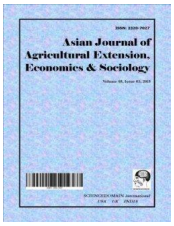

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Evaluation of Extension Services Delivery for Climate Change Adaptation by Crop Farmers in Niger State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author OE designed the study. Author TAA was involved in data collection and performed the statistical analysis, author OE wrote the protocol and wrote the first draft of the manuscript. Authors TMB and TAA managed the analyses of the study. Author OE managed the literature searches and author TMB reviewed the final draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Agriculture mostly depends on weather and climate for optimum productivity. Climate change has become a global threat to agriculture and humanity**.** To cope with these changes, farmers employ adaptation strategies. This paper evaluates the Extension Service Delivery for Climate Change Adaptation by Crop Farmers in Niger State, Nigeria. Multistage sampling technique was used to randomly select 162 respondents. Data were analyzed using descriptive statistics and Likert-scale. The results showed that respondents were mostly (81.13%) male, between 31 and 45 years of age (42.14%). They had one form of formal education (52%) or the other; 74.21% had extension contact; without access to credit. Extension services used for technological transfer were extension meetings, method demonstration, result demonstration and mass media. These extension services

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may be inadequate to effectively transfer climate change adaptation strategies to farmers. Farmers' sources of information were mainly radio, extension agents, fellow farmers and television. Farmers' level of awareness on climate change adaptation strategies was not high. Planting of improved crop varieties, change in planting dates and mixed farming were some strategies used by the farmers. The impact of climate change observed to be very high were high temperature (3.86), low rainfall (3.61) and low output/yield (3.57). These impacts cause shortage in the food supply, malnutrition, poor health status and poverty to farming households. Farmers are faced with the inadequate fund (96.23%); lack of access to weather forecast information (89.94%); and high cost of improved and resistant varieties (86.79%). It, therefore, concludes that Extension Services are a pertinent means of improving climate change adaptation strategies; however, Extension services available are inadequate. The study recommends that extension agents should visit crop farmers more regularly to increase awareness to boost farmers' knowledge on adaptation strategies; credit facilities and inputs should be provided to the farmers timely and at the required quantity.

Keywords: Adaptation; agriculture; awareness; climate change; extension service; perception.

1. INTRODUCTION

Agriculture is a combination of four sub-activities (Crop Production, Livestock, Forestry and Fishing). The importance of Agriculture to Nigerian economy cannot be over emphasized. The contribution of Agriculture to Gross Domestic Product (GDP) was 19.79 percent in the first Quarter of 2015, compared to 23.86 percent in the fourth Quarter of 2014 [1]. Agriculture is the main source of food, employs 70-80 percent of the population, whereas, most of the activities of the sector depends on weather and climate for its optimum productivity [2]. The sector serves as a source for raw materials to other sectors and foreign exchange earner. Despite its contributions to the nation's economic development, Nigerian agricultural sector is challenged with multitude of problems among which is the changes in climatic conditions, industrialization, urbanization, degradation and depletion of resources, population increase, poor public spending on rural infrastructure and services.

Climate change is a global phenomenon which has become very prominent in policy formulation processes and media. Climate change is the change in climate which can be identified through statistical tests; change in the mean and the variability of climatic properties that persist for an extended period of decades or longer [3]. The International Panel on Climate Change Assessment Report [4] stated the anticipated impact of climate change, this represents an awakening demand for the general public and policy-makers to act in the right direction in order to attain the Millennium Development Goals (MDGs) and reduce extreme poverty. According to Nnadi et al. [5], the key projected future climate change are a continued rise in temperature, increased incidence of heat waves and heavy precipitation events, decreased rainfall in sub-tropical areas, rising sea levels and the increased likelihood that these aspects will develop in a non-linear and non-predictable manner. These alterations in the patterns of natural activities have the potential to cause heavy damage to the agricultural sector, mostly in developing countries in Africa, where yields from rain-fed agriculture is predicted to be reduced by 20-50 percent by 2020 [6].

