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Adaptation Practices Among Arable Crop Farmers Against Perceived Effects of Climate Change in Rural Southwestern Nigeria

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Abstract

The way farmers perceived their environment dictates how they practice agriculture and by extension, type of adaptation measure to undertake in mitigating the effects of climate change on their crops. Therefore, the study examined the adaptation practices being employed by farmers to mitigate the perceived effects of climate change on selected arable crops in Rural Southwestern Nigeria. The specific objectives were to: identify sources of agricultural information; determine awareness of climate change by arable crop farmers; determine the perceived effects of climate parameters on selected arable crops; and identify adaptation measures employed to mitigate the perceived effects of climate change on arable crops in the study area. The only hypothesis was that there was no significant relationship between adaptation measures employed by farmers and perceived effects of climate change on selected arable crops. Multistage sampling technique was used in selecting 350 arable crop farmers.

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The results revealed that 97.4% of the respondents were aware that climate was changing and that arable crops were almost uniformly affected unfavourably by rainfall while 98.8% never insured their farms against climate change. The odd ratio of logistic regression revealed that planting different crops (7.23); employing tillage methods such as ridging, terracing, use of compost (2.74); use of mulching (0.42) and farming combined with non-farming activities (2.51) were significantly related to perceived effects of climate change on selected arable crops, all at $p \leq 0.05$ level. It was recommended that farmers should adopt planting of their arable crops sequentially. Extension services must be invigorated to persuade farmers to use early maturing and drought resistance planting materials.

Keywords: Adaptation; practices; farmers; climate change; perceived effects; arable crops.

1. Introduction

Odewumi, Awoyemi, Iwara and Ogundele [1] had opined that it has been recognized that people make decisions in their environment not the way the environment is but the way they perceived it. In addition, the perceptions of farmers have the tendency of influencing the coping strategies which ultimately determine the extent to which climate affects agriculture [2]. However, the issue of climate change is particularly important considering the fact that agriculture constitutes the mainstay of about 60 - 70% of the Nigerian populace [3]. Furthermore, [4] had asserted that continued dependence of agricultural production on sunlight, heat, water and other climatic factors, the dependent of much of the world's population on agricultural activities, the significant magnitude and rapid rates of possible climate change, all combine to create the need for a comprehensive consideration of the potential impacts of climate on global agriculture. Therefore, this study had examined adaptation practices applied to mitigate perceived effects of climate change by arable crop farmers in Southwestern Nigeria. Hence, the specific objectives were to:

1. identify sources of agricultural information in the study area,
2. determine awareness of climate change by arable crop farmers in the study area,
3. determine the perceived effects of climate parameters on arable crops in Southwestern Nigeria, and
4. identify adaptation strategies (measures) employed to mitigate the perceived effects of climate change on arable crops in the study area.

Ho: There is no significant relationship between adaptation measures employed by farmers and perceived effects of climate change on arable crops.

2. Related Work

Various researches have been conducted about the perception of farmers in relation to climate change and its adaptation generally in Africa and particularly in Nigeria. [5] examined farmers' adaptation strategies to climate change and their implication in the Zou Department of South Benin. Their study delved much on the understanding and determining farmers' adaptation choices and long term implication of farmers' adaptation choices in Benin. The main adaptation strategies employed by farmers as mentioned by [5] were crop-livestock diversification, use of improved varieties and agroforestry and perennial plantation. Apata (2016) [6] examined

