EFFECTIVENESS OF CLIMATE CHANGE ADAPTATION PRACTICES OF FARMERS IN SOUTHEAST NIGERIA: AN EMPIRICAL APPROACH.

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ABSTRACT
The study investigated the effectiveness of climate change adaptation practices of farmers in southeast Nigeria using primary data obtained with the aid of two sets of structured questionnaire. The first set of questionnaire was administered to 360 farm households and it sought information on their climate change adaptation practices. The second set of questionnaire was administered to 28 respondents who are experts in agricultural production and climate change adaptation research, and it sought information on the effectiveness of various climate change adaptation practices. However, only responses from 348 and 23 of these respondents, respectively were useful in the analysis. The data were presented using descriptive statistics such as frequency distribution, weighting scale and percentages. Results showed four categories of climate change adaptation practices: land/soil management, water management, crop management and livelihood diversification categories. Raising of mounds and ridges across slopes (80%), cultivation of cover crops (78%), multiple/intercropping (96%) and off-farm labour employment (66%) were the most frequently used climate change adaptation practices of the farmers under each of those categories, respectively. Further results showed that the climate change adaptation practices of the farmers were moderately effective. The water management category was effective in climate change adaptation, while land/soil management, crop management and livelihood diversification categories were moderately effective in climate change adaptation, respectively. Avoiding bush burning, water harvesting and storage, cultivation of early maturing crops and trading were the most effective adaptation practices of the farmers under land/soil management, water management, crop management and livelihood diversification categories, respectively. The study recommended the adoption of more effective climate change adaptation practices.

Key words: Climate Change, Effective Adaptation Practices, Farmers, Southeast Nigeria

1.0 INTRODUCTION

Climate change has been described as the worst environmental, social and economic threat facing humanity across every endeavour (Enete *et al.*, 2011; Oti, 2017). According to the Intergovernmental Panel on Climate Change [IPCC] (2007), it refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period typically decades or longer. This manifests in different forms such as extreme conditions of flooding, temperature rise (heat waves), rises in sea levels, drought and desertification, wind storms, and the drying up of streams and rivers (Nigerian Environmental Study Team [NEST], 2004).

The impact of climate change is spatially heterogeneous across temporal and spatial scales, although the manifestations suggest that countries in temperate locations may benefit from small economic advantages because additional warming will increase their agricultural sector (Dinar, Mendelsohn, Hassan & Benhin, 2008). This is unlike countries in the tropics (mainly developing economies) where additional warming will be detrimental to agricultural production(Dinar *et al*., 2008). Worse still, the threat is more severe in developing countries and sub-Saharan Africa (SSA), in particular, due to its over reliance on climate-sensitive sectors (e.g. agriculture and fisheries) coupled with low adaptive capacity (UNFCCC, 2007). This makes the region's agriculture highly vulnerable to climate change.

Alvaro, *et al.* (2009) reported that agricultural production in the region is mainly rain-fed, as it accounts for about 97 per cent of total cropland. According to FAO (2015), only about 3% of total cultivated area in sub-Saharan Africa are irrigated compared to a global average of 21% and 41% in Asia. This exposes agricultural production to high seasonal rainfall (climate) variability. Further to this, NEST (2004) observed that the vulnerability of countries and societies to climate change depends not only on the magnitude and sensitivity of their economies to climate parameters, but also, on the capacity of the affected societies to adapt. The capacity to adapt is a function of livelihood, and this is generally poor, rural and insecure in SSA. Farmers lack requisite skills and manpower, access to commercial markets for their produce, credit facilities, affordable improved inputs and requisite labour services needed for effective adaptation and optimum agricultural production.

Climate change adaptation involves adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Such adjustments could

be human, ecological or physical response to climate change vulnerability (CCV) (Adger *et al.*, 2007). The vulnerability of SSA agriculture to climate change has informed the litany of research in the area (Adger *et al*., 20017; Below *et al*., 2012; Dinar *et al*., 2008; Enete *et al*., 2011; IPCC, 2007; NEST, 2004; Oti, 2013, 2017), aimed at better understanding of the concept and the development of appropriate responses and adaptation to it. This will boost agricultural production, increase farmers' income and productivity, create increased employment opportunities, reduce hunger and poverty, and stimulate overall socioeconomic growth and development.

