Journal of Agriculture and Ecology Research International
3(1): 24-32, 2015; Article no.JAERI.2015.028
ISSN: 2394-1073

SCIENCEDOMAIN *international*
www.sciencedomain.org

Determinants of the use of Indigenous Coping Strategies against Climate Change among Smallholder Farmers in Katsina State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author SU designed the study, wrote the protocol, and wrote the first draft of the manuscript and analyzed the data. Author MWM managed the literature searches, reviewed the article before submission and discussed the conclusion. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAERI/2015/14785
Editor(s):
(1) Vincenzo Tufarelli, Department of DETO - Section of Veterinary Science and Animal Production, University of Bari "Aldo Moro", Italy.
Reviewers:
(1) Marcelo Sacardi Biudes, Instituto de Física, Universidade Federal de Mato Grosso, Brasil.
(2) Anonymous, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=921&id=37&aid=7747

Original Research Article

Received 21st October 2014
Accepted 26th November 2014
Published 10th January 2015

ABSTRACT

Aims: This study assessed the indigenous coping strategies employed by smallholder farmers in response to adverse effects of climate change in Katsina State and the factors that determine the use of such strategies.
Place and Duration of Study: The research was carried out in Ajiwa and Dutsinma zones of Katsina State Agricultural and Rural Development Authority. The study was initiated in March, 2013 and ended in April, 2014.
Methodology: A sample of 200 farmers was randomly selected from a sample frame of 1332 irrigation farmers. Structured interview and focus group discussion were employed for data collection. The data obtained were analyzed using descriptive statistics, coping strategy index and regression analyses.
Results: Age of respondents, total land size, total annual income and years of membership of

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farmers' cooperatives were found to be positively related to the use of indigenous coping strategies against climate change and significant at 1% probability. The constraints to the effective use indigenous coping strategies against climate change were identified to be: Poverty (identified by 87.5% of the respondents), poor record keeping and documentation (84%), poor access to information on climate change (72%), low level of education (59.5%), uncertainty in the agricultural enterprises due to reliance on natural conditions (46.5%), land tenure system (39%) and inadequate physical and social infrastructure in the rural areas (29.5%).

Conclusion: Despite the constraints hindering effective use of indigenous coping strategies among smallholder farmers in the study area, they were able to, over time, develop and fine-tune such strategies.

Keywords: Adaptation; climate change; coping strategy index; indigenous coping strategies; smallholder.

1. INTRODUCTION

It has been confirmed that global climate is indeed getting warmer and the effect of climate change and ozone layer depletion on the society is enormous [1]. Global warming leads to erratic weather conditions in most places worldwide [2]. [1], defines climate change as statistically significant variations in climate condition that persists for an extended period, typically for decades or longer. It is any change in climate, rainfall or productivity caused by natural variability and direct or indirect human activities that alter the composition of the atmosphere [1]; [3,4]. A research sponsored by the International Food Policy Research Institute also shows that agriculture and human development will continue to be adversely affected by climate change [5]. It further shows that populations in the developing nations, which are already vulnerable and food insecure are likely to be the worst hit and that further climatic changes pose huge challenges to food security.

It was also established that, climate change is not a completely new idea to Africa and Africans [6]. Local populations through their indigenous knowledge systems (IKS) have developed and implemented extensive coping strategies that have enabled them reduce their vulnerability to