Nigerian Journal of Soil Science

Journal homepage:www.soilsjournalnigeria.com

Land Adaptation Strategies across the Rain-fed Agricultural States as Climate Change Persists.

[*]Towolawi, A.T.[1,2], Oguntoke, O.[2], Bada, B.S.[2] and Adejuwon, J.O.[3]

[1]Center for Excellence in Agricultural Development and Sustainable Environment (CEADESE), Federal University of Agriculture, Abeokuta, PMB 2240, Ogun State, Nigeria.

[2]Department of Environmental Management and Toxicology, Federal University of Agriculture, Abeokuta, PMB 2240, Ogun State, Nigeria.

3Department of Water Resources Management and Agrometeorology, Federal University of Agriculture, Abeokuta, PMB 2240, Ogun State, Nigeria.

ARTICLE INFO

Article history:
Received June 25, 2021
Received in revised form July 18, 2021
Accepted August 27, 2021
Available online October 26, 2021

Keywords:

Climate Adaptation,
Land Degradation,
SDG 15 (Life on Land),
World Bank .

Corresponding Author's E-mail Address:
taofiktowolawi@yahoo.com +2348060172946

https://doi.org/10.36265 njss.2021.310308
ISSN– Online **2736-1411**
Print **2736-142X**

ABSTRACT

Acquisition of land for farming activities is hitting hard on the interested small-scale farmers in Nigeria while the available land faces climate change influenced degradation. This current research verified how farmers are coping across four rain-fed (Benue, Edo, Ondo and Niger) states using 1600 copies of pretested questionnaire administered through the multistage procedure. The retrieved copies were coded and analyzed descriptively (frequency and percentage) and inferentially (Chi-Square) at $p < 0.05$ levels of significance. The results showed that most farmland sizes were three plots, and adaptation of soil management techniques was observed in both Benue and Ondo States, where there were significant ($p < 0.05$) differences in the farmers' responses to indicate possible differences in policy could assist the two elements of quests. The farmers' responses indicated addressing of land degradation significantly ($p < 0.05$), but not with application of fertilizers except in Ondo State ($\chi = 14.413$, $p = 0.108 > 0.05$). The farmers responsively planted trees with the same reasons in Ondo State ($\chi = 4.813$, $p = 0.850 > 0.05$). The farmers hardly exercised zero tillage except in Edo State, while the Ondo State's farmers had no different ($\chi = 4.813$, $p = 0.850 > 0.05$) opinion. Farmers' responses on farmland size, soil management techniques, and land degradation were positive but significantly different. Therefore, the investigation deduced that states with significantly different responses would require different decisions, agricultural policies, and adaptation strategies to lessen and ease the effects of climate change on the land of such states.

1.0 Introduction

The land is a fixed asset, one of the factors of production and property that determines farmland size and agricultural productivity (FFP, 2016). Anthropogenic and natural driven-factors hardly let the land rest to provide fertility to the biosphere (Farris *et al.,* 2014). Unlike the former, the latter gradually and unnoticeably affects the fertility of land through degradation. The degradation in the era of climate change is so severe that agricultural systems are being affected. No doubt farmers would see the adaptation of land or soil management technique germane, though land management could be humanly and objectively specific. Thus, it is calling for a masterminded way to address land or soil degradation as climate change persists with resultant threats on agricultural harvest expectation (Flavelle, 2019).

Many local, state, national and international policies govern land acquisition (Isaac *et al.,* 2019). Though the Nigerian Land Use Act of 1978 seemed to give a chance of equal right for affordable land acquisition for either industrial estates or mechanized agriculture, Nwocha (2016) declared that the citizens' opportunity had changed after thirty years of the operation of the law. The ripple effects impede the development of every sector. It spared no agricultural sector, especially small-scale farming, which strives to meet both ends (Gbonegun, 2017). So, the small land that such farmers possess either through family inheritance or purchase is being hijacked by the threats of climate change. The Sustainable Development Goal 15: Life on Land campaigns against the threats the climate change poses on land from where the plant life taps its needed nutrients to provide 80 % of human agricultural produce and upon which agriculture system relies being a vital resource and means to development. The SDG 15 targets conservation and restoration of terrestrial ecosystems (forests, wetlands, drylands and mountains) erect on land for human livelihood and usage.

In turn, the ecologists advocate for promoting sustainable land or soil ecosystem management to mitigate, facilitate, and moderate the persisting climate change impacts. Seeing land as an integral sphere of human existence, UNEP (2021) illustrated that its protection from the threat of climate change is essential because land provides an array of resources, service provisions that ranges from carbon sequestration, soil fertility, biodiversity reservation to water reservoir maintenance and water flow regulation. The environmental stakeholder expressed the above to necessitate maintaining land ecosystems through multifaceted efforts, adaptation to and mitigation of climate change effects. If such efforts are combined, its aim should be to ensure the endowed benefits of land-based ecosystems for human livelihood and sustainability. Thus, an urgent strategy should be crafted to minimize the loss of natural habitats and biodiversity. This inherently common heritage renders complete services to the farming activities for human survival and food security (https://www.jointsdgfund.org/sustainable-development-goals/goal-15-life-land).

