INTERNATIONAL JOURNAL OF CONTEMPORARY ACADEMICS (IJCA) ISSN 2536-7110 © 2017 VOL. 1(1), Pp.53-66, ©SEPTEMBER 2017

CLIMATE CHANGES VARIABILITY AND ADAPTIVE STRATEGIES USED BY ARABLE CROP FARMERS TOWARDS SUSTAINABLE AGRICULTURAL DEVELOPMENT IN OGUN STATE, NIGERIA

BY

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Abstract

The prediction of climatic changes has the potential to severely affect farmers' livelihoods, resulting in food shortages, among other consequences. This study aimed to assess the perception of smallholder farmers to climate change and adaptation strategies to its effect on agricultural activities in Ogun state Nigeria. Multi-stage sampling procedure was used to select 240 smallholder farmers from the three (3) senatorial districts in Ogun State. Structured interview schedule was used to elicit information from the respondents. Data collected were analysed using descriptive and inferential statistics. Results revealed that 75.0% were male, 87.5% had formal education, 79.2% were between the age of 40 – 70 years and 54.2% had been smallholder farmers for above 10 years. The two major adaptation strategies used by smallholder farmers were early harvesting (81.7%), irrigation and mixed farming (75.0%). The constraints faced were lack of adequate knowledge ($\bar{X}$=2.42), no access to forecast technologies ($\bar{X}$ =2.40). Chi-square analysis shows that there is significant relationship ($p<0.05$) between marital status (χ^2 = 42.051), level of education (χ^2 = 110.15) and the perception of smallholder farmers on climate changes. The study concludes that efforts should be geared towards providing adequate information that will be of help to smallholder farmers on changes in climate. It is therefore recommended that most of the strategies/practices currently used by smallholder farmers should be improved upon to ensure appropriate sustainable agricultural development in the country.

Keywords: Perception, Smallholder farmer, Adaptation, Strategies, Effect, Climate change

INTRODUCTION

The prediction of climatic changes has the potential to severely affect countries highly dependent upon agrarian livelihoods, resulting in food shortages, among other consequences. Therefore, people who depend on farming activities will require a variety of adaptation strategies to mitigate the negative effects of climate change effects and maintain the

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livelihoods of farming families. Global warming leads to erratic weather conditions in most places worldwide (Fayiga and Adedoyin, 2011). The International Panel on Climate Change (IPCC), defines climate change as statistically significant variations in climate condition that persists for an extended period, typically for decades or longer. It is any change in climate, rainfall or productivity caused by natural variability and direct or indirect human activities that alter the composition of the atmosphere (IPCC, 2001; IPCC, 2007; United Nations, 1998). A research sponsored by the International Food Policy Research Institute also shows that agriculture and human development will continue to be adversely affected by climate change (Nelson *et al.,* 2009). It further shows that populations in the developing nations, which are already vulnerable and food insecure are likely to be the worst hit and that further climatic changes pose huge challenges to food security. Frequent natural hazards due to climate change affect agricultural enterprises and, subsequently, the key to agricultural production activities- farm households- are also severely affected. Some farm households have already altered their production strategies in response to environmental degradation (regardless of cause) and weather variability associated with climate change effects. Such changes in production strategies are referred to in this paper as coping strategies. Choices about management practices, enterprise types, and genetic varieties of crops, have been adapted by farmers according to soil properties, location, and climatic conditions. Proper management systems such as weeding, mulching, irrigation with fresh water, and thinning applied by the farmers can help overcome salinity and drought.

