that adaptation necessarily involves reaction to this sort of variability (Yohe and Tol, 2002).

It is vital to recognize what is already being done by the small scale farmers and organizations in order to build climate change resilience and adaptation techniques into new policies and projects like design of new irrigation systems, urban planning and soil conservation techniques. This will encourage farmers to invest in sustainable agricultural/crop production management systems which will help them to adapt to climatic changes. This means improving soil conservation/ management techniques like contouring, mixed cropping, crop rotation, planting cover crops, zero tillage, mulching and simple terracing methods among others to adapt to climate change. These soil conservation techniques restore the soil while also capturing soil carbon and limiting the oxidation of organic matter in the soil.

Recent research has focused on regional and national assessments of the potential effects of climate change on agriculture (Lobell, *et al*, 2008; Hassan and Nhemachem, 2008; Fischer *et al*, 2002 in Apata *et al*, 2009). These efforts have, for the most part, treated each region or nation in isolation

and do not integrate (i.e. combined biophysical and economic) assessment of the potential effects of climate change on small scale agriculture but mostly focus on world agriculture (ODI, 2007; Segerson and Dixon, 1998). Consequently this research intends to investigate how soil conservation techniques can be used as climate change adaptation technique in order to strengthen the farmers to cope in ways that will be beneficial to them.

Objectives of the Study

The study is set to ascertain the use of soil conservation techniques as climate change adaptation techniques among arable crop farmers in Yewa North Local Government Area of Ogun State. Specifically, the study aimed at (1) identifying the types of climate change adaptation strategies among arable crop farmers; (2) determining the level of awareness and use of climate change adaptation strategies by farmers; (3) ascertaining the attitude of the farmers towards the use of climate change adaptation strategies; and (4) examining the constraints to the use of climate adaptation strategies. The study hypothesized that no significant relationship exists between personal characteristics and use of soil conservation techniques.

Methodology

The area of the study is Yewa North Local Government Area of Ogun State, it is one of the twenty (20) Local Government Areas in Ogun State. It is bounded in the West by the Republic of Benin, in the South by Yewa South Local Government Area, and in the North by Oyo State. Ayetoro which is the local government area headquarter is located at the latitude 7^{o}15N and longitude 3^{o}3E in a derived savannah zone of Ogun State. Multistage sampling technique was used to sample arable crop farmers. The first stage was the selection of 50 % of the 4 major divisions of Yewa North Local Government which are Iju and Ketu South. The second stage was the random selection of 10% of the sampled villages to give 4 out of the 38 villages in Iju, and 9 in Ketu South making a total of 13villages. The third stage is the random selection of 5% of the arable crop farmers yielding a total of 102 farmers. Data were gathered through the use of structured interview schedule.

Results and Discussions

Table 1 revealed that most (81.4 %) of the sampled arable crop farmers in the study area are males, while females constitute 18.6 %. Both males and females are involved in arable crop production. However, access and control of resources and land tenure system tend to favour the men. Over one half of the respondents (54.9 %) are within the age range of 31- 50 years. The result indicates that majority of the farmers are in their active and prime age. According to Surry (1994), individual's efficiency tend to be high and activities are approached with seriousness when one is young and agile. Eighty percent of the respondents have one form of formal education which usually facilitates communication, information flow and technology transfer like soil conservation techniques. According to Fullan (1996), education and skills are required in dealing with new ideas, programmes/projects, activities and structures and a vital part of the adoption of most successful innovation.

Table 1: Distribution of farmers by their personal characteristics n= 102.

Personal characteristics		**Frequency (%)**
Sex	Male	83 (81.4)
	Female	19 (18.6)
Age (years)	<30	17 (16.7)
	30-40	26 (25.5)
	41-50	30 (29.4)
	>50	29 (28.4)
Educational level	No formal education	18 (17.6)
	Primary	36 (35.3)
	Secondary	38 (37.3)
	NCE/Grade II	8 (7.8)
	Others	2 (2.0)
Farm size (hectares)	<1	22 (21.6)
	1-3	62 (60.8)
	4-6	13 (12.7)
	>6	5 (4.9)
Years of farming experience	<10	15 (14.7)
	10-20	33 (32.4)
	21-30	27 (26.5)
	31-40	15 (14.7)
	>40	12 (11.8)

Source: Field Survey, 2010.

The farm size of the respondents revealed that 60.8 % have farm sizes of between 1-3 hectares. This implies that most of the respondents are small scale farmers, which is typical of most farmers in this part of the world. This result agrees with the view of Erie (1996), cited in Ajayi and Solomon (2010) that small farming holdings constitute more than 70.0% of all farming activities in Nigeria. Experience plays a prominent role in any agribusiness or farm enterprise. The distribution of arable crop farmers by number of years of experience shows that 73.6% of the farmers have over 10 years of farming experience. Also, these soil conservation techniques also double up as climate change adaptation strategies used by them in order to still keep them in the farming business.