It is necessary to understand the way farmers cope with climate change, especially across the region. The climate demarcates land, assigns peculiar characteristics, and enforces the farmers to be intuitive in crafting adaptation strategies according to their regions. The study was based on the concerns about the prominent medium, i.e. land, upon which growing crops survive and where the crops tap their required nutrients to ensure food security for humans. Soil quality in the agricultural rain-fed regions in Nigeria is being adversely affected by climate change, thereby challenging the farmers in supplying the food demand by the population. The approach then was to verify how the known hubs of yearly agricultural produce would survive the climate change effects and adapt to them. The current study sourced six elements for farmers' views across the four states known to provide a high yield of crops yearly in Nigeria. The elements were farmland size which dictates the scale for farming activities, soil management techniques to ascertain if the farmers have and apply any, addressing land degradation, organic fertilizers application, tree planting and zero tillage. The study ascertained if each element was conceived the same way in each state for decision making and agricultural policy.

2.0. Materials and Methods

2.1. Study areas

The climatic condition of Nigeria is tropical, with two (wet and dry) seasons. The former displays high humidity and a rainfall distribution that spans between April and October, while the latter season ranges from November to March. Table 1 shows the chronological order of the population and landmass of the four states considered in this study. The study adopted a multistage approach (Amujoyegbe, 2010) to perceptively collate information on how farmers cope with the climate change effects on land across the four chosen hubs of agriculture: Benue, Edo, Niger and Ondo States known for high yearly agricultural produce.

$of\ 384 = (384 \text{ X } 10)/100 = 38.4$

2.2. Data gathering

The study team contacted the farmers through the Agricultural Development Programmes (ADP) offices, whose structure is the same in reaching the farmers across the nation. The sample size for each state was determined using Cochran (1977) formula

$$N = Z^2P\ (1\text{-}P)/\ (D^2) \text{ ------ Equation 1}$$

$$n = (1.96^\wedge 2 * 0.50 * 0.50)/\ 0.05^\wedge 2 = 384.16 \quad \text{--Equation 2}$$

A non-response rate of 10 % of 3584 = (384 x 10)/100 = 38.4 --- Equation 3

where n = minimum sample size required, z = confidence limit of the survey at 95% (1.96), p = proportion of respondents/ farmers, d= absolute deviation from true value (degree of accuracy) = 5%. Obtained values from equations 2 were rounded off to 400 copies of questionnaire.

The study then used 1600 copies of the questionnaire for the four chosen states. For the pretest validation, 10 % of 1600 copies of the questionnaire (i.e. 160) were distributed among the final year students of Agriculture in the Federal University of Agriculture, Abeokuta.

The students were not in any of the four chosen states of the study. The retrieved copies were subjected to a validity test. The result had Cronbach's ***α-value*** of 7.8, which indicated the adequacy of the questionnaire elements consistent with the research objectives. The ADP has a director in the headquarters of each state, followed by the zonal offices across local government areas, from where their field officers are in touch with the farmers. The organization has a solid structure premising on a top-down and bottom-up approach to keep the farmers abreast. It was that approach the study team availed to gather land adaptation strategies put in place by the farmers to survive the threats being experienced as climate change persists.

2.3. Statistical analysis

The retrieved copies of the questionnaire were coded in the EXCEL spreadsheet, transferred to the SPSS v23 and

Table 1: Population and Landmass of the Four Study Areas in the Descending Order

Rank	Nigerian States	Population 2006	Landmass Km^2	Population Density (Km^2)
9	Benue State	4,219,244	34,059.00	124
14	Niger State	3,950,249	13,930.00	284
18	Ondo State	3,441,024	14,606.00	236
24	Edo State	3,218,332	17,450.00	184

Source: MACOS Urban Management Consultants (2021).

analyzed descriptively for frequency and percentage. The Chi-square (inferential statistics) test was performed to investigate whether there are significant differences among the farmers' responses in each state, thereby determining if the same policy might be used for the farmers

3.0. Results and Discussion

3.1. Farmland size cultivated by the farmers

Responses of the farmers indicated that farmland size varied across the study states (Table 2). The highest number of farmers cultivated three plots of land in Benue State (128 out of 370), with Benue north having the highest number of farmers (59 out of 140), and Ondo State (103 out of 330) with Okitipupa having the highest number of farmers (31 out of 100). Two plots were most cultivated in Edo State (111 out of 376), with the highest in Edo South (49 out of 170), and Niger State (210 out of 396), with Niger Central having the highest (88 out of 160). Chi-Square tests showed that the size of the farmland being cultivated across the study areas was significantly ($p<0.05$) different. Maintenance of land for fertility throughout the farming periods for crops of interest may be a significant factor for small-sized farming across the study states. Affordability to pay may also contribute to the farm structure that most of the farmers keep.

Restrictive government land acquisition measures tend to contribute to the small land available to be sold or leased for agricultural activities. At the same time, it may give room to medium-sized and large farms for high agricultural holding sizes (AHS) (Zolin and Caldogno, 2011). The size of farmland cultivated by the farmers indicated the structure of agricultural systems and the approach required of the farmers for their farmland management. It would ease out the likely conflict that might arise if another methodology is introduced. Primary practical production, administration and management views revolve around the farmland size commonly used in the study areas. Eurostat (2014) data showed that nearly 90 % of the cultivated agricultural area is acquired by agricultural investors with the AHS more than 1500 plots, making up 11 % of the total agricultural holdings. Janovska *et al.* (2017) pointed out that the average AHS is an inverse of the land-user density expression and indicates the present worldwide trend of the decreasing numbers of people working in agriculture.