Climate change is considered to be one of the most unprecedented threats of our time. According to Adebayo *et al.,* (2011) climate change is not a new phenomenon, its recent usage, especially in the context of development, refers to changes in the prevailing climate, particularly since the 20th century and the perceived impacts on the economy and livelihoods. Climate patterns play a fundamental role in shaping natural ecosystems, human economies and cultures that depend on them. Therefore, a change in climate has implications on the livelihoods of humans, animals, plants, and the ecosystems. According to the Fourth Assessment Report of the United Nation's Intergovernmental Panel on Climate Change (IPCC, 2007), over the last century, atmospheric concentrations of carbon dioxide increased from a pre-industrial value of 278 parts per million (ppm) to 379 ppm in 2005 and as a result the average global temperature rose by 0.74 °C. The IPCC report gives detailed projections for the 21st century and these show that global warming will continue and even accelerate. The best estimates predict that the earth could warm by 3°C by 2100. This warming is critical because even with a temperature increase of between 1- 2.5°C serious effects are predicted which include reduced crop yields in tropical areas leading to increased risk of

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hunger, spread of climate sensitive diseases such as malaria, and an increased risk of extinction of around 20-30 per cent of all plant and animal species. There is therefore a strong consensus among experts that climatic variability will have drastic consequences on agricultural production and productivity (Watson, 2010).

Misconception about climate change and its associated risk may result in no adaptation or maladaptation thus increasing the negative impact of climate change (Grothmann and Patt 2005). Even without climate change, Africa's agricultural development has been severely constrained by several multi-stressors that include: poverty, poor governance, underdeveloped markets, lack of sufficient infrastructure, low technological capacity and adoption etc. As a result of this vulnerability, climate change and agriculture have become central to Africa's development goals. Unfortunately, predicting the impact of climate change on complex biophysical and socio-economic systems of arable crop farmers is very difficult**.** Nevertheless, many African smallholder farming communities have thrived for decades and centuries even in the face of changing climate (Ozor, Madukwe, Onokala, and Enete *et al.*, 2010). However, there is very little appreciation for the indigenous knowledge and technologies that have been applied to address these challenges in the past. Traditionally, African farmers have used indigenous knowledge to understand weather and climate patterns in order to guide their decisions in crop and livestock management.

Changes in climate are severely affecting agricultural production in many African countries (UNEP, 2007). Increased temperatures and accompanying decrease in water availability reduce the length of growing seasons and yield potential and hence the areas suitable for agriculture, further adversely affecting food security over the continent (Thornton, *et al.,* 2006). Adaptation is the adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderated harm or exploits beneficial opportunities (UNFCCC, 2007). The arable crop farmers (smallholder), to a large extent have been able to develop their livelihood strategies in a way that enables them to constantly cope and adapt to the changing climatic conditions, pest attack and agricultural policies in the country. Smallholder's farmers' ability to adapt to impacts of climate variation depends on factors such as wealth, technology, education, information, infrastructure, access to resources and management abilities. There is need to gain as much information as possible and learn the positions of the rural farmers and their needs about what they know about climate variation and change in order to offer adaptation practices that meet their needs (Lobell *et.al*, 2008). In making informed decisions about climate change, Olorunfemi (2009) is of the view that timely and useful information is necessary about the possible consequences of climate change, people's

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perceptions of those consequences, available adaptation options, and the benefits of slowing the rate of climate change. Similarly, Apata *et al.* (2009) found that there is a need for agricultural economists and other stakeholders in environmental management and agricultural sustainability in developing countries to come to terms with negative impacts of climate change and likely positive and beneficial response strategies to global warming. Against this background, this research was conceived to examine the perception of smallholder farmers to climate change, their adaptation strategies and its effect on agricultural activities in Ogun State, Nigeria. The objectives of the study were to:

1. ascertain the socio-economic characteristics of the smallholder farmers in the study area.
2. ascertain the adaptation strategies used by smallholder farmers in the study area.
3. ascertain the extent of utilization of adaptation strategies on climate change in the study area
4. ascertain the constraint militating against the smallholder farmers to climate changes in the study area

Hypothesis of the Study

H_{o1}: There is no significant relationship between socio-economic characteristics of the smallholder farmers and their extent of use of adaptation strategies in the study area.

