Journal of Agriculture and Crops
ISSN(e): 2412-6381, ISSN(p): 2413-886X
Vol. 9, Issue. 2, pp: 240-249, 2023
URL: https://arpgweb.com/journal/journal/14
DOI: https://doi.org/10.32861/jac.92.240.249

Academic Research Publishing Group

Original Research **Open Access**

Farmers' Adaptation Strategies to the Effect of Climate Variation on Yam Production in Ebonyi State, Nigeria

Chukwu Victor A.
Ebonyi State Agricultural Development Programme, Km-8 Abakaliki, Ogoja Express, Abakaliki Ebonyi State, Nigeria

Osuafor Ogonna Olive (Corresponding Author)
Department of Agricultural Economics and Extension, Nnamdi Azikiwe University, Awka Anambra State, Nigeria
Email: oo.osuafor@unizik.edu.ng

Ukwuaba Ikenna C.
Department of Agricultural Economics, University of Nigeria Nsukka

Enyigwe Juliet
Department of Agricultural Economics, Management and Extension, Ebonyi State University, Abakaliki

Chinenye Chinaza Priscilia
Department of Agricultural Economics, Management and Extension, Ebonyi State University, Abakaliki

Article History
Received: 3 December, 2022
Revised: 22 February, 2023
Accepted: 21 March, 2023
Published: 27 March, 2023

Abstract

This study analyzed farmers' adaptation strategies to the effect of climate variation on yam production in Ebonyi State, Nigeria. Primary data were collected with the aid of questionnaire and interview schedule from 240 yam farmers using multi-stage random sampling techniques. Primary data were collected with the aid of questionnaire and interview schedule; while secondary data were collected from Nigerian Institute of Metrological Agency in Ebonyi State and Metrological station of Ebonyi State University, Abakaliki. Result shows that environmental factors such aslate rainfall (x=3.0), high temperature (x=3.0) and high relative humidity (x=2.9) were accepted because they scored above the decision point of 2.5. Majority (45.42%) of the respondents were aware of changes in environmental factors through radio programmes and announcements.Further analysis revealed that majority (37.50%) and (36.25%) of the yam farmers in Ebonyi State adopted mixed cropping and improved farming techniques, respectively as their major adaptation strategies.coefficient of multiple determination an R^2 of 0.553 or 55.3 percent; which implied that about 55.3 percent of the fluctuations in the output of yams were explained by the changes in explanatory variables contained in the regression model. Rainfall (X_1) was negatively signed and statistically insignificant. Temperature (X_2) was positively signed. Sunshine (X_3)waspositively and significantly signed; while relative humidity (X_4) bore a negative sign. The null hypothesis tested was rejected at 5%level of significance since F-cal (3.089) was greater than F-tab (2.14). This study had shown that climatic factors significantly influenced yam production in Ebonyi State. Based on the findings of this study,it wasrecommended that the socio-economic status of the yam farmers should be enhanced to enable them afford and adopt proven measures that would mitigate environmental factors; all available sources of information on environmental factors should be embraced and enhanced for fast spread of information to the farmers; extension agents who are in close touch with the yam farmers should be trained on interpretation of weather forecasts so as to disseminate same to their farmers among others.

Keywords: Adaptation strategies; Yam production; Awareness; Climatic factors.

How to Cite: Chukwu Victor A., Osuafor Ogonna Olive, Ukwuaba Ikenna, Enyigwe Juliet, Chinenye Chinaza Priscilia, 2023. "Farmers' Adaptation Strategies to the Effect of Climate Variation on Yam Production in Ebonyi State, Nigeria." *Journal of Agriculture and Crops*, vol. 9, pp. 240-249.

1. Introduction

Agricultural production in Ebonyi State, Nigeria is vulnerable to climate change effect. In order to feed Nigeria's expanding population, agriculture must be protected to ensure steady food production in both quality and quantity [1, 2]. The impact of climate on agricuture is dependent on variations in local climates. Climate variation is a reality that is seriously distressing the earth already, especially challenging agricultural productivity and thus, requires urgent attention [3-5]. Changes in climatic factors such as rainfall, temperature, sunshine and relative humidity among others have adverse effects on the agricultural sector in sub-Saharan Africa, especially Nigeria. Through variations in temperature and precipitation, climate variability has direct effects that make natural and societal systems vulnerable. The modification of natural and human systems in response to anticipated climate consequences is known as adaptation [1].

Yam is a root crop with huge economic and nutritional importance in Nigeria. Yam serves as a staple food in many tropical and even sub-tropical countries of the world. World yam production amounts to 6030 million tonnes annually and 90% are grown in the yam producing regions of West Africa [6]. Yam forms a basic staple food for

millions of people in Nigeria where it is eaten boiled, roasted, fried and also can be processed into various forms of flour and starchy paste [7]. In the dominant yam producing zone of West Africa, consumer demand for yam is generally very high and its cultivation is profitable despite production costs [8]. Ipilakyaa, *et al.* [9], reported that yam is in the class of roots and tubers that are of staple of the Nigeria and West Africa diets which provides some 200 calories of energy per capita daily.