Table 2: Farmland size cultivated across the study areas

Farm Size		**Benue N140**	**Benue C130**	**Benue E130**	**Total**	**Edo N130**	**Edo C100**	**Edo S170**	**Total**	
A plot	Count	18	32	31	81	20	18	40	78	
	%	22.2%	39.5%	38.3%	100.0%	25.6%	23.1%	51.3%	100.0 %	
Two plots	Count	46	36	22	104	30	32	49	111	
	%	44.2%	34.6%	21.2%	100.0%	27.0%	28.8%	44.1%	100.0%	
Three plots	Count	59	44	25	128	39	31	39	109	
	%	46.1%	34.4%	19.5%	100.0%	35.8%	28.4%	35.8%	100.0%	
> Three plots	Count	2	3	52	57	36	19	23	78	
	%	3.5%	5.3%	91.2%	100.0%	46.2%	24.4%	29.5%	100.0%	
Total	Count	125	115	130	370	125	100	151	376	
	%	33.8%	31.1%	35.1%	100.0%	33.2%	26.6%	40.2%	100.0%	
	Chi-Square Tests for Benue State					Chi-Square Tests for Edo State				
		Value	Df	Asymp. Sig. (2-sided)		Value	Df	Asymp. Sig. (2-sided)		
Pearson Chi-Square		108.637[a]	6	0.000		13.200[a]	6	0.040		
Likelihood Ratio		111.476	6	0.000		13.025	6	0.043		
Linear-by-Linear Association		10.189	1	0.001		11.698	1	0.001		
Farm Size		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
A plot	Count	26	9	39	74	12	9	19	18	58
	%	35.1%	12.2%	52.7%	100.0%	20.7%	15.5%	32.8%	31.0%	100.0%
Two plots	Count	84	88	38	210	18	13	20	16	67
	%	40.0%	41.9%	18.1%	100.0%	26.9%	19.4%	29.9%	23.9%	100.0%
Three plots	Count	10	51	22	83	43	31	18	11	103
	%	12.0%	61.4%	26.5%	100.0%	41.7%	30.1%	17.5%	10.7%	100.0%
> Three plots	Count	0	10	19	29	27	28	33	14	102
	%	0.0%	34.5%	65.5%	100.0%	26.5%	27.5%	32.4%	13.7%	100.0%
Total	Count	120	158	118	396	100	81	90	59	330
	%	30.3%	39.9%	29.8%	100.0%	30.3%	24.5%	27.3%	17.9%	100.0%
	Chi-Square Tests for Niger State					Chi-Square Tests for Ondo State				
		Value	df	Asymp. Sig. (2-sided)		Value	Df	Asymp. Sig. (2-sided)		
Pearson Chi-Square		84.753[a]	6	0.000		27.596[a]	9	0.001		
Likelihood Ratio		95.621	6	0.000		27.506	9	0.001		
Linear-by-Linear Association		8.843	1	0.003		7.821	1	0.005		

Table 1: Population and Landmass of the Four Study Areas in the Descending Order

The landowners hardly lease the land out for farming activities as the sector is viewed as a low-profit yielding. Owners' reservation to give farmers their land is crucial to the current state and trends in the agricultural economy (Latruffe *et al.,* 2013).

3.2. Soil management techniques by the farmers

Interviewing the farmers if they practise or adapt soil management techniques (SMT), their responses in each state showed that they adapted it in both Benue and Ondo States but not in Edo and Niger States. The highest (50.5 and 31.9) % of the farmers that adapted SMT were traced to Benue east and Ikare zone, while the highest (41.2 and 46.1) % of those that did not practise SMT were found to come from the Edo south and Niger north-central. Chi-Square results showed that farmers' responses were significantly ($p < 0.05$) different in each state (Table 3). The number of farmers that practised SMT averagely showed that they were after their farmland soil conditions. The SMT is necessary because the health and condition of soil determine the performance of a crop as the medium on which it grows. Soil that lacks the nutrients required of a particular crop would jeopardize the efforts of the farmers giving low yield at the harvest.

Soil sustains most living organisms as the key harbouring source of mineral constituents. Its good management practice ensures that appropriate nutrients are not lacking, toxic to plants, and supplied inappropriately. Views on the current state of threats from climate change observed that achieving future food security through sustainable management of soil might be tasking through proper nutrient management and soil conservation practices (White *et al.,* 2012). The tasks were linked to degradation of soils from contamination, drought, flooding and the accompanied nutrient depletion. Soil quality influence on crop and farm productivity is ascertained from prevention of contaminant entrance, development of enhanced agronomic exercise, avoidance of deforestation at the agricultural intensified vicinities, adoption of good agroforestry systems, monitoring of soil mineral contents for adequacy, and judicious application of amendments. The way the soil is managed improves or degrades the quality as a complex ecosystem harbouring living microorganisms and serves as an interface for plant roots, mineral particles, and organic matter, which collectively form a dynamic structure to regulate water, air, and nutrients. Managing soil for its health improvement is the foundation for profitable, productive, and environmentally sustainable farming systems (Penn State Extension, 2017).

Table 3: Soil management techniques as soil-land management adaptation strategy

Soil Management Technique		**Benue N140**	**Benue C130**	**Benue E130**	**Total**	**Edo N130**	**Edo C100**	**Edo S170**	**Total**
Yes	Count	43	66	111	220	67	44	56	167
	%	19.5%	30.0%	50.5%	100.0%	40.1%	26.3%	33.5%	100.0%
No	Count	91	57	19	167	59	51	77	187
	%	54.5%	34.1%	11.4%	100.0%	31.6%	27.3%	41.2%	100.0%
Total	Count	134	123	130	387	126	95	133	364
	%	35.0%	32.0%	33.0%	100.0%	34.4%	25.7%	39.9%	100.0%

Chi-Square Tests for Benue State	Value	Df	Asymp. Sig. (2-sided)	Chi-Square Tests for Edo State: Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	83.136[a]	6	0.000	17.002[a]	6	0.009
Likelihood Ratio	91.559	6	0.000	17.663	6	0.007
Linear-by-Linear Association	65.320	1	0.000	11.320	1	0.001