Climatic change, an attribute of anthropogenic (human-induced) activities and natural climate cycle, has unfavorably affected agricultural productivity in Africa [7]. According to Ozor et al. [8] anthropogenic activities such as the burning of fossil fuels and changes in land use like deforestation, release greenhouse gases (GHGs) into the atmosphere which increases the already existing concentration of these gases. As a result of these activities, the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent [9]. This brings about poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa [10]. Farmers are therefore confronted with catastrophic failure in crop output, reduced agricultural productivity, increased hunger, malnutrition and diseases [9]. The vulnerability of the developing countries like Nigeria is worsened by heavy reliance on renewable natural resources for livelihoods, employment and incomes [11]. The negative conditions of climate change are bound to compromise national activities mainly agricultural productions, nutritional and health status, trading in agricultural commodities, human settlements, tourism and recreation among others [12].

As Africans, particularly Nigerians, struggle to surmount poverty and advance economic growth in diverse ways especially through participation on poverty reduction programmes of the governments; yet, climate change factors threaten to intensify vulnerabilities, erode hard-won gains and critically demoralize prospects for development. Therefore, it necessitates more concerted efforts in tackling this menace in order to increase food production and alleviate poverty. To solve this problem and attain food security, Galadima and Nandi [13] observed that farmers are making efforts to adapt to climate change in various ways such as planting tolerant varieties, altering planting schedules, planting early maturing varieties and crop diversification. These efforts may be futile if the agricultural extension service system does not come to the assistance of farmers to initiate more and effective strategies for change to cope with the changing climate. This is because adaptations to climate change impacts require a change in knowledge, attitudes, resilience capacities and skills of the people, and agricultural extension can bring this change [5]. A report by Onubuogu and Esiobu [14] stated that greater proportion of crop farmers are conservative and remains unaware of the negative impact of climate change while others have developed the capacity to counteract the negative impact of climate change in the area but the speed and intensity at which the changes occur is outpacing their capacity to adapt.

The responsibility of extension service as a source of information as well as new technologies to farmers in order to enable them combat the menace of climatic change is however documented and generally accepted. Leeuwis and Aarts [15] viewed agricultural extension as a series of embedded communicative interventions that are meant, among other things, to develop and/or induce innovations. Such innovations supposedly help to resolve difficult issues. It has been observed by Ogunlade et al. [16], that agricultural extension is involved in public information and education programs that could assist farmers in mitigating the effects of climate change. Such involvements include awareness creation and knowledge brokerage on the issues of climate change [7]. According to Ogunlade et al. [16], a good extension service should be able to provide information on new and better technologies that solve particular constraints from research institutions to farmers, and back to researchers and policy-makers. It is also recognized that an appropriate communication mechanism is a crucial component for bridging the gap existing in the transferability of technical information from research institutes through extension agents to farmers and encourages the application of improved technical knowledge on agriculture by farmers. The extension service takes the problem of farmers to research institutions for solution [17].

Nigeria has a well developed agricultural extension service system with a number of institutional and government agencies established to ensure that farmers get to know and adopt improved agricultural technologies that are relevant to their needs and situations from research systems. These agencies facilitate the dissemination of improved agricultural technologies through various methods. Therefore, the role of agricultural extension agents is very crucial in improving agricultural development in Nigeria. It does this by facilitating the education of farmers to improve their skills, knowledge and attitude in relation to agricultural development [17]. These roles of extension service are to help farmers improve their productivity, earn more income and improve their standard of living [18]. Consequently, agricultural extension is an agent of change, through education and communication in farmers' attitude, knowledge and skills which can assist farmers to make informed decisions.

