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Effect of climate change adaptation on sweet potatoes and three-leaved yam production in Bende Local Government Area of Abia State, Nigeria

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ABSTRACT

Irregular pattern in weather conditions is more frequent than ever in the changing climate scenario across the globe. Developing countries like Nigeria often depend on rainwater for crop production. However, unpredictable changes in the onset of rains in the last 10 years are contributing to crop failure. This is because crops planted with the arrival of early rains get smothered in the soil by an unexpected prolonged dry period. Farmers are now adopting several adaptation options in order to cushion the negative impacts posed by climate change. This study focused on the effects of climate change adaptation strategies on sweet potatoes and three-leaved yam intercrop production in Bende Local Government Area of Abia State, Nigeria. The study utilized primary data generated using questionnaire and personal interview schedule. Eleven (11) communities were randomly selected from the study area and 6 sweet potatoes and three-leaved yam farmers were randomly selected from each community giving 66 farmers. Descriptive statistics and multiple regression models were the analytical tools used. The results showed that major adaptation practices adopted by farmers include: mulching, irrigation practice, fertilizer application, mounds making and use of improved crop varieties for planting. Regression result showed that irrigation practices, mounds making, use of improved crop varieties, early planting and late planting positively influenced sweet potatoes and three-leaved yam yield at 5% level while labour had a negative influence on the crop yield at 5% level. Farmers should adopt the use of improved crop varieties for planting, adopt early planting in coping as an adaptation measure to reduce the negative effects of climate change.

Keywords: Climate change, adaptation options, sweet potatoes, three-leaved yam, intercrop

INTRODUCTION

Agriculture plays an important role in the life of people in Nigeria in terms of provision of food, employment, raw materials for industries (Apata, Samuel and Adeola, 2009). Agriculture contributes over 40% of Nigeria's GDP, employs about 70% of the population, and produces about 80% of the food needs (Aye, 2013).

In Nigeria, rainfall pattern has already altered, affecting commencement of the planting season and resulting in poor harvest yields. Although IPCC projections suggest that rainfall in southern Nigeria will increase [Intergovernmental Panel on climate change (IPCC) (2001)], the simultaneous increase in temperature may increase evaporation and

potential evapo-transpiration, leading to a tendency towards droughts. Indeed, recent studies indicate a 10-25% decrease in precipitation in southern Nigeria since the beginning of the century. If this trend persists, rainfall in the humid regions of southern Nigeria may be about 50% to 80% of the 1900 values by 2100 (Adejuwon, (2004). Such periods 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 times of food crisis.

Given the fundamental role of Agriculture in human welfare, concerns have been expressed by federal agencies and others regarding to the potential effects of climate change on agricultural productivity (Federal Ministry of Information and Culture, 2016, Mbah, Ezeano and Saror, (2016). A two-day South-south regional intensive training workshop organized by Department of Climate Change under the Federal Ministry of Environment and the National Planning Commission (NPC) in collaboration with the United Nations Development Program (UNDP) held in Calabar in 2016 (Beyioku, 2016), to strengthen stakeholders capacity towards mainstreaming climate change into state development plans. It was noted that climate change has become a threat to the environment and economy in ways that would affect and impact the various sector if left unchecked. They concluded that climate change is a development issue and should be mainstreamed into various sectors of national, regional and state development plans. According to Mbah., Ezeano and Saror, (2016), climate change affects crop and livestock production, input supplies and other components of agricultural systems. This is posing serious threats to food security in the country. However, the Federal government attempting to tackle challenges posed by climate change, had proactively taken steps in addressing environmental problems. These include effective management of waste, flood and coastal erosion. It has also built up our advocacy programmes through workshops, seminars, public lectures, media campaign, climate change and waste water summits, tree planting land reclamation, landscaping and beautification, campaign against desertification through the desert warriors, and control of land, water, noise and air pollution (Beyioku, 2016). There is also a growing awareness on issues of climate change which is presently at low ebb especially amongst vulnerable groups like women, children, even at the grassroots, especially rural dwellers, as well as reviving the tree planting program by raising awareness for individuals to plant trees.

