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Climate variability effect on the yield of arable crops in South-East Nigeria and role of Extension workers in ameliorating the effect

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Abstract
The study investigated the effects of climate variability on yield of maize, yam, and cassava in South east Nigeria and the role of agricultural extension on climate variability mitigation and adaptation measures Secondary and primary data were used. Secondary data on climate variables and yield were collected for twenty years (1995-2014) from the Nigeria Meteorological Agency Enugu and from National Bureau of Statistics (NBS) respectively. Primary data were collected from the Agricultural Development Programmes (ADPs) of the three selected states of South East Nigeria by use of structured questionnaire. The list of expected role of extension agent was measured by the use of a four-point likert-type scale. Simple random sampling technique was used in selecting Agricultural zones and blocks. Data on climate variability was measured by nominal values of yes (2) and no (1) and was analyzed with crop yield by use of Mean, Multiple Regression, Pearson Correlation Coefficient, and Analysis of Variance respectively. Data on the role of Extension workers were analyzed by the mean score and standard deviation. The study revealed that climate variables significantly accounted for the yield of yam (R2= 55.7%) and cassava (R^2= 51.1%). Temperature minimum and solar radiation have significant effect on the yield of maize. The relationship between climate variability and yield of arable crops was established. There was significant difference between the yield of cassava, yam, and maize in the three States, with F-values = 62.497, 249.722 and 36.37 respectively. It was found that the significant role of extension workers includes production of publication on the cause of climate change ($\overline{x}$ = 2.23) and village transect walk and study of the environment in relation to climate change ($\overline{x}$ = 2.23). The advisory role of extension agents in climate variability mitigation and adaptation measures was inadequate. The study recommended the planting of arable crops should be done at the onset of the rains. It is recommended that extension agents be trained on their role in climate change variability mitigation and adaptation measures, and also be updated with information on Climate variability from meteorological Agencies.
Keywords: Climate variability, effect, yield, arable crops, extension workers, role

Introduction
The weather variables most often used in describing climate variability are temperature, rainfall, relative humidity and wind. Global Climate Change Impacts in the United States (GCCIUS, 2009). Climate is a principal factor of farming efficiency and sustainability. The climate of an area is often related to vegetation as well as type of crop that could be cultivated. Factors like sunshine, day length, temperature, rainfall and humidity, is one of the key climatic elements that influence crop production (Sowunmi and Akintola, 2010). The overall predictability of these climatic elements is imperative for the day-to-day and medium-term planning of farm operations (Akinro, Opeyemi and Ologunagba , 2008; Adejuwon, 2004, Zewdie, 2014). Incidence of new crop diseases and yield in many instances were attributed to climate variability (Omotayo, 2010). In many parts of the world, climate represents one of the major uncertainties affecting the performance and management of agricultural Systems. Devereux and Edwards (2004) opined that due to global climate change, climatic variability and occurrence of extreme weather conditions, there was likely to be increase in agricultural risks and thereby destabilization of farm income.

Agriculture being the main driving force of economic growth and provision of food in most developing countries has remained threatened by the harmful effects of climate elements in the African, Caribbean and Pacific countries. Many parts of Africa in 2007 suffered severe drought and floods which led to destruction of hectares of farm lands, roads, and buildings (CTA, 2008; IPCC, 2007)).

The Southeast of Nigeria is more vulnerable to climate hazards when compared with North-Central. The impacts of climate in the region is very evident from the increased flooding, landslide and erosion which has often led to loss of lives, houses, farm lands, properties, and roads (Agwu and Okhimamhe, 2009).

According to Ngoddy, (1991), the capability of the arable farmers to solve problems posed by their environment involving the systematic use of scientific methods will depend on their awareness and training. Frangton *et al.* (2015) maintained that farmers in Africa have traditionally used indigenous knowledge to cope with climate hazards based upon observations and interpretation of natural phenomena. They opined that there is a need to realign and adopt new policies that will contribute to greater resilience of the agricultural sector to change in climate. Agricultural extension have a role to play in providing farmers with information, technology, and education on how to cope with climate change and way to contribute to GHC mitigation. A study conducted on information needs of rural farmers in Enugu State by Okoro (2010) revealed that farmers need for information on mitigation and adaptation measures against climate change was not high. Creating awareness on issues of climate change, its effects and adaptation options available to farmers have been a challenge to agricultural extension agents. Studies have shown that the level of awareness on climate change issues were inadequate (Nzeadibe, Egbule, Chukwuone and Agu, 2010; Nzeh and Eboh, 2010). Thus, this study has been designed to investigate the effects of climate variability on yield of selected arable crops (cassava, yam, and maize) of farmers in southeast Nigeria and to highlight the role of agricultural extension workers in ameliorating climate variability effect. The specific objectives were to investigate the relationship of climate variability and yield of cassava, yam, and maize in Southeast Nigeria from 1995 to 2014. It also investigated the role of agricultural extension on climate variability mitigation and adaptation measures among arable farmers in the study area.