Most agricultural research [19,20,21,22,23,11] on climatic change has tended to focus on assessing the sensitivity of various attributes of crop systems without evaluating the role of agents of change. In the Niger State of Nigeria, presently, crop farmers' socio-economic characteristics; climate change awareness level on adaptation strategies; and barriers impeding climate change adaptation strategies as well as sources of information used by extension agents in disseminating climate change mitigation measures have not been properly understood or are still unknown. Meanwhile, a proper understanding of these issues is critical to the fight against the scourge of climate change. Therefore, this research seeks to provide information that is lacking for proper understanding of the climate change adaptation strategies, awareness and barriers. This information will be useful to researchers, policy makers, farmers and other stakeholders on climate change issues.

The inadequacy or absent of proper assessments often times examine climatic

change effects in seclusion. Thus, providing little insight into what and how farmers are adapting to climate change and what hampers their adapting the mitigation measures as well as their best sources of information regarding climate change adaptation strategies. Sometimes, some of the adaptation strategies are location based. So, it hinders the proper adoption of such measures in other places because Nigeria is endowed with multiple ethnic groups which often serve as a hindrance to smooth adoption of innovations. Therefore, to tackle food demand shortage and address climatic adversities, which are central to economic and sustainable development; it is pertinent to address these issues which can enhance crop production and reduce poverty in Niger State. Thus, there is need to develop and disseminate alternate production technologies that provide a layer of resilience against climate change effects to ensure food and livelihood security for millions of crop producers in Niger State in particular and Nigeria in general. Hence, this study seeks to evaluate extension services delivery for climate change by crop farmers in Niger State, Nigeria.

1.1 Objectives of the Study

The broad objective of this study is to evaluate extension services delivery for climate change adaptation by crop farmers in Niger State, Nigeria. Specifically, the paper sought to:

1. Assess the socio-economic characteristics of crop farmers in the study area;
2. Investigate the agricultural extension services available to crop farmers in the study area;
3. Determine crop farmers' level of awareness on climate change adaptation strategies;
4. Evaluate perceived impact of climate change on crop production in the area; and
5. Identify the barriers to climate change adaptation among crop farming households in Niger State

2. MATERIALS AND METHODS

The study was carried out in Niger State of Nigeria. Niger State falls within Guinea Savanna ecological zone of Nigeria. The State lies between latitudes 8°22' and 11°30'North and longitudes 3°30' and 7°20'East. The State experiences distinct dry and wet seasons with annual rainfall ranging from 1600mm in the south to 1100 mm in the north with average monthly temperature range of about 23°C to 39°C [24]. Niger State has land mass of 92,800 kilometer square and having a population of 3,950,249 people whose majority tribes are Nupe, Gwari, Hausa and Kambari with about 85 percent of this population engaged in agriculture, mainly crop and livestock production (Niger State Government Diary, in Waziri et al. [25,26]).

The sample design for the study was based on the agricultural activities in the State. As a result, a Multi-stage sampling technique was used to select three Local Government Areas (LGAs) (Katcha, Wushishi and Paikoro LGAs), one from each agricultural zone in the State were randomly selected. A total of 162 respondents were randomly selected from 9 randomly selected villages from the LGAs (3 each). A structured questionnaire and interview scheduled methods were used for data collection. Data from the study were analyzed using both descriptive and likert scale. Descriptive statistics include percentage, charts, mean and frequencies. Perceived impact of climate change on crop production was measured by using a 4-point Likert-scale of Very high = 4, High = 3, Fairly high = 2, and Not high = 1. To calculate mean score, the values of the scale (1+2+3+4) were summed up to obtain 10. The sum was further divided by 4 to get 2.5 which is the mean. Any perceived impact with a mean score of 2.5 and above depicts the impact is high and any indicator with mean less than 2.5 was regarded as not high impact.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Crop Farmers

The 159 questionnaires retuned out of the 162 distributed were analyzed. Data analyzed on the socio-economic characteristics of the respondents showed diversity in their characteristics. The outcome of the result depicts that crop farmers in the study area were mostly (81.13 percent) male (Table 1). The finding conforms to expectations because of the involvement of women in off-farm activities like processing and trading. The dominance of male in crop production is attributed to the fact that crop production activities require physical energy. The age range of the respondents was between 22 and 74 years, with majority (42.14 percent) been between 31 and 45 years, while 27.04 percent were between 46 and 60 years.