Climate in a narrow sense is usually defined as the average weather condition of a particular place or geographical area over a long period of time from months to thousands or millions of years. The classical period is 30 years, as defined by World Meteorological Organization (WMO) (Intergovernmental Panel on Climate Change (2007).Climate change which is an attribute to the natural climate cycle and human activities, has adversely affected agricultural productivity in Africa(Tachie-obeng, et al., 2010). As the planet warms, rainfall pattern shift, and extreme event such as drought, floods become more frequent (Zoellick 2009 in Enete and Amusa, 2010), which results in poor and unpredictable yields, thereby making farmers more vulnerable particularly in Nigeria.

Climate effects can influence farming output at any stage of cultivation. Even if there is sufficient rain, its irregularity can affect yields adversely if rain fails to arrive during the crucial growing stage of the crops (Molua and Lambi, 2007; Rudolf and

Hermann, 2009). Adaptation is therefore considered a feasible option in reducing vulnerability and associated negative climate change effects (Jones, 2010 in Mustapha, Undiandeye and Gwary, 2012). Adaptation to climate change as defined by IPCC (2001) is an adjustment in ecological, structures, social or economic systems in response to actual or expected climatic stimuli and their effects or impacts. In other words, adaptation methods are those strategies that enable farmers to cope with or adjust to the impact of unfavourable climate conditions (Mustapha, Undiandeye and Gwary, 2012). Such strategies include planting early maturing crops, mulching, adoption of drought resistance varieties, changing planting dates, adoption of mixed crop and farming system etc (Onyeneke and Madukwe, 2010).

Climate change is affecting local farmers in Bende Local Government Area of Abia State. Production of three leaved yam and sweet potatoes crops like every other crop is also affected by factors varying from physical, economic to cultural (Obiokoro, 2005). Climate, one of the physical factors, is the most crucial factor, which determines the nature of the natural vegetation, the characteristics of the soils, the crops that can be grown, and the type of farming and cultural practices that could adopted in any region (Obiokoro, 2005). The most important climatic elements for crop growth and yield are radiant energy, or solar radiation, temperature and water or rainfall (Ekaputa, 2004). Solar radiation in turn determines the thermal characteristics of the environment, namely net radiation, day-length or photoperiod, the air and soil temperatures (Fu, Kikuno, and Maruyama, 2011). Soil and air temperatures also affect the developmental stages more than any other factor (Ayoade, 2004). Irregular pattern in rainfall experienced especially in the southern Nigeria worsen by unpredictable period of dry season is a major problem of farmers especially sweet potato and three leaved yam farmers in Bende LGA in Abia State. Crop farming being their major livelihood activities is threated by negative effects of climate change like pest and diseases infestation, prolonged dry season etc. Thus, there is need for adaptation strategies to be undertaken (Chanwali 2000, in Balama, et al., 2013). Climate change scenario makes farmers face prospects of tragic crop failures, reduced agricultural productivity, increased hunger, malnutrition and diseases (Zoellick, 2009 in Enete and Amusa, 2010). It is projected that crop yield in Nigeria may fall by 10- 20% by 2050 or even up to 50% due to climate change (Jones and Thornton, 2003) particularly because Nigerian agriculture is predominantly rain fed and hence dependent on the vagaries of weather. In Bende Local Government Area of Abia State, sweet potatoes are usually planted in crop mixture and mostly intercropped with three-leaved yam. Sweet potato is a warm-season, spreading vegetable of tropical origin. It is a good choice for a garden because it is easy to grow, is drought and heat-tolerant, and has few pests or diseases (Ecocrop, 2010). Sweet potato (Ipomoea batatas) belongs to the family convolvulaceae (Woolfe, 1992). It is an important food crop of both tropical and sub-tropical regions with a cultivation spread across 100 countries (Nwaru, 2003). Its production is becoming popular in Nigeria especially in southern Nigeria. Sweet potato is cultivated as a perennial in tropical and can be grown with temperature between 15°C and 35°C (Heuzé et. al, 2015). However, lower and higher temperatures have detrimental effects on the crop yield. This is because sweet potatoes

grow best in a sandy loam, well-drained soil. It is a staple root crop, very nutritious and low in calories, rich source of energy and vitamin A.