adaptation strategies to effects of climate change on arable crop production in Southwestern Nigeria where emphasis was laid on the need for determination of perception, by the farmers, the effects of climate change on arable crop production, farmers' socioeconomic characteristics including how climate change affects the cultivation of arable crops and food security generally in Southwestern Nigeria. He concluded that there were visible effects of climate change on arable crop production such as crop yield reduction, pest and disease infestation and extinction of crops. In another dimension, Apata (2008) [7] did another work on the effects of global climate change on Nigerian agriculture as an empirical analysis, in which a simulation for the whole country (Nigeria) was made and modelled scenarios for Nigeria. The scenarios were not segregated into different zones that made up Nigeria but were lumped together which may not effectively reflect the real life situation for Ogun, Oyo and Osun States (Southwestern Nigeria) either collectively or separately. However, the conclusion that climate impact was positive in Southern Nigeria was a generalized statement which in most cases were not usually true in the real life situation. Tarfa et. al. (2019) [8] in their study of climate change perception and adaptation in Nigeria's guinea savanna: Empirical evidence from farmers in Nasarawa State, Nigeria. Comparison between trend of meteorological data and pattern of perception of farmers' on climate change were made and analysis of farmers' characteristics including the effects on adaptation choices also investigated. They concluded that farmers' perception reflected the empirical reality and that farmers have attempted some forms of adaptation strategies to cope with climate variability. In view of various studies that had been carried out, there was no work that has specifically investigated adaptation practices among rural arable crop farmers against perceived effects of climate change in Ogun, Oyo and Osun States of Southwestern Nigeria. Also, our study had focused primarily on effects of climate change and adaptation on sampled crops from each group of arable crops such that cassava represented tubers, maize represented cereals and tomatoes represented vegetables. Crops of focus (cassava, maize and tomatoes) were copiously cultivated as staple crops that help in maintaining food security in the study area

3. Methodology

The population for the study was all arable crop farmers cultivating maize, yam and tomato in Southwestern States of Nigeria. These crops were randomly selected from their respective groups. Multistage sampling procedure was used in selecting the arable crops farmers across the states in the study area. Firstly, 50 % of the Southwestern states were purposively selected because arable crops cultivation was prevalent in the area. Using Agricultural Development Programme (ADP) delineations in the Southwestern Nigeria, 50% of the zones in each of the chosen States were selected giving six (6) zones out of eleven (11) zones (Ogun State has 4, Osun State has 3 and Oyo State has 4). From the selected zones, 25% of the blocks were randomly selected. From these selected blocks, 50% of the cells were randomly selected. Out of three hundred and fifty two groups in the selected cells, 20% was randomly sampled to give seventy groups. Therefore, 20% of the registered farmers from each group were randomly sampled to give a total of three hundred and fifty (350) arable crops farmers as the respondents for this study.

4. Results and discussion

4.1 Sources of agricultural information

Results in Table 1 revealed that in Southwestern Nigeria, majority (84.3%) of the respondents chose extension agents as the source from where they got agricultural information, particularly on climate change, 72.0 percent chose radio, 51.4 percent chose friends/neighbor and 45.1 percent chose Television as their source of agricultural information. This implies that extension agents and radio were the major sources of agricultural information that were prominently used by the farmers in Southwestern Nigeria. These have been identified as the major means of mass communication that the rural people, mostly, were familiar with. However, it could be due to the fact that these sources were readily accessible to the farmers, relatively cheap to obtain, can be used in places where there is no electricity and they surpass the barrier of illiteracy [5], [6], [7]. Therefore, agricultural extension practitioners should take cognizance of these available and mostly used sources of information utilization when planning to introduce innovations and climate change mitigation practices to the farmers, especially in the rural areas where farming activities are much predominant. However, only 2.6 percent claimed that NGOs was their source of agricultural information in Southwestern Nigeria. This implies that activities of NGOs were very low in the study area.

Table 1: Sources of agricultural information in Southwestern Nigeria

Sources of agricultural information*	Frequency	%
Extension agents	295	84.3
Friends/neighbours	180	51.4
Radio	252	72.0
Television	158	45.1
Internet	23	6.6
NGOs	9	2.6
Newspapers	46	13.1
Mobile phones	31	8.9

* Multiple responses

Source: Field Survey, 2018

4.2 Awareness on climate change by arable crop farmers

Table 2 depicted the result of respondents' awareness of climate change in Southwestern Nigeria. Majority (97.4%) were aware that climate was changing. This is supported by the findings of [1] that the respondents were of the opinion that climate is changing and the variability in the climatic conditions have become more pronounced in recent years. However, being aware of climate change is very germane in agriculture especially in arable crop production as the awareness would trigger guide on how to mitigate the effects of climate change appropriately and effectively. Adepoju, Ezekiel and Olapade-Ogunwole [8] had reported in their findings that virtually all the sampled farmers in their study were aware of climate change and this knowledge of climate change would help the farmers in knowing the adaptation strategies to employ. This is also supported by the findings of [9] that majority of the members of the communities investigated were aware of climate variability.

