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THE TECHNOLOGICAL CAPABILITIES OF FARMERS IN CLIMATE CHANGE ADAPTATION: A CASE STUDY OF BENUE STATE, NIGERIA

Chinwe Joy Obiora

Department of Agricultural Extension, University of Nigeria, Nsukka

ABSTRACT

The study examined the technological capabilities of farmers in Benue State, Nigeria, with regards to climate change adaptation. Specifically, it ascertained the respondents' awareness about climate change; perceived adverse effects of climate change and the technological capabilities (investment, learning and linkage). The sampling frame for the study was both crop and livestock farmers in Benue State. Multistage sampling was used to select a sample size of 120 farmers from the three (3) agricultural zones in the State. Data were collected through interview schedule and were analyzed using descriptive statistics including percentage and mean scores. Almost (95%) all the respondents were aware of climate change. Crop failure/poor harvest (2.45), poor fish harvest (2.24) and flooding of farmland (2.46) were among the perceived effects of climate change. Majority of the farmers lacked investment capabilities in equipment (80%) and human resource development (75%). Learning (65%) and linkage (70%) capabilities were strong among the farmers. For a sustainable farming that will thrive in the face of adverse effects of climate change, the study recommends that the government and private organizations should aid the farmers and boost their investment capability in both equipment and human resource development. For instance, farmers should be given non-interest loan to acquire equipment needed for irrigation. This will help them overcome the problem of unpredictable rainfall pattern which is aggravated by climate change. Furthermore, Government should boost human resource development of the farmers by providing quarterly meteorological information and research-oriented adaptation strategies to them.

Keywords: climate change, farmers, climate change adaptation, technological capabilities, Benue State Nigeria.

INTRODUCTION

Agriculture is one of the oldest economic activities in the world. It gainfully employs over seventy (70) percent of the world's population. It also depends highly upon weather and climate in order to produce the food and fibre necessary to sustain human life. Consequently, this dependency makes agriculture vulnerable to climate variability and change (Intergovernmental Panel on Climate Change (IPCC, 2007). Agricultural production in many African countries is projected to be severely compromised by climate variability and change (Harris, 2009; Crib, 2008; Glantz & Cullen 2003). The increasing climatic variability brought about by the increase in the extreme whether events – global warming, sea water rise and deficit in rainfall would obviously have serious implications for food production and availability in Sub- Saharan Africa (Oyiga, Haile & Waschkeit, 2011). Thus, climate change would significantly affect the livelihoods patterns, the ability to access food and the socio-economic lives of the majority in the region (Oyiga, Haile & Waschkeit, 2011).

In Nigeria, there is glaring evidence of climate change and its impacts are already occurring and touching lives. For instance between July and October 2012, most part of Benue State was submerged with flood ravaging farmlands and farm stead. Furthermore, the yield of some agricultural products e.g. cowpea has been reported to be negatively affected by climate change (Ajetomobi & Abiodun, 2010). As the challenges posed by climate change grow, technologies, knowledge and practices that enhance farmers' adaptation to climate change becomes imperative.

Climate change adaptation is defined by (IPCC, 2007) as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates, harm or exploits beneficial opportunities. The (IPCC, 2007) further defines adaptation as having three possible objectives: to reduce exposure to the risk of damage; to develop the capacity to cope with unavoidable damages; and to take advantage of new opportunities. Effective climate change adaptation by the farmers demands that they should poses requisite technological capabilities for climate change adaptation.

Technological capability is defined as the variety of skill and knowledge which firms need so that they can acquire, assimilate, use, adapt, change and create technology (Ernst, Mytelka& Ganiatsos, 1994). Technological capabilities could be determined in any of these seven categories namely: investment, production, minor change, major change, learning, strategic marketing and linkage capabilities (Ernst, Mytelka & Ganiatsos, 1994; Biggs, Manju, & Srivastava 1995).

