Sub-Sahara African Academic Research Publications
December, 2022, Editions

JRATR
Journal of Renewable Agricultural Tech. Research
Vol. 26, No.1, ISSN 2813 – 9650

EFFECTS OF WEATHER VARIABILITY & CHANGE ON CASSAVA AND YAM PRODUCTION IN SOUTH WESTERN NIGERIA

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Abstract
Agriculture remains the main stream of Nigeria economy, contributing over 40% of the country's gross domestic products {GDP}. It is the lead sector for generating income, employment and sustenance for rural dwellers, climate variability and change have adversely affected this sector and the situation is expected to worsen in the future. Unfortunately, there is paucity of information on the effect of climate variability and change on yam and cassava cropping system in south western Nigeria. The objective of the study was to determine the effect of climate variability and changes on cassava and yam production in south western Nigeria. Multi stage purpose sampling techniques was used to select arable farmers.154 and 69 respectively in Oyo and Ekiti states totally 223 selected farmers, a structured questionnaire was administered to elicit information from the respondents. The data were subjected to statistical analysis {p<0.50} were measured on four rating scale, and weighted Mean Score {WMS} was calculated and ranked. Respondents from Oyo and Ekitistates ranked Heavy rainfall as the {1st} , late rainfall, poor yield and low income as {2nd} , pest and disease{5th}, drought and erosion as {6th}, fire{8th}, wind{9th}, cold{10th}, and heat {11th} ranked the least as severity of the risks/hazards of weather variables and changes in the study Areas.

Keyword: Agriculture, Climate change, farmers, production, weather variability &change

INTRODUCTION
According to a student guide of global climatic change (2017), the crops that are grown for food need specific conditions to thrive, which include the right temperature and enough water. Therefore changing climate may have both positive and negative effects on crop grown.

In Africa, particularly in Nigeria; the already altered pattern of rainfall has affected the start of the planting season and resulted in poor yield. Concurrent rise in temperature may amplify evaporation and potential evapo-transpiration, leading to a tendency towards drought indeed; recent studies indicate a 10-25% decrease in precipitation in southern Nigeria since the start of the century.Although projections by IPCC suggested that rainfall in the southern part of Nigeria will increase (IPCC, 2001). However,if this trend persists, Nigeria may be about 50-80% of the 1900 values by 2100 (Adejuwon, 2004). Such period of drought will have a drastic impact upon agricultural output in the region, particularly if there is no forest remaining to act as a buffer during time of food crises. Therefore in the southern Nigeria where the temperature is not that high more heat could help certain crop growth, however in northern Nigeria where temperature is high, more higher temperature can hurt crop growth, thus climatic change will affect agriculture and food supply in so many other ways.

Climate change can make the temperature too high to cultivate certain type of crops and also decrease the quantity of H_2O available for irrigation through drought. Climate change might also cause powerful storms and cause more floods, which in turn can damage crops grown (US EPA, 2016).Changing rainfall patterns and higher temperature can help some kind of pests and weeds to spread to new areas, if the global temperature rises an additional of 3.6^{o}F, corn production in USA is expected to reduce by 10 to 30% (US EPA, 2016).Climate is defined generally as an average weather, climate change and weather are said to be inter coined. There have been observations that show changes in the weather over times indicative of climate change. While the climate change and the weather are closely related, there have been important differences. Thus a common confusion that occurred between climate and weather arises when the scientist are asked about how they can predict climate for as long as 60 years when the weather for a few weeks cannot be predicted. This unpredictability beyond a few days is as a result of the chaotic nature of weather, however projected changes in climate is a much more different and manageable issue.

IPCC (2007) has provided several reports that had assessed the scientific literature on climate change. The IPCC third Assessment Report, published in 2001, concluded that the poorest regions and countries would be the hardest hit with reduction in crop yield. Reduction in water availability and unexpected insect pest occurrence or a changed insect pest prevalence has been a major problem in most tropical and sub-tropical regions. In Africa and Latin America many crops that are rain fed are close to their maximum temperature limit, so even a little change in climate can affect the yields; falls in Agriculture yield over the 21st century are expected to be up to 30%. There will also be a significant effect on Marine life and the fishing industry in some regions. When climate change is induced by increase in greenhouse gases, crops are likely to be affected differently from areas to areas. For example, the average crop yieldin Pakistan is expected to fall down to about 50%.However, in Europecorn production is expected to rise up to 25% in optimal hydrologic conditions (IPCC, 2007). More favourable effects on

yield have a tendency to rely to a larger extent on realizations of the beneficial effects of water use efficiency and the benefits of CO_2 on the growth of crop. Yield would most likely decline due to the dwindling water availability, reduction in the growing period, and poor vernalization (IPCC, 2007).