Materials and Methods

Study Area

The study was carried out in Ogun State, Nigeria. Ogun State covers a land area of approximately 16,409,26 square kilometres with a population of about 3,728.098 people (NPC, 2007), and is bounded in the west by the Republic of Benin, on the south by Lagos State and the Atlantic ocean, and on the east by Ondo State and in the south by Oyo State. It falls between longitudes 2º 40ºE - 6º 40ºE and latitudes 4º 40ºN -9º 15ºN. Ogun state has a total of 20 local government areas. These are Abeokuta North, Abeokuta South, Ogun Waterside, Ijebu Ode, Ijebu North, Ijebu East, Ijebu North East, Odogbolu, Ikenne, Sagamu, Obafemi Owode, Odeda,Ado/Ota, Yewa North, Yewa South, Imeko Afon, Ipokia, Ewekoro, Ifo and Remo North. The state has a tropical climate with mean annual rainfall of about 1,500 millimetre and temperature range of 25^0C – 35^0C. The raining season runs between April and November, is characterised by two distinct raining seasons brought about by temporary cease of rain in August: (Adebayo *et al.,* 2015). Agriculture is the major occupation of the people of Ogun State, which is favoured by the climatic condition. Commonly crops cultivated are maize, yam, plantain, beams, cocoa, rubber, palm tree, sugar cane, and cassava. The commonly reared livestock in the State include sheep, goat, poultry, cattle, and local chickens.

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Sampling Techniques and Sample Size

The population of study was arable crop farmers in Ogun State. A multistage sampling technique was used. Ogun state has three (3) Senatorial districts which comprises of Ogun central, Ogun West and Ogun East. Ogun State Agricultural Development Programme (OGADEP) has four operational zones that cut across all the senatorial district. 75% of the zones were selected purposively due to the availability of more arable farmers in Abeokuta, Ilaro, and Ijebu-ode which falls under the three senatorial districts of Ogun State. One block was randomly selected from each zones, those selected were Wasimi, Oke-odan, and Ijebu-ife. Furthermore, from the selected blocks purposive selection of 4 cells was selected making a total of 12 cells on convenience which cut across the senatorial district in Ogun State. Two villages were selected from each of the selected cells to make a total of 24 villages. Ten (10) smallholder farmers were purposively selected to make a total of 240 respondents for the study.

Measurement of Variables

- Adaptive strategies adopted by the arable crop farmers were measured using 2 point rating scale: of Yes (2) and No (1).
- Extent of adaptation strategies were measured using 3 point rating scale of Always (3) occasionally (2) never (1).
- Constraints militating/encountered was measured with 3 points rating scale: major constraint (3), minor constraint (2) not a constraint (1)

Data Analysis

Data collected were subjected to descriptive statistics and inferential statistics. Descriptive statistics such as frequency count, percentage distribution and table were used. Chi-square and Pearson Product Moment of Correlation (PPMC) were used to test the hypotheses.

Result and discussion

Socio-economic characteristics of the Respondents

The result in Table 1 reveals that majority (79.2%) of the respondents were between the ages of 40 and 70 years, with the mean age of 53.5years. This corroborates the findings of Oluwasusi and Tijani (2013) who opined that most of the farmers in the study area were old while young people prefer less climate risk business. Most of the respondents (75.0%) were male, this suggests that smallholder farmers are more practiced by males as a result of the drudgery and strenuous agronomic practices involved in its production. The results further show that the majority (83.3%) of the respondents were married, while very few 4.2% were widowed. This means that married people were more involved in farming than single fellows. In terms of educational requirement, majority (87.5%) of the respondents had a form of formal education: primary, secondary or post-secondary education. Only 13.0% had no formal education. This implies that majority of the respondents were literates, which is in support of

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Williams (1997) that reported that farmers‟ adoption of improved technology is influenced by their level of education, thus respondents‟ level of education will assist them to seek information on climate variation. The farming experience of the respondents shows that, majority of the respondents (87.5%) had been practicing farming for more than 10 years, while few (12.5%) had been practicing farming for a period less than 10 years. The mean years of farming experience was 18.5years. This implies that the respondents had useful information and experiences in climate with coping mechanisms as it affects their farming practices and production. Also, Table 1 further revealed that most (62.5%) of the respondents had between 1 to 3 hectares of farmland, 8.3% of the arable crop farmers had more than 7 hectares of farmland while 29.2% had between 4 to 6 hectares. The result shows that many of the respondents were small scale farmers. This is in consonance with similar result obtained by Olayide (1990) who categorized small scale farmers as ranging from 0.2 hectares to 9 hectares holding in Nigeria. Thus, many of the respondents in this study area have farm sizes of less than 9 hectares justifying the respondents as small scale farmers.