Table 2: Distribution of respondents by awareness of climate change

	Frequency	*%*
Awareness	341	97.4

Source: Field Survey, 2018

4.3 Perceived effects of climate parameters by arable crop farmers

Table 3 showed the results of perceived effects of climate parameters on selected arable crops in Southwestern Nigeria. It was revealed that 72.3 percent of the respondents perceived that sun intensity/temperature has, highly unfavourable effects on their maize. However, 22.0 percent and 5.7 percent of the respondents perceived sun intensity/temperature as having moderately unfavourable effects and no effects on maize, respectively. Also, 81.1 percent, 16.6 percent, and 2.3 percent perceived the effects of sun intensity/temperature on their yam as being highly unfavourable, moderately unfavourable and no effects on their yam, respectively. Furthermore, 74.9 percent, 23.1 percent, and 2.0 percent perceived the effects of sun intensity/temperature as highly unfavourable, moderately unfavourable and no effect on their tomatoes, respectively. This alludes to the fact that heat stress was negatively affecting arable crops in the study area. This was corroborated by (10) that heat stress might affect the whole physiological development, maturation and yield of cultivated crops when temperature exceed optimal level for biological processes of which crops often respond negatively. Data in the Table further revealed that 75.7 percent, 22.9 percent perceived the effects of rainfall as being highly unfavourable and moderately unfavourable while only 1.4 percent perceived rainfall as having no effect on their maize. It was further revealed that 69.1 percent, 28.0 percent perceived rainfall as being highly unfavourable and moderately unfavourable but only 2.9 percent perceived rainfall as having no effect on their yam. However, 76.0 percent as well as 20.9 percent perceived rainfall as having highly unfavourable effects and moderately unfavourable effects on tomatoes, respectively while 3.1 percent of the respondents perceived rainfall as having no effect on their tomatoes. This implies that arable crops were almost uniformly affected unfavourably by rainfall in the study area. Furthermore, 66.7 percent, 31.4 percent of the respondents perceived the effect of wind as being highly unfavourable and moderately unfavourable on maize, respectively while 2.0 percent perceive wind as having no effect on maize. Also, 16.6 percent and 19.1 percent perceived the effects of wind as being highly unfavourable and moderately unfavourable on yam, respectively and 64.3 percent perceived wind as having no effect on yam. However, 1.4 percent and 35.5 percent perceived the effects of wind on tomatoes as being highly unfavourable and moderately unfavourable on their tomatoes, respectively while 63.1 percent perceived wind as having no effect on tomatoes. The finding, therefore, revealed that wind was perceived mostly to have unfavourably affected maize but did not have much effect on yam and tomato. This is noticed when wind caused the maize stem to break or lodge as a result of high wind velocity. This is in line with Edmond (11) that strong winds can cause lodging or toppling. However, lodging is a very common effect of wind with high velocity. This implies that, generally, sun intensity/temperature and rainfall were the major climate parameters that were perceived as unfavourably affecting arable crops as a result of inclement weather in Southwestern Nigeria. This was supported by (12) that delay in rainfall commencement and high

temperatures result in stunted growth and eventual death of some young plants.

Table 3: Distribution of respondents by perceived effects of climate parameters on selected arable crops in Southwestern Nigeria1

Climate parameters	Highly unfavourable		Moderately unfavourable		No effect	
	Frequency	*%*	*Frequency*	*%*	*Frequency*	*%*
Sun intensity/ temperature:						
Maize	253	72.3	77	22.0	20	5.7
Yam	284	81.1	58	16.6	8	2.3
Tomatoes	262	74.9	81	23.1	7	2.0
Rainfall:						
Maize	265	75.7	80	22.9	5	1.4
Yam	242	69.1	98	28.0	10	2.9
Tomatoes	266	76.0	73	20.9	11	3.1
Wind:						
Maize	233	66.6	110	31.4	7	2.0
Yam	58	16.6	67	19.1	225	64.3
Tomatoes	5	1.4	124	35.5	221	63.1