Three-leaved yam on the other hand is one of the 6 species of yam cultivated in Nigeria (Fasaanu, Oziegbe, and Oyedapo, 2013). It is in the class of roots and tubers that is a staple in the Nigerian and West African diet. These annual crops seasonally crops are cultivated and consumed in many parts of Nigeria and Abia state.

Sweet potato/ three-leaved yam are grown together as intercrop. Sweet potatoes and three leaved yam are intercropped to give higher income, improve soil mate content, maintain soil fertility as the nutrient uptake is made from both layers. It acts as an insurance against failure of crop in abnormal year. Farmers are not exempted from changing climate effects. Small holder farmers in the area are applying some measures to combat and adapt to the climate change farm production problems. Some of these measures include; altering of the timing or the use of improved water management using technologies, conserve soil moisture and use water more effectively, disease and weed management practices etc. It is expected that measures adopted by farmers to reduce climate change variations would help reduce the negative impacts on crops at the same time increase farm yield. It is on this background the study analysed the effects of climate change adaptation measures on sweet potato and three-leaved yam production in Bende L.G.A of Abia State. Specifically, the study:

1. identified climate change adaptation measures used by sweet potato and three-leaved yam farmers in the study area;
2. estimated the effects of climate change adaptation measures on the sweet potatoes and three-leaved yam intercrop production; and
3. identified constraints farmers face while adapting to climate change.

MATERIALS AND METHODS

Area of Study

This study was conducted in Bende Local Government Area of Abia State in Nigeria. The LGA is made up of 11 communities namely. Itumbauzo,Uzuakoli, Umuhu-Ezechi, Nkpa, Ozui-Item Umu-menyi, Igbere, Alayi, Ugwueke, and Item. It has a total population of 192, 621 people (National Population Commission (NPC), 2006). The LGA occupies a total land area of 46,053km^2 with coordinates latitude of 5°34'59" (5.6497) North and longitude of 7°35'24" (7.59°) East. Two major climatic sessions in the study area include rainy session (which last between March and October) and dry session (usually between November and February). The people cultivate yam, cassava, cocoyam, three leaved yams, potato and oil palm.

Sample Size and Sampling Techniques

Multi-stage sampling technique was adopted in the selection of the respondents. Eleven communities were randomly selected from each of the LGAs; were further selected from each community giving a total of 66 respondents.

Method of Data Collection

Data used for the study was collected from primary source with of structured questionnaire and oral interview in the 2016 farm production year.

Method of Data Analysis

Objectives i, ii, and iv were analysed using descriptive statistics including frequency, percentage, mean scores. Objective iii was analysed using multiple regression model.

Model Specification

Climate change adaptation measures was determined using mean score of some selected variables. Decision rule:4+3+2+1=10. 10÷ 4= 2.5: Mean ≥ 2.5 Accept as adaptation measure if mean ranks ≥ 2.5, reject as adaptation measure if mean rank≤ 2.4

Decision rule for constraints to adaptation of climate change measures**:** Accept as adaptation measure if mean rank equal 2.5 and above, reject as adaptation measure if mean rank 2.4 and less than 2.

Multiple Regression Model

Implicitly, the function is represented thus:

$Y = f(X_1+X_2+X_3+X_4+X_5+X_6 \ldots+X_7) +e$

The explicit function of the linear regression is as follows

$Y = \beta_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\beta_4 X_4+\beta_5 X_5+\beta_6 X_6 +\beta_7 X_7+e$

Where;

Y= Sweet potato yield + three-leaved yam yield (Kg/ ha)

b_0= Intercept

$\beta_1 - \beta_7$ Regression coefficients

X_1= Mulching (dummy 1 or 0)

X_2 = Irrigation practices or watering (dummy 1 or 0)

