academicJournals

Vol.9(10), pp. 223-229, October 2017
DOI: 10.5897/JAERD2017.0895
Articles Number: 8C111DE66003
ISSN 2141-2170
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Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Utilization of climate change adaptation strategies among rice farmers in three states of Nigeria

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Received 5 July, 2017; Accepted 3 August, 2017

The phenomenon of climate change has negative impacts on rice production in Nigeria as it lowers its output and reduces farmers' income with a resultant depreciation in their livelihood. This accentuates the need for adaptation to climate change in order to reduce the growing dependency on rice importation, ensure food security as well as achieve a sustainable rice production system in Nigeria. The study therefore investigated the utilization of climate change adaptation strategies among rice farmers in three states of Nigeria. Data were collected from 298 rice farmers using interview schedule in Ebonyi, Ekiti and Niger States on their socio-economic and farm enterprise characteristics, knowledge and utilization of Climate Change Adaptation Strategy (CCAS). Data analysis was done using Statistical Package for Social Sciences (SPSS) and analysis of variance (ANOVA). Knowledge of CCAS was high (55.7%) among respondents while utilization of CCAS was low (65.4%). A non-significant difference existed in the use of CCAS across the states (F = 43.15; p-value>0.05). However, continuous and frequent weeding, appropriate use of fertilizer, and early harvesting of crops were major CCAS used by respondents. The result implies that rice farmers are not totally ignorant of CCAS, but have been using one form of adaptation strategy or the other irrespective of the agro-ecology. Also, the study revealed that CCAS is ecology specific thus effective utilization should be ensured.

Key words: Climate change, adaptation strategies, utilization, rice farmers.

INTRODUCTION

Rice farming is highly dependent on environmental factors which are the most important among several factors that influence agricultural production. According to Edeh et al. (2011), rice production depends on optimum combination of production inputs in order to achieve remarkable yield. These inputs are not limited to the familiar production inputs but include the various environmental factors provided by nature. Rainfall characteristics (intensity and duration), relative humidity and temperature constitute these weather-related and environmental factors that affect rice yield and its variability. As reported by Kuta (2011), local farmers are seriously concerned about these weather variations because of the impact on food security, availability, stability, accessibility and utilization. The change in weather affects livestock, forestry, fishery and decreases

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aquatic plant species including rice.

According to Building Nigeria's Response to Climate Change (BNRCC, 2008), the prolonged change in weather resulting in a change in climate has created a significant loss of food security; increased frequency and severity of natural disasters such as desertification, drought, and flood; and human displacement and natural resources depletion. Furthermore, other consequences of climate change include lack of clean water supply, animal migration, pest management issues, diseases and health concerns, loss of cultural practices and traditional ways of life, economic downturns, and energy crises which thus affect overall development in Nigeria.

The impacts of climate change in Nigeria vary from one agro-ecological zone to the other. These include unprecedented floods in hitherto dry areas, iron toxicity caused by soil degradation, frequent intervening dry spells as well as extreme temperatures experienced across the country. This climatic fluctuation is putting Nigeria's agriculture system especially crop production under serious threat and stress (Ayinde et al., 2011).

Rice (*Oryza sativa*) is a staple food consumed globally by a large population of people. It is one of the multi-value chain crops that plays a significant role in national food security and employment sustenance, generates income as well as serves as a source of raw materials for agro industries (Okoro et al., 2015). However, as a crop, rice is affected by many abiotic factors (drought, submergence, extreme temperatures, salinity, and low soil fertility) and biotic constraints (weeds and diseases such as blast) which limit the continent's rice production. Climate change, by inducing variations in climate patterns (increasing incidence of drought, extreme temperatures and flooding, and increasing salt stress levels), aggravates these constraints, thereby affecting rice yields (Manneh et al., 2007).

Rice is one of the crops grown by farmers in most vegetative zones in Nigeria and these farmers have been witnessing heavy downpours due to intense rains as a result of variability in timing and amount of rainfall caused by climate change. The degree and intensity at which rains are experienced in recent times is far beyond what farmers are familiar and can grapple with in order to remain productive. According to Tiamiyu et al. (2015), extreme rainfall variability triggers environmental problems such as floods, gully erosion, drought and desertification which have serious effects on rice yield. While floods wash away and destroy rice farmlands as well as those of other staples thereby creating a heavy yield loss to farmers who spend much establishing the crop farms, increase in temperature on the other hand shortens the duration between sowing and harvesting in rice cycles and this adversely affects yield as it leads to early occurrence of senescence (National Research Council (NRC), 2011). Furthermore, frequent outbreaks of crop pests and diseases caused by increased duration of the wet season combined with higher temperatures due to climate change also reduces rice yield. These pests, especially quelea birds are mostly driven by droughts and are difficult to control with pesticides as they ravage rice fields with resultant food shortages and severely malnourished children in the affected regions (Abubakar et al., 2012).