Nigeria is the largest world producer of yams with annual production estimated at 26.587 million metric tonnes [6]. Yam is an important tuber crop in Nigeria; where it is produced as food and cash crop [10]. The per capita consumption has increased over the years. In fact, per capita yam consumption increased from 48.9Kg/year in 1990 to 89.7kg/year in 2009 [11]. Given that yam consumption has increased, its role in the nutritional status and attainment of food security in Nigeria is vital [2]. Nigeria currently accounts for about 80% of West African yam production and 60 Percent of global production [11]. Similarly, Asumugha, *et al.* [10] reported that Nigeria produced 26.59 million metric tonnes of yam in 2006 as against 31.50 million metric tonnes in 2003, showing a decline of yam production. This decline in productivity represents a major challenge to increasing yam production in the country. Nigeria has made several efforts to address the issue of improved food production in both quantity and quality [2] of which yam is among the major focus.For the Ebonyi people, yam farming is a significant source of livelihood and food security. According to Mbah [12], income and standard of living are generally low in rural areas of Ebonyi State where yam is produced. This is occasioned by incidence of poverty and low standard of living probably brought about by poor agricultural productivity. Despite the immense contributions of yam farmers to economic advancement of both household and national economies, they are constantly faced with diverse socio-economic, political and cultural factors which have continued to hinder the realization of their potentials in yam production [13].

Climate variability will present significant challenges for Nigeria in particular, including weak infrastructure, economic poverty, drought, excessive rainfall, poor livestock health, decreased crop yields, low productivity, and a variety of other issues. The effects of climate change are felt by everyone, but they will be most pronounced among vulnerable populations and groups [1, 7]. Due to the high level of poverty, conflicts, and disease prevalence, Nigeria's population of which Ebonyi state is a major participant in terms of population size and the domestic market for yam produce is extremely vulnerable to climatic changes. Yam is the notable food source for the inhabitants of Ebonyi State, who value it for its flavor and for its cultural significance as an important menu item when pounded for ceremonial occasions. In South east Nigeria, Ebonyi state serves as a key hub for yam production. Yam production and yield patterns are of economic importance to the yam production of an Ebonyi farmer, as they link to food security in rural communities in the state. Ngetich, *et al.* [14], stated that the realization of the inescapability of climate variation has bolstered more research on adaptation strategies. Ojemade, *et al.* [15], asserted that climate variability has the capacity to reverse major achievement in agricultural production across a range of crops if not addressed properly. Hence, adaptation seems to be the most significant option for the subsistence farmers if they must thrive in the business of farming [7]. According to Zilberman, *et al.* [16], adaptation is the response of economic agencies and societies to major shocks such as climate variability.

Production of yam has not kept pace with population growth leading to demand exceeding supply [17]. A recent study on yam has shown that the absolute level of production in West Africa and the world have remained static for three decades [18]. Research has shown that there has been a general decline in yam production in Nigeria over the years. Elijah, *et al.* [7], reported that yam cultivation and total yam output were declining. This is also applicable to the situation in Ebonyi State of Nigeria. The static or declining trend may be connected with environmental factors which influence its productivity. Yam production dropped in Nigeria, from 14.9% in 1986-1990 to 2.5% in 1996-1999 but an increase in average yield (about 23.4%) was recorded between 2001-2006 [19]. This observed trend represents a major challenge to increasing yam production and its availability as food in the country. This decline in productivity could be due to changes in climatic factors. There seems to exist a gap in knowledge on adaptation strategies adopted by yam farmers in Ebonyi State in the face of climatic factors. Hence, the need for this study.

The broad objective of this study is to analyze farmers'adaptation strategies to the effect of climate variation on yam production in Ebonyi State, Nigeria. The specific objectives include to;

- determine yam farmers' level of awareness of climatic factors influencing yam production;
- identify sources of information on changes in climatic factors to the yam farmers;
- ascertain the effects of selected climatic factors (rainfall, temperature, sunshine and relative humidity) on yam yield over a specified period of time (2000-2015);
- ascertain various adaptation strategies adopted by the yam farmers in the face of climatic factors; and
- identify constraints faced by the farmers in adapting to climatic factors in the area.
- One null hypothesis was tested:

Ho: Climatic factors (rainfall, temperature, sunshine and relative humidity) do not significantly affect yam yield in the study area.

2. Materials and Method

The study area is Ebony State, which lies approximately on latitudes 7°3' N and 8^{0}4'Elongitudes 5°4' N and 6°45' E and located in the south eastern part of Nigeria. The state is made up of thirteen (13) local government areas, which are divided into three (3) major agricultural zones, namely: Ebonyi North, Ebonyi Central and Ebonyi South. Ebonyi State has a landmass of approximately 5,932 square kilometers [20].

The farmers in the Ebonyi state grow intensively staple food crops which range from cereals to root crops such as yam, rice, maize, cassava, sweet potato and cocoyam are most commonly grown [21]. Yam is produced in all parts of Ebonyi state. The sweetness of Ebonyi yam commonly known as Abakaliki yam made it attractive to so many people in different parts of Nigeria. As a result, the white yam which is very sweet is always in high demand. Marketing of yam in the State is usually carried out by various marketing channels such as direct sales from the producers, marketing by middle men, whole sales and commission agents. Yam can be purchase from the local, daily and regional markets in the area. It is readily available all year round; but the price is dependent on the season of sale.

A multi-stage random sampling technique was employed in the selection of the respondents for the study.Multi-stage sampling technique was used for easy enumeration of large clusters. This was used to select respondents for the study as follows: In stage one, two (2) Local Government Areas (LGAs) were randomly selected from each of the 3 (three) agricultural zones in Ebonyi State, giving a total of six (6) LGAs used for the study. Stage two involved a random selection of 4 (four) communities from each of the LGAs. This gave a total of eight (8) communities per zone and 24 communities in the state. Stage three involved a random selection of ten (10) yam farmers from each community. This gave a total of 80 (eighty) yam farmers in each of the three agricultural zone and a total of 240 (two hundred and forty) yam farmers for the study.

