International Journal of Climate Research
2017 Vol. 2, No. 1, pp. 19-25
ISSN: 2690-2796
DOI: 10.18488/journal.112.2017.21.19.25
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PROMOTING CLIMATE CHANGE ADAPTATION MEASURES FOR IMPROVING PRODUCTIVITY AMONG SMALLHOLDER FARMERS IN TARABA STATE, NIGERIA

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Article History
Received: 8 May 2017
Revised: 9 June 2017
Accepted: 5 July 2017
Published: 17 July 2017

Keywords
Climate change
Adaptation
Measures
Smallholder farmers
Productivity
Nigeria.

ABSTRACT

The study assessed promoting climate change adaptation measures for improving productivity among smallholder farmers in Taraba State, Nigeria. Interview schedule/questionnaire was used to collect data from a sample of ninety (90) respondents used for the study. Data were analyzed using factor analysis. Findings indicate that major effects of climate change among smallholder farmers were named based on the items loading for factors 1, 2 and 3 as food security, poor quality of produce and soil conservation effects, respectively. Factor analysis of variables with regards to climate change adaptation measures practiced by smallholder farmers based on the item loadings were named factors 1, 2 and 3 (agronomic practices, farm inputs and production measures, respectively). Variables which loaded high under agronomic practices include practicing of mulching (0.776), planting early maturing varieties of crops (0.643), early harvesting of matured crops (0.604) and adjustment of planting dates (0.542). Loadings under farm inputs were planting of cover crops to reduce loss of water from the soil (0.794), use of organic manure (0.794), practicing bush fallowing to increase soil fertility (0.743) and planting of improved varieties of crops (0.630). Production measures comprised value addition of farm produce (0.647), use of high yielding varieties of crops (0.630), practicing mixed cropping to guard against crop failure (0.577), practicing zero tillage (0.472) and erection of dams for storing water (0.464). Constraints to climate change adaptation measures among smallholder farmers were grouped into infrastructural, labour and fund-related problems. Efforts are highly needed in cushioning the effects of climate change by the stakeholders such as the government at all levels, extension agencies, research institutions, metrological institutes, disaster management agencies, higher institutions, local farmers and others by giving out first hand information on weather forecast so as to know the right and best time to plant and harvest crops. It also highlights the need for provision of adequate infrastructure to enhance easy adaptation to climate change as well as increasing productivity.

Contribution/Originality: This study is one of very few studies that established adaptation measures practiced by smallholder farmers to include mulching, planting early maturing varieties of crops, early harvesting of matured crops, etc. Efforts are needed by the stakeholders such as government at all levels to cushion the effects of climate change.

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1. INTRODUCTION

Change in climate over time due to natural variability or human activities are referred to as climate change. The Institute for Global and Environmental Strategies (IGES) [1] defines climate change as a change that is attributed directly or indirectly to human activities which alters the composition of the global atmosphere and in addition to natural climate variability observed over comparable periods.

Climate change being one of the most outstanding challenges facing the global community has been defined by various authors according to their perception and the way it affects them. The Intergovernmental Panel on Climate Change (IPCC) [2] defines climate change as statistically significant variations that persist for an extended period, typically decades or longer.

It is evident that more frequent and intense extreme weather events such as droughts, heat and cold waves, heavy storms, floods; rising sea levels and increasing irregularities in seasonal rainfall patterns are already having immediate impacts on not only food production, but also food distribution, incidence of food emergencies, livelihood assets and human health in both rural and urban areas [3].

Changes in rainfall in terms of late arrival, early departure and low amount of rainfall result in poor harvest of crops which consequently affect the income of the people and the nation in general. Drought affects the volume of water in the rivers and lakes, used for irrigation and fishing activities [3].

The actual adjustments or changes in decision environments which might ultimately enhance resilience or reduce vulnerability to observed or expected changes in climate is referred to as Adaptation practices. Adjustments can take place in order to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation occurs in physical, ecological and human systems. It involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce potential damages or realize new opportunities. Adaptations include anticipatory and reactive actions, private and public initiatives and can relate to projected changes in temperature and current climate variations and extremes that may be altered with climate change. Adaptations are on-going processes which reflects many factors rather than discrete measures to address climate change specifically [4].

The ability or potential of a system to respond successfully to climate variability and change in behaviour, resources and technologies is known as adaptive capacity. The presence of adaptive capacity has been shown to be a necessary condition for the design and implementation of effective adaptation strategies in order to reduce the likelihood and the magnitude of harmful outcomes resulting from climate change [5].