Adaptation strategies used by smallholder farmers in the study area. and extent of use

Based on multiple responses from the respondents, the result in Table 2 shows the various adaptation strategies employed by arable crop farmers to mitigate the impact of climate variation in the study area. All the respondents (100%) indicated planting of cover crops as a measure to mitigate climate changes, while most employed the use of mulching (98.3%), mixed farming (95.8%), movement to different site (93.3%), crop rotation (91.7%), and application of farmyard manure (83.3%). Other adaptation strategies recorded high percentage of usage except, changing in planting date (45.8%), bush fallowing (41.7%) and use of weather forecast which is non-cultural (37.5%) that recorded lower level of usage. This means that weather forecasts information is not readily accessible and available to the arable crop farmers to utilize. Ole *et al.,* (2009) validated the above findings that rural communities in Nigeria have always managed their resources and livelihoods in the face of challenging environmental and socio-economic conditions.

Result in Table 3 reveals that most (75.0%) of the smallholder farmers utilize planting of cover crop always with the mean value of 2.75 and ranked 1st among the extent of utilization in the study area. Most (60.0%) of the smallholder farmers utilize mixed farming always with the mean value of 2.57 and ranked 2nd among the extent of utilization in the study area. Also most (58.3%) of the smallholder farmers utilize mulching always with the mean value of 2.56 and ranked 3rd among the extent of utilization in the study area. Evidence from the extent of use of adaptive strategies showed that most of the smallholder farmers have moderate level of extent of use of adaptive strategies to their farming activities in the study area.

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Table 1: Distribution based on socio-economic characteristics of respondents (n = 240)

Variables	Frequency	Percentage	Mean (x)
Sex			
Male	180	75.0	
Female	60	25.0	
Age (years)			
≤ 40	20	8.4	
41 – 50	50	20.8	
51 – 60	60	25.0	53.5years
61 - 70	80	33.3	
Above 70	30	12.5	
Marital status			
Single	30	12.5	
Married	200	83.3	
Widowed	10	4.2	
Religion			
Christianity	165	68.8	
Islam	70	29.2	
Traditional	5	2.0	
Household Size (persons)			
< 3	22	9.2	
3 – 5	174	72.5	4persons
6 – 8	32	13.3	
9& above	12	5.0	
Educational status			
No formal education	30	12.5	
Primary education	120	50.0	
Secondary education	70	29.2	
Tertiary education	20	8.3	
Farming experience			
Less than 10	30	12.5	
10 -19	150	62.5	18.5years
20 – 29	28	11.7	
Above 30	32	13.3	
Total land size (hectares)			
1 – 3	150	62.5	2.78
4 – 6	70	29.2	

7 – 9	20	8.3

Field survey, 2015.

Table 2: Adaptive strategies and extent of use in the study area (n = 240)

Adaptation strategies*	Yes	(%)
Planting cover crop	240	100
Mulching	236	98.3
Mixed farming	230	95.8
Movement to different site	224	93.3
Crop rotation	220	91.7
Application of farmyard manure	200	83.3
Increased land cultivated	180	75.0
Decreased land cultivated	176	73.3
Changing in planting period	140	58.3
Planting of tree	130	54.2
Minimum tillage	120	50.0
Changes in harvesting date	110	45.8
Bush fallowing	100	41.7
Use of weather forecast	90	37.5

Field survey, 2015

Table 3: Extent of utilization of adaptation strategies (n = 240)