The implication of this result is that crop farmers in Niger State are mainly young people who are still in their productive ages. This result is in conformity with the study by Waziri et al. [25] which reported that majority of yam farmers in Niger State are in their agriculturally active years of less than 50 years. Therefore, crop farmers are likely going to substitute the problem of insufficient labour with their high level of energy to tackle with the labour intensive nature of crop production. The involvement of young people into crop production is expected to yield positive result in innovation adaptation level. The young are expected to be ready to receive and use information better than the elderly that are expected to resist new information [27].

From the result, 93.03 percent of the sampled crop farmers are married, implying ability to take responsibilities and source for means of catering for their dependents through provision of food and income to avert food insecurity and poverty. The maximum household size of the respondents was 33 people. Majority (52.83 percent) of the households had between 6 and 10 people. This indicates that the farmers may use household members as source of labour for their crop farming operations. This affirms the opinion of [28] that farmers need a large family to reduce the cost of farm labour and maintain a relatively stable life style in the rural area. Educational attainment of the respondents revealed that 33.96 percent of the sampled population do not have formal education training, whereas, 13.84 percent had Arabic education, while crop farmers with one form of formal education or the other constitute majority (about 52 percent) of the respondents. This suggests that most crop farmers are likely to exhibit positive attitudes to the adoption of new technologies because education influences adoption rates. The finding of this study is in agreement with the result obtained by Bello et al. [21] that farmers in Central States of Nigeria are mostly (71.0%) literate with secondary and tertiary education. They further stated that, formal education enables farmers to obtain useful information from diverse sources including bulletins, agricultural newsletter and other sources. Therefore, higher level of education determines the quality of skills of farmers, their allocative abilities, efficiency and how well informed they are to the innovations, technologies and awareness levels as well as adaptation to climate change.

Crop farming demands wealth of experience. Years of farming experience are important because management skills improved with experience. The result shows that most of the crop farmers in the study area had long time farming experiences. About 51 percent of the sampled farmers had farming experiences above 20 years while those with less than 15 years and between 16 to 20 years were 11% and 38% respectively. It is believed that those who had spent more years in farming are more likely to sort for new ways of improving their output; thus, adopting new technologies because farmers' previous experience with other innovations will likely influence their understanding of the gross margin of innovation. This finding supports the work of Ironkwe et al. [29] which posits that experience improves farmers' production skills such as good planting methods and the use of improved seed. Farmers' contact with extension workers can influence the decision to adopt a technology. It was observed that about 74.21 percent of the respondents have contact or access to extension services. This indicates high level of extension service in the area due to the importance of agriculture to the people. This high level of access to extension service could be attributed to large number of crops cultivated in the area. More so, the implementation of climate change adaptation strategies in the area by crop farmers has high adoption potential. Knowler and Bradshaw [30] and Deressa et al. [31] noted that adequate extension contact have a positive relationship with the adoption of agricultural technologies since extension agents transfer modern agricultural technologies to farmers to help them counteract the negative impact of climate change in their area. Majority (79.25 percent) of the respondents do not have access to credit.

3.2 Agricultural Extension Services Available to Crop Farmers

The response of sampled population on extension services methods used and sources of information to educate farmers on new technologies are presented in Table 2. Majority of the farmers stated that the most extension service available to them is extension meetings (contacts) which recorded 78 percent. This indicates that extension service is widely used in the area. Therefore, unavailability of sufficient extension agents could hinder the adaptation of climate change strategies. Respondents (62.89 percent) highlighted that, method and field demonstration is the avenue for their extension