Benue State is majorly an agricultural state and a major producer of food. This earned her the name 'Food Basket' of the Nation. In view of the adverse effect of climate change on food production, it is then imperative to determine the technological capabilities (skills and knowledge) of farmers in Benue State in adapting to the challenges of climate change. Hence, the following research questions were raised- what is the awareness level of farmers in Benue State about climate change? Does climate change have adverse effect on the agricultural activities of the farmers? Which technological capabilities exist among the farmers? Which technological capabilities are lacking and why? Answers to the above will make farming in the State to be effective and also sustainable in the face of the threats posed by climate change. The study therefore aims to:

1) identify respondents' awareness about climate change;

2) ascertain the perceived adverse effects of climate change on the agricultural activities of the respondents;

3) examine the technological capabilities (investment, learning and linkage) of the respondents

METHODOLOGY

Study area

Benue State is one of the 36 states in Nigeria. It lies within the lower river Benue trough in the middle belt region of Nigeria. Its geographic coordinates are Longitude 7° 47' and 10° 0' east and Latitude 6° 25' and 8° 8' north. It shares boundaries with five other states namely: Nassarawa to the north, Taraba to the east, Cross-River to the south, Enugu to the south-west and Kogi to the west (fig 1) (http:www/fao.org/ag/agp/agpc/doc). The state also shares a common boundary with the Republic of Cameroun on the south-east **(**www.benuestate.gov.ng**).** Benue State has a population of 4,780,389 (National Population Commission, 2006) and occupies a landmass of 32,518 square kilometers. The State has two distinct seasons, the wet/rainy season and the dry/summer season. The rainy season lasts from April to October with annual rainfall in the range of 100-200 mm. The dry season begins in November and ends in March. Temperatures fluctuate between 23 - 37° C.

Agriculture is the mainstay of the economy, engaging over 75% of the state farming population. Benue State is the nation's acclaimed 'food basket' because of its rich agricultural produce which include yams, rice, beans, cassava, potatoes, maize, soya beans, sorghum, millet and cocoyam. She also produces fish in large quantities because of the river Benue which is the second largest river in Nigeria.

Study area

Fig 1: Map of Nigeria showing the study area

Source: Modified after http:www.fao.org/ag/AGP/AGPC/doc

Population and sampling procedure

The targeted population of the study comprised all the farmers in Benue State. The state is divided into three (3) agricultural zones namely: (1) Central zone- made up of eight blocks (Ogbadibo, Oju, Ado, Obi, Okpokwu, Agatu and Otukpo) (2) Eastern zone made up of eight blocks (Kastina-ala, Ushongo, Kwande, Ukum, Logo, Konshisha, Vandeikya andAadikpo) and (3) Northern zone made up of six blocks (Guma, Buruku, Gwer-west, Makurdi, Gwer_east and Gboko.

Multistage sampling was used to select the sample for the study. In the first stage, two (2) blocks were randomly selected from each of the three agricultural zones giving a total of six (6) blocks. For stage two, two (2) circles were randomly selected from each block giving a total of twelve (12) circles. In the third stage, ten (10) farmers were randomly selected from each of the twelve circles giving a total sample size of one hundred and twenty (120) farmers.

Instrument for data collection and measurement of variables

Interview schedule was used for data collection. The questions developed for the interview were based on the objectives of the study.

Objective 1 sought information on the awareness of respondents about climate change. Respondents were asked to indicate if they were aware or not aware of climate change. Nominal values 1 and 2 were assigned to 'aware' and 'not aware' respectively. Those that indicated awareness were asked to select from the list of options provided the evidences of climate change.

Objective 2 sought information on the perceived adverse effects of climate change on their agricultural activities. Respondents who indicated awareness were required to select from the list of variables provided the effects of climate change on their crop and animal production. To achieve this objective, a three-point likert rating scale was used. Each respondent was required to indicate opinion by checking any of the three options i.e. "not serious'' (ns), "serious'' s, and "very serious (vs). Values that were assigned to these options were 1, 2 and 3 respectively. The values of the three responses were added to get 6, which was divided further with 3 to get a mean of 2. Therefore, variables with mean of 2.0 and above were regarded as perceived adverse effects of climate change on their agricultural activities.

Objective 3 sought information on technological capabilities of the respondents namely: (a) investment capabilities: investment capability is represented by project execution activities including feasibility studies, equipment search, assessment of equipment, employee training. Hence, investment capability could be investment in machinery (equipment) or human resource development. Farmers identified investment at the farm in terms of additional farm inputs, increase in farm area, purchase of new crop varieties or livestock, purchase of both processing and storage facilities. (b) Learning capabilities: farmers responded to such questions as- do you have any built-in mechanisms for acquiring new information and for learning through feedback? Is there evidence that you are learning/ have learned/unlearned? describe what you have learnt over the years with regards to climate change (c) linkage capabilities: innovation is fundamentally a process of learning through knowledge and information flows that result through interaction, therefore the respondents were asked to indicate 'yes or no' if they have linkage capability or not, what their traditional practices with regard to forming linkages were? Do they form linkages and if so with what kinds of actors? Respondents were also required to indicate the number of institutions they have close cooperation (linkage) with.