Both primary and secondary data were used for data collection. Primary data were collected for the study using a structured questionnaire augmented with interview schedule while secondary data were collected from Nigerian Institute of Metrological Agency in Ebonyi State and Metrological station of Ebonyi State University, Abakaliki. Time series data on crop yield were sourced from Ebonyi State Agricultural Development Programme for 15 years (2000-2014). Objectives I, II and IV achieved using descriptive statistics such as frequency counts, percentages and mean scores generated from a four point likert scale. Four functional forms of multiple regression analysis was used to analyze objective III; while objective V was analyzed using Principal Component Analysis. The linear form was chosen as the lead equation.

2.1. Model Specification

2.1.1. Likert Scale Rating Technique

A likert scale is a psychometric scale in survey research. When responding to a likert questionnaire item, respondents specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of items statements. The scale captures intensity of their feelings. A 4 –point likert scale was employed in this study. This was graded as Highly Aware (HA), Aware (A), Not Aware (NA) and Not Very Aware (NVA) with corresponding values of 4, 3, 2 and 1 respectively. The mean score of the respondents based on the 4-point rating scale was computed as:

$$\frac{4+3+2+1}{4} = 2.50$$

Using the interval scale of 0.05, the upper limit cut-off point was 2.50+0.05 = 2.55 while the lower limit cut-off point was 2.50-0.05 = 2.45. Based on this, any score below 2.45 (MS <2.45) was taken as a weak factor and not considered while those with mean scores of above 2.55 (MS>2.55) was taken as strong factors and considered.

2.1.2. Multiple Regression Model

The four functional forms of multiple regression analysis used is shown below

$Y = F(X_1, X_2, X_3, X_4, ut)$

Where;

Y = Yam Yield for 15 years (2000-2014)

X_1 = Rainfall (mm) for 15 years (2000-2014)

X_2= Temperature (^{0}C)

X_3 = Sunshine (Hours)

X_4 = Relative Humidity (%)

$X_1 – X_4$ = estimated parameters

b_0 = Constant

ut = error term

2.1.3. Hypothesis Testing

The null hypothesis tested was tested with F-test at 5% level of significance as shown:

$$\text{F-cal} = \frac{R2\,(N-K)}{(1-\text{R2})\,(\text{K}-1)}$$

Where:

R^2 = Coefficient of Multiple Determination

N = Sample Size

K = Number of Variables

2.1.4. Decision Rule

If F-cal > F-tab, reject the null hypothesis otherwise accept its alternative.

3. Results and Discussion

3.1. Yam Farmers Awareness of Climatic Factors Influencing Yam Production.

Yam farmers 'awareness of climatic factors influencing yam production was analyzed using mean scores generated from a 4-point likert scale. The result of the analysis is shown in Table 2.

Table-1. Mean Scores of Yam Farmers Awareness of Climatic Factors Influencing Yam Production in Ebonyi State.

Environmental Factors	Mean Scores (x)	Remarks
Flooding	2.7	Accepted
Soil erosion	2.8	Accepted
Early rainfall	2.5	Accepted
Late rainfall	3.0	Accepted
Long dry season	2.9	Accepted
High wind storm	2.6	Accepted
Excessive heat	2.7	Accepted
Short dry season	2.6	Accepted
Increased wind	2.8	Accepted
Increased sunshine	2.8	Accepted
High relative humidity	2.9	Accepted
High temperature	3.0	Accepted
Low temperature	2.6	Accepted

Source: Field Survey Data, 2020.

The result of data analysis in Table 1 showed that all the items enumerated as environmental factors were accepted because they scored above the decision point of 2.5. This means that there is high level of awareness of changes in climatic factors that affect yam production in the study area. The result further revealed that late rainfall and high temperature ranked highest among others. But, early rainfall and low temperature were the least ranked by the farmers. This implies that most of the farmers in the area are more aware of changes in rainfall patterns and variation in temperature more than other environmental factors. This may be attributed to frequent broadcast of temperature and rainfall patterns by the media through radio announcement. This supports the findings of Barbier *et al*. (2009) who noted that farmers had quite elaborate knowledge of environmental factors such as temperature and rainfall and its impact on crops. However, Bello [22] reported that the amount of rainfall is not as important as its spread for yam to perform well in the field.

Some authors such as Falola, *et al.* [23] and Ugwoke, *et al.* [24] in Nigeria, [25] in Burkina Faso have reached similar conclusions. According to Traoré, *et al.* [25], this perception of farmers in tropical regions can be justified by the fact that the climatic variables have a direct influence on agricultural production in tropical Africa.

The implication of this finding is that yam farmers are likely to adopt aggressive means to cushion the effects of these changes. This is supported by Hassan and Nhemachena [26] who noted that the awareness of environmental problems and the potential benefits of taking action is an important determinant of adoption of agricultural technologies. The finding of this study is also corroborated by that of Onyekwe, *et al.* [3] and Maddison [27] who noted that farmers' awareness of changes in environmental factors is important to adaptation decisions. Hassan and Nhemachena [26], in their separate studies also argued that awareness and perceptions of soil erosion problems caused by climate change positively and significantly affected their decision to adopt soil conservation measures. This result agrees with the findings of Enete and Onyekuru [28] and Enete, *et al.* [29] which revealed that 96% of farmers in Imo and Enugu states of Southeast Nigeria are aware of changes in climatic factors (elements). But, this result is inconsistent with the findings of Ishaya and Abaje [30] that revealed poor awareness of climate change scenarios among indigenous farmers in Kaduna State. This disparity is not surprising since the two areas are located in different climatic zones in Nigeria.