X_3= Fertilizer (Kg)

X_4 = Mounds (dummy 1 or 0)

X_5= Labor (Man / hour)

X_6 = Planting material varieties (Improved = 1, local = 0)

X_7 = Time of planting (dummy early planting = 1, late season = 2)

Functional Forms

Linear Equation

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e$

Semi - log

$Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \text{ Log } X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + \beta_6 \log X_6 + \beta_7 \log X_7 + e$

Double Log

$\text{Log } Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \text{ Log } X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + \beta_6 \log X_6 + \beta_7 \log X_7 + e$

RESULTS

The Socio-economic characteristics of respondents are presented in Table 1 which showed gender, age, marital status, educational status, occupation, head of household, farming experience and farm size. Table 1shows that majority 52.3 % of the farmers were females while males accounted for 47.7%. Majority 44.45% of the respondents attained primary school education and 24.6% of them had been doing farming business between 11-15 years.

Table 1: Socio-economic characteristics of respondents

Variables	Frequency (66)	Percentage
Sex		
Male	31	46.96
Female	41	62.12
Age in years		
21-30	26	39.39
31-40	27	40.91
41-50	8	12.12
51-60	2	3.03
61-70	3	4.55
Marital status in number		
Single	12	18.18
Married	50	75.76
Divorced	1	1.52
Widowed	3	4.55
Educational level		
Non formal education	10	15.15
Primary school	30	45.45
Secondary school level	19	28.79
Tertiary education	7	10.61
Occupation		
Farming only	27	40.91
Farming and trading	23	34.85
Farming and sewing	2	3.03
Farming and carpentry	1	1.52
Farming and others	12	18.18
Farming, trading and others	1	1.52
Household size in persons		
1-5	28	13.64
6-10	36	45.45
>11	2	24.24
Farming experience in years		
>5	9	13.64
6-10	30	45.45
11-15	16	24.24
16-20	6	9.09
>20	5	7.58
Farm size in hectares		
<0.1 hectare	24	36.36
0.1-0.9	4	6.06
1.0-1.9	5	7.58
2.0-2.9	16	24.24
>2.9 hectare	17	25.76
Total	66	100

Source: Field study, 2016.

The adaptation measures to climate change used by farmers in the area as indicated by the data (Table 2) were mulching, mounds making, early planting, irrigation practice, fertilizer application, use of improved crop varieties which showed a mean rank score of greater than 2.5. Late season planting had mean rank score of 2.1 is an indication that variable is not a common adaptation measure used by farmers in the area.

Table 2: Climate change adaptation measures used by sweet potato and three leaved yam farmers in the study area.

S/N	Adaptation measures	Total rank score	Mean rank score	Remark
1.	Mulching	240	3.692	Practiced
2.	Irrigation practice	218	3.354	Practiced
3.	Fertilizer application	218	3.354	Practiced
4.	Mounds	288	3.508	Practiced
5.	Improved varieties	194	2.985	Practiced
6.	Early planting	244	3.754	Practiced
7.	Late season planting	137	2.108	Not practiced

Source: Field study, 2016.

Table 3 showed the extent farmers applied adaptation to climate change strategies in cushioning the effects of climate on sweet potatoes and three leaved yam production. Data showed that 90. 90% of the farmers reported that early planting as a climate change adaptation strategy was very effective while 60.60% of farmers agreed that late season planting as an adaptation strategy was fairly effective in reducing climate change negative effects.

Table 3: Famers adaptation strategies and their effectiveness

Variables	Very greatly effective Frequency (%)	Greatly effective Frequency (%)	Moderately effective Frequency (%)	Fairly effective Frequency (%)
Mulching	46 (69.70)	10 (15.15)	6 (9.09)	4(6.06)
Irrigation practice	25 (37.88)	32 (48.48)	7 (10.60)	2 (3.03)
Fertilizer application	47 (71.21)	12 (18.18)	6 (9.09)	1 (1.52)
Mounds making	55 (83.33)	7 (10.60)	3 (4.55)	1 (1.52)
Improved varieties	34 (51.51)	20 (30.30)	12 (18.18)	4 (6.06)
Early planting	60 (90.90)	2 (3,03)	3 (4.55)	1 (1.52)
Late season planting	2 (3.03)	8(12.12)	16 (24.24)	40 (60.60)

Source: Data from field survey, 2016.