Adaptation to climate change involves managing risks by improving the quality of information and its use, providing insurance against climate change risk, adopting known good practices to strengthen the resilience of vulnerable livelihood systems as well as finding new institutional and technological solutions [6]. There is a long record of practices in adapting to the impacts of weather as well as natural climate variability which include proactive measures such as adjustment of planting dates; use of crop varieties (inclusion of drought-resistant crops) accumulation of commodity stocks as economic reserve; spatially separated plots for cropping and grazing to diversify exposures; diversification of income by adding livestock operations; provision of crop insurance; creation of local financial pools (as alternative to commercial crop insurance) and crop and livelihood diversification. Others include seasonal climate forecasting; community-based disaster risk reduction; famine early warning systems; insurance; water storage; supplementary irrigation; ex-post adaptations, for example, emergency response, disaster recovery and migration [7].

The most vulnerable to climate variability and change are the poor and marginalized, who generally are the least able to cope with disasters, live in most hazard prone areas and generally have the least information, knowledge and resources to reduce their risk. The predicted impacts of climate change will intensify existing vulnerabilities, inequalities and exposure to hazards and will therefore impact most on those least able to cope with climate risks. Smallholder farmers are the most vulnerable to the predicted impacts of climate change. These

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vulnerable groups tend to own fewer livelihood assets, including land and livestock, receive lower income, low levels of education and less access to community and government services. They tend to be reliant on rain-fed agriculture and occupy land that is prone to floods and drought [8].

This therefore raises the following pertinent questions. What are effects of climate change among smallholder farmers? What are climate change adaptation measures practiced by smallholder farmers? And what are constraints to climate change adaptation among smallholder farmers?

The specific objectives of the study were to:

1. identify effects of climate change among smallholder farmers;
2. ascertain climate change adaptation measures practiced by smallholder farmers; and
3. identify constraints to climate change adaptation measures among smallholder farmers.

2. METHODOLOGY

The survey was conducted in Taraba state, Nigeria. It is one of the states that make up the North East geographical zone of Nigeria. Taraba state covers an area of 60,291.8 square kilometers (km^2) and lies at longitude 10°30' east and latitude 8°00' north. The state has a population of approximately 2,300,736 [9] with a population density of 27 people per square kilometer. Jukuns, Mambila, Fulani, Keteb, Mumuye, Jenjo, Wukum, Ichen, Tiv, Kaka, Hausa and Ndoro are the major ethnic groups in the state.

Farming is the primary occupation of the inhabitants. Crops grown are coffee, tea, groundnut, cotton, maize, rice, sorghum, millet, cassava, yam, etc. Livestock reared include cattle, sheep, goat, poultry, rabbit and pig. The state has three (3) agricultural zones namely; northern, north central and southern. Southern zone was selected purposively for the study which is made up of five (5) blocks namely; Ussa, Takum, Dongo, Wukari and Ibi. Two (2) blocks namely; Ussa and Takum were selected from the five blocks using simple random sampling technique. Three (3) circles were selected from each of the blocks, totaling six (6) circles. Fifteen (15) farmers were selected randomly from each of the circles, giving a total of ninety (90) respondents used for the study. Data were collected using interview schedule/questionnaire. Factor analysis was used in analyzing data collected for the study.

Variables with loadings of 0.40 and above at 10% overlapping variance were used in naming the factors. Variables that had factor loading of less than 0.40 were not used while variables that loaded in more than one factor were also discarded. Data were subjected to exploratory factor analysis with varimax rotation. The results of the rotated component matrix showing the extracted factors based on the responses of the respondents for objective 1 were named food security, poor quality of produce and soil conservation effects for factors 1, 2 and 3 respectively. Objective 2 were named agronomic practices, farm inputs and production measures for factors 1, 2 and 3 respectively while objective 3 were named infrastructural, labour and fund-related problems for factors 1, 2 and 3 respectively.

3. RESULTS AND DISCUSSION

3.1. Factor Analysis of Effects of Climate Change among Smallholder Farmers

Results in Table 1 show the factor analysis of effects of climate change among smallholder farmers. Based on the items loading, factors 1, 2 and 3 were named food security, poor quality of produce and soil conservation effects, respectively. The factors represent the major effects of climate change on smallholder farmers.

Factors which loaded high under food security were leads to food insecurity in households (0.702), reduction in soil fertility (0.807), poor yield of crops (0.738), reduction in farm income/revenue (0.743), increases hunger/famine among family members (0.739) and drying of seedlings after germination and transplanting (0.783).

Variables which loaded high under poor quality of produce included water logging of farmland (0.697), high incidence of pests and diseases infestation (0.680) and poor quality of farm produce (0.587).