3.2. Sources of Information on Climatic Factors

The sources of information on climatic factors were examined. The result obtained are shown in Table 2.

Table-2. Distribution of the Respondents According to Sources of Information on Environmental Factors

Sources of Information	Frequency	Percentage
Radio programmes and Announcement	109	45.42
Friends and Relatives	88	36.67
Fellow Farmers	74	30.83
Extension Agents	69	28.75
Community/ Opinion Leaders	57	23.75
Yam Cooperatives and Marketers	45	18.75
Churches/Mosque	42	17.50
Total	**484***	

Source: Field Survey Data, 2020

*Multiple Responses Recorded

On the sources of information on changes in climatic factors as shown in Table 2, majority (45.42%) indicated that they became aware of changes in climatic factors through radio programmes and announcements, 36.67% were aware through friends and neighbours, 30.83% became aware from fellow farmers while 28.75% and 23.75% sourced their information through extension agents and community/opinion leaders respectively. This result implies that radio has been the most effective medium of disseminating information on environmental factors to farmers in Ebonyi State. Churi, *et al.* [31] found that radio communication was recognized as the most accessible and potential useful means of disseminating vital information to farmers.

Information has been shown to significantly affect adoption of improved agricultural technologies [10]. The study of Tambo and Abdoulaye [32] captured important information sources including membership of association, extension visits and participation in training and field days. Membership of association facilitates easy access to credit, land and labour resources and support in times of hardship and conflict resolution. There is the tendency of obtaining information about new technologies quality seeds and inputs. This is because increased awareness will improve attitude, knowledge, skills and aspirations of the farmers.

3.3. Effects of Selected Environmental Factors on Yam Yield

Four functional forms of multiple regression analyses were used to determine the effects of climatic factors on the yield of yam over a specified period of time (15 years). The dependent variable was yam yield (Y); while independent variables were: rainfall (X_1), temperature (X_2), sunshine (X_3) and relative humidity (X_4). The result of the analysis is shown in Table 3.

Table-3. Four Functional Forms of Multiple Regression Results on the Effects of climatic factors on Yam Yield in Ebonyi State (2000-2014)

Explanatory variables	Linear function	Semi-log function	Exponential function	Double-log function
Constant	6.004 (3.660)	-3.788 (13.036)	0.867 (0.138)	0.532 (0.492)
Rainfall (mm)	-0.002 (0.004)	-0.712 (13.036)	-9.858 (0.000)	-0.0029 (0.054)
Temperature (^{O}C)	0.189 (0.112)	15.088 (8.846)	0.007 (0.004)	0.541 (0.334)
Sunshine (Hr)	0.312 (0.121)**	4.124 (1.697)**	0.011 (0.005)	0.150 (0.064)
Relative Humidity	0.312 -(0.017)	-4.831 -(3.008)	-0.001 (0.001)	-0.180 (0.114)
Adj R^2	0.374	0.329	0.359	0.314
R^2	0.553*	0.521	0.542	0.510
F-ratio	3.089	2.714	2.964	2.602
Durbin-watson	0.912	0.920	0.865	0.871
S .E .E	0.383	0.396	0.014	0.014

Source: Field Survey Data, 2020.

The results of the four functional forms of multiple regression analysis were analyzed and compared. From all criteria, the linear function was chosen as the lead equation because the value of its coefficient of multiple determination (R^2) was the highest and also most of the variables (independent) conformed to the a priori expectations.

Considering the R^2 of (0.553) and the value of F-ratio (3.089) which denoted a high statistical significant relationship between the explained and the explanatory variables. The value of the R^2 of 0.553 or 55.3% implied that about 55.3% of the fluctuations in the output of yam were explained by the changes in explanatory variables contained in the regression model. This is quite high when compared to Magna et al., 2018 who reported that only 10.6% of the proportion of variation of yam yield was explained by temperature and rainfall during their study period. The F-ratio was statistically significant at 1% and this indicated that the values assumed by the coefficient of the explanatory variables were statistically different from zero. Also, the Durbin-Watson value of 0.912 showed an absence of autocorrelation. The overall performance of the regression model showed that it is statistically reliable.

Rainfall (X_1) was negatively signed and statistically insignificant. This reveal that rainfall adversely affected the yields of yam in the study area. This finding is in agreement with the findings of Olanrewaju [33] who studied the effects of climate change on yam production in Kwara State and identified increased rainfall to be negatively related to yam yield in Kwara State of Nigeria. Similarly, Ayanlade, *et al.* [34] who in their study of inter-annual climate variability on crop yields anomalies observed that variation in rainfall and other climate variables affected yam yields adversely in the middle belt of Nigeria. Yahaya, *et al.* [35] and Mohammed [36] obtained a significant and positive response between rainfall and yam yield in Niger State, Nigeria. This result is in conformity but deviated slightly from the findings of Ayinde, *et al.* [37] which indicated that rainfall was not a significant factor influencing crop yield. It should be noted that well-distributed rainfall provides sufficient water needed by rain-fed lowland yam production prominently cultivated in the study area because yam requires sufficient amount of water for growth and development.

Temperature (X_2) was significant and positively signed meaning that it has positive relation on the yield of yam. This reveals that increasing temperature would lead to increase in yam yield. This agrees with the findings of, Onwubuya and Ajani [38] whose work identified increasing temperature to play a major role in determining the

yield of agricultural crops. The result also conformed to the findings of Ogbuene (2010) that temperature had a positive significant effect on rice yield in Ebonyi state of Nigeria. But, the result contradicted the study of Ater and Aye [39] whose research identified that temperature was negative and significantly related to mean yields of maize and its square is negatively and significantly related to yields. It may be that maize is not in the same family of crops like yam. Also, the study was carried out in a different agro ecological zone. However, the result did not agree with the finding of Nwaiwu [40] that temperature was negatively related to agricultural sustainability and the findings of Ayinde, *et al.* [37] which revealed that temperature was not significant in explaining the effect of climate change on crop production in Niger State. Elijah, *et al.* [5], showed that climate change has no significant effect on the production of certain root and tuber plants in Cross River Sate, Nigeria.