Extent of utilization	A (%)	O (%)	N (%)	Mean
Planting cover crop	180(75.0)	60(25.0)	-	2.75
Mulching	140(58.3)	96(40.0)	4(1.7)	2.56
Mixed farming	146(60.8)	84(35.0)	10(4.2)	2.57
Movement to different site	130(54.2)	94(39.2)	16(6.6)	2.50
Crop rotation	136(56.7)	84(35.0)	10(8.3)	2.48
Application of farmyard manure	130(54.2)	70(29.2)	40(16.6)	2.37
Increased land cultivated	120(50.0)	60(25.0)	60(25.0)	2.25
Decreased land cultivated	110(45.8)	66(27.5)	64 (26.7)	2.19
Changing in planting period	80(33.3)	60(25.0)	100(41.7)	1.92
Planting of tree	40(16.6)	90(37.5)	110(45.8)	1.71
Minimum tillage	90(37.5)	30(12.5)	120(50.0)	1.88
Changes in harvesting date	80(33.3)	30(12.5)	130(54.2)	1.79
Bush fallowing	80(33.3)	20(8.3)	140(58.3)	1.75
Use of weather forecast	60(25.0)	30(12.5)	150(62.5)	1.62

Field survey, 2015

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Constraints militating against the smallholder farmers to climate changes (n = 240)

The finding in Table 3 shows the various climate related constraints, the smallholder farmers were faced in their production in the state. Majority (86.7%) of the respondents indicated limited income with the mean value of 2.78 as a constraint militating against the smallholder farmers to climate change in the study area. Majority (85.0%) of the respondents revealed that with the mean value of 2.75 as a constraint militating against the smallholder farmers to climate change and 80.8% of the respondents also indicate pest and diseases with the mean value of 2.72 as a major constraints militating against the smallholder farmers to while most (79.2%) of the respondents indicated erosion occurrences, 75.0% instability of planting calendar, 72.5% high cost of irrigation and 69.2% inadequate knowledge on how to cope or build resilience as a constraints militating against the smallholder farmers to. Half (50.0%) of the respondents revealed that reduction in soil fertility was a minor problem militating against climate changes. Also above half (52.5% and 50.8%) of the respondents revealed that lack of access to weather forecast technology and low yield were the major climate change constraints confronting them. Benhin (2006) reports that lack of access to credit or saving and adequate information about climate change are some of the major problems encountered by farmers in adapting to climate change in Africa. Deressa (2008) reported that most of the problems or constraints encountered by farmers in adaptation to climate change are associated with poverty. The major factor affecting smallholder farmers was poverty in the State towards the goal of sustainable development goal in Ogun State and the nation at large.

Hypothesis one: There is no significant relationship between socio-economic characteristics of smallholder farmers and the extent of utilization of adaptation strategies in the study area.

The result in Table 4 shows the result of the test of relationship between in the socio-economic characteristics of arable crop farmers and the extent of adaptation strategies used in the study area using Chi-square and Pearson's Product Moment Correlation (PPMC) analysis. Chi-square analysis showed that there is a significant relationship ($P < 0.05$) between level of education ($\chi^2 = 45.21$), marital status ($\chi^2 = 51.13$) and the extent of utilization of adaptative strategies used in the study area. The implication of this is that level of education of the arable crop farmers will have effect on the adaptative measure used in the study area. Furthermore, the correlation analysis in Table 5 reveal that a significant relationship ($p < 0.05$) exist between household size ($r = 0.671$) and years of farming experience ($r = 0.282$) of the arable crop farmers and the extent of adaptative strategies in the study area. Therefore it can be deduced that the household size and years of farming experience of the respondents will have greater influence on the adaptative measure used to combat climate changes over times.

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Table 5: Chi-square analysis of socio-economic characteristics of the respondents and the extent of adaptation strategies used in the study area.