The aforementioned evidences of climate change fallout, nevertheless, can be reduced through adaptation (Kurukulasuriya and Mendelsohn, 2006). Though adaptation is not a new concept to farmers as they have survived and coped in various ways to maintain their livelihood and adaptive capacity nonetheless, it could be limited by low technological advancement, poverty and illiteracy. Therefore, understanding how they have adapted to changes become imperative for designing incentives to enhance adaptation. Hassan and Nhemachena (2008) stated that supporting adaptation strategies of local farmers through appropriate public policy, investment and collective actions can help increase adaption measures which will reduce the negative consequences of the predicted changes in future climate with great benefits accruing to vulnerable rural communities in Africa. Therefore, the objectives of the study were to investigate the socio-economic and farm enterprise characteristics of rice farmers, their knowledge and utilization of climate change adaptation strategies.

MATERIALS AND METHODS

An evaluative research design was used to determine the impact of climate change adaptation strategies on rice production in Ebonyi, Ekiti and Niger States, Nigeria. These areas where chosen because they represent the luxuriant rainforest (characterised by intense rains and longer rainy season) and Guinea savannah (characterized by lower rainfall and shorter rainy season) vegetative zones with comparative advantage in rice production. These natural vegetative zones are governed by the combined effects of temperature, humidity, and particularly variations that occur in rainfall. The variations in climate change, however, have led to devastating consequences and effects in various parts of the country such that the rainforest zone is affected by sea-level rise, deforestation-induced changes, erosion, flooding and land degradation while the savannah zone is affected by changes due to overgrazing, drought, desertification and heat stress (Ozor et al., 2012). These environmental conditions therefore make it necessary for the country to develop an array of adaptation options which will meet the different conditions of the different agro-ecological locations of the nation.

For purposes of data collection, 10% of the local government areas (LGAs) from each state including Abakiliki, Efon Alaye, Ekiti East, Bida and Lapai were randomly selected. Using a proportionate sampling technique, 20% of the farmers were selected from the Rice Farmers Association list of 1488 registered farmers in i the selected LGAs (Table 1). Thus, a sample size of 298 respondents was obtained. Data was collected using interview schedule and analyzed using descriptive frequency counts, percentages and mean, while the hypothesis was analyzed using Analysis of Variance (ANOVA).

Results were presented using frequency distribution and percentages. Aggregate mean score was obtained and used to

Table 1. Sampling procedure and sample size of respondents.

Agro ecological zones	10% of states sampled	Sampled states	No of LGAs in the sampled states	10% of sampled LGAs	Sampled LGAs	No of farmers registered with RIFAN	20% of RIFAN farmers sampled
Guinea savannah (10)	1	Niger	21	2	Bida	299	60
					Lapai	275	55
		Ebonyi	12	1	Abakiliki	411	82
Rainforest (15)	2						
		Ekiti	16	2	Efon	248	50
					Ekiti East	255	51
Total	-	-	-	-	-	1488	298

RIFAN: Rice Farmers Association of Nigeria.

categorize knowledge of CCAS as high or low where a "Yes" response was scored 1 and "No" scored 0. A 3 point-Likert-type scale of always=3, sometimes=2 and rarely=1. Was used to determine the extent of utilization of CCAS. The weighted mean score for each strategy was obtained by multiplying the point scale by the number of respondents in each point scale in order to identify the most frequently used strategy. Furthermore, respondents' aggregate mean score of 58.2±15.3 was used to categorize respondents' level of utilization of CCAS. Those with scores above or equal to the mean score were adjudged using more of the strategies and respondents with scores below the mean score as using less of the strategies.

RESULTS AND DISCUSSION

Respondents socio-economic and farm enterprise characteristics

Table 2 reveals that 40.9% of rice farmers are within the age bracket of 41 to 50 years suggesting they are within economically productive age, implying availability of physical strength and by extension mental alertness in adopting and practicing modern farming techniques which are capable of reducing adverse effect of climate change on rice. This result however is in agreement with Ojehomon et al. (2009) who stated that farmers within the age group of 20 to 60 years are amenable to re-orientation for adoption of productivity-enhancing innovations and technologies. Result also shows that 67.1% of respondents earned between ₦50,000 and 89,000 per acre from rice production and 30.2% had tertiary education. Respondents' years of experience was 17.04±10.5 which suggest higher chances of adapting to climate change because farming experience improves awareness about climate change and increases chances of adaptation. Experience according to IPCC (2007) would enable farmers observe changes in climate and should be for at least a period of one decade. About 39.0% of the respondents obtained planting materials from their previous harvests (seeds) which signify their inability to obtain seeds from extension agents and research institutes. According to Awotide (2009), rice farmers had been having problems obtaining enough good quality seeds which had reduced yield. More than half (64.8%) of the respondents rarely had contacts with extension agents (Table 2). This can affect use of climate change adaptation strategies among farmers since their understanding of climatic change depends mostly on their previous experiences. FARO 44 was the most (36.6%) cultivated improved rice variety as stated by respondents. The result is consistent with a report from the AfricaRice (2009), which stated that many farmers prefer FARO 44 for its early maturity, good grain quality and high yield when compared with the local varieties. The analysis of socio-economic and farm enterprise characteristics suggests that respondents had the ability to understand the effects of climate change on their enterprise. This finding is in agreement with Fadullah et al.'s (2015) study.