Sunshine hour (X_3) was significant and positively correlated with yam yield; meaning that it has positive relation on the yield of yam. This reveals that adequate sunshine would lead to increased yam productivity. This finding collaborated with the study of Adejuwon [41] who in the study of potential effects of climate change on root crops in Nigeria observed that crop yields were enhanced by adequate solar radiation. Also, Eke-Okoro and Njoku [42] stated that moderate rainfall and sunshine were very important in reducing variations and increasing growth and productivity of cassava. This result disagrees with the finding of Nwaiwu, *et al.* [43] that sunshine hour was inversely related to the sustainability of agricultural production.

Relative Humidity (X_4) bore a negative sign; meaning negative relation to the dependent variable. This means that relative humidity adversely affects the yield of yam in the study area. These results are in line with the findings of International Institute for Tropical Agriculture (IITA) [44] which reported that high humidity and drought may promote the development of specific infection agent and the spread of their associated diseases that lead to decrease in yam yield.

3.4. Adaptation Strategies Adopted by Yam Farmers in the Face of Climatic Factors

The adaptation strategies adopted by yam farmers in the face of climatic factors was examined. The result obtained is shown in Table 4.

Table-4. Distribution of Adaptation Strategies Adopted by Yam Farmers in the Face of Climatic Factors

Adaptation Strategies	Frequency	Percentage
Use of irrigation practices	52	21.67
Construction of local drainage channel	63	26.25
Early land preparation and planting	64	26.67
Adoption of recommended plant spacing	50	20.83
Use of improved yam seedlings	79	32.92
Agro forestry practices	20	8.33
Acceptance of NAIC	25	10.42
Sub-soiling with organic manure	30	12.50
Use of cover crops	42	17.50
Mixed cropping	90	37.50
Adoption of improved farming techniques	87	36.25
Involvement in non-farm business	53	12.08
Diversification to non-crops agro-enterprises	43	17.92
Total change from farming to other occupation	36	15.00
Total	**734***	

Source: Field Survey data, 2020. *Multiple Responses recorded

The result of data analysis in Table 4 revealed that majority (37.50%) and (36.25%) of the yam farmers in Ebonyi State adopted mixed cropping and improved farming techniques as their major adaptation strategy against climatic factors. This implies that mixed cropping and adoption of improved farming techniques were the most adopted strategies by the yam farmers. This could be so because most of the activities of the state ADP is tailored towards adoption of improved farming techniques. This conforms to the work of Ngetich, *et al.* [14] who reported that most yam farmers resort to planting of early maturing cultivars as their most preferred climate adaptation strategies.

In addition, diversification is also another high ranked strategy adopted by most of the respondents (34.58%). This is in line with the findings of Elijah, *et al.* [7], Altieri, *et al.* [45] and Apata, *et al.* [46] who reported that main strategies for reducing environmental effects on crop production is to diversify crop production like soil and water management measures, and plant protection measures that varied to maintain adequate crop yields. Oluwasusi [1], obtained similar results in Ekiti State, Nigeria.

Further analysis revealed that few (15%) and (10.42%) changed from farming to other occupation and as well obtained NAIC certificate as a means of coping with the challenges of environmental factors. The low percentage of the above least items indicate that changing from farming to other occupation was not too common in the area. Also, acquisition of NAIC certificates by the farmers was not too common because the activities of NAIC is only limited to the city where rural farmers may find difficult to access due to distance barrier. This entails that most of the farmers in the study area have made frantic efforts in adopting farming practices which enabled them cope with environmental factors which affect their yam production.

3.5. Constraints Faced by Farmers in Environmental Factors Management

Factor analysis was done to ascertain constraints faced by the yam farmers. The result obtained is shown in Table 5.

Table-5. Varimax Rotated Component Matrix on Constraints to Environmental Factors Management

Variables Names	Factor 1 Socio-economic Constraint	Factor 2 Institutional Constraint	Factor 3 Infrastructural Constraint
High cost of improved varieties of yam	0.234	0.786	0.123
High cost of farm labour	0.594	0.211	0.111
Lack of financial Resources	0.744	0.321	0.218
Poor access to information sources relevant to adaptation	0.949	0.289	0.199
Lack of relevant information on adaptation measures	-0.566	-0.567	0.825
Lack of access to weather forecasts and interpretation	0.122	0.145	0.505
Lack of Irrigation Facilities	0.298	0.188	0.763
Absence/weak Implementation of Government policies	0.288	0.765	0.129
Scarcity and High Cost of Farm Inputs	0.129	0.571	0.256
Lack of Drainage Facilities	0.198	0.288	0.668
Inadequate Extension Services	-0.689	0.453	-0.678
Insecure Land Tenure System	0.567	-0.889	-0.890
Low Management Skills due to low literacy	0.455	0.213	0.234

Source: Field Survey Data, 2020.

From the data obtained through field survey, three (3) major constraints were extracted based on the responses of the respondents. After critical examination, the variables were grouped into three (3) major constraints as component 1 (Socio-economic Constraint), component 2 (Institutional Constraint) and component 3 (Infrastructural Constraint).