Regression result in Table 4 showed that the coefficients of irrigation practices, mounds making, early planting and late planting positively influenced sweet potatoes and three-leaved yam yield at 5% level of significance. Use of improved crop varieties positively influenced yield at 1% level of significant while quantity of labour had negative influence on the crop yield at 1% level of significance.

Table 4: OLS results of the climate change adaptation strategies on sweet potatoes and three leaved yam yield.

Variables	Linear	Semi-log	Double-log
Constant	66.689	133.061	2.605
	(0.836)	(1.736)	(3.433)
Mulching	-0.516	-0.628	-3.046
	(-2.901)	(-3.422)***	(-3.603)
Irrigation practices	-0.045	0.086	0.168
	(0.364)	(0.726)	(0.592)
Fertilizer	-0.049	-0.106	0.067
application	(-0.413)	(-0.911)	(0.248)
Mounds making	0.074	0.073	-0.222
	(0.618)	(0.641)**	(-0.622)
Labour in manday	-0.377	-0.323	-0.722
	(-3.085)	(-2.868)***	(-2.841)
Improved planting	0.518	0.560	1.335
varieties	(3.611)	(3.561)***	(3.955)
Early planting	0.233	0.216	0.70.6
	(1.881)	(1.807)**	(1.469)
Late planting	0.378	0.308	0.364
	(2.548)	(2.110)**	(1.267)
R^2	0.385	O.404	0.377
F-ratio	4.379	4.738	4.234
Significant variables	4	4	3
Standard error estimated	37.85668	37.27306	0.36888

Source: Field survey, 2016 and SPSS result**significant at 5% level. ***significant at 1%

Data in Table 5 showed that improved crop varieties, high cost of fertilizers, irrigation facilities, poor government intervention, illiteracy, lack of extension programmes, culture, cost of labour etc had mean rank score of 2.5 and above and were indicated as constraints faced by farmers in adapting to climate change scenarios.

Table 5: Constraints faced by farmers in using adaptation measures to climate change

S/N	Constraints	Total rank score	Mean score	Rank	Remark
1.	High cost of improved crop varieties	214	3.29		Yes
2.	High cost of irrigation	255	3.92		Yes
3.	Poor government Intervention	213	3.28		Yes
4.	Illiteracy problem	253	3.89		Yes
5.	Inadequate extension service	248	3.82		Yes
6.	Cultural belief	204	3.24		Yes
7.	Cost of labour	219	3.37		Yes
8.	Late maturity	221	3.40		Yes
9.	Rotting of crops	243	3.74		Yes
10.	Disease infestation	235	3.62		Yes
11.	Increase population	179	2.75		Yes
12.	High temperature	250	3.85		Yes
13.	Runoff of soil nutrient	245	3.77		Yes
14.	Inadequate water supply	247	3.80		Yes

Data computed from field survey, 2016

DISCUSSION

Data in Table 1 shows that majority 62.12% of the farmers were females while males accounted for 37.88% and mainly married people with 75.76%. This implies that more females than males were engaged in sweet potatoes and three-leaved yam production in the study area. This is in conformity with the finding of (Prakash, 2003) study, which reported that women were more involved in food production than their men counterpart in India. It was also observed that 40.91% of the respondents were in the age bracket of age bracket of 31- 40 years. This dominant age bracket 31- 40 years is an indication that the farming population are mainly youths in their active age and therefore would possess physical strength required in doing farming business. Data on the age distribution showed that 39.39% of the farmers within age bracket 21- 30 years.

The result further indicated that majority (44.6%) had primary education while only 15.4% of them had no formal education. It is implied that majority of them were educated. Hence farmers with good education would be able to acquire good managerial ability and would be receptive to adopting innovation in their farm business which is expected to help improve their farm production activities and output.