Respondents knowledge of climate change adaptation strategies

Table 3 shows that respondents were most knowledgeable about climate change adaptation strategies such as adjustment of rice planting calendar based on onset of rainfall (96.6%), use of mulch materials to conserve soil moisture (94.0%) and appropriate use of fertilizer (84.6%). They were more knowledgeable in adaptation strategies that are indigenous to them, been practiced over long periods of time and passed from one generation to the other than technological innovation strategies such as planting drought-resistant varieties (17.1%), crop insurance against natural disasters (22.5%), and planting submergence-resistant varieties (25.2%). This result corroborates the research finding of Watson (2010) who reported that African farmers have used indigenous knowledge to understand weather and climate patterns in order to guide their decisions in crop and livestock management. It therefore becomes

Table 2. Respondents socio-economic and farm enterprise characteristics (Objective 1).

Variable description	Frequency	Percentage
Age (years)		
≤30	18	6.0
31-40	65	21.8
41-50	122	40.9
51-60	75	25.2
>60	18	6.0
Mean age = 45.3±9.1		
Estimated annual income (₦/acre)		
<10,000	6	2.0
10,000-49,000	52	17.4
50,000-89,000	200	67.11
≥ 90,000	40	13.4
Educational attainment		
Non-formal (vocational training)	37	12.4
Primary	54	18.1
Secondary	117	39.3
Tertiary	90	30.2
Years of experience		
1-10	156	52.3
11-20	67	22.5
21-30	47	15.8
>30	28	9.4
Mean = 17.04±10.5		
***Source of planting materials**		
Previous harvest (seeds)	200	38.8
Research institutes	128	24.9
Extension agents	75	14.6
Growth Enhancement Scheme (GES)	112	21.7
***Contact with extension agent**		
Always	9	3.0
Sometimes	96	32.2
Rarely	193	64.8
***Rice variety cultivated**		
Local	104	16.1
Improved		
Faro 42	86	13.3
Faro 44	237	36.6
Faro 52	141	21.8
Faro 56	21	3.2
Nerica 7	12	1.9
Nerica 8	46	7.1

*Variables are multiple response.

imperative that farmers be sensitized on issues of climate change and its adaptation especially with regards to rice production.

Table 4 reflects the knowledge level of respondents on climate change adaptation strategies. The knowledge and understanding of an innovation is a determinant of its

Table 3. Distribution of respondents' knowledge of climate change adaptation strategies.

Items	Knowledgeable (%)
Adjustment of rice planting calendar based on onset of rainfall	96.6
Use of power tillers	63.8
Use of charms to scare birds	35.9
Timely provision of weather information	20.1
Planting drought resistant varieties	17.1
Crop insurance against natural disasters	22.5
Planting submergence resistant varieties	25.2
Cultivating different crop variety according to rainfall predictions	76.8
Diversification into other livelihood activities	39.6
Preservation and selection of seeds for next planting season	85.2
Changing planting date	19.1
Planting other crops like cowpea, sorghum	67.8
Draining excess water from the field	36.9
Use of mulch materials to conserve soil moisture	94.0
Appropriate use of fertilizer	84.6
Praying	66.1
Keeping updates on weather forecast	45.3
Regular monitoring of field for bird attack	88.3
Adopting different cropping methods	61.1
Use of improved tillage practices	85.2
Land leveling	47.3
Knowledge acquisition through trainings	22.5
Use of different cropping patterns	41.3
Planting pests and disease resistant variety	32.2
Fallow method	62.4
Planting short duration high yielding variety	73.2
Use of Integrated Pests Management (IPM)	31.9

Table 4. Categorization of respondents' on knowledge of climate change adaptation strategies in the study area.