The variables that constitute the socio-economic constraints with their construct effect size were: High cost of improved varieties of yam (0.594), lack of financial resources (0.744), poor access to information source relevant to adaptation (0.949), insecure land tenure system (0.567), high cost of labour (0.437) and low management skills due to low literacy level (0.455). This finding corresponds to the work of Ayanwuyi, *et al.* [47] that identified socio-economic constraints such as lack of finance as a constraint to yam production in Oyo State, Nigeria.

Institutional constraints include absence/weak implementation of government policies (0.765), scarcity and high cost of farm inputs (0.571) and inadequate extension services (0.453). This is similar to the finding of Ozor and Nnaji [48] who identified high cost of functional irrigation scheme as a constraint faced by farmers in Enugu State, Nigeria. This also agrees with Obianefo, *et al.* [49] who reported that inadequate extension services militate against adoption og good agronomic practices by rice farmers in Anambra State, Nigeria.

The infrastructural constraints were identified as lack of relevant information on adaptation measures (0.825), lack of access to weather forecasts (0.505) and lack of drainage facilities (0.668). All these resulted due to unavailability of infrastructures relevant for mitigating environmental factors in the study area**.** The result of this study has shown that smallholder farmers are faced with multiple constraints that are contributing to low adaptive capacity [50]. Similarly, Barbier, *et al.* [51] carried out a research in Burkina Faso; it became apparent that insufficient rural infrastructure was a major factor limiting increases in crop production. The findings of this study further corroborates with the works of Ajijola, *et al.* [18] and Maikasuwa and Ala [13].

3.5.1. Test of Hypothesis

The null hypothesis which stated that the environmental factors such as rainfall, temperature, sunshine, relative humidity do not influence yam yield in Ebonyi State was tested using F-test at 0.05 level of significance as shown:

F-critical

V1 = N-K = 240 – 5 = 235

V2 = K-1 = 5-1 = 4

F-tab = 2.14

Where:

N = Number of respondents

K = Number of variables

3.5.2. Decision Rule

If F-cal is greater than F-tab, reject the null hypothesis, otherwise accept its alternative. Since F-cal (3.089) is greater than F-tab (2.14). The null hypothesis was rejected; while its alternative was accepted. This implies that the environmental factors considered in this study statistically influence the yield of yam in the study area.

4. Conclusion and Recommendations

This study has shown that environmental factors such as rainfall, temperature, sunshine, relative humidity among others influence yam production in the study area. Farmers in their effort to cushion the effects of these factors usually adopt proven techniques such as early land preparation and planting, mixed cropping, use of cover crops among others. But, socio-economic, institutional and infrastructural constraints limit yam farmers' effort in mitigating environmental factors.

Based on the findings of this study, the following recommendations were made:

- The socio-economic status of the yam farmers should be enhanced to enable them afford and adopt proven technologies that would mitigate environmental factors.
- All available sources of information on environmental factors should be embraced and enhanced for fast spread of information to the farmers.
- Extension agents who are in close touch with the yam farmers should be trained on interpretation of weather forecasts so as to disseminate same to their farmers.
- Government and its agencies should provide physical infrastructures such as drainage, irrigation and storage facilities to enable yam farmers adapt to environmental factors.
- Farmers should be encouraged to actively participate in cooperative societies to facilitate access to credit, market and agro-based information.
- Climatic data should be made available to extension agents who should be trained on its interpretation and result made available to all yam farmers in the state.

References

[1] Oluwasusi, J. O., 2013. "Farmers adaptation strategies to the effect of climate change variation on yam production in ekiti state, Nigeria." *Journal of Food, Agriculture and Environment,* vol. 11, pp. 724-728.

[2] Osuafor, O. O., Obianefo, C. A., and Dike, A. B., 2020. "Food security and poverty status of cassava processors in awka north local government area of anambra state of Nigeria." *The Bangladesh Journal of Agricultural Economics,* vol. 41, pp. 1-16.

[3] Onyekwe, N. C., Osuafor, O. O., Ude, K. D., and Onwuemelie, C. P., 2021. "Level of awareness and climate-smart agricultural technologies used by rice farmers in south-east, Nigeria." In *Being a paper presented at the 54th Annual Conference of the Agricultural Society of Nigeria. Theme: Climate smart agriculture and agribusiness development in Nigeria, held from 31st Jan -4th Feb. 199-206.*

[4] Anarah, S. E., Ezeano, C. I., and Osuafor, O. O., 2019. "Perceived effects of climate variability on cassava production among small scale farmers in Anambra State, Nigeria." *Journal of Agricultural Studies,* vol. 7, pp. 27-43.

[5] Elijah, S. T., Osuafor, O. O., and Anarah, S. E., 2018. "Effects of Climate Change on yam production in Cross River State, Nigeria." *International Journal of Agriculture and Forestry,* vol. 8, pp. 104-111.

[6] Ibok., O. W., Ekanem, J. T., and Umoh, I. U., 2015. "Factors influencing the utilization of agricultural extension technologies by yam farmers in Yakurr LGA of Cross River State, Nigeria." *Journal of Basic and Applied Research International,* vol. 5, pp. 100-109.

[7] Elijah, S. T., Osuafor, O. O., and Edeh, O. C., 2020. "Yam farmers' adaptation practices towards climate change disaster in cross river state, Nigeria." *American International Journal of Agricultural Studies,* vol. 3, pp. 1-13.

[8] Verter, N. and Becvarova, V., 2014. "Yam production as pillar for food security in logo local government area of benue state, Nigeria." *European Scientific Journal,* vol. 10, pp. 27-42.