Soil Management Technique		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	16	55	96	167	61	56	41	33	191
	%	9.6%	32.9%	57.5%	100.0%	31.9%	29.3%	21.5%	17.3%	100.0 %
No	Count	93	100	24	217	23	39	48	39	149
	%	42.9%	46.1%	11.1%	100.0%	15.4%	26.2%	32.2%	26.2%	100.0 %
Total	Count	119	155	120	384	84	94	89	72	340
	%	30.0%	40.0%	30.0%	100.0%	26.8%	26.3%	25.5%	21.4%	100.0 %

Chi-Square Tests for Niger State	Value	Df	Asymp. Sig. (2-sided)	Chi-Square Tests for Ondo State: Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	129.488[a]	6	0.000	29.513[a]	9	0.001
Likelihood Ratio	138.778	6	0.000	31.608	9	0.000
Linear-by-Linear Association	104.532	1	0.000	1.511	1	0.219

3.3. Addressing land degradation

Responses of the farmers to addressing land degradation (ALD) in each state showed that the farmers adapted it with the order that followed: 322 out of 400 in the Niger States where highest (34.5) % was found in Niger north east > 311 out of 382 in the Edo States where highest (43.1) % was found in Edo south > 262 out of 371 in the Ondo States where highest (31.7) % was found in Ikare zone > 203 out of 394 in the Benue States where highest (51.7) % was found in Benue east. Chi-Square results showed that farmers' responses were significantly ($p < 0.05$) different in each state (Table 4). The methods to ALD have to consider complex factors that might effectively awake healthy land to secure soil resources, improve crop management and tackle soil erosion. Mueller *et al.* (2014) admitted that land degradation is hardly defined as it is considered with the individual derived benefit.

UNEP (2017) outlined the myriad of factors to include sand and dust storms, loss of biodiversity and degradation of ecosystems, soil erosion, drought, the unsustainable use of land and water resources, and urbanization and climate change. Overgrazing by animals, over-working of farmland areas, mismanagement of water sources, land clearing and failure to replanting are other non-negotiable contributors. The farmers were made to realize that ALD should be handled individually with possibly available resources to avert to deficient of not only macro (Ca, Mg, N, P and K) but micro (such as Zn, Bo, Mn and S) nutrients also (Singh *et al.*, 2002) from over-cultivation of their land or collectively with the exploration of modern technology (World Bank, 2008). The incidences impede the cohesiveness of the soil, strip the ground of its cover and decline soil moisture. The productivity impacts the crop area due to the land quality reduction where degradation occurs. The study of Eswaran *et al.* (2001) attributed a 50 % productivity reduction of certain farmlands to soil erosion and desertification. Addressing land degradation necessitates restoration through augmentation with soil amendments for land resilience, soil quality and ecosystem service functionality (UNCCD, 2012). Among the measures to address land degradation (Briones, 2010) are to campaign for support to increase and widen incentives, adopt soil conservation and promote permanent tree crops with improved occupancy measures.

Table 4: Addressing land degradation as a soil-land management adaptation strategy

Addressing Land Degradation		**Benue N140**	**Benue C130**	**Benue E130**	**Total**	**Edo N130**	**Edo C100**	**Edo S170**	**Total**
Yes	Count	36	62	105	203	94	83	134	311
	%	17.7%	30.5%	51.7%	100.0%	30.2%	26.7%	43.1%	100.0%
No	Count	103	63	25	191	35	17	19	71
	%	53.9%	33.0%	13.1%	100.0%	49.3%	23.9%	26.8%	100.0%
Total	Count	139	125	130	394	129	100	153	382
	%	35.1%	32.1%	32.8%	100.0%	33.9%	26.1%	39.9%	100.0%

	Chi-Square Tests for Benue State			Chi-Square Tests for Edo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	83.475[a]	4	0.000	12.168[a]	4	0.016
Likelihood Ratio	87.920	4	0.000	12.216	4	0.016
Linear-by-Linear Association	72.282	1	0.000	11.126	1	0.001

Addressing Land Degradation		Niger` N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	110	101	111	322	83	66	56	57	262
	%	34.2%	31.4%	34.5%	100.0%	31.7%	25.2%	21.4%	21.8%	100.0%
No	Count	10	59	9	78	16	32	40	21	109
	%	12.8%	75.6%	11.5%	100.0%	14.7%	29.4%	36.7%	19.3%	100.0%
Total	Count	120	160	120	400	99	98	96	78	371
	%	30.0%	40.0%	30.0%	100.0%	26.5%	26.5%	25.7%	21.2%	100.0%

	Chi-Square Tests for Niger State			Chi-Square Tests for Ondo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	51.311[a]	2	0.000	22.466[a]	9	0.008
Likelihood Ratio	51.289	2	0.000	25.202	9	0.003
Linear-by-Linear Association	.026	1	0.871	4.199	1	0.040

3.4 Application of organic fertilizers by the farmers

Usage of organic fertilizer was found from the responses of the farmers to be embraced only in Benue State with 238 out 394, and the highest (47.5) % was traced to the Benue north. A higher number of farmers chose "No Option" in the remaining three states; the order followed 294 out of 397 in Niger State where the highest (39.1) % was in Niger north-south > 191 out of 378 in Edo state where the highest (44) % occurred in Edo north > 176 out of 370 in Ondo State where the highest (30.1) % of the farmers that did apply organic fertilizers was traced to be in Ikare zone. Chi-Square analysis showed that there was a significant ($p < 0.05$) difference in each state's farmers' responses (Table 5).