Source: Field Survey, 2018

4.4 Categorization of farmers' by perceived effects of climate change on arable crops

Table 4: Categorization of farmers' perceived effects of climate change on selected arable crops in Southwestern Nigeria

Categories of perceived effect score	*Range of scores*	*Frequency*	*Percentage*
Favourable effect $\leq (\bar{X}$- Sd)	(14 - 28)	**77**	22.0
Unfavourable effect $> (\bar{X}$- Sd)	(29 – 45)	273	78.0

Mean ($\bar{X}$) = 35.3, Sd = 7.6

Source: Field Survey, 2018

Table 4 showed the categorization of the respondents according to how they perceived the effects of climate change on arable crops in Southwestern Nigeria. It was revealed that majority (78.0%) of the respondents claimed that effects of climate change on arable crops were unfavourable. This study therefore affirmed that the effect of climate change was well perceived and as such the change has unfavourable effects on arable crops. It is then worrisome that arable crops are negatively affected because majority of the rural farmers may lack the capacity to grapple with the effects of climate change. According to (15) most adverse effects will be felt mainly by developing countries, especially those in Africa due to their low level of coping capabilities. Interestingly, Nigeria is in Africa and by extension, among the developing countries that are seriously experiencing the negative effects of climate change. Therefore, efforts towards adapting to these unfavourable effects on crops in order to ensure food security of our nation must be vigorously pursued by all stakeholders. In the drive to

achieve this pursuit, farmers had to make some adjustments to cope and re-align with new situation imposed by climate change. This could be achieved by farmers adopting appropriate adaptation options and this may involve change in production pattern in order to completely or partially adjust to new condition.

4.5 Adaptation practices to cope with climate change

Table 5 revealed that, in Southwestern Nigeria, majority (98.9%) of the respondents always applied various tillage methods such as ridging, terracing, using compost as measures to counter the effect of climate change. This is soil management and improvement which had formed part of age-long agronomic practices that helps soil to increase its capacity to hold more water. The soil with high capacity to hold water will support crops to perform well. This type of soil may assist crops to withstand water stress for some time during dry spell. Also, 91.7 percent always combined farming with non-farming activities in order to assuage the effect of climate change. This implies that there were other income generating activities being undertaken by the farmers to cushion the impoverishment that might arise due to reduction in yields of their crops as the effect of climate change. This yield loss impact might have reduced the expected economic gains from crop yields thereby reducing their standard of living. However, (13) asserted that poverty reduction is strongly linked to the ability of rural people to diversify and complement their often meager agricultural based sources of income through non-farm activities. They concluded that non-agricultural activities are not a step for leaving agriculture but rather a search for additional income to be able to continue the farming activities. That is, if eventually, there was crop failure as a result of climate change, incomes from non-farm activities would compensate for the loss that would have been experienced. Therefore, such farmers will not be forced out of farming completely. About 87.4 percent always plant different crops as a coping strategy against climate change. This helps to reduce the harsh economic effect that climate change could have unleashed on the farmers as failure of one crop would be compensated for by the other crops that might not be affected by climate change. Majority (98.0%) of the respondents never planted at different dates. This implies that each farmer, in the study area, always plant crops almost at the same time especially at the on-set of rain, which could be a “false start of rain”. They never staggered their cropping pattern. This could result in a devastating effect because if there was weather disruption, all the crops planted at the same time would be badly affected. Therefore, there is a need for the farmers to plant their crops in sequence because staggered planting of crops can reduce the yield loss as climate change may not equally affect the staggeredly planted crops. However, 86.7 percent never applied irrigation on their farms which could be that irrigation technology was costly, complex or sophisticated for the farmers thereby not within the reach of resource poor farmers. Also, 98.8 percent of the respondents in southwestern Nigeria never insured their farms against climate change. This is a dangerous trend because farmers that insured their farms against climate change can get relief when harsh weather destroy crops as against those who did not insure their farms. Maybe, the farmers were unaware or totally ignorant of the benefits that could accrue to them by insuring their farms against unforeseen situations like climate change that could devastate their farms. However, most respondents never planted: early maturing varieties (83.7%); pests and diseases resistance varieties (82.3%); crops more adaptable to new climate situation (77.3%) and drought resistance varieties (76.3%). This implies that most of the farmers in Southwestern Nigeria were not used to using technology-based practices like planting improved crops varieties and management practices as part of their adaptation strategies. This was supported by (14) that the system of food production comprised small uneconomical production unit,