Materials and methods

Description of study area

The study was carried out in southeast Nigeria. Nigeria comprises of six geopolitical zones namely North East, North West, North Central, South East, South West, and south south zones (Aniedu, 2006). The states in south east Nigeria are: Abia, Anambra, Ebonyi Enugu and Imo. The zone is located between latitudes 04^0 30'N and 07^0 30'N and longitudes 06^0 45'E and $08^0$45'E (Igbokwe *et al.* 2008). It covers an area of 29,908 square kilometers with a population of about 16,381,729 (National Population Commission, 2006). Three (3) states were randomly selected out of the five states that compose south-east Nigeria for purpose of comparing and examining the effects of climate variables yield of selected arable crops. These were Anambra, Ebonyi and Enugu states. All agricultural extension workers in southeast Nigeria constituted the population of study. Simple random sampling technique was used in selecting states, agricultural zones, and blocks. All the extension professionals including the Zonal Managers (ZM), Zonal Extension Officers (ZEO), Subject Matter Specialist (SMS), Block Extension Supervisors (BES), Block Extension Agents (BEA) and the Extension Agents (EAs) in the selected zones constituted the extension workers. This was made up of 44, 97 and 48 extension workers from Anambra, Ebonyi and Enugu state respectively as seen in Table 2. This gave a total of one hundred and eighty nine (189) extension workers. Primary data were collected by use of structured questionnaire which was used to elicit information from Extension workers on role of agricultural extension agents on climate variability mitigation and adaptation measures. Secondary and primary data were used. Secondary data on climate variables and yield were collected for twenty years (1995-2014) from the Nigeria Meteorological Agency Enugu due to availability, consistency and continuity of data and from National Bureau of Statistics (NBS) respectively. A list of expected roles of extension agents were presented to the extension agents. These were measured by the use of four point Likert -type scale. The scale was coded as follows; strongly agree = 4; agree = 3; disagree = 2; strongly disagree = 1, A cutoff point of 2.50 was used to dichotomize the responses into agreed and disagreed. Any item with a score of 2.50 and above was regarded as agreed while below 2.50 was regarded as disagree.

Method of data analysis

Data collected for Climate variability and Crop yield were analysed by use of mean, t – test, Analysis of Variance, Multiple Regression and Correlation while data collected from the role of Agricultural Extension agents were realized using mean score and standard deviation.

Results and Discussion

Relationship between climate variables and yield of maize, yam and cassava were subjected to multiple regression and presented in the following sections.

Climate variability and yield of maize

Result in Table 3 reveal that climate variables accounted for 34.9% increase in the yield of maize by (F= 3.038, P= 0.046). The following climate variables were significant predictors of maize yield: temperature minimum (t = -2.370, p = 0.033), solar radiation (t = -2.836, P = 0.013). However, temperature maximum (t = 0.864, p = 0.402), rainfall (t = 0.116, p = 0.909) were not significant but have positive relationship. Relative humidity (t= -1.176, p = 0.259) was also not significant but has negative relationship. The two climate variables that were significant had negative values, which implied that both temperature (minimum) and solar radiation had inverse relationship with the yield of maize. The lower the value of minimum temperature and solar radiation, the higher the yield of maize. This implied that the yield of maize was not significantly influenced by the other climate variables except the minimum temperature and solar radiation.