However, most of these studies had concentrated largely in understanding the adaptation behaviour of farmers with limited efforts on the effectiveness of such adaptation behaviours (Below *et al*., 2012; Dinar *et al*., 2008; Enete *et al*., 2011; Oti, 2013). Adaptation process is complex, forward looking and site-specific in nature (Below *et al*., 2012). It also involves time and budget, and therefore requires utmost precision to achieve the intended objectives. This is not tenable without empirical information. There is therefore an urgency in the need for a better understanding of the effectiveness of the various climate change adaptation behaviour of farmers. This will contribute to evidence-based policies of government for increased agricultural production and accelerated socioeconomic growth and development in SSA.

2.0 METHODOLOGY

This study was carried out in southeast region of Nigeria, which consists of five states namely Abia, Anambra, Ebonyi, Enugu and Imo (Fig. 1). It is located East of River Niger, between Longitude 6 - 8^0 East of the Greenwich Meriden and Latitude 5 - 7^0 North of the Equator on a landmass of 16,000 square miles (40,000km^2) on an elevation ranging from 0 ft (0m) to 3,300 ft (1,000m) (National Bureau of Statistics [NBS], 2014). Data were collected through multistage random sampling technique using two sets of structured questionnaire administered to two sets of samples, respectively.

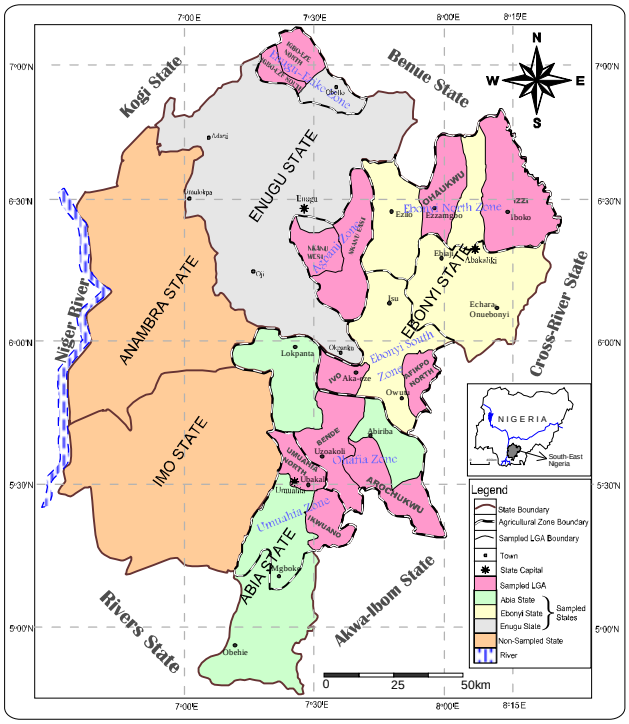

Fig. 1: Map of southeast Nigeria showing sampled locations
Source: Adapted from NBS (2014).

In the first sample, 360 households were selected. This involved firstly, a random selection of three states (Abia, Ebonyi and Enugu) in the region, followed by another random selection of two agricultural zones from each of the selected states. Subsequently, two local government areas (LGAs) were randomly selected from each of the selected agricultural zones, from where two communities were randomly selected, respectively. Finally, 15 farm households were randomly selected from each of the selected communities. Only responses from 348 of them were useful in the analyses. In the second sample, purposive sampling technique was used to select 28 respondents, who have expert knowledge in agricultural production and climate change research. These experts were drawn from universities, research institutes, state ministries of agriculture and agricultural development programme

(ADP). The responses from 23 of the experts were however used in the analyses.