predominance of primitive techniques, limited use of biological and chemical technology. However, maybe the farmers were not aware of these improved technologies or did not know where to get them. Therefore, agricultural extension practitioners have a lot to do as far as extension delivery of these improved practices are concerned. Table 5 further explained (by ranking) various adaptation measures being employed by arable crop farmers to mitigate the effects of climate change. It was revealed that employing tillage methods such as ridging, terracing, use of compost was ranked 1st; planting different crops ranked 2nd farming combined with non-farming activities ranked 3rd. The practices that had weighted mean score (WMS) of less than 1.50 were not always employed as adaptation measure to mitigate the effect of climate change. However, practices that had WMS of 1.50 and above were those frequently and strongly employed since the maximum WMS was 3.0. Therefore, practices such as planting drought resistant varieties was ranked 7th; planting pests and diseases resistant varieties which ranked 8th; planting early maturing varieties that ranked 9th; planting crops more adaptable to new climate situation was ranked 10th; insure your farm ranked 11th; planting at different dates that was ranked 12th application of irrigation which ranked 13th were the least employed adaptation options by the respondents as mitigating mechanisms to climate change in Southwestern Nigeria. It was observed that all these adaptation measures being employed by the farmers, to counter the effect of climate change, were the already known (traditional) agronomic practices which had been used over many years. Despite the fact that most of these adaptation options seem not new, those practices that are so critical to climate mitigation but were not usually employed by farmers could be redesigned and re-engineered, by extension practitioners, to become relevant with the modern trend.

Table 5: Distribution of respondents by adaptation practices in Southwestern Nigeria

Adaptation measures	***Always***		***Sometimes***		***Never***			
	Freq	***%***	***Freq***	***%***	***Freq***	***%***	***WMS***	***Ranks***
Planting crops more adaptable to new climate situation	0	0.0	78	22.3	272	77.7	1.22	10th
Application of irrigation	0	0.0	0	0.0	350	100	1.00	13th
Planting early maturing varieties	3	0.9	54	15.4	293	83.7	1.17	9th
Planting different crops (mixed cropping)	306	87.4	37	10.6	7	2.0	2.85	2nd
Planting drought resistance varieties	20	5.7	63	18.0	276	76.3	1.32	7th
Planting pests and diseases resistant varieties	5	1.4	57	16.3	288	82.3	1.19	8th
Employing tillage methods e.g. ridging, terracing, composting	346	98.9	4	1.1	0	0.0	2.99	1st
Planting at different dates	0	0.0	7	2.0	343	98.0	1.02	12th
Alternating seasons for cropping	60	17.1	160	45.7	130	37.2	1.80	6th
Use of mulching	127	36.2	201	57.4	22	6.4	2.30	4th
Combined farming with non-farming activities	321	91.7	29	8.3	0	0.0	2.83	3rd
Insure your farms	3	0.9	1	0.3	346	98.8	1.05	11th
Prayers (spiritual effort)	170	48.6	115	22.8	65	18.6	2.30	4th

Midpoint score: 1.50

Source: Field Survey, 2018

4.6 Hypothesis

The result of logistic regression in Table 6 revealed the existence of significant relationships between some adaptation measures employed by the farmers and perceived effects of climate change on selected arable crops in the study area. The odd ratio of the regression revealed that planting different crops was 7.23; employing tillage methods such as ridging, terracing, use of compost was 2.74; use of mulching was 0.42 and farming combined with non-farming activities was 2.51 were significantly related to perceived effects of climate change on selected arable crops, all at $p \leq 0.05$ level. This implies that the listed adaptation measures were the practices that really seemed to have probability of helping farmers to cope with climate change and were actually perceived as being helpful in alleviating the effects of climate change on their crops.