Data analysis

Objectives 1 and 3 were analyzed with percentage whereas objective 2 was analyzed using mean score. Data were presented using tables and charts

RESULTS AND DISCUSSION

Awareness about climate change and evidences

Almost (95%) all the respondents were very much aware about climate change (Fig 2). Table 1 shows the evidences of climate change which the respondents outlined as flooding (100%), severity of dryness (85%), excessive precipitation (90%), excessive sunlight (95%), receding and drying streams (90%), changes in timing and pattern of seasons (95%),

loss of some fish species(85%), loss of crops to floods (90%), loss of animals to flood (90%), loss of farmstead to flood (90%), loss of human lives to flood (70%), incidences of wild fire (70%), intense storms (70%), high temperature (95%) and unpredictable rainfall pattern (90%).

The high level awareness about climate change among the respondents implies that climate is already changing in Benue State as the evidences they outlined agree with what is obtainable globally (Khanal, 2009).

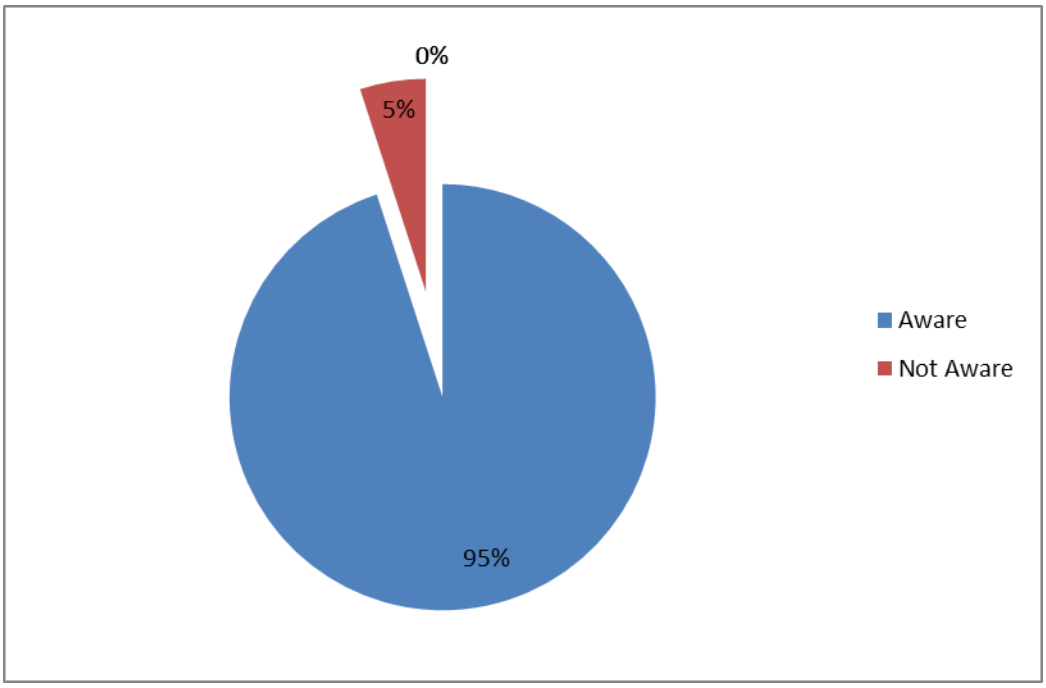

Fig 2: Pie chart showing percentage distribution of respondents on awareness about climate change

Table 1: Percentage distribution of respondents on evidences of climate change (n=114)

Evidences of climate change	%
Flooding	100
Severity of dryness	85
Excessive precipitation	90
Intense sunlight	95
Receding/drying streams	90
Changes in timing and pattern of season	95
Loss of some fish species	85
Loss of crops due to flood	90
Loss of animals due to flood	90
Loss of farmstead due to flood	90
Loss of human lives due to flood	70
Incidences of wildfire	70
Intense storms	70
High temperature	95
Unpredictable rainfall pattern	90

Source: Field survey, 2012

PERCEIVED ADVERSE EFFECTS OF CLIMATE CHANGE ON THE AGRICULTURAL ACTIVITIES OF THE RESPONDENTS

Entries in Table 2 show the perceived adverse effects of climate change on both crop and animal production of the farmers. All the variables listed crop failure and poor harvest (2.45), poor fish harvest (2.24), unproductiveness and death of livestock (2.06), drying up and rottening of farm produce (2.43), erosion (2.25), bush fires (2.24), flooding of farmland (2.46), strange pests/diseases of crop and animal (2.25) had mean scores above two. This implies that all the listed variables were the perceived effects of climate change on agricultural activities of the respondents. This result agrees with the results of those of Obiora & Onwubuya; Lama & Devkota 2009; Mutekwa, 2009) that the effects of climate change were drought, flooding, erosion, crop failure, excessive rainfall, water scarcity etc.