The data were analysed using descriptive statistics such as frequency distribution and weighting scale. Weights were assigned on a 5-point scale by experts in agricultural production and climate change research, on the climate change adaptation practices of farmers based on their level of effectiveness. Farmers also provided complimentary assessment on the suitability or otherwise of each practice as a climate change adaptation measure. This weights is specified as follows:

$$ECA_i = \frac{\sum W_{ji} P_{ji}}{N}, \quad j = 1, 2, \dots, 23; i = 1, 2, \dots, 27; N = 23. \quad (2.1)$$

ECA_i = effectiveness of i^{th} climate change adaptation practice

W_{ji} = weight of j^{th} expert on i^{th} climate change adaptation practice, where: (5 = very effective [ECA = 100%]; 4 = effective [80% ≤ ECA ≤ 99%]; 3 = moderately effective [60% ≤ ECA ≤ 79%]; 2 = poorly effective [40% ≤ ECA ≤ 59%]; 1 = not effective [ECA ≤ 39%]

P_{ji} = j^{th} household's assessment of the suitability of farm practice 1 for change adaptation (1 if suitable, 0 if otherwise)

3.0 RESULTS AND DISCUSSION

3.1 Climate Change Adaptation Strategies of the Rural Farm Households

The frequency distribution of the rural farm households according to their adoption of various climate change adaptation practices is shown in Table 1. These practices consisted of four categories: land/soil management, water management, crop management, and livelihood diversification.

3.1.1 Land/Soil Management Practices

The result showed that raising of mounds and ridges across slopes (80%), prompt physical weeding and removal of insects (73%), and organic manure application (62%) were the most frequently and widely used climate change adaptation practices. Raising of mounds and ridges across slopes help to check the devastating effect of erosion and flooding on farms. This is particularly important in southeast Nigeria, where large areas of agricultural lands have either been lost completely, or have become unsuitable for cultivation or any other productive economic activity, as a result of erosion (Ezeigwe, 2015). These practices have relatively low technical requirements and cost implications, and as such, could have informed their widespread adoption by the farm households.

Table 1: Frequency distribution of the rural farm households according to their of adoption of various climate change adaptation practices

Adaptation practices	Frequency*	Percentage (%)
Land/Soil Management Category		
Land rotation/bush fallow	63	18.10
Use of insecticides and weedicides	90	25.86
Agro-forestry practices	97	27.87
Fertilizer application	136	39.08
Avoiding bush burning	177	50.86
Organic manure application	216	62.07
Prompt physical weeding and removal of insects	254	72.99
Raising of mounds and ridges across slopes	278	79.89
Water Management Category		
Tree planting	14	4.02
Physical irrigation	49	14.08
Water harvesting and storage	77	22.13
Construction and maintenance of drainage channels	104	29.89
Prevention of forest losses along water bodies	125	35.92
Mulching	181	52.01
Cultivation of cover crops	271	77.87
Crop Management Category		
Use of weather forecast	21	6.03
Crop rotation	42	12.07
Cultivation of drought-resistant crop varieties	48	13.79
Cultivation of disease-resistant crop varieties	70	20.11
Cultivation of early maturing crops	97	27.87
Use of improved crop varieties	108	31.03

Changing of planting dates	184	52.87
Multiple/intercropping/mixed farming	334	95.97
Livelihood Diversification Category		
Artisans	97	27.87
Trading	136	39.08
On-farm employment (labourer)	146	41.95
Off-farm employment (labourer)	230	66.09

* Multiple responses. Source: Field survey, 2017.

3.1.2 Water Management Practices

The result showed that cultivation of cover crops (78%) and mulching (52%) were the adaptation practices highly adopted by the farmers. Cover crops are very important crops of farmers with cowpea (*Vigna unguiculata*) as the major cover crop. They also help to mulch the soil. This helps in the management of soil erosion, soil fertility, soil quality, soil water, and weeds, pests and diseases control (Lu, Watkins, Teasdale, & Abdul-Baki, 2000). Furthermore, the cultivation of these cover crops does not require additional costs on the farmers. These may have informed their wide use as a measures of climate change adaptation by the farmers.

3.1.3 Crop Management Practices

The result showed that multiple cropping/intercropping/mixed farming (96%)and changing of planting dates (53%) were the highly adopted adaptation practices of the farmers. A mutual relationship exists in mixed farming, such that in sub-Saharan Africa, it is a common practice for rural farm households to keep some livestock, especially goats and poultry birds, in their farms/homes while still cultivating the field. The grasses from the field and domestic wastes are used to feed the livestock, while the animal droppings (wastes) are used as organic manure. Furthermore, with delays in the onset of rains due to climate change, it is becoming very rationale for farmers to change their planting dates, which could have informed its wide adoption.