The farmers rarely applied organic fertilizers as soil conditions might be favourable to make the crops germinate buoyantly. The soil properties promote yields under low or no application of fertilizers. The response did not indicate that farmers had not understood that nutrient variability and release pattern of organic fertilizers is necessary (Deugd *et al.,* 1998) to supply plants with the required nutrients for optimal performance as they rebuild soil fertility, ensure environmental and natural resources protection. The authors' views corroborated what FAO and IFA (2000) said that most farmers consider the general fertilizer requirements of each plant before they apply the fertilizers. More organic fertilizers are consumed than the inorganic as soil organic matter declines from the influence of optimal environmental factors when converting organic minerals to inorganic nutrients to be quickly and readily available for plant uptake (Benbrook *et al.,* 2008). Seaweed, animal remnants and animal waste are known organic fertilizers. Animal waste organic fertilizers, including dairy and poultry droppings, have been explored for their usefulness to improve soil fertility (Ahmad *et al.,* 2006; Bada *et al.,* 2019). The authors mentioned that organic fertilizers' benefits are not limited to changes in soil properties, increased crop biomass,d crop biomass, and enhanced root distributions. Bada *et al.* (2019) deduced from their study that dairy manure and poultry droppings potentially contain essential nutrients which the growers could explore for plant healthy growth. Eghball (2002) research observed that manure amendment reduces soil bulk density and increases amended soil porosity.

Table 5: Application of organic fertilizers as a soil-land management adaptation strategy

Application of Organic Fertilizers		**Benue N140**	**Benue C130**	**Benue E130**	**Total**	**Edo N130**	**Edo C100**	**Edo S170**	**Total**
Yes	Count	113	88	37	238	45	50	62	157
No	Count	22	33	94	149	84	43	64	191
	%	14.8%	22.1%	63.1%	100.0%	44.0%	22.5%	33.5%	100.0%
Total	Count	138	125	131	394	130	98	150	378
	%	35.0%	31.7%	33.2%	100.0%	34.4%	25.9%	39.7%	100.0%

	Chi-Square Tests for Benue State			Chi-Square Tests for Edo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	100.583[a]	4	0.000	33.116[a]	4	0.000
Likelihood Ratio	104.048	4	0.000	35.660	4	0.000
Linear-by-Linear Association	63.322	1	0.000	1.515	1	0.218

Application of Organic Fertilizers		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	5	64	34	103	38	57	45	35	175
	%	4.9%	62.1%	33.0%	100.0%	21.7%	32.6%	25.7%	20.0%	100.0%
No	Count	115	93	86	294	53	36	48	39	176
	%	39.1%	31.6%	29.3%	100.0%	30.1%	20.5%	27.3%	22.2%	100.0%
Total	Count	120	157	120	397	100	96	98	76	370
	%	30.2%	39.5%	30.2%	100.0%	27.0%	25.9%	26.5%	20.5%	100.0%

	Chi-Square Tests for Niger State			Chi-Square Tests for Ondo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.925[a]	2	0.000	14.413[a]	9	0.108
Likelihood Ratio	57.659	2	0.000	15.429	9	0.080
Linear-by-Linear Association	18.192	1	0.000	1.724	1	0.189

3.5 Tree planting by the farmers

Windbreaker and erosion abatement strategy, also known as tree planting (TP), was observed across the study states. The farmers' responses showed that the technique is friendly adapted. Responses of the farmers to TP in each state (Table 6) indicated that its adaptation in each state followed the order: 306 out of 399 in Niger State with the highest (39.2) % of farmers dwelling in Niger north-central > 267 out of 380 in Benue State having its highest (37.8) % was found in Benue east > 238 out of 340 in Edo State. Their highest (47.9) % was found in Edo south > 178 out of 243 in the Ondo States where highest (35.4) % was found in Ikare zone. The Chi-Square analysis indicated that the farmers' responses had no significant (χ = 4.813, p = 0.850 > 0.05) difference in Ondo State.

The results implied that effects of the climate change would be less felt across the studied locations. Planting trees has the utmost advantage of capturing carbon dioxide, thereby checking the number of emissions from human activities and the heat prevailing in the surroundings and driving global warming. An expanse of land without trees is prone to erosion, land degradation, soil fertility loss and low yield at harvest in turn. The TP had been viewed as the utmost forest restoration strategy as it abates emissions from fossil fuel burning and forest destruction. It is the naturally cheapest method of combating climate change effects. The efficiency is certain when hetero-culture plantation forests are nurtured (Carrington, 2019). The entirety of earth ecosystems could still support more than 2 billion acres of forested areas if a man regularly embarks on TP. The peripheral solution would reduce emission source and have temperature: 1.5 °C or 2.7 °F of the pre-industrial level (Buis, 2019). The five critiques put together by Muilis (2019) demand ponderings over TP as a strategy to curb climate change effects. They are listed to range from leaving fossil fuels stored at reservoir, negligence of capacity of other living things with the potential to reserve and sequester carbon stocks, exaggeration on actual sequestered carbon quantity, unrealistic planting on every bit of availably appropriate land, and overlooking of human motivation and interest as the human heart is a significant source of uncertainty.