Climate variability and yield of yam

Table 4 shows that climate variables accounted for 55.7% increase in the yield. Temperature minimum (t = -3.266; p=0.006), rainfall (t = 2.395; p = 0.031), and solar radiation (t = -2.290; p = 0.038) were significant predictors of yam yield while Temperature maximum (p= 0.402) and relative humidity (p= 0.259) were not significant predictors of the yield of yam (P> 0.05). From the three climate variables that were significant two (Temperature minimum and Solar radiation) had negative values which implied that temperature (minimum) and solar radiation had inverse relationship with the yield of yam, whereas rainfall had a direct relationship with the yield of yam. This implied that the lower the value of rainfall the lower the yield of yam vice versa. The result showed that maximum temperature and relative humidity did not significantly influence the yield of yam. However, temperature minimum; Rainfall and solar radiation significantly influenced yam yield in the South-East Nigeria.

Climate variability and yield of cassava

The R^2 value in Table 5 shows that climate variables significantly accounted for 51.1% of cassava yield. Temperature maximum (t = 2.253; $\boldsymbol{p}$ = 0.041), temperature minimum (t = 4.274; p = 0.001) and solar radiation (t = -3.635; p = 0.003) were significant predictors of cassava yield, whereas rainfall (t = 0.021; p = 0.984) and relative humidity (t = 0.530; p = 0.605) were not significant predictors of the yield of cassava. From the three climate variables that were significant, temperature (maximum) had a positive value (t=2.253), while temperature (minimum) and solar radiation had a negative values of (t= - 4.274 and t= – 3.635) respectively. Temperature (maximum) had a direct relationship with the yield of cassava, while Temperature (minimum) and solar radiation had inverse relationship with the yield of cassava. In other words, an increase in the temperature (maximum) will increase the yield of cassava, whereas increase in temperature (minimum) and solar radiation will decrease the yield of cassava and vice versa.

Table 6 shows that out of the fifteen expected roles of extension workers in climate change adaptation and mitigation measure the ones agreed on by extension agents are: production of publication on the cause of climate change ($\overline{x}$ =2.23) and village transect walk and study of the environment in relation to climate change ($\overline{x}$ =2.06), the extension workers did not agree with the remaining thirteen roles expected by the extension workers. From Table 6, linking farmers with the sources of drought resistant crops variety ($\overline{x}$ = 1.87) regular update on the situation and current trends on issues of climate change ($\overline{x}$ =1.79), production of publications on the effects of climate change and Training on climates change adaptation strategies ($\overline{x}$ =1.74) were among the most poorly performed roles. Others are linking farmers with early maturing crop variety, training on the cause of climate change and training on the effects of climate change ($\overline{x}$ =1.68), the introduction of improved climate friendly agronomic practices ($\overline{x}$ =1.62), introduction of organic manure ($\overline{x}$ =1.59), training on mitigation approaches ($\overline{x}$ =1.56), introduction of improved crop variety ($\overline{x}$= 1.44), regular visit to farms ($\overline{x}$= 1.37) and introduction of drought resistant crop variety ($\overline{x}$= =1.32). Many observers of rural development in recent times have commented on the frequent manifestations of unsatisfactory extension performance (Rivera et al, 2001). Feder *et al* (2001) stated that in the developing country extension performance was deficient; the factors which accounted for poor performance were low staff morale and financial stress. One more such key factor is the number of clients and the vast spectrum of information/services needed to be covered by extension systems.

Conclusion

Climate variables significantly accounted for the yield of yam and cassava. There was significant difference in yield of the three crops. Late maize and cassava should be planted in October instead of September. The zone depends largely on rain fed agriculture, therefore, mitigation measures should be geared towards favourable rainfall, temperatures, solar radiation and relative humidity. The advisory role of extension agents in climate variability mitigation and adptaion measures were inadequate therefore extension agents should be trained on their role on climate variability mitigation and adaptation measures. Climate smart Agricultural Dlivery services require climate data therefore the extension workers should be armed with the year to year variablity data before advising farmers on climate mitigation and adaptation measures Government should integrate issues of climate variability as well as adaptation strtaegies into the national developmental plan and project since the climate variability risks has remained high.