[9] Ipilakyaa, T. D., Yanshio, E. T., and Gundu, D. T., 2017. "Design, construction and testing of a motorized tuber chipping machine." *European Journal of Advances in Engineering and Technology,* vol. 4, pp. 492-496.

[10] Asumugha, G. N., Lemka, D. M., Njoku, M. E., Ogbonna, M. C., Okoye, B. C., Dung, E., Amaefula, A., and Nwosu, K. I., 2009. "An analysis of the efficiency of the marketing system for yams in Nigeria." *Definitive Trends for Food Systems in Latin America,* vol. 1, pp. 39-45.

[11] Bergh, K., Orozco, P., Gugerty, M. K., and Anderson, L., 2012. "Sweet Potato Value Chain: Nigeria." Evans School Policy Analysis and research (EPAR), Brief No. 220."

[12] Mbah, S. O., 2021. "Effects of rural-urban migration on yam production in ezza south local government area of ebonyi state, Nigeria." *International Journal of Agriculture and Rural Development,* vol. 24, pp. 5764-5773.

[13] Maikasuwa, M. A. and Ala, A. L., 2012. "Determination of profitability and resource-use efficiency of yam production by women in bosso local government area of niger state, Nigeria." *Journal of Agriculture and Environmental Sciences,* vol. 1, pp. 19-25.

[14] Ngetich, F. K., Mairura, F. S., Musafiri, C. M., Kiboi, M. N., and Shisanya, C. A., 2022. "Smallholders' coping strategies in response to climate variability in semi-arid agro-ecozones of Upper Eastern Kenya." *Social Sciences and Humanities Open,* vol. 6, pp. 1-14.

[15] Ojemade, A. C., Osuafor, O. O., Bankole, A. S., Akagbosu, B. E., and Osifo, M., 2018. "Climate Change Awareness and Perception among Oil Palm Farmers in Abia state, Nigeria." In *Being a paper presented in the 52nd Annual Conference of Agricultural Society of Nigeria. Theme: Sustainable Strategies for Enhancing Food Security & Livelihoods in Nigeria, from 22-26 October, ARCN, Abuja.*

[16] Zilberman, D., Zhao, J., and Heirman, A., 2012. "Adoption versus adaptation with emphasis on climate change." *Annual Review of Resource Economics*, vol. 4, pp. 27-53.
[17] Egbeadumah, M. O., Akeredolu, T. D., Olayiwola, S. A., Zarewa, M. N., and Amos, G. T., 2022. "Economic analysis of yam production in Ibi Local Government Area of Taraba State, Nigeria." *Academic Journal*, vol. 7, pp. 24-30.
[18] Ajijola, S., Awoyemi, T. T., Oluwatayo, I. B., Aduramigba-Modupe, V. O., and Odetola, S. K., 2014. "Resource use and economic efficiency for yam production in Oyo State, Nigeria." *European Journal of Physical and Agricultural Sciences*, vol. 2, pp. 39-43.
[19] Idumah, F. O. and Owombo, P. T., 2019. "Determinants of yam production and resource use efficiency under agroforestry system in edo state, Nigeria." *Tanzania Journal of Agricultural Sciences*, vol. 18, pp. 35-42.
[20] Ebonyi State Ministry of Information EBMOI, 2005. "Ebonyi State Ministry of Information Diary. A publication of the Ministry of Information, Abakaliki, Ebonyi State."
[21] Chukwu, V. A. and Osuafor, O. O., 2016. "Socio-economic determinants of adoption of improved rice production technologies among rice farmers in Ebonyi State, Nigeria: A logit regression model approach." *Contemporary Journal of Arts and Sciences*, vol. 5, pp. 158-175.
[22] Bello, N. J., 2010. "Climate change: Implications for food production and security in Nigeria, A special book on climate change, NMets." pp. 1-14.
[23] Falola, A., Salami, M. F., Bello, A. A., and Olaoye, T. A., 2017. "Effect of yam storage techniques usage on farm income in Kwara State, Nigeria." *Agrosearch*, vol. 17, pp. 54-65.
[24] Ugwoke, F. O., Nnadi, F. N., Anaeto, C. F., Aja, O. O., and Nwakwasi, R. N., 2012. "Crop Farmers' Perception of and Adaptation to Climate Change in Orlu Agricultural Zone of Imo State, Nigeria." *Journal of Agricultural Extension*, vol. 16, pp. 22-23.
[25] Traoré, L., Bello, O. D., Togola, A., Balogoun, I., Chabi, F., Yabi, I., Ahoton, E. L., and Saïdou, A., 2013. "Farmers' perceptions of climate change and adaptation strategies on sorghum productivity in the Sudanian and Sahelian Zones of Mali." *African Crop Science Journal*, vol. 29, pp. 157-175.
[26] Hassan, R. M. and Nhemachena, C., 2008. "Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis." *African Journal of Agricultural and Resource Economics*, vol. 2, pp. 83-104.
[27] Maddison, D., 2006. *The perception of and adaptation to climate change in Africa. Ceepa discussion paper no 10. Centre for environmental economics and policy in Africa*. South Africa: University of Pretoria, Pretoria.
[28] Enete, A. A. and Onyekuru, A. N., 2011. "Challenges of Agricultural Adaptaion to climate change. Empirical evidence from Southeast Nigeria." *Tropicultura*, vol. 29, pp. 243-249.
[29] Enete, A. A., Madu, I. I., Mojekwu, J. C., Onyekuru, A. N., A., O. E., and Eze, F., 2011. "Indigenous Agricultural Adaptation to climate change: study of south east Nigeria. African technology policy studies research Network. No6."
[30] Ishaya, S. and Abaje, I. B., 2008. "Indigenous people's perception on climate change and adaptation strategies in Jema'a local government area of Kaduna State, Nigeria." *Journal of Geography and Regional Planning*, vol. 1, pp. 138-143.
[31] Churi, A. J., Mlozi, M. R. S., Tumbo, S. D., and Casmir, R., 2012. "Understanding farmers information communication strategies for managing climate risks in rural semi-arid areas, Tanzania." *International Journal of Information and Communication Technology Research*, vol. 2, pp. 838-845.
[32] Tambo, J. A. and Abdoulaye, T., 2012. "Smallholder farmers' perceptions of and adaptations to climate change in the Nigerian savanna." *Regional Environmental Change*, vol. 13, pp. 375-388.
[33] Olanrewaju, R. M., 2010. "Effect of Climate Change on Yam Production in Kwara State, Nigeria." *Environmental*, pp. 302-34.
[34] Ayanlade, A., Odekunle, T. O., Orinmogunje, O. I., and Adeoye, N. O., 2009. "Inter annual climate variability and crop yields anomalies in middle belt of Nigeria." *Advances in Natural and Applied Science*, vol. 3, pp. 452-465.
[35] Yahaya, T. I., Tsado, E. K., and Odinukaeze, N. E., 2014. "Effect of rainfall variation on yam production in Kuta, Shiroro Local Government area of Niger State, Nigeria." *IOSR Journal of Environmental Science Toxicology and Food Technology*, vol. 48, pp. 51-58.
[36] Mohammed, J. M., 2018. "Effect of Rainfall Trend on yam yield in Mokwa Local Goversnment Area of Niger State, Nigeria." *Environmental Analysis and Ecological Studies*, pp. 50-55.
[37] Ayinde, O. E., Ojehomon, V. E. T., Dara Mola, F. S., and Falaki, A. A., 2013. "Evaluation of the effect of climate change on Rice in Niger State, Nigeria." *Ethiopian Journal of Environmental Studies and Management*, vol. 6, pp. 771-780.
[38] Onwubuya, E. A. and Ajani, E. N., 2012. "Strategies for improving production and processing of cocoyam among farmers in Anambra state, Nigeria." *Universal Journal of Education and General Studies*, vol. 1, pp. 169-173.
[39] Ater, P. I. and Aye, G. C., 2012. "Economic impact of climate change on Nigeria maize sector: a Ricardian analysis. In C.A. Brebbia and T.S. Chon." *Environment Impact*, vol. 162, pp. 231-239.
[40] Nwaiwu, 2014. "International Institute for Tropical Agriculture (IITA) 2009. Yam (*Dioscorea* species)." Available: http:// www.iita.org/yam