3.6 Zero tillage by the farmers

The results showed that zero tillage (ZT) was hardly adapted. The farmers' responses in each state indicated the orderliness of 260 out of 387 in Benue State with the highest (41.5) % of farmers dwelling in Benue east > 250 out of 397 in Niger State having its highest (40) % found in Niger north-south > 126 out of 249 in Ondo State. Their highest (38.9) % was found in the Ikare zone. The Edo State farmers showed "Yes Response" to practising zero tillage with 166 out of 256, and the highest (56.6) % was traced to Edo south. However, the Chi-Square analysis revealed that it was amidst the Ondo State farmers that their responses had no significant (χ = 8.801, p = 0.456 > 0.05) difference (Table 7). The idea of no-till of farmland could not have been highly understood by the farmers who see farming activities as clearing of earth cover and sowing of crops for better performance despite that ZT is an integral idea of agriculture.

Table 6: Tree planting as soil-land management adaptation strategy

Tree Planting		**Benue N140**	**Benue C130**	**Benue E130**	**Total**	**Edo N130**	**Edo C100**	**Edo S170**	**Total**
Yes	Count	85	81	101	267	53	71	114	238
	%	31.8%	30.3%	37.8%	100.0%	22.3%	29.8%	47.9%	100.0%
No	Count	49	34	30	113	58	16	28	102
	%	43.4%	30.1%	26.5%	100.0%	56.9%	15.7%	27.5%	100.0%
Total	Count	134	115	131	380	111	87	142	340
	%	35.2%	31.4%	33.4%	100.0%	34.3%	25.7%	39.9%	100.0%

	Chi-Square Tests for Benue State			Chi-Square Tests for Edo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.002[a]	6	0.014	55.734[a]	6	0.000
Likelihood Ratio	18.572	6	0.005	57.293	6	0.000
Linear-by-Linear Association	7.008	1	0.008	32.572	1	0.000

Tree Planting		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	105	120	81	306	63	1	65	49	178
	%	34.3%	39.2%	26.5%	100.0%	35.4%	.6%	36.5%	27.5%	100.0%
No	Count	15	39	39	93	23	0	19	23	65
	%	16.1%	41.9%	41.9%	100.0%	35.4%	0.0%	29.2%	35.4%	100.0%
Total	Count	120	159	120	399	86	1	84	72	243
	%	30.1%	39.8%	30.1%	100.0%	36.5%	.4%	34.7%	28.4%	100.0%

	Chi-Square Tests for Niger State			Chi-Square Tests for Ondo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.646[a]	2	0.001	4.813[a]	9	0.850
Likelihood Ratio	14.374	2	0.001	5.243	9	0.813
Linear-by-Linear Association	13.393	1	0.000	.494	1	0.482

The farmers did not view it genuine to leave land untilled between harvest of the previous crops and period of sowing new crops. Consideration of the farmers to hardly practise ZT might corroborate the observations of Prieur (2016), who bolstered that no-till farming practice requires accurate tests of carbon deposits at the subsoil, cover crop to improve soil health by returning carbon into the soil thereby increasing crop yield, application of more herbicide to hinder land cover and weeds from competing for available soil nutrients, and previous cover crops might require additional pesticides to be removed. The author still highlighted benefits of the ZT that are not limited to the potential to minimize climate change impacts, decrease the soil system evaporation peculiar to extreme droughts or flooding, and increase moisture to the plants' roots which are shorter and closer to the surface. Before that, Mangalassery *et al.* (2015) outlined the importance of ZT to include reduction of runoff, enhancement of water retention and prevention of soil erosion, conservation and enhancement of soil organic matter levels sequestrations of carbon in both top and sub-layers of soil. However, breaking up the soil and removing the land cover to sow seeds release carbon and nitrogen, which, when combined with oxygen, release climate change driving criteria air:

Table 7: Zero tillage as soil-land management adaptation strategy

Zero Tillage		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	34	70	23	127	64	8	94	166
	%	26.8%	55.1%	18.1%	100.0%	38.6%	4.8%	56.6%	100.0%
No	Count	101	51	108	260	65	2	23	90
	%	38.8%	19.6%	41.5%	100.0%	72.2%	2.2%	25.6%	100.0%
Total	Count	135	121	131	387	129	10	117	256
	%	35.0%	31.7%	33.2%	100.0%	50.0%	3.8%	46.2%	100.0%

	Chi-Square Tests for Benue State			Chi-Square Tests for Edo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	56.768[a]	6	0.000	28.899[a]	6	0.000
Likelihood Ratio	58.222	6	0.000	30.451	6	0.000
Linear-by-Linear Association	0.501	1	0.479	15.610	1	0.000

Zero Tillage		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	18	82	47	147	47	0	39	37	123
	%	12.2%	55.8%	32.0%	100.0%	38.2%	0.0%	31.7%	30.1%	100.0%
No	Count	100	77	73	250	49	1	46	30	126
	%	40.0%	30.8%	29.2%	100.0%	38.9%	0.8%	36.5%	23.8%	100.0%
Total	Count	118	159	120	397	96	1	85	67	249
	%	30.1%	39.8%	30.1%	100.0%	36.7%	0.4%	35.2%	27.8%	100.0%

	Chi-Square Tests for Niger State			Chi-Square Tests for Ondo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.119[a]	4	0.000	8.801[a]	9	0.456
Likelihood Ratio	46.422	4	0.000	9.743	9	0.372
Linear-by-Linear Association	16.548	1	0.000	1.431	1	0.232

NH_3, N_2O and CO_2. Non-removal of disturbing competitors on the farmlands could be achieved by spraying with herbicides, spreading appropriate mulching, and retaining stubble for erosion control (ESE, 2013).