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Table 1: Distribution of Agricultural Zones and blocks in the three selected States of South East Nigeria

States	Agricultural Zones	Blocks
Anambra State	*Aguata*	Aguata, Nnewi North and South, Orumba North and South
	Awka	Awka North and South, Anoicha, Dunukofia and Njikoka
	Anambra	Oyi, Anyamelum, Anambra East and West
	Onitsha	Idemili North and South, Onitsha South and North, Ekwisigo and Ihiala
Ebonyi State	*Ebonyi North*	Abakaliki, Ebonyi, Izzi and Ohaukwu
	Ebonyi Central	Ikwo, Ezza South and North and Ishielu
	Ebonyi South	Afikpo North and South, Onitsha and Ivo.
Enugu State	*Agbani*	Enugu South, Nkanu West, Nkanu East
	Awgu	Oji River, Awgu and Aninri
	Enugu	Enugu North and East, Isi-Uzo
	Enugu-Ezike	Igboeze South and North and Udenu
	Nsukka	Nsukka, Igboetiti and Uzo-Uwani
	Udi	Udi and Ezeagu

Source: Anambra, Ebonyi and Enugu States ADPs

Table 2: Population of Extension workers in selected states and zone

Selected State (50%)	Selected Zone (50%)	Number Of Extension Workers
	Anambra	19
	Awka	25
Ebonyi	Ebonyi North	43
	Ebonyi Central	54
Enugu	Udi	12
	Nsukka	25
	Enugu-Ezike	11
	Total	**189**

Table 3: Relationship between climate variables and yield of Maize

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.721[a]	.520	.349	16.0250123

a. Predictors: (Constant), Relative Humidity, Rain fall, Temperature (Maximum), Solar radiation, Temperature (Minimum).

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	878.408	571.021		1.538	.146
Temperature (Maximum)	16.874	19.537	.275	.864	.402
Temperature (Minimum)	-26.241	11.073	-.844	-2.370	.033*
Rain fall	.319	2.742	.023	.116	.909
Solar radiation	-34.684	12.231	-.699	-2.836	.013*
Relative Humidity	-1.423	1.210	-.321	-1.176	.259

a. Dependent Variable: Maize

*Significant at 0.05

Table 4: Relationship between Climate variability and yield of yam

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.821[a]	.674	.557	109.1263690

a. Predictors: (Constant), Relative Humidity, Rain fall, Temperature (Maximum), Solar radiation, Temperature (Minimum)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	**Std. Error**	**Beta**		
1	(Constant)	5674.175	3888.511		1.459	.167
	Temperature (Maximum)	133.961	133.040	.264	1.007	.331
	Temperature (Minimum)	-246.262	75.405	-.960	-3.266	.006*
	Rain fall	44.705	18.669	.387	2.395	.031*
	Solar radiation	-190.739	83.292	-.466	-2.290	.038*
	Relative Humidity	-3.945	8.239	-.108	-.479	.639

a. Dependent Variable: Yam

Table 5: Relationship between Climate variables and yield of Cassava

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.800[a]	.640	.511	285.9323725

a. Predictors: (Constant), Relative Humidity, Rain fall, Temperature (Maximum), Solar radiation, Temperature (Minimum)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	9218.712	10188.656		.905	.381
	Temperature (Maximum)	785.464	348.591	.621	2.253	.041*
	Temperature (Minimum)	-844.481	197.577	-1.320	-4.274	.001*
	Rain fall	1.024	48.917	.004	0.021	.984
	Solar radiation	-793.201	218.240	-.776	-3.635	.003*
	Relative Humidity	11.436	21.589	.125	0.530	.605

a. Dependent Variable: Cassava

Table 6: Responses of Extension workers on the Role of Agricultural Extension Service on Climate change adaptation and mitigation

Roles of Extension workers on climate change adaption and mitigation	***Mean***	***SD***
Regular visit to educate farmers on climate mitigation adaptation measure	1.37	0.528
Introductionof improved crop variety	1.44	0.559
Introduction of drought resistant crop variety	1.32	0.510
Training on mitigation approaches	1.56	0.664
Training on climate change adaptation strategies	1.74	0.665
Training on the causes of climate change	1.68	0.701
Training on the effects of climate change	1.68	0.606
Productionof publications on the effects of climate change	1.74	0.752
Productionof publication on the cause of climate change	2.23*	0.987
The introduction of improved climate friendly agronomic practices	1.62	0.708
Introductionof organic manure	1.59	0.758
Linking farmers with the sources of early maturing crop variety	1.69	0.789
Linking farmers with the sources of drought resistant crops variety	1.87	0.854
Regular update on the situation and current trends on issues of climate change	1.79	0.740
Villagetransect walk in study of the environment in relation to climate change	2.06*	0.854

*Means indicating respondent perception of roles of agricultural extension
2.5 is the cut-off point