On a longer run, agriculture could be affected in several ways due to climate change. i.e

- Productivity; in terms of the quality and quantity of cultivated crops
- Agricultural practices; through changes in water use(irrigation) and usage of agricultural inputs such as fertilizers, herbicides and insecticide,
- Environmental effects; this is particularly in relation to the frequency and the intensity of soil drainage (which leads to nitrogen leaching), soil erosion, reduction of crop diversity
- Rural lands; through the increase and decrease of agricultural lands, land speculations, land repudiation and hydraulic amenities.
- Adaptation; organizations may become less competitive and there might be an urgency from human to develop organisms with competitive advantages.e.g varieties of rice that are flood or salt resistant. (IPCC, 2007)

They are large uncertainties to uncover, particularly because there is lack of information on many specific local regions and include the uncertainties on magnitude of climate change, effects of technological changes on productivity, global demands and the numerous possibilities of adaptation (IPCC, 2007).

Most agronomists believed that the severity and speed of climate change is an important factor that affects agricultural production. A rapid climate change could harm agriculture however a gradual climate change might give enough room for biota adjustment. This harm could be greaterin countriesthat are already suffering from poor soil and climatic conditions, because there is less time for optimum natural selections and adaptations. Facts about how climate change may exactly affect farming and food security remains relatively inadequate partly because the effects of farmer behaviour are poorly capture by crop climate models.

A number of researchconducted by a researcher at the University of Guelph in Ontario, Canada showed that whether a drought has a significant or insignificant impact on crop production is largely dependent on the socio economic context of farming. Sometimes, minor droughts might have significanteffects on food security as was the case in Ethiopia in the early 1980s when a minor drought resulted in a massive famine versus as against cases where major weather related issues were easily adapted to without causing much hardship (Fraser, 2007). The studies by Evan Fraser combined socio economic models alongside climatic models to categorize “vulnerable hotspots” (EVA *et al.*, 2012).

However, other studies relied on projections of important agro metrological or agro climatic indices, such as growing season duration, heat stress on plant, or initiation of field operations identified by stakeholders in land management and that provide important information on mechanisms that drive climate change effects on agriculture

(Harding*et al.*, 2015; Monier*et al.*, 2016). Maize production in the United Stateshas been identified by some studies as mainly vulnerable to climate change because it is usually be exposed to the worse drought while farmers do not have the socio economic conditions that will help them adapt to these changing condition (Fraser*et al.*, 2013).
Climate is the mean atmospheric condition of a place over a long period of time say 35 years, which dependent on the interaction between atmospheric element, elevation above main sea level and human factors {HLPE} 2012. Climate variability expresses the variations in the mean state of climate in time scales limited seasons, yearly, a few decades, unlike in the case of climate change which persists for an extended period {Fraser et al.2013}. Climate variability plays a significant role in the performance of agricultural production {Adejuwon, 2004}. Important climatic elements for crop growth and yield include water {rainfall}, temperature, solar radiation. Thus relationship between weather variability and agricultural activities has attracted multiple interest from the scholar's {CCE, 2019}, as a result of the depending of agricultural activities on the weather variability of a region, thus the effects of weather variability and changes on agriculture on manifest negatively or positively {Adejuwon,2004 }. Though it is speculatedthat variability in climate and weather events may affect agricultural productivity and livelihood, especially in the developing economic like Nigeria where farmers depends majorly on agriculture which is climate sensitive for their living, making them valuable to climate change effects {Adejuwon 2004}. The international panel on climate change {IPPC, 2007} says that many African countries including Nigeria are likely to be severely affected by weather variation and changes in food crop production.
Cassava and yam are annual tuber and monocot plants.

MATERIALS AND METHODS.

Study Area

The study was carried out in Oyo and Ekiti states, south western Nigeria. These two States lies between latitude 6.00^0N and 9.00^0N, Longitude 2.00^0E and 7.00^0E. The Agro climatic conditions in the two States favours the cultivation of crops like maize, yam, cassava, rice, plantains, cocoa, palm produce and cashew. Agriculture has been the backbone of these two states, providing income and employment opportunities for over 70% of the rural population (http://geographic.org.2019).

SAMPLING PROCEDURE AND SAMPLING SIZE.