4.0 Conclusion

The research concluded that farmland size in Benue and Ondo was mostly three plots while farmers in Edo and Niger cultivate on two plots of land. There was a significant ($p < 0.05$) difference in their choice of response from the Chi-Square test, indicating that different policies could work on the reason of land acquisition in each state. A higher number of farmers adapted soil management techniques in Benue and Ondo. Farmers' decisions differed ($p < 0.05$) on whether or not to manage the soil. All the farmers addressed land degradation as peculiar to them in each state because the Chi-Square test showed a significant ($p < 0.05$) difference in the farmers' responses.

Application of organic fertilizers was hardly embraced across the study states except in Benue; the Chi-Square tests indicated no significant ($\chi = 14.413$, $p = 0.108 > 0.05$) difference in the Ondo State farmers' response, and their decisions seemed to be alike which could be assisted with the same agricultural policy. All the farmers were observed to plant trees on their farmland, perhaps because of the accepted knowledge of the importance of trees as windbreakers and erosion buffer. However, the farmers' responses differed except in Ondo State ($\chi = 4.813$, $p = 0.850 > 0.05$). However, zero tillage was hardly practised except in Edo State, and the farmers in Ondo State had no significant ($\chi = 4.813$, $p = 0.850 > 0.05$) difference in their responses in not using zero tillage.

Farmers' responses on farmland size, soil management techniques and addressing land degradation were significantly ($p < 0.05$) different throughout the four study states, indicating that different decisions and agricultural policies have to be adapted for them. Fertilizer application was common in Benue State but not different in Ondo State farmers' responses, tree planting was embraced across the states, and Ondo State had the same reason. Edo State farmers practised zero tillage while Ondo State farmers had the same reason not to practice it. Therefore, the investigation deduced that states with significantly different responses would require different agricultural policies and adaptation strategies to abate and ameliorate the effects of climate change on such states.

5.0. Acknowledgements

I am expressing deep gratitude to the World Bank for the research grant given to me, Adeleke Taofik TOWOLAWI (Matriculation Number: PG 09/ 0181) as a 3rd Cohort and PhD Student in the Environmental Systems & Climate Change programme. I am extending unquantifiable appreciation to the Director of the Centre of Agricultural Development and Sustainable Environment (CEADESE), Prof. O. D. Akinyemi, and my Programme Leader: Prof. O. S. Awokola. For my data coding and analyses, I thank Olaide Khadijat, Qanita Rooreromi and Yasir Ooreoluwa.

Funding: This work was supported by the World Bank [grant number: PG09/ 0181] that sponsors the CEADESE in the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

References

Ahmed, F., Rahman, M.A., Jaahn, M.A.H.S., Ahmed, M., Khayer, M.A. 2006. Effect of different planting systems in maize/ spinach-red amaranth intercropping. Bangladesh Journal of Agriculture and Environment 2 (2), 69-79.

Amujoyegbe, B.J. 2012. Farming system analysis of two agro-ecological zones of Southwestern Nigeria. Agricultural Science Research Journal 2(1), 13–19.

Bada, B.S., Towolawi, A.T., Akinsola, O.E., Arowolo, M.N., Odufuye, A.O., Adeleke, O.S., Oguntade, M.A. 2019. Qualitative assessment of six-animal dungs in University Teaching and Research Farm. FUTY Journal of the Environment 13(2), 29-43.

Benbrook, C., Zhao, X., Yáñez, J., Davies, N., Andrews, P. 2008. New evidence confirms the nutritional superiority of plant-based organic foods. https://organic-center.org/reportfiles/ Nutrient_Content_SSR_Executive_Summary_FINAL.pdf. 8 pp (accessed 26 February 2020.

Briones, R.M. 2010. Addressing land degradation: benefits, costs, and policy directions. Philippines Journals of Development 37(1), 41-79.

Buis, A. 2019. Examining the viability of planting trees to help mitigate climate change. NASA's Jet Propulsion Laboratory. Global climate change. vital signs of the Planet. https://climate.nasa.gov/news/2927/examining-the-viability-of-planting-trees-to-help-mitigate-climate-change/ (accessed 26 February 2020).

Carrington, D. 2019. Tree planting has mind-blowing potential to tackle the climate crisis. Greenhouse gas emission. The Guardian. https://www.theguardian.com/environment/2019/ Jul/04/ planting-billions-trees-best-tackle-climate-crisis-scientists-canopy-emissions (accessed 26 February 2020).

Cochran, W.G. 1977. Sampling Techniques (3rd ed.). John Wiley Sons, New York

Deugd M., Röling, N., Smaling, E.M.A. 1998. A new praxeology for integrated nutrient management, facilitating innovation with and by farmers. Agriculture, Ecosystems and Environment 71(1-3), 271–285.

Eghball, B. 2002. Soil properties as influenced by phosphorus- and nitrogen-based manure and compost applications. Agronomy Journal 94, 128–135.

ESE (Eurostat Statistical Explained), 2013. FAO - soil tillage in Africa: needs and challenges 1993 - Chapter 8 Conservation Tillage for Increased Crop Production. https://ec.europa.eu/eurostat/statistics-explained/ index.php/Glossary:Zero_tillage (accessed 26 February 2020).

Eswaran, H., Lal, R., Reich, P.F. 2001. Land Degradation: An Overview. *In:* Bridges, E.M., Hannam, I.D., Oldeman, L.R., Pening de Vries, F.W.T., Scherr, S.J., Sompatpanit, S. (edn). Responses to Land Degradation. Proceedings of 2nd International Conference on Land Degradation and Desertification, Khon Kaen, Thailand. Oxford Press, New Delhi, India.