[41] Adejuwon, J. O., 2006. "Food crop production in Nigeria II: Potentials effect of climate change." *Climate Research Journal,* vol. 32, pp. 229-245.

[42] Eke-Okoro, O. N. and Njoku, D. N., 2012. "A review of cassava development in Nigeria from 1940-2010." *Journal of Agricultural and Biological Science,* vol. 7, pp. 59-65.

[43] Nwaiwu, U. O., Orebiyi, J. S., Ohajianya, D. O., Ibekwe, U. C., Onyeagocha, S. U. O., Henri-Ukoha, A., Osuji, M. N., and Tasie, C. M., 2014. "The effects of climate change on agricultural sustainability in Southeast Nigeria: Implications for food security." *Asian Journal of Agricultural Extension, Economics & Sociology,* vol. 3, pp. 23-36.

[44] International Institute for Tropical Agriculture (IITA), 2009. "Yam (Dioscorea species)." Available: http://www.iita.org/yam

[45] Altieri, M. A., Nicholls, C. I., Henao, A., and Lana, M. A., 2015. "Agroecology and the design of climate change-resilient farming systems." *Agronomy for Sustainable Development,* vol. 35, pp. 869-890.

[46] Apata, T. G., Samuel, K. D., and Adeda, A. O., 2009. "Analysis of climate change perception and adaptation among arable food crop farmers in southwestern Nigeria." In *Paper presented at the Conference of International Association of Agricultural Economics.* pp. 2-9.

[47] Ayanwuyi, E., Akinboye, A. O., and Oyetoro, J. O., 2011. "Yam production in Orire Local Government Area of Oyo State, Nigeria: Farmers Perceived Constraints." *World Journal of Young Researchers,* vol. 1, pp. 16-19.

[48] Ozor, N. and Nnaji, C., 2010. "Difficulties in adaptation to climate change by farmers in Enugu State, Nigeria." *Journal of Agricultural Extension,* vol. 14, pp. 106-122.

[49] Obianefo, C. A., Okoroji, N. O., Obiekwe, N. J., Osuafor, O. O., and Shah, Z. A., 2022. "Economics of good agronomic practices adotion by rice farmers in value chain development programme, anambra state, Nigeria." *African Journal of Food, Agriculture Nutrition and Development,* vol. 22, pp. 21308-21330.

[50] Ericksen, S., Aldunce, P., Bahinipati, C. S., Martins, R. D., Molefe, J. I., Nhemachena, C., O'brien, K., Olorunfem, F., Park, J., *et al.*, 2011. "When not every response to climate change is a good one: Identifying principles for sustainable adaptation." *Climate and Development,* vol. 3, pp. 7-20.

[51] Barbier, B. H., Yacouba, H., Karambiri, M., and Zorome, B., 2009. "Human Vulnerability to climate variability in the Sahel Farmer's adaptation strategies in Northern Burkina Faso." *Environmental Management,* vol. 43, pp. 790-803.