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Soil conservation effects comprised causes stunted growth in crops (0.559), loss of farmland to flood and erosion (0.629), increase in growth of weeds (0.656), reduction in supply of raw materials to agro-allied industries (0.402), easy loss of water from the soil as a result of excessive heat of the sun (0.415) and loss of biodiversity (0.528).

The results are in line with Oladipo [10] who noted that agriculture is most sensitive to global warming of climate change and its effects lead to stunted growth of crops, easy spread of pests, diseases attack on crops, livestock and fish, drying of seedlings after germination and transplanting, low yield of crops/crop failure, low quality of farm produce, fall in farm revenues/incomes (economic losses), isolated location of farms, small farm size, low level of technology adoption, reduced supply of raw materials for agro-based industries, impact on water resources and late fruiting of fruit trees.

Table-1. Factor analysis of effects of climate change among smallholder farmers

Effects	Factor 1 (Food security)	Factor 2 (Poor quality of produce)	Factor 3 (Soil conservation)
Leads to food insecurity in households	**0.702**	0.184	0.124
Causes stunted growth in crops	0.262	0.033	**0.559**
Loss of farmland to flood and erosion	0.270	0.248	**0.629**
Increase in growth of weeds	-0.061	-0.011	**0.656**
Reduction in supply of raw materials to agro-allied industries	0.152	0.073	**0.402**
Water logging of farmland	0.090	**0.697**	0.333
Easy loss of water from the soil as a result of excessive heat of the sun	0.206	0.352	**0.415**
High incidence of pests and diseases infestation	0.255	**0.680**	0.142
Reduction in soil fertility	**0.807**	0.200	0.180
Poor yield of crops	**0.738**	0.291	0.219
Poor quality of farm produce	0.222	**0.587**	-0.196
Reduction in farm income/revenue	**0.743**	0.216	0.177
Increases hunger/famine among family members	**0.739**	0.080	0.331
Changes in dates of onset of rainy season	0.406	-0.167	0.729
Drying of seedlings after germination and transplanting	**0.783**	0.021	-0.252
Loss of biodiversity	0.150	0.002	**0.528**

Extraction method: Principal Component Analysis

Rotation method: Varimax with Kaiser Normalization

3.2. Climate Change Adaptation Measures Practiced by Smallholder Farmers

Factor analysis of variables with regards to climate change adaptation measures practiced by smallholder farmers based on the item loadings, factors 1, 2 and 3 (named agronomic practices, farm inputs and production measures, respectively) is represented in Table 2.

Variables which loaded high under agronomic practices include practicing of mulching (0.776), planting early maturing varieties of crops (0.643), early harvesting of matured crops (0.604) and adjustment of planting dates (0.542).

Loadings under farm inputs were planting of cover crops to reduce loss of water from the soil (0.794), use of organic manure (0.794), practicing bush fallowing to increase soil fertility (0.743) and planting of improved varieties of crops (0.630).

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Production measures comprised value addition of farm produce (0.647), use of high yielding varieties of crops (0.630), practicing mixed cropping to guard against crop failure (0.577), practicing zero tillage (0.472) and erection of dams for storing water (0.464).

The finding is in line with a study carried out by Ajani, et al. [11] which stated that with the realization of declining soil quality and productivity, several indigenous management practices have evolved over the years to conserve the soil. Some of these practices include adjusting the timing of farm operations such as planting or sowing dates and treatments, bush fallowing, organic manuring, intercropping, crop rotation, agro-forestry and practicing conservation tillage.

Table-2. Factor analysis of adaptation measures practiced by smallholder farmers

Adaptation measures	Factor 1 (Agronomic practices)	Factor 2 (Farm inputs)	Factor 3 (Production measures)
Practicing of mulching	**0.776**	0.170	0.079
Planting early maturing varieties of crops	**0.643**	0.352	0.209
Early harvesting of matured crops	**0.604**	-0.042	0.364
Adjustment of planting dates	**0.542**	0.302	0.171
Planting of cover crops to reduce loss of water from the soil	0.090	**0.794**	0.175
Use of organic manure	0.090	**0.794**	0.175
Practicing bush fallowing to increase soil fertility	0.226	**0.743**	-0.006
Planting of improved varieties of crops	0.239	**0.630**	0.115
Afforestation/planting of trees	-0.026	0.220	0.172
Value addition of farm produce	0.266	0.134	**0.647**
Use of high yielding varieties of crops	0.084	0.028	**0.630**
Practicing mixed cropping to guard against crop failure	0.083	0.159	**0.577**
Practicing zero tillage	0.158	0.022	**0.472**
Diversification in crop and livestock production	0.149	0.194	0.120
Practicing crop rotation	0.187	0.267	0.213
	0.268	0.169	0.031
Erection of dams for storing Water	0.132	0.344	**0.464**
Use of drought resistant varieties of crops	0.167	-0.023	0.053
Increase in area of land cultivated	0.171	0.125	0.251
Proper preservation of planting materials	0.051	0.168	0.283