3.1.4 Livelihood Diversification

The result showed that majority of the farm households (66%) were engaged in off-farm employment as labourers, while a lower proportion of them (42%) were engaged equally as labourers in on-farm employment. Agricultural production in SSA is characterized by land fragmentation, drudgery, low productivity, low income and poverty. As such, most of the rural dwellers who are predominantly farmers engage in other economic activities as a means of insurance against complete crop failure and also to increase their household income.

3.2 Effectiveness of Climate Change Adaptation Practices of Farmers

The level of effectiveness of the various climate change adaptation practices of farmers is shown in Table 2.

Table 2: Level of effectiveness of various climate change adaptation practices of farmers

Adaptation practices	Weight	Percentage (%)	Decision
Land/Soil Management Category			
Land rotation/bush fallow	3.67	73.4	Moderately Effective
Use of insecticides and weedicides	2.85	57.0	Poorly Effective
Agro-forestry practices	4.33	86.6	Effective
Fertilizer application	3.00	60.0	Moderately Effective
Avoiding bush burning	4.70	94.0	Effective
Organic manure application	3.27	65.0	Moderately Effective
Physical weeding and removal of insects	3.00	60.0	Moderately Effective
Raising of mounds and ridges across slopes	2.33	46.6	
Sub-total	**27.15**		
Sub-average	**3.39**	**67.8**	**Moderately Effective**
Water Management Category			
Tree planting	3.39	67.8	Moderately Effective
Physical irrigation	4.40	88.0	Effective
Water harvesting and storage	4.66	93.2	Effective
Construction and maintenance of drainage channels	4.20	84.0	Effective
Prevention of forest losses along water bodies	4.50	90.0	Effective
Mulching	4.00	80.0	Effective
Cultivation of cover crops	3.67	73.4	Moderately Effective
Sub-total	**28.82**		

Sub-average	**4.12**	**82.3**	**Effective**
Crop Management Category			
Use of weather forecast	3.30	66.0	Moderately Effective
Crop rotation	3.67	73.4	Moderately Effective
Cultivation of drought-resistant crop varieties	4.00	80.0	Effective
Cultivation of disease-resistant crop varieties	4.18	83.6	Effective
Cultivation of early maturing crops	4.80	96.0	Effective
Use of improved crop varieties	4.33	86.6	Effective
Changing of planting dates	4.05	81.0	Effective
Multiple/intercropping/mixed farming	3.30	66.0	Moderately Effective
Sub-total	**30.65**		
Sub-average	**3.83**	**76.6**	**Moderately effective**
Livelihood Diversification Category			
Artisans	3.28	65.6	Moderately Effective
Trading	3.47	69.4	Moderately Effective
On-farm employment (labourer)	2.65	53.0	Poorly Effective
Off-farm employment (labourer)	3.21	64.2	Moderately Effective
Sub-total	**12.61**		
Sub-average	**3.15**	**63.0**	**Moderately Effective**
Potential Weight	**135**		
Total Weighting	**99.23**		
Average Weighting	**3.68**	**73.6**	**Moderately Effective**

Source: Field survey, 2017.

The result showed that on the average the adaptation practices of the farmers were moderately effective. This implies that more effective practices could be adopted by the farmers with attendant implications on increased food production and security. Water management practices were more effective in climate change adaptation than those of land/soil, crop management and livelihood diversification practices. Agricultural production in the region is mainly rain-fed, as such, farmers are more likely to adopt measures that will increase availability of water to their farms, given increasing rainfall variability. Agro-forestry practices and avoidance of bush burning were the only effective land/soil management adaptation practices of the farmers.

4.0 CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

The study investigated the effectiveness of climate change adaptation practices of farmers. Increasing threat by climate change on agricultural production and livelihood activities has necessitated the need for adaptation by the farmers. Most of the adaptation practices that were highly adopted by the farmers were poorly effective in climate change adaptation, while the more effective practices were lowly adopted. Water management practices were the most effective climate change adaptation measures of the farmers.

4.2 RECOMMENDATION

Based of the findings of this study, the following recommendation is being made:

i. farmers should be encouraged to adopt more effective climate change adaptation practices such as cultivation of early maturing and improved crop varieties, avoiding of bush burning, harvesting and storage of water to enhance irrigation of farms, prevention of forest losses along water bodies and cultivation of improved crop varieties.

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