Table 1. Socio-economic characteristics of crop farmers in Niger State

Socio-economic characteristics	Frequency	Percent (%)
Sex		
Female	30	18.87
Male	129	81.13
Class of age		
16-30	21	13.21
31-45	67	42.14
46-60	43	27.04
61-75	28	17.61
Marital status		
Married	148	93.03
Single	11	6.97
Household size		
≤ 5 persons	28	17.61
6-10 persons	84	52.83
11-15 persons	33	20.75
> 15 persons.	14	8.81
Educational attainment		
No formal education	54	33.96
Primary education	36	22.64
Secondary education	35	22.01
Tertiary	12	7.55
Arabic education	22	13.84
Farming experience (Years)		
1-5	3	1.89
6-10	6	3.77
11-15	9	5.66
16-20	60	37.74
21-25	38	23.90
26-30	29	18.24
≥30	14	8.81
Extension contact		
No	41	25.79
Yes	118	74.21
Access to credit		
No	126	79.25
Yes	33	20.75

service. Result demonstration and mass media (print and audio-visual) have 57.23 percent and 52.20 percent respectively for technology transfer. The use of these extension services methods may be grossly inadequate to effectively transfer climate change adaptation innovations to farmers. Pretty and Volouche in Imoloame and Olanrewaju [32] mentioned the extension methods that extension staff should draw from to address specific needs. They include: (a) Individual farm and home visit for follow up, (b) Group method: demonstrations to farmers groups, field days, (c) Mass method to create awareness and reach large population at a time, (d) farmers trainings and (e) participatory methods in which extension staff work with farmers to analyze current situations and problems and determine appropriate action for self-reliance.

It was observed that 82.39 percent of the respondents used radio as their source of information while 79.25 percent, 54.09 percent and 47.80 percent secure information on climate change from extension agents, fellow farmers and television respectively. This inferred radio as the most widely used source of information on climate change by the respondents. According to

Nhemachena and Hassan [33] information through extension agents enhanced more the chances of adapting to climate change. The meteorological station is the least source of information on climate change available to respondents.

3.3 Farmers' Level of Awareness on Climate Change Adaptation Strategies

The power to adapt to climate change can be notably influenced by the farmers' level of awareness on climate change adaptation strategies within the environment. Although, adaptation is not new to human history as man has had to adapt to changes in climate and the environment for centuries. The adaptation strategies known to the crop farmers in Niger State vary based on the individual. The result revealed that levels of awareness for each strategy are indication of the commonness of the strategy to the people. Result in Table 3 presents level of awareness of climate change adaptation strategies by respondents. Planting of improved crop varieties was ranked 1st (64.78 percent) among the adaptation strategies used by the respondents to cope climate change effects on crop production. The level of awareness was medium. This means that extension service delivery still has much work to do. Ranked 2nd was changed in planting dates (62.89 percent) which recorded medium level of awareness. Mixed farming had 59.12 percent, and was ranked 3rd because it recorded medium level of awareness among crop farmers. Use of irrigation, intensive manure application and off-farm income activities were ranked 4th, 5th and 6th with 55.97 percent, 52.20 percent and 50.94 percent respectively, however, the level of these climate change adaptation strategies was medium. Other adaptation options crop farmers identified include soil conservation/infiltration (47.80 percent), crop diversification (44.03 percent), use of mulching/cover cropping (42.14 percent) and planting of late maturing varieties (37.11 percent). Ranked 11th, 12th, 13th and 14th were the use of crop rotation (35.85 percent), planting of early maturing varieties (30.82 percent), construction of drainage systems and culverts (28.93 percent) and use of inter-cropping (28.30 percent) respectively. Also, 16.98 percent of the respondents are aware of afforestation/ tree planting method; 10.69 percent of the sampled population knows that insuring crops is a strategy of climate change adaptation; use of weather forecasting and erosion control by using bamboo stakes recorded 8.18 percent and 5.03 percent respectively. All adaptation strategies that were ranked 10th to 18th had low level of awareness for the effective offsetting of climate change hazards in the area. This collaborates why [34] emphasized the need for increased education and awareness creation among farmers as potent tools for climate change adaptation in Nigeria. Maddison [35] affirmed that one of the major constraints encountered by farmers in adaptation is still inadequate information and consequently low awareness of climate change.