Table 2: Mean distribution of respondents based on perceived adverse effects of climate change on their agricultural activities (n=114)

Perceived effects	Mean (m)	SD
Crop failure and poor	2.45*	1.12
Poor fish harvest	2.24*	1.00
Unproductiveness and death of livestock	2.06*	0.95
Drying up and rottening of farm produce	2.43*	1.10
Erosion	2.25*	1.04
Bush fires	2.24*	1.00
Flooding of farmland	2.46*	1.12
Strange pests/diseases of crop and animal	2.25*	1.04

*Mean ≥ 2

Source: Field survey, 2012

TECHNOLOGICAL CAPABILITIES (INVESTMENT, LEARNING AND LINKAGE) OF THE RESPONDENTS

Investment capability of the respondents

Investment capability is represented by machine acquisition, employee training etc. Hence, investment capability was either investment in equipment or human resource development. Figure 3 shows that in investment capability in terms of equipment, 20.0% of the respondents have capability while 80.0% have none. The Figure equally shows that in terms of human resource development, 25.0% said they have capability whereas 75.0% have none.

The finding indicates that majority of the respondents have no investment capability in both equipment and human resource development. Lack of investment capability implies that these farmers are not adequately positioned to tackle the adverse impact of climate change. This becomes a source of serious worry based on the predictions that the climate will keep changing in the future and if the type of flooding observed in the state in the year 2012 repeats itself, farmers will not be able to adequately adapt.

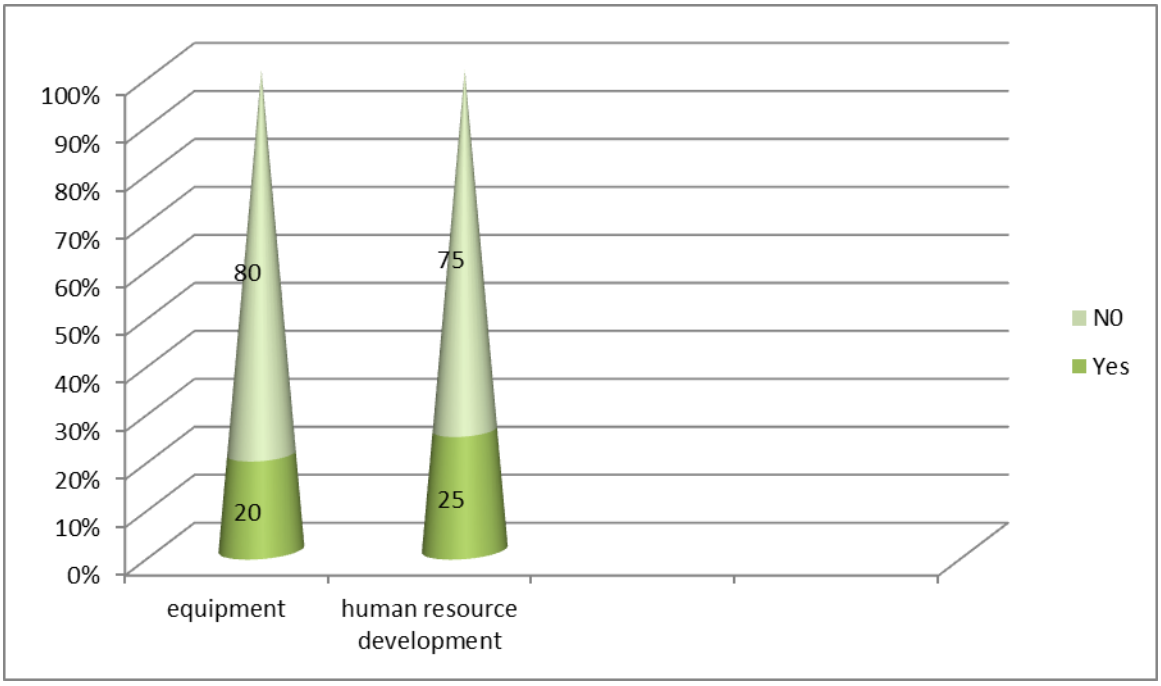

Fig 3: Conical bar chart showing percentage distribution of respondents based on the number that has investment capability