Table 6: Summary of logistic regression analysis showing the relationships between adaptation measures employed and perceived effects of climate change on selected arable crops

Adaptation measures	***Coefficient***	***P>z***	***Odd ratio***
Planting crops more adaptable to new climate situation	-.2690814	0.408	0.76
Application irrigation	.0640551	0.836	1.07
Planting early maturing varieties	.1031573	0.737	1.12
Planting different crops	1.978835	0.000*	7.23
Planting drought resistant varieties	-.1577429	0.631	0.85
Planting pest and disease resistant varieties	-.2727349	0.335	0.76
Employ tillage methods such as ridging, terracing, composting,	1.009695	0.012*	2.74
Planting at different dates	-1.082472	0.558	0.64
Alternating seasons for cropping	.1188733	0.525	1.13
Use of Mulching	-.8575727	0.046*	0.42
Farming with non-farming activities	.9215007	0.001*	2.51
Insure farms	.0542916	0.846	1.06
Prayers/spiritual efforts	-.3833364	0.139	0.68
Constant	-2.499584	0.013	

Number of obs=350, LR chi-square (7) =18.11, Prob > chi-square = 0.0115, Log likelihood= -191.5162, Pseudo R2=0.0451

* = Significant at 0.05

Source: Field Survey, 2018

Therefore, for these categories of adaptation practices that have significant relationship with farmers' perceived effects of climate change on their arable crops, the null hypothesis is hereby rejected. However, null hypotheses were upheld for the other categories of adaptation practices whose probability of being employed did not show

any significant relationship with perceived effects of climate change. Such adaptation practices were those which the farmers did not usually apply on their farms. Probably, the farmers did not have much information on, or out rightly ignorant about, such adaptation measures and are listed as follows: planting of crops more adaptable to new climate situation; application of irrigation; planting early maturing varieties; planting drought resistant varieties; planting pests and diseases resistance varieties; alternating seasons for cropping; insure farms and prayers/spiritual efforts. It was observed that the practices that showed no relationship with farmers' perceived effect on arable crops were those that were seen as "alien" to the farmers. Most of these "alien" technologies/practices were generated by research institutions and which can help the farmers to adapt to changes in climate but were not seemed to be popular practices among farmers in the study area. Maybe, the awareness was very low or totally lacking about these adaptation measures against climate change. This could be responsible for their non-use by the farmers because the higher the level of farmers' awareness about proven adaptation measures, the more the farmers may likely employ such adaptation measures to mitigate the effects of climate change on their crops. The *a priori* expectation was that when farmers perceived any dangerous trend in climate, they try to make efforts to mitigate the effects by employing adaptation measures to reduce or eliminate such effects from the perceived change. This is supported by (16) that adaptation has potential to significantly contribute to reductions in negative impacts of climate conditions as well as other changing socioeconomic conditions.

5. Conclusion

It was concluded that farmers were aware that there has been manifestation of climate change. They never planted their crops sequentially rather; they always planted most of their crops at the onset of raining season. Adaptation measures such as planting of crops more adaptable to new climate situation; application of irrigation; planting early maturing varieties; planting drought resistant varieties; planting pests and diseases resistance varieties; alternating seasons for cropping and insure farms were least adopted by farmers in the study area. It was hereby recommended that farmers should adopt sequential planting of their various crops. Also, extension services must be intensified so that farmers would adopt agronomic practices such as early maturing and drought resistance planting materials that would help farmers beat the effects of climate change on their arable crops. Extension services should, as a matter of urgency, intensity campaigns to encourage farmers to embrace insuring their farms against crop failure as a result of effect of climate change. However, further research on how the perceived climate effects would affect the socioeconomic status of rural farmers could be investigated in the study area.

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6. Conflict of Interest

We declare that there was no conflict of interest

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Authors Profile

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