Multi- stage sampling methods was used in selection of the respondents for the study. **In the first stage, involved selection of two States out of the six States in the South West Nigeria Ekiti and Oyo were randomly selected.*At the second stage 12% local government areas (LGAs) were selected from each of the two States.* The LGA selected were purely rural with high concentration of arable crop farmers. During the third stage 1% of the village in each local government were randomly selected,**

thereafter, 15% of arable crop farmers in the states were randomly selected in each village which constitutes the sample size of the study. Purposive sampling technique was used in selecting the respondents in the study areas with the assistance of the extension agents in each LGA who recognised the registered arable crop farmers and questionnaire were used to elicit information from the farmers.

Data Analysis

Data collected were subjected to Statistical Analysis [P<0.05], Percentage measured on four rating scale, very severe (3); severe (2); mild (1); not severe (0); and Weighted Mean Score{WMS} was calculated around.

Formula for percentage

1. Determine the whole or total amount of what you want to find a percentage for.
2. Divide the number that you wish to find a percentage for.
3. Multiply the value from step two by 100.

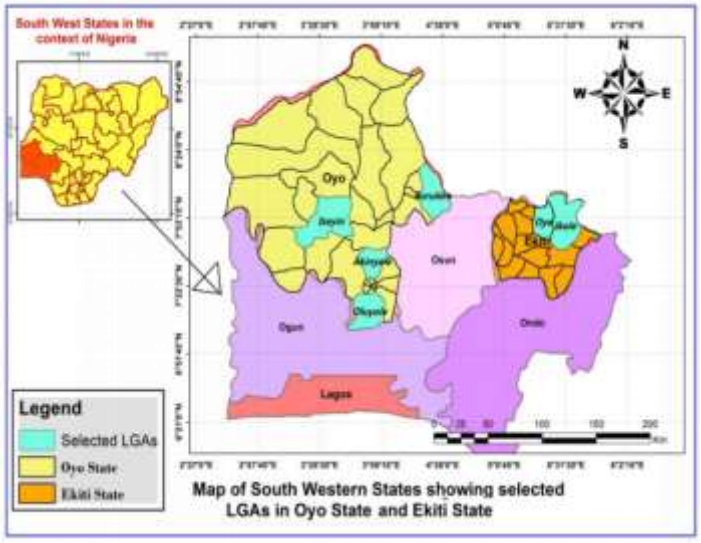
Formula for Weighted Mean Score[WMS] is also known as lited rating.

WMS is arithmetic mean in which some elements at the data set carry more importance than other, both in math and statistics WMS can be calculated by multiplying each value in set by its weight then add up the production and divide the products sum by the sum of weight.

Formula

$$\sum W \times \sum W$$

In other words, multiply each weight W by its matching value X, sum that all up and divide by the sum of weight.



Source: Lautech URP Dept. GIS Lab (2021)

Figure 1: Map showing the selected areas for sampling

RESULTS

Age of respondents

The age distributions of the respondents were 46.1% and 50.7% in Oyo an Ekiti states respectively shown in table 1. Sampled farmers indicated 50yrs and above were majority (47.5%) from the

pooled result. Also, 12%, 18.4% and 22.0% indicated maximum of 30yrs, 31-40yrs and 41-50yrs of age respectively, while the mean age was 51.88years.
In the same table 1, majority (80.3%) of both states farmers sampled were male, while only (19.7%) were female.

Religion of the Respondents
On distribution, 76.0% and 94.2% of the respondents from the both states were Christian, while 23.4% and 5.8% respondents from both states were Muslim. Traditional worshipers were 0.06% in Oyo state alone.

Marital status
Most of the respondents 99.4% and 92.2% from Oyo and Ekiti states respectively were married, while only 0.6% and 5.8% were single from the two states in similar order. (Table 1)

Level of education
The level of education of the respondents presented in (table 1) showed that 35.1% and 8.7% from Oyo and Ekiti states respectively have primary education, 39.0% and 36.% respectively have secondary education, 9.1% and 46.6% have tertiary education respectively, while only 16.9% and 8.7% respectively do not have formal education.

Household size
The household size revealed that more than half (52.6%) from Oyo and 42.0% from Ekiti indicated more than 6persons are their household size. Also 32.5% (Oyo) and 30.4% (Ekiti) had between 4-6 persons as shown in table 1.