Learning capabilities of the respondents

Figure 4 shows percentage distribution of respondents based on if they have learning capability while Table 2 shows what the actors have actually learnt. The result shows that 65.0% of the farmers said they have learnt quite a number of things with regards to climate change. The result indicates quite a good learning capability among the respondents. Technological capabilities generally involve learning and the accumulation of new knowledge, and also the integration of behavioural, social and economic factors, as adapted to specific contexts (Lammarino, Piva, Vivarelli &Von Tunzelmann). This result implies that the respondents posses quite a reasonable learning capability which will help them be able to adopt new technologies (if provided) in order to cope with the challenges of climate change.

Entries in Table 3 show that majority (80%) of the respondents have learnt evidences/indicators of climate change. The Table equally shows that a good percent of the responds have also learnt the impact of climate change on human health (50%), animal health (50%), aquatic lives (60%), crop production (75%), animal production (65%) and water resources (60%). the road map to technological capabilities building is learning; hence the result implies that the respondents are already building capability since there is abundant learning capability.

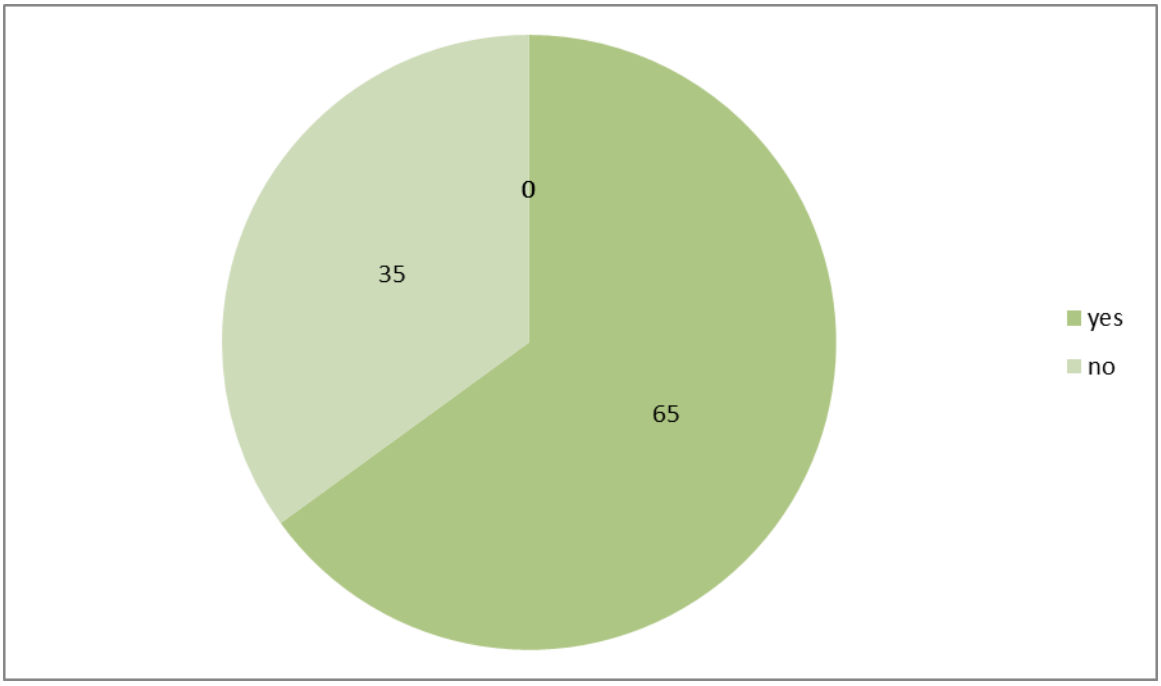

Fig 4: Pie chart showing percentage distribution of respondents based on number that have acquired learning capability

Table 3: Percentage distribution of respondents based on lessons learnt with regards to climate change (n=114)

Lessons learnt	**%**
Concept of climate change	40.0
Causes of climate change	30.0
Adaptation measures	40.0
Mitigation measures	30.0
Evidences of climate change	80.0
Impact on human health	50.0
Impact on animal health	50.0
Impact on aquatic lives	60.0
Impact on crop production	75.0
Impact on animal production	65.0
Impact on water resources	60.0