The data further indicated farming was indicated as their primary occupation with 40%. Data also showed that farmers who combined farming with petty trading business was 35.4%. This is an indication that farmers are increasingly participating in other economic activities that would attract additional income to them. It was noted that family size of 6-10 persons was 54% while that of 1-5 persons was 43.1%. Large family size in the area is an indication of availability of family labour in the area. This implies that family members would assist in carrying out climate change adaptation activities. This is so, because it is a practice

in Africa especially in Nigeria that family members help in doing family businesses.

Experience is an important variable in considering adaptation options to climate change would reduce its effects on crop yield. It was observed that 24.6% of the farmers spent 11-15 years in doing farming business and only 7.7% had more than 20 years of experience. Since majority of the farmers had been doing farming business for more than15 years, it is possible that they would have acquired ample experience in farming which is expected to help improve in adapting to climate change. The result further showed that 35. 4% of the respondents cultivated farmland which less than 0.1 hectares during the study period. This could be explained by the fact that female dominated the farming population. The small farm plots cultivated could also be due to land tenure arrangement in most of the communities in Nigeria that impose restrictions on farmers cultivating large portion of land.

The result in Table 02, shows that mulching, mounds making, early planting, irrigation practice, fertilizer application, use of improved crop varieties had mean rank score of greater than 2.5. This supports the findings by Onyeneke and Madukwe, (2010) who argued that climate change adaptation strategies used by farmers include planting early maturing crops, mulching, adoption of drought resistance varieties, changing planting dates, adoption of mixed crop and farming system. The study showed that farmers applied more quantity of mulch materials to reduce loss of water from the soil which is evaporation. In terms of mounds making, the height and sizes of mounds for planting were increased and mulch materials placed on them after planting.

Irrigation practice was adopted as a climate change option. It showed a mean value of 3.354, an indication that it was practiced as adaptation measure. This is could be so, because 90.90% of the farmers reported that they carried out early planting as an adaptation to climate change. Farmers may have experienced problems of water supply to their crops due mainly to delay in rainfall during the planting season. This could be responsible for the use of irrigation practice as a means of water supply to the crops. It was observed that watering cans were mainly used for water supply in the farms.

The variable ‘early planting’ which was planting between ‘January to March’ of the cropping season showed a mean of 3.754 which is classified as climate change adaptation measure. Planting crops in the early season was mainly due to early rainfall experienced in the area which was not sustained. This prompted the use of irrigation practice during the period. Farmers also reported that they planted crops during the early planting season period to enable cultivated crops benefit from rainfall water supply to their crops.

Mulching was highly practiced as adaptation measure by the farmers. They explained that prolong, and intensive dry season lead to stress in the crop due to inadequate water supply for the crop growth and development. Applying mulch materials on the soil do not only reduce evaporation of water from the soil but also help to improve the soil organic matter content needed for plant growth. It was a common practice adopted by the farmers in the area which involved the use of plant materials on the soil to reduce soil water loss.

Late season planting is planting of crops between May and June during the cropping season. This happens when there is

prolonged dry season or delay in rainfall at the beginning of the year. Late season planting was adopted by farmers as an adaptation option by the farmers showed a mean rank score of 2.1. It is an indication that late season planting was not a common adaptation measure used in the area. It is very clear because 90% of the sweet potato farmers practiced early planting during the season under consideration. This could be explained by the changes in the pattern of rainfall which resulted to early rainfall. This supports the findings of Akpan and Aye, (2016), which stated that the main climate change effect experienced by farmers were flooding, soil erosion, decrease in soil fertility etc. The results also revealed that the most effective method adopted by farmers in cushioning the effect of climate change were mulching, constant weeding, use of organic manure etc.