Results on respondents'' awareness and use of climate change adaptation strategies are shown on Table 2. Majority of the farmers were aware of mulching, manuring, planting of vegetative cover, mixed cropping, crop rotation and ridging as climate change adaptation strategies. The findings indicate that arable crop farmers are quite aware of different climate adaptation strategies that can enhance their yield and productivities. Yohe and Tol (2002) reported that these adaptive capacity/strategies varies significantly from system to system, sector to sector and region to region due to range of available technological options for adaptation, availability of resources and their distribution across the population and stock of human capital with respect to education and security among others.

However, about half (53.9% and 50.0%) of the farmers were not aware of terracing and contouring respectively as climate adaptation strategies in the study area. The non-awareness of these two strategies might be due to their complexity and newness to the farmers in that they don't know much about them and also that these strategies are more applicable in areas that are hilly. The results show that some techniques such as mulching ($\bar{x}$ = 3.89), crop rotation ($\bar{x}$ = 3.75), mixed cropping ($\bar{x}$ = 3.69) and ridging ($\bar{x}$ = 3.62) are the ones that the farmers used. This implies that the con-

servation techniques used were those they were aware of. This result affirms the views and findings of many researchers that for adoption or use of any improved technology to occur, the users must be aware of such technologies/techniques (Osuji, 1983; Onyenwaku and Mbuba, 1991; Agwu, 2001; Ajayi, 2002; Asiabaka *et al*, 2001 and Ajayi and Solomon, 2010).

Table 2: Distribution of respondents by awareness of soil conservation techniques as climate change adaptation strategies.

Soil conservation techniques	**Aware (%)**	**Not aware (%)**
Mulching	102 (100.0)	-
Liming	99 (82.5)	03 (2.9)
Planting of vegetative cover	101 (99.0)	01 (1.0)
Terracing	47 (46.1)	55 (53.9)
Contouring	51 (50.0)	51 (50.0)
Mixed cropping	100 (98.0)	02 (2.0)
Manuring	102 (100.0)	-
Fertilizer use	101 (99.0)	01 (1.0)
Crop rotation	98 (96.1)	04 (3.9)
Shifting cultivation	82 (80.4)	20 (19.6)
Ridging	92 (90.2)	10 (9.8)
Land rotation	76 (74.5)	26 (25.5)
Bush fallowing	87 (85.3)	15 (14.7)
Others	98 (96.1)	04 (3.9)

Source: Field Survey, 2010. Multiple responses recorded

Table 3: Respondents use of soil conservation techniques as climate change adaptation strategies.

Soil conservation techniques	**Very often frequency (%)**	**Often frequency (%)**	**Seldomly frequency (%)**	**Never use frequency (%)**	**Mean**
Mulching	91 (89.2)	11 (10.8)	-	-	3.89
Liming	33 (32.4)	34 (33.3)	26 (25.5)	9 (8.8)	2.89
Planting of vegetative cover	26 (25.5)	74 (72.5)	2 (2.0)	-	3.24
Terracing	2 (2.0)	-	9 (8.8)	91 (89.2)	1.14
Contouring	-	5 (4.9)	17 (16.7)	80 (78.4)	1.26
Mixed cropping	71 (69.6)	31 (30.4)	-	-	3.69
Manuring	22 (21.6)	38 (37.3)	41 (40.2)	1 (1.0)	2.69
Fertilizer use	10 (9.8)	49 (48.0)	43 (42.2)	-	2.68
Crop rotation	78 (76.5)	23 (22.5)	1 (1.0)	-	3.75
Shifting cultivation	3 (2.9)	6 (5.9)	13 (12.7)	80 (78.4)	1.33
Ridging	66 (64.7)	33 (32.4)	3 (2.9)	-	3.62
Land rotation	1 (1.0)	11 (10.8)	6 (5.9)	84 (82.4)	1.30
Bush fallowing	9 (8.8)	46 (45.1)	28 (27.5)	19 (18.6)	2.44
Others	31 (30.4)	68 (66.7)	1 (1.0)	2 (2.0)	3.25

Source: Field Survey, 2010.

The major constraints affecting the use of climate change adaptation strategies are population pressure on the land/effect of urbanisation ($\bar{x}$ = 2.84), lack of knowledge on soil conservation techniques ($\bar{x}$ = 2.77) and inadequate information and education ($\bar{x}$ = 2.67). This result corroborates the importance of education and extension service in providing information to farmers on different tech-

niques/strategies. Ajayi and Oloruntoba (2004) in Ajayi and Solomon (2010) reported that adequate information with adequate follow up are useful for farmers' adoption and continuous use of improved technologies and techniques like soil conservation techniques. IPCC, 2001 also reported that meeting human needs in many instances is causing land degradation through loss of soil fertility which in turn adversely affects food security thereby threatening the ability to meet present and future needs.

Table 4: Distribution of respondents' constraints to the use of soil conservation techniques.