This result suggests that respondents are aware that one form of adaptation strategies or the other can be employed in order to reduce effect of climate change on crop production. This awareness must have been created through different means, although, in totality, it brings

Table 2. Extension services and sources of information on climate change

Extension services	*Frequency	Percentage
Result demonstration	91	57.23
Mass media	83	52.20
Method and Field demonstration	100	62.89
Extension meetings	124	77.99
Sources of information		
Extension agents	126	79.25
Radio	131	82.39
Religious bodies	29	18.24
Television	76	47.80
Meteorological station	19	11.95
Internet	30	18.87
Print media	73	45.91
Cooperative societies	39	24.53
Fellows farmers	86	54.09

*Multiple responses**

Table 3. Farmers' level of awareness of climate change adaptation strategies

Climate change adaptive strategy	*Frequency	Percentage	Ranking	Level
Planting of early maturing varieties	49	30.82	12th	Low
Construction of drainage system and culvert	46	28.93	13th	Low
Planting of improved varieties	103	64.78	1st	Moderate
Change in planting date	100	62.89	2nd	Moderate
Use of weather forecasting	13	8.18	17th	Low
Erosion control by using bamboo stakes	8	5.03	18th	Low
Use of afforestation/ tree planting	27	16.98	15th	Low
Crop rotation	57	35.85	11th	Low
Use of mulching / cover cropping	67	42.14	9th	Moderate
Soil conservation/ infiltration	76	47.80	7th	Moderate
Use of Irrigation	89	55.97	4th	Moderate
Mixed farming	94	59.12	3rd	Low
Crop diversification	70	44.03	8th	Moderate
Intensive manure application	83	52.20	5th	Moderate
Use of inter cropping	45	28.30	14th	Low
Planting of late maturing varieties	59	37.11	10th	Low
Insurance	17	10.69	16th	Low
Off-farm income activities	81	50.94	6th	Moderate

**Multiple responses*

about higher adoption level. For instance, an extension agent is a change agent; hence increased extension service delivery to crop farmers will result in a change of farmers' attitude and increase adoption of improved technology that can bring about higher yield. Also, membership of a social group increases interactions among farmers and between farmers and other social groups increase awareness, social capital formation, knowledge sharing and exchange of facts concerning farming activities. This enhances adoption or the used of any improved farm technology. This is why a large proportion of the respondents get information from their fellow farmers. This finding support [36], who reported that main strategies for reducing climate risk are to diversify production and livelihood system. This finding is in tandem with a number of other researches such as those by Anyoha et al. [37] in Africa; Deressa et al. [38] Onubuogu and Esiobu [14] and Akpan et al. [20] in Nigeria; Gbetibouo [39] in Ethiopia; Nhemachena and Hassan [33] and Evengelista [40] in South Africa, Sofoluwe et al. [41] in Zimbabwe, who have separately noted that farmers access to information on climate change is likely to enhance their probability to perceive climate change, and hence adoption of new technologies and take-up adaptation techniques to counteract the negative impact of climate change.

3.4 Perceived Impact of Climate Change on Crop Production

These changes have affected agricultural productivity through crop failures thereby decreasing agricultural productivity, increasing food shortages and prolonging famines. This has affected even the livestock sub-sector through decreased animal forage. Thus, farming has become a costly enterprise to undertake now than before, due to change in climate, which leads to failures in different ways. This discourages new entries into the sector. As a result of this adverse situation, many people, especially, able bodied men migrate to urban areas in search of white-collar jobs, leaving fewer people in agricultural production. The effects of these are noticeable in high rate of school drop-out, child labour to augment household income, and predominant malnutrition and hunger among farming households due to insufficient income generation.