Variables	χ^2	Df	p-value	Decision
Sex	54.32	1	0.72	NS
Marital status	51.13	2	0.00	S
Religion	47.62	2	0.63	NS
Educational level	45.21	4	0.01	S
Main occupation	68.70	1	0.45	NS
Ethnicity	76.20	1	0.10	NS
Membership of association	21.3	1	0.21	NS

Source: Field survey, 2015
Note: S= Significant at 0.05 level, NS= Not significant at 0.05 level.

Table 6: Relationship between socio-economic characteristics of the respondents and the extent of adaptation strategies used in the study area.

Variable	r	P-value	Decision
Age	0.077	0.14	NS
Household size	0.671	0.01	S
Years of experience	0.242	0.03	S

Source- Field survey, 2015
P - value ≤ 0.05 = Significant, P-value > 0.05 = Not significant.

Table 5: Chi-square analysis of socio-economic characteristics of the respondents and the extent of adaptation strategies used in the study area.

Variables	χ^2	Df	p-value	Decision
Sex	54.32	1	0.72	NS
Marital status	51.13	2	0.00	S
Religion	47.62	2	0.63	NS
Educational level	45.21	4	0.01	S
Main occupation	68.70	1	0.45	NS
Ethnicity	76.20	1	0.10	NS
Membership of association	21.3	1	0.21	NS

Source: Field survey, 2015
Note: S= Significant at 0.05 level, NS= Not significant at 0.05 level.

Table 6: Relationship between socio-economic characteristics of the respondents and the extent of adaptation strategies used in the study area.

Variable	r	P-value	Decision
Age	0.077	0.14	NS
Household size	0.671	0.01	S
Years of experience	0.242	0.03	S

Source- Field survey, 2015

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P - value ≤ 0.05 = Significant, P-value > 0.05 = Not significant.

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The capacity to adapt to climate change can be asymmetrically distributed within a community (depending on age, social status or sex) and may change over time. Adaptive capacity depends on a range of factors, some of which coincide with the determining factors of vulnerability described in chapter two of this report. The determinants of adaptive capacity include: social capital, social networks, values, perceptions, customs, traditions, and levels of cognition. Additionally, the capacity to adapt is also affected by external factors including violent conflicts or the spread of infectious diseases .However, even if the capacity to adapt is given within a society, successful adaptation may not occur. Research has shown that in some cases societies are reluctant to adapt even though they would actually possess the capability to adapt. There are significant issues which hinder adaptation including poverty, policies, lack of resources, financial or technological limits.

5.2 RECOMMENDATION

The following recommendations were made:

1. Smallholder farmers should be empowered via meaningful information to address climate change issues. This could be achieved by helping these groups to explore climate change scenarios, assisting them in engaging with national level climate change strategizing and planning, and in general connecting to the international and national level policy discourses on climate change.
2. Government should ensure that the interests of smallholder farmers are properly addressed in any negotiations on large scale carbon sequestration projects, biofuel projects or avoided deforestation projects.
3. Government, private and NGOs financial transfers linked to these measures flow to all legitimate beneficiaries including smallholder farmers and indigenous forest dwelling peoples.
4. There is need to teach climate change adaptation measures to smallholder farmers using the language the farmers can understand in a participatory manner.
5. Farmers should be taught the use of improve varieties and changing of timing of farm operation to enable them cope with the unpredictable nature of climate change.
6. There is need to encourage creation of linkages and development of partnerships between the government and other actors in climate change issues. Government on her part need to develop policies to back up institution efforts to combats threats of climate change.

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Acknowledgement: The research team genuinely registers our deep appreciation to Tertiary Education Trust Fund **(TETFUND)** Abuja. The Provost Federal College of Education Osiele, Ogun State Nigeria, **Dr A.A Ajayi,** the management team and the **TETFUND Desk Officer, Mr A. A. Abati** for granting us the endorsement and release of fund to carry out this research work titled ***"Assessment of Indigenous Agricultural Practices and Adaptation to Climate Change among Rural Farmers in South West, Nigeria"***. Finally we thank our respondents (rural farmers), extension agents and field enumerators in both Ogun and Oyo state for their co-operation and support.

Sponsored by:

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