Constraints	Very serious	Somewhat serious	Not serious	Mean
Population pressure on the land	86 (84.3)	16 (15.7)	-	2.84
Effect of urbanisation	87 (85.3)	14 (13.7)	1 (1.0)	2.84
Lack of knowledge on soil conservation techniques	79 (77.5)	23 (22.5)	-	2.77
Inadequate information and education	69 (67.6)	32 (31.4)	1 (1.0)	2.67
Inadequate supply of organic manure	50 (49.0)	25 (24.5)	27 (36.5)	2.23
Inadequate farmland	41 (40.2)	42 (41.2)	19 (18.6)	2.22
Unfavourable land tenure system	38 (37.3)	27 (26.5)	37 (36.3)	2.00
Lack of credit	41 (40.2)	60 (58.8)	1 (1.0)	1.41

Source: Field Survey, 2010

Farmers' attitude to the use of climate change adaptation strategies

Table 5 reveals the attitudes of arable crop farmers to the use of soil conservation techniques as climate change adaptation strategies. The results shows that 61.8%, 60.8%, 59.8% and 58.8% of the arable crop farmers agree that the use of these strategies increase their yield, increase their scale of production, are accepted by their household members and control pests and diseases on their farms respectively.

Table 5: Distribution of arable crop farmers by their attitude to the use of soil conservation techniques.

s/n	Attitudinal statements	SA	A	U	D	SD	Mean
1.	Soil conservation techniques increases my production	62 (60.8)	37 (36.3)	1 (1.0)	-	2 (2.0)	1.36
2.	I don't like using these soil conservation techniques because they are too expensive	1 (1.0)	69 (67.6)	4 (3.9)	14 (13.7)	14 (13.7)	3.28
3.	The use of these techniques save me from pests and disease infestation	60 (58.8)	38 (37.3)	-	2 (2.0)	2 (2.0)	1.50
4.	The use of soil conservation techniques involves technical knowhow which I don't possess	3 (2.9)	42 (41.2)	31 (30.4)	17 (16.7)	9 (8.8)	3.13
5.	I enjoy the end result of these conservation techniques after their application	40 (39.2)	62 (60.8)	-	-	-	1.61
6.	The use of soil conservation techniques is determined by ones wealth	16 (15.7)	18 (17.6)	7 (6.9)	42 (41.2)	19 (18.6)	2.71
7.	There are no visible effect on my yield with the use of these techniques	93 (91.2)	8 (7.8)	-	1 (1.0)	-	4.89
8.	I enjoyed high yield using soil conservation techniques	37 (36.3)	63 (61.8)	-	-	2 (2.0)	1.69
9.	Soil conservation techniques applied depend on the type of soil available	9 (8.8)	-	-	16 (15.7)	77 (75.5)	1.51
10.	My entire household is favourably disposed to using soil conservation techniques	41 (40.2)	61 (59.8)	-	-	-	1.59
11.	I cannot start any farming operations without first considering soil conservation techniques	35 (34.3)	65 (63.7)	2 (2.0)	-	-	1.68
12.	Use of soil conservation techniques is not economical	15 (14.7)	87 (85.3)	-	-	-	4.15

Source: Field Survey, 2010. SA=Strongly agree; A=Agree; U=Undecided; D=Disagree; SD=Strongly Disagree

Moreover, 85.3% and 67.6% agree that use of these strategies is not economical and rather expensive respectively while 91.2% strongly agree that using these techniques has no visible effect on their yields. This shows that generally the farmers have a favourable attitude to the use of these soil conservation techniques. Therefore, if the constraints are worked upon it will enhance the use of these techniques by the farmers.

Relationship between respondents' personal characteristics and use of climate change adaptation strategies

Table 6 shows that the respondents' educational level (χ^2=15.603) and age (r = 0.217) had significant relationship on the use of soil conservation techniques at $p<0.05$. This implies that the higher the educational level of the farmer, the higher the tendency of using improved soil conservation techniques. This also confirms the earlier finding that majority of the farmers had one form of formal

education or the other. Akinbile (2003) reported that, the more literate farmers are, the better they comprehend use of technologies than those that are not. The result also suggests that the older the age of the respondent, the more the soil conservation techniques carried out by them. In other words the older the age of the respondent the more experienced he/she becomes in using different soil conservation techniques.

Table 6: Relationship between selected personal characteristics and use of soil conservation techniques.

Variables	**r- value**	**P value**	**Decision**
Age	0.217	0.028	Significant
Variable	χ^2	**P value**	**Decision**
Educational level	15.603	0.048	Significant

Source: Field Survey, 2010

Conclusion and Recommendation

Based on the findings, the result has shown that the farmers are aware of different soil conservative techniques and also use some of them which are vital in improving the nutrients in their farmlands and increasing their yield. In addition the study has identified some major constraints that could affect the use of these soil conservation techniques like population pressure on the land, effect of urbanisation, lack of knowledge on soil conservation and inadequate information and education of farmers on the use and advantages of these techniques.

The study therefore makes the following recommendations.

1) a review of government policies on land use/tenure system in Nigeria is needed for expansion of farmlands in order to increase production and reduce leaching and overuse of small farm holdings available to the small scale farmers.
2) Trainings should be organised for the farmers to educate and inform them about environmental friendly soil conservation practices that will improve and increase their yield thereby improving their income.
3) Agricultural extension agents should intensify their efforts in the dissemination of research information techniques on soil conservation techniques suitable for small scale farmers as climate change adaptation techniques.

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