The perceived impact of climate change among crop farmers in the area varies from farmer to farmer. From the result, it was observed that high temperature (3.86), low rainfall (3.61) and low output/yield (3.57) were perceived to be very high (Table 4). Observed flooding, excess sunshine, increased and prolong drought occurrence, change in relative humidity and

reduced length of growing season recorded weighted mean of 2.88, 3.09, 2.53, 3.24 and 2.71 respectively. Thus, they were perceived to have high impact on the environment and crop production. Meanwhile, climate change indicators perceived to have fairly high impact on crop production include crop species extinction, increased post-harvest deterioration of crops, increased desertification and extreme cool temperature. Others are high winds and heat waves, crop blooming variation, land degradation and constant loss of biodiversity. Whereas, increased rainfall intensity and fast water evaporation from the ground were reported not to be high. Through frequent crop failure due to variable in the climatic conditions of the environment via shift in rainfall pattern, temperature, loss of crop yield, crop scourging sunshine level, increased desertification and variation in blooming dates makes farmers to invest more into farming. It, therefore, becomes more difficult for young and educated people who want to make good money to undertake investments, such as crop farming, that is exposed to climate risks. This change in climatic conditions means the planned work cannot be implemented which often times leads to reduced cropping seasons especially in the face of constant land degradation and loss of biodiversity.

Findings of this study on perceived impact of climate change on crop production correspond with the study of Maddison [42] who confirmed that most Nigerian farmers have perceived changes in climate through various indicators. In the same vein, [43] reported that preliminary evidence from a number of studies across African countries showed that a large number of farmers already perceive that the climate has become hotter and the rain has become less predictable and shorter in duration. The common observable effects of climate change are changes in the day-to-day variability and appearance of the weather. Hence, the result of this study conforms to that of [21] who reported that knowledge and perception of the respondents in the Central States of Nigeria critically identified high temperature, low level of rainfall and low crop yields as the most contributory indicators to climate change.

3.5 Barriers to Climate Change Adaptation among Crop Farming Households

The impact of climate change has brought about shortage in food, malnutrition, poor health status, poverty, and other adverse effects on the lives of the people of Niger State and Nigeria at large. Therefore, adaptation to climate change measures is expected to be confronted by different barriers. The result of barriers to adaptation to climate change among the respondents is presented in Table 5. The most important highlighted barrier is inadequate fund/financial resources which recorded 96.23 percent hence it is ranked 1st among the constraints. This could be attributed to high cost of adaptation options. Inadequate fund hinders farmers from getting the necessary resources and technologies which assist to adapt successfully to climate change. Deressa et al. [31] reported that adaptation options are costly. Hence if farmers do not have sufficient family labour or the financial means to hire labour, they cannot adapt. The 2nd ranked constrain was lack of access to weather forecast information (89.94 percent). This could be attributed to dearth of research on climate change as well as poor information dissemination on the part of the government information agencies. Thus, information is lacking in this area. This constrain affects the prediction of climate change by farmers because access to weather information can harness the planning of crops' season as well as taking precautions.

High cost of improved and resistant varieties of crops (86.79 percent), non-availability of credit facilities (86.16 percent), lack of conducive and stable government policies (81.13 percent) and high cost of fertilizer and other inputs (74.84 percent) were ranked 3rd, 4th, 5th and 6th by the respondents. Meanwhile, inefficient or poor storage facilities, influence of traditional beliefs and practices, poor agricultural extension service delivery, poor access to the technologies necessary for adaptation and inadequate and high cost of farm labour recorded 67.92 percent, 62.26 percent, 61.64 percent, 60.38 percent and 59.12 percent respectively. The least ranked constraints were unfavourable land tenure system, poor access to information sources and inadequate knowledge of how to build resilience which was ranked 14th, 15th and 16th respectively. Adaptation options to climate change require large amount of funds to purchase the needed equipment to enhance easy adaptation to climate change; thus non-availability of credit facilities impedes adaptation of the strategies. This could be attributed to poor formal and informal credit sources in the area as well as their various exorbitant security charges before lending to