Table 3 showed the extent sweet potatoes and three leaved yam farmers applied climate change adaptation strategies in cushioning the effects of climate on their crops. Data showed that 69.70% of the respondents stated that application of mulching material as an adaptation option was greatly effective in reducing climate change negative effects. However, 6.06% of them observed that mulching was fairly effective in adapting to climate change. In terms of irrigation practice, result showed that 37.88% of farmers noted that application water to crops using irrigation practice very greatly effective while only 3.03% observed that it was fairly effective in reducing climate to climate change effects. Fertilizer application, mounds making, used of improved varieties as planting material, early planting and late season planting were greatly used an effective as adaptation options at 71.21%, 83.33%, 51.51%, 90. 90 %, respectively. Farmers vehemently reported that using improved varieties of planting seeds and seedlings were very effective I adapting to climate change problems.

Result in Table 4 showed that F-ratio and R-square were significant at 5% implying fitness of the model for analysis. R^2 values for linear, semi- log and double log models were 38.5%, 40.4% and 37.7% respectively. Semi-log model was used as the lead equation because, it had the highest R^2 (0.404), F-ratio (4.738) and highest number of significant values. The R^2 of 40.4% implies that the variability in sweet-potatoes and three leaved yam intercrop yield was accounted by the adaptation practices adopted by the farmers in the study area by 40.4%.

The coefficients of irrigation practices, mounds making, early planting and late planting positively influenced the sweet potatoes and three-leaved yam intercrop yield at 5% level of significant. Use of improved varieties positively influenced crop yield at 1% level of significant while quantity of labour had a negative influence on the crop yield at 1% level of significant. Fertilizer coefficient was also significant at 5% but had negative influence on crop yield. This implies that a unit increase in the negative signed variables will reduce sweet potatoes and three-leaved yam yield in the study area.

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The coefficients of irrigation practices, mounds making, early planting and late planting positively influenced sweet potatoes and three-leaved yam yield at 5% level of significance, improved crop varieties used positively influenced crop yield at 1% level of significance while quantity of labour had a negative influence on the crop yield at 1% level of significance. This result is not surprise because the variables are important climate change adaptation options expected. It is expected that the adoption of these measures would help reduce negative effects of these variables, at same time increase crop yield. Mulching coefficient was also significant at 5% but showed negative influence on the crop yield. This implies that a unit increase in the use of fertilizer variable would reduce sweet potatoes and three-leaved yam intercrop yield by 3.4% in the study area.

Finally, result on Table 05 showed that high cost of improved crop varieties was indicated by the farmers as a constraint to climate change adaptation. It is so, because the improved varieties of the crops are not readily available. They can only be sourced from government agencies and research institutes. Also, the selling price of the crops planting seeds in the open market is high when compared with local varieties which are very easily to find and a cheaper source.

High cost of fertilizer was also indicated as an important constraint in adaptation to climate to climate change. Fertilizer is important in improvement of soil fertility especially in the climate change scenario. High cost of fertilizers, irrigation facilities, poor government intervention, illiteracy, lack of extension programes, culture, cost of labour etc had mean rank score of 2.5 and above and were indicated as constraints faced by farmers in adapting to climate change scenarios.

It is important to note that inadequate knowledge among farmers due to low level of education on climate change problems is a limiting factor to adaptation of climate change options in the study area. Also, farmers' poor to access climate change information may have contributed to their inability to get the right information on climate change adaptation option expected to reduce the negative impacts of climate change on crops.

CONCLUSION

The major adaptation measures used by the sweet potatoes and three-leaved yam intercrop farmers in Bende Local Government Area of Abia State, Nigeria were application of irrigation practices, mounds making and use of improved crop varieties for planting. Irrigation practices, mounds making, early planting and late planting positively influenced sweet potatoes and three-leaved yam intercrop yield while application of mulch materials showed negative influence. Major barriers to using climate change adaptation measures were high cost of improved crop varieties, inadequate extension service programmes, illiteracy of food crops farmers and poor government intervention programmes such as fertilizer subsidy, grower anchor programmes, etc. Farmers are advised to increase the use of improved crop varieties for planting, adopt early planting in coping with climate change challenges. This would help increase farm productivity of sweet potato and three-leaved yam in in Bende Local Government Area of Abia State, Nigeria.

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