Eurostat 2014. Farm structure survey. Structure of agricultural holdings 2007. European Communities, Luxembourg. *In*: Walter. JGG 2018. The adequacy of measures of gender roles attitudes: a review of current measures in omnibus surveys. Quality & Quantity. International Journal of Methodology 52, 829–848.

FAO and IFA 2000. zFertilizers and Their Use. 4th eds. Food and Agriculture Organization of the United Nations and International Fertilizer Industry Association, Rome, Italy.

Farris, A.Y.O., Achille, E.A., Yvonne, B., Brice, S. 2014. Ecological factors influencing physical soil degradation in the Atacora Mountain Chain in Benin, West Africa. Mountain Research and Development 34(2), 157-166.

FFP 2016. Four Factors of Production: Land, Labor, Capital and Entrepreneurship 2016. Retrieved from https://study.com/academy/lesson/four-factors-of-production-land-labor-capital-entrepreneurship.html (accessed 03 July 2021).

Flavelle, C. 2019. Climate Change Threatens the World's Food Supply, United Nations Warns. Climate and Environment. The New York Times. 08 August 2019. Available at https://www.nytimes.com/2019/08/08/ climate/climate-change-food-supply.html (accessed 03 July 2021).

Gbonegun, V. 2017. Farmers Seek Government Intervention for Land Acquisition. Business Agro. 05 February 2017. https://guardian.ng/features/farmers-seek-government-intervention-for-land- acquisition/ (accessed 03 July 2021).

Isaac, B., Timothy, O., Ojo, AOO 2019. Land Acquisition and Use in Nigeria: Implications for Sustainable Food and Livelihood Security, Land Use - Assessing the Past, Envisioning the Future. Luís Carlos Loures, IntechOpen, DOI: 10.5772/intechopen.79997.

Janovska, V., Simova, P., Vlasak, J., Sklenicka, P. 2017. Factors affecting farm size on the European level and the national level of the Czech Republic. Agricultural Economics – Czech 63 (1), 1–12.

Latruffe, L., Dupuy, A., Desjeux, Y. 2013. What Would Farmers' Strategies be in a no-CAP Situation? An Illustration from Two Regions in France. Journal of Rural Studies 32, 10–25.

MACOS Urban Management Consultants (2021). https://macosconsultancy.com/Lists%20of%20Nigerian%20State%20by%20Landmass%20and%20Population%20Densityyy.html (accessed 26 August 2021).

Mangalassery, S., Sjögersten, S., Sparkes, D.L., Mooney, S.J. 2015. Examining the potential for climate change mitigation from zero tillage. The Journal of Agricultural Science 153(7), 1151-1173.

Mueller, E.N., Wainwright, J., Parsons, A.J., Turnbull, L. (ed.) 2014. Patterns of Land Degradation in Drylands. Understanding Self-Organized Ecogeomorphic Systems, Springer Netherlands. 389 pp. DOI: 10.1007/978-94-007-5727-1.

Muilis, S. 2019. Five (5) Things to know about fighting climate change by planting trees. Debate breaks out over whether the climate-saving potential of tree planting was exaggerated. Climate. Science News, Independent Journalism since 1921. https://www.sciencenews.org/ article/controversy-fighting-climate-change-planting-trees (accessed 26 February 2020).

Nwocha, M.E. 2016. Impact of the Nigerian land use act on economic development in the country. *Acta Universitatis Danubius. Administratio,* 8(2): http://89.136.240.76/index.php/administratio/article/ view/3976/3876 (accessed 15 May 2021).

Penn State Extension 2017. Managing soil health: concepts and practices. Agroecology in practice. Cooperative Extension, College of Agricultural Sciences. The Pennsylvania University. https://extension.psu.edu/ managing-soil-health-concepts-and-practices (accessed 25 February 2021).

Prieur, D. 2016. Could No-Till Farming Reverse Climate Change? Tilling Farmland Increases Carbon dioxide Emissions, but Not Tilling may not Work for Every Farm. USS News and World Reports. https://www.usnews.com/news/articles/2016-08-04/could-no-till-farming-reverse-climate-change (accessed 27

February 2020).

Singh, R.B., Woodhead, T., Papademetriou, M.K. 2002. Strategies to sustain and enhance Asia-Pacific rice production. *In* Dat Van Tran (ed.), sustainable rice production for food security: Proceedings of the 20th Session of the International Rice Commission, Bangkok, 23–26 July. http://www.fao.org/3/Y4751E/y4751e00.htm. Food and Agriculture Organization of the United Nations, Rome.

UNCCD (United Nations Convention to Combat Desertification) 2012. Zero Net Land Degradation. A Sustainable Development Goal for Rio+20 to Secure the Contribution of Our Planet's Land and Soil to Sustainable Development, including Food Security and Poverty Eradication. UNCCD Secretariat Policy Brief. https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=526&menu=35 (accessed 26 February 2020).

UNEP (United Nations Environment Programme), 2017. Addressing Land Degradation is Good for Your Health. Climate Change. https://www.unenvironment.org/news-and-stories/story/addressing-land-degradation-good-your-health (accessed 25 February 2020.

UNEP (United Nations Environment Programme), (2021). SDG 15: Life on Land. https://www.unep.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-15 (accessed 03 July 2021).

White, P.J., Crawford, J.W., Dıaź Alvarez, M.C., Moreno, R.G. 2012. Soil management for sustainable agriculture. Hindawi Publishing Corporation. Applied and Environmental Soil Science, Article ID 850739, 3pp. DOI: 10.1155/2012/850739.

World Bank (2008). Agriculture for Development: World Development Report 2008. The International Bank for Reconstruction and Development/ World Bank. Washington DC 20433. https://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf (accessed 26 February 2020).