Primary occupation
The data obtained showed that 62.3% and 37.2% from Oyo and Ekiti States respectively were engaged in farming as their primary occupation, 37.0% (Oyo) and 36.2% (Ekiti) engaged in trading as primary occupation. However, few 26.1% from Ekiti and 0.6% from Oyo among the respondents indicated artisan as primary occupation as shown in table 1

Year of farming experience
The data obtained showed that ≤10 years of farming experience of the respondents on yam and cassava production, 11% (Oyo), 11.6% (Ekiti), 11 – 20 years 25.3% (Oyo), 31.9% (Ekiti), 21 – 30 years 26% (Oyo), 23.2% (Ekiti), 31 – 40 years 16.9% (Oyo), 14.5% (Ekiti), 41 – 50 years 9.7% (Oyo) 14.5% (Ekiti), greater than 50 years 11% (Oyo) and 4.3% (Ekiti). **Table 1.**
Farm size

From Table 1 more than half of the respondents 57.1% in Oyo and 50.7% in Ekiti had a maximum of ≤ 2 hectares of farmland, 49.3% in Ekiti and 35.1% in Oyo cultivated between 3 – 6 hectares of farmland, furthermore, 5.8% in Oyo and 0% in Ekiti cultivated between 7 – 10 hectares, 0.9% in Oyo and 0% in Ekiti cultivated more than 10 hectares of farmland

Table 1: Distribution of respondents by age, sex, religion, marital status and educational level in Oyo and Ekiti states

SAMPLED STATES (Percentages)			
Socio-economic variables	**Oyo (n = 69)**	**Ekiti (n = 31)**	**pooled (n = 100)**
Age (years)			
<30	11.0	14.5	12.0
31-40	22. 1	10.1	18.4
41-50	20.7	24.6	22.0
>50	46.1	50.7	47.5
Sex			
Male	87.7	63.8	80.3
Female	12.3	36.2	19.7
Religion			
Christianity	76.0	94.2	81.6
Islam	23.4	5.8	17.9
Traditional	0.6		0.4
Marital status			
Married	99.4	94.2	97.8
Single	0.6	5.8	2.2
Level of education			
No formal	16.9	8.7	14.3
Primary	35.1	8.7	26.9
Secondary	39.0	36.2	38.1
Tertiary	9.1	46.4	20.6
Household size			
<3	14.9	27.5	18.8
4-6	32.5	30.4	31.8
>6	52.6	42.0	49.3
Primary occupation			
Farming	62.3	37.2	18.8
Trading	37.0	36.2	36.8
Artisan	0.6	26.1	8.5
Years of farming experience			
<10	11.0	11.6	11.2

11-20	25.3	31.9	27.4
21-30	26.0	23.2	25.1
31-40	16.9	14.5	16.1
41-50	9.7	14.5	11.2
>50	11.0	4.3	9.0
Farm size			
<2	57.1	50.7	55.2
3-6	35.1	49.3	39.5
7-10	5.8	-	4.0
>10	1.9	-	1.3
Total	**100.0**	**100.0**	**100.0**

Level of severity of the risks/hazards of climate variability

Four rating scale of very severe (3); severe (2); mild (1) and not severe (0) respectively were employed. Again Weighted Mean Score (WMS) was computed and ranked as well. The results in Table 2revealed that heavy rainfall had the highest WMS of 2.93 and was ranked 1st, followed by low income, poor yield and late rainfall all had 2.91 WMS each and were ranked 2nd. Pest and diseases, drought and erosion with respective WMS of 2.89 and 2.88 each were ranked 5th and 6thin that order. Also fire (WMS = 2.85), wind (WMS = 2.75), cold (WMS = 2.13) and heat (WMS = 0.35) were ranked low (8th, 9th, 10th and 11th) (Table 2).

Table 2: Distribution of respondents by level of severity of the risks/hazards of climate variables and changesin the study area

	Level of severity (Percentage)					
Risks/hazards	**Very severe**	**Severe**	**Mild**	**Not severe**	**WMS**	**Rank**
Heavy rainfall	96.4	0.9	1.8	0.9	2.93	1st
Late rainfall	95.5	0.4	3.1	0.9	2.91	2nd
Drought	95.1	0.9	1.3	2.7	2.88	6th
Heat	10.3	1.3	0.9	87.4	0.35	11th
Cold	65.0	4.0	10.3	20.6	2.13	10th
Wind	88.3	3.1	3.6	4.9	2.75	9th
Pest/disease	92.8	4.0	2.2	0.9	2.89	5th
Erosion	94.6	0.9	2.5	2.5	2.88	6th
Fire	92.8	2.2	1.8	3.1	2.85	8th
Poor yield	96.0	0.4	1.8	1.8	2.91	2nd
Low income	96.4	0.4	0.9	2.2	2.91	2nd