Source: Field survey, 2012

Linkage capability

Figure 5 portrays the percentage distribution of respondents based on linkage capability. It shows that 70.0% of the respondents have capability to link with others (co- farmers and institutions like Agricultural Development Programme - ADP). This result shows abundant linkage capability among the respondents. This implies that learning could take place

when farmers link and interact in different context which are socially embedded within institutions. This interaction foster knowledge flow, either old knowledge used in new ways or new knowledge diffused as innovation (Oyelaran-Oyeyinka, 1997). System interaction otherwise known as linkage capability is an important asset which could help farmers share experiences/lessons learnt about climate and share strategies that will help them to adapt.

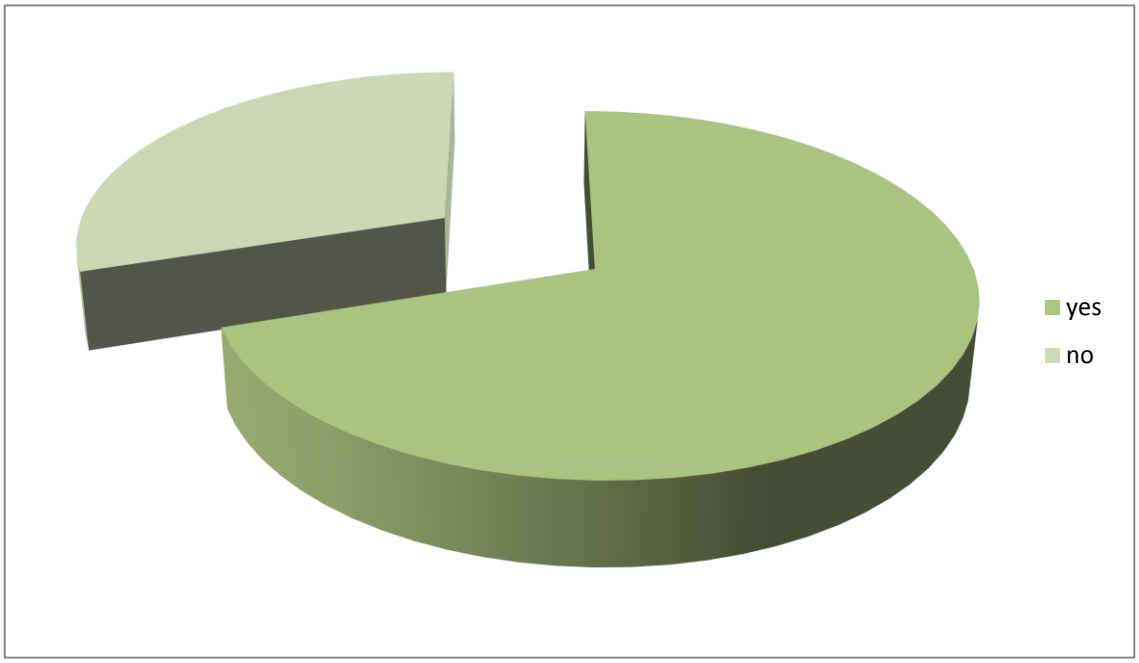

Fig 5: Pie chart showing percentage distribution of respondents based on number that possess linkage capability

CONCLUSION AND RECOMMENDATIONS

The study showed that the respondents are very much aware of climate. Climate change is already adversely impacting on the agricultural activities of the farmers. The farmers lacked investment capabilities (equipment and human resource development). Lack of investment capabilities implies that the farmers are not properly positioned to tackle the adverse impact of climate change hence agricultural sustainability in the study area is threatened. The farmers showed strong learning and linkage capabilities. The strong learning and linkage capabilities are assets that will help the farmers to exchange views about climate change and also learn and upgrade their knowledge on the issue.

The study recommends that both state and federal ministries of Agriculture under the present 'Transformation Agenda' of the incumbent President of Nigeria should aid the farmers to acquire investment capability in equipment and in human resource development. This could be achieved if the farmers are given non-interest loan to help them access some equipment needed for irrigation. With irrigation, the farmer will overcome the problem of unpredictable rainfall pattern which is aggravated by climate change. More importantly, Government should also boost human resource development of the farmers by providing quarterly meteorological information and research-oriented adaptation strategies to them through extension services.

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ABOUT THE AUTHORS:

Dr (Mrs) Chinwe Joy Obiora: Department of Agricultural Extension, University of Nigeria, Nsukka