Table 4. Perceived impact of climate change on crop production

Impact of climate change	Weighted mean	Perception
High temperature	3.86	Very high
Increased desertification	2.30	Fairly High
Low Rainfall	3.61	Very high
Increased rainfall intensity	1.29	Not high
Extreme cool temperature	2.18	Fairly High
Low output/yield	3.57	Very high
Observed flooding	2.88	High
Excess sunshine	3.09	High
Crop species extinction	1.84	Fairly High
Increased and prolong Drought occurrence	2.53	High
High winds and heat waves	2.09	Fairly High
Variations in bloom date (fruiting of crops)	2.44	Fairly High
Change in relative humidity	3.24	High
Increased post-harvest deterioration of crops	1.91	Fairly High
Constant loss of biodiversity	1.98	Fairly High
Fast water evaporation from the ground	1.47	Not high
Land degradation	2.03	Fairly High
Reduced length of growing season	2.71	High

Table 5. Barriers to climate change adaptation among crop farming

Barriers	*Frequency	Percentage	Ranking
Inadequate fund/financial resources	153	96.23	1st
inadequateweather forecast information	143	89.94	2nd
High cost of improved and resistant varieties of crops	138	86.79	3rd
Non-availability of credit facilities	137	86.16	4th
Inconsistent and unstable government policies	129	81.13	5th
High cost of fertilizer and other inputs	119	74.84	6th
Inefficient or unavailability of storage facilities	108	67.92	7th
Influence of traditional beliefs and practices	99	62.26	8th
Poor agricultural extension service delivery methods	98	61.64	9th
Poor access to the technologies necessary for adaptation	96	60.38	10th
Inadequate and high cost of farm labour	94	59.12	11th
Poor market facilities	91	57.23	12th
High cost of irrigation facilities	87	54.72	13th
Unfavourable land tenure system	83	52.20	14th
Poor access to information sources	76	47.80	15th
Inadequate knowledge of how to build resilience	65	40.88	16th

**Multiple responses*

farmers. Limited availability of land could be ascribed to land tenure system practiced by the people in the area as well as the increasing population. Poor extension contacts methods may be due to poor encouragement of extension staff by the government and inadequate training and knowledge of the extension agents.

4. CONCLUSION AND RECOMMENDATIONS

This study concerned itself with duty of Agricultural Extension services delivery to assist crop farmers in adapting to climate change strategies in the Niger State of Nigeria. This is because climate change is perhaps the most serious environmental threat to the fight against hunger, malnutrition, disease and poverty in developing countries, Nigeria inclusive, essentially because of its impact on agricultural productivity. This impact stemmed from high temperature, low rainfall, flooding, excess sunshine, increased and prolong drought resulting in low output/yield. It can be concluded that though extension services is a pertinent means of improving climate change adaptation strategies. The extension services available to the farmers are inadequate to effectively handle

climate change. These changes are noticed through shift in temperature, decreased rainfall and low output which are perceived to be very high. Crop farmers avert these changes through some mitigation strategies such as planting of improved crop varieties, change in planting dates, crop diversification, off-farm income and use of irrigation which were moderately known to the respondents. The awareness level for the adaptation strategies was noticed not to be high. This means that, there is a bridge of information which is supposed to be augmented by extension agents. This bridge of information is constrained by several factors such as inadequate fund which is needed to purchase facilities for the adaptation of climatic change strategies, lack of access to weather forecast information which could be helpful in predicting climate.

The study recommends that Agricultural services delivery should make room for Extension Agents to visit farmers more regularly to create awareness, and disseminate proven measures to boost farmer's knowledge in adapting to climate change; the Government and the concern agencies should make more available information on climate change and possible ways to overcome barriers to adaptation; the land ownership system and land policies of the government should be directed on measures of acquiring land to reduce the land constraint caused by tenure system. The government should make available credit facilities to the farmers as well as inputs subsidy to enable farmers purchase the needed inputs timely at the required quantity; extension agents should be trained and re-trained on climate change indicators and general knowledge on new technologies and methods of disseminating information to the farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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