Source: Field Survey, 2019.
WMS: Weighted Mean Score
*** Multiple responses**

DISCUSSION

All the sampled farmers that were involved in yam and cassava production were of different age group, the result showed that many of the sample respondents were married, including that they are expecting to be matured and possesses ability to be conversant with the weather variability and change effect of cassava and yam production. Both male and female were involved in cassava and yam production in the study areas, this assertion is in compliance with Akintonde. et al; (2019) who reported that being married as a status may suggest a high desire of responsibility and great capability of sound rational conversant with the effects of weather variability and change on cassava and yam production. Both male and female were involved in yam and cassava production in the study areas, the variation in the percentages may be attributed to the fact that male are more involved in agricultural production, this may be due to energy and stress associated with farming. When many men can survive than women. It is a usual assumption that male dominate agricultural production in many part of the world, including Nigeria. This finding is in conformity with Ejembi and Ejembi (2006), who reported that traditionally recognized visible human input in agricultural sector is more of males than females.

Many of the respondents were literate and are expected to be familiar with the weather variability and changes, this finding corroborate those of Akintonde et al (2016), who reported that it's also an indication that they will conversant with the yam and cassava production process and expected to have a better understanding of the possible effects of weather variability and change on yam and cassava production and employ remedies to curbs its different effects. The variation in their year of experience may be due to age differences and time of engagement in farming as either primary or secondary occupation, however, the farmers' year of experience is expected to determine the farmers' knowledge on effects of weather variability and changes of crops.

The result is in line with Hassan and Nhemachena(2007), in their study of climate adaptation strategies in south Africa, noted that the more farming experience increases, the probability of farmers adapting to climate change. According to Akintonde et al (2016). The higher the farmland cultivated is, the size of possibility of high crop yield which of course would determine the income level of the farmers and a factor that is expected to influence the use of climate change adaptation strategies among farmers.Many of the respondents were literate and should not be novice on climate variability and should possess ability in the application of appropriate strategies to curb its effects in order to ensure expected output from yam and cassava production. This finding corroborates Akintonde*et al*. (2016).

All the sampled respondents have certain number of years of farming experience on yam and cassava production. The variation in their years of experience may be due to age differences and time of engagement in farming as either primary or secondary occupation. However, the farmer's years of experience is expected to determine the type and level of use of climate change adaptation strategies. The result is in conformity with Hassan and Nhemachena (2009) in their study of climate adaptation strategies in South

Africa noted that the more farming experience increases the probability of farmer adaptation to climate change. All the respondents sampled had different knowledge and interpretation of changes observed in climate. The variation in their knowledge and interpretation of climate change may be due to differences in their perception towards climate change in relation to their experience in agricultural production over time. All the respondents affirmed that climate change have several negative effects on yam/cassava production. Of course the effect would be in relation to crop yield as well as household revenue of the farmers in the areas. This finding is in agreement with Akintonde*et al*. (2019) in their study of 9000 farmers in 11 African countries predicting a fall in farm income with the present climate setting. However, this is expected to necessitate the implementation of climate change adaptation strategies to curb its effects on crop production among the farmers.

Conclusion

Weather effects undermine livelihood with grave consequences on food security, health and well-being and the overall socio-economic development of any country. Food security is a major challenge in Nigeria and its effects are making food unavailability and inaccessibility worst. In order to avoid hunger and poverty, farmers are adjusting to climate change by using different methods.

The farmers of arable crops were of different age groups; male constituted the larger proportion of the respondents and were married or single,Most of the respondents were literate,The respondents engaged in diverse occupation while majority were farmers,All the respondents had different years of farming experience and activated different farm sizes,Majority of the respondents were already aware of changes in the weather variability and experienced the impact of the change in their farming systems,The study established that weather variability and change have different effects on both yam and cassava production,

Recommendations

The following recommendationsare suggested:

Though many people are aware of the effects and impacts of weather variability and change, more public campaign about weathervariability and change and its effects on individuals is needed. This may be with the aid of mass media, utilization of indigenous languages and integration of it into curriculum of education at all levels.The farmers should be particularly and adequately informed to make necessary adjustment in that regard so as to ensure that expected yield from yam/ cassava production are realized, Local/state governments should prepare mitigation measures to alleviate the impact and effects of weather variability and change as well as plan for the suitable adaptation strategies in accordance with the needs and conditions in Oyo/Ekiti states, Farmers need to be encouraged on the utilization of recommended weather variability and change adaptation strategies of which both the government and non-governmental organization

can assist hence food insecurity would be discouraged having ameliorated weather variability and change effects on yam/cassava production.

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