Extraction method: Principal Component Analysis

Rotation method: Varimax with Kaiser Normalization

3.3. Factor Analysis of Constraints to Climate Change Adaptation Measures among Smallholder Farmers

Table 3 shows the factor analysis of factor analysis of constraints to climate change adaptation measures among smallholder farmers. Based on the items loading, factors 1, 2 and 3 were named infrastructural, labour and fund-related constraints respectively.

Variables which loaded high under infrastructural constraints were high cost of storage facilities (0.785), lack of modern processing facilities (0.784), unavailability of modern farm inputs (0.744), high cost of labour (0.632), inadequate provision of loan (0.575), poor access to information on climate change adaptation (0.785), high cost of irrigation facilities (0.784) and unavailability of labour saving technologies (0.744).

Labour constraints include inadequate training opportunities (0.797), poor road networks (0.737), unavailability of labour (0.675) and high cost of labour (0.652).

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Loadings under fund-related constraints were high cost of farm inputs such as fertilizer, herbicides, etc. (0.727), inadequate access to improved varieties of crops (0.604), lack of funds (0.582) and government inability to come to aid of farmers affected with floods (0.554).

This finding agrees with Mendelson and Williams [12] who stated that lack of money hinders small scale farmers from getting the necessary resources and technologies due to the fact that adaptation strategies are very costly which make farmers vulnerable to the negative effects of climate change. Apata, et al. [13] reiterated that the most adverse effects of climate change are felt mainly by developing countries, especially those in Africa due to their low level of coping capacities.

Table-3. Factor analysis of constraints to climate change adaptation measures among smallholder farmers

Constraints	Factor 1 (Infrastructural constraints)	Factor 2 (Labour constraints)	Factor 3 (Fund-related constraints)
High cost of storage facilities	**0.785**	-0.032	-0.048
Lack of modern processing facilities	**0.784**	0.039	0.122
Unavailability of modern farm inputs	**0.744**	0.029	0.210
High cost farm labour	**0.632**	0.098	0.056
Inadequate provision of loan	**0.575**	-0.037	-0.173
Inadequate training opportunities	0.100	**0.797**	-0.074
Poor road networks	0.038	**0.737**	0.103
Unavailability of labour	0.148	**0.675**	0.017
High cost of labour	-0.216	**0.652**	0.257
High cost of farm inputs such as fertilizer, herbicides, etc.	-0.004	0.044	**0.727**
Inadequate access to improved varieties of crops	0.322	-0.079	**0.604**
Lack of funds	-0.144	0.288	**0.582**
Poor extension services delivery	0.067	-0.053	0.039
Lack of access to weather forecasts	0.342	0.138	-0.125
Government inability to come to aid of farmers affected with floods	0.120	0.051	**0.554**
Lack of access to credit facilities	-0.132	0.111	0.027
Poor access to information on climate change adaptation	**0.785**	-0.032	-0.048
High cost of irrigation facilities	**0.784**	0.039	0.122
Unavailability of labour saving technologies	**0.744**	0.029	0.210

Extraction method: Principal Component Analysis

Rotation method: Varimax with Kaiser Normalization

4. CONCLUSION AND RECOMMENDATIONS

Climate change adaptation measures practiced by smallholder farmers were mulching, planting early maturing varieties of crops, early harvesting of matured crops, adjustment of planting dates, planting of cover crops to reduce loss of water from the soil, use of organic manure, practicing bush fallowing for increase in soil fertility, planting of improved varieties of crops, value addition of farm produce, use of high yielding varieties of crops, practicing mixed cropping to guard against crop failure, among others. Constraints to climate change adaptation measures among smallholder farmers were categorized into infrastructural, labour and fund-related problems. In order to cushion the effects of climate change on smallholder farmers, efforts are needed by the stakeholders such as the government at all levels, extension agencies, research institutions, metrological institutes, disaster management agencies, higher institutions, local farmers and other stakeholders in giving out first hand information on weather forecast so as to know the right and best time to plant and harvest crops for optimum productivity.

Funding: The researchers funded the survey study.
Competing Interests: The authors declare that they have no competing interests.
Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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