Knowledge level of CCAS	Score	Total	
		F	%
Low	0-18	132	44.3
High	19-36	166	55.7
Mean±SD		19.5 ±4.7	

utilizations in order to achieve positive results. According to Meijer et al. (2014), the knowledge an individual possesses about an innovation forms the basis of his adopting and utilizing it. The result shows that the respondents were knowledgeable about climate change adaptation strategies as revealed by more than half of the respondents (55.7%) who had higher knowledge of the strategies compared to 44.3% of the respondents who were less knowledgeable. This implies that adapting to climate change is not dependent only on knowledge acquisition but on the utilization of the strategies in order to enhance production. It could also be inferred from the result that despite farmers' long years of experience, there is dire need for them to be sensitized on issues of climate change and how to adapt to it especially as it regards rice production. This finding agrees with that of Moundzo (2012) that farmers especially rice growers do not have adequate knowledge for the efficient management of their farms under the impacts of a transformed climate, so they rely on individual experience and local know-how to deal with the problem of climate change.

Table 5. Climate change adaptation strategies utilized by respondents.

Adaptation strategies	Extent of utilization (weighted mean ±SD)
Planting pests and diseases resistant varieties	2.38±0.6
Use of drought tolerant varieties	1.90±0.7
Continuous and frequent weeding	2.87±0.4
Use of integrated pest management (IPM)	2.21±0.8
Appropriate use of fertilizer	2.74±0.5
Planting crops with early rainfall	1.88±0.7
Planting submergence-tolerant varieties	2.02±0.3
Early harvesting of crops	2.48±0.9
Use of timely and adequate weather information	1.64±0.8
Using charms to scare birds	0.9±1.1
Draining excess water in field to prevent water logging	0.70±1.0
Forming a farmers group to finance adaptation	0.98±0.8
Improved extension services using modern ICT tools	1.52±0.9
Attending field schools to improve cultivation methods	1.47±0.5

Table 6. Categorization of respondents' utilization of climate change adaptation strategies (CCAS).

CCAS	Score	Total	
		F	%
Low	36 - 57	195	65.4
High	58 - 180	103	34.6
Mean ±SD	-	58.2±15.3	

Table 7. ANOVA showing difference in utilization of adaptation strategies by respondents.

Strategy	Sum of squares	df	Mean square	F	p value
Between groups	15788.33	2	7894.16	43.15	0.17
Within groups	53966.57	295	182.94	-	-
Total	69754.90	297	-	-	-

Respondents utilization of climate change adaptation strategies

Table 5 depicts the most utilized adaptation strategies as continuous and frequent weeding (2.87±0.4), appropriate use of fertilizer (2.74±0.5) and early harvesting of crops (2.48±0.9). The result implies that rice farmers are not totally ignorant of climate change adaptation strategies but have been using one form of adaptation strategy or the other. Findings of Ukwungwu and Abo (2004) and Ozor et al. (2012) support this result. They reported increased weed infestation being a major constraint to rice production ranking second to drought stress in reducing rice yield and quality. To respond to this challenge, farmers frequently weed their farms if they are to obtain meaningful harvests. Additionally, Table 5 further shows the least utilized strategies as draining excess water in field to prevent waterlogging (0.70±1.0), using charms to scare birds (0.9±1.1), and forming a farmers group to finance adaptation (0.98±0.8).

Table 6 shows that utilization of climate change adaptation strategies was low (65.4%) among respondents. This result implies poor utilization of adaptation strategies by respondents and could be an impediment to achieving a sustainable rice production. This is because adaptation will reduce vulnerability, increase resilience, ensure food security as well as reduce the huge foreign exchange expended on rice importation. Furthermore, the ANOVA result (Table 7) shows a non-significant difference in the adaptation strategies used in the study area ($F = 43.15$; p-value>0.05). This suggests that impact of climate change may vary across agro-ecologies. It therefore becomes expedient for farmers to adopt different strategies based

on the ecologies in response to climate change. Corroborating this assertion, Fakayode (2009) stated that for rice production efficiency to be established, adaptation must differ across agro-ecological zones since it is influenced by precipitation and ecology. This is because the agro ecological zones are characterized and governed by the combined effects of temperature, humidity, and the variations that occur in rainfall. These climate parameters form a major influence on the type of indigenous crops and plants that grow successfully in different parts of the country.

CONCLUSION AND RECOMMENDATION

Rice farmers are not totally ignorant of climate change adaptation strategies. They have adapted to different challenges over time, having means of ensuring that their production is improved and livelihoods sustained. This they do by using one form of adaptation strategy or the other such as early harvesting of crops and draining excess water in field to prevent waterlogging. The focus of climate change adaptation by farmers therefore, should be on the new extremes and magnitude of climate change which they should adapt to so as to enhance production. Effective and productive adaptation strategies depend on factors such as wealth, information, education and management capabilities. However, the study revealed that climate change adaptation strategies are ecology specific. Thus, it is recommended that while designing intervention programmes on climate change adaptation strategies by policymakers/stakeholders for farmers, the agro-ecologies where such strategies are to be used should be put into consideration for effective use bearing in mind that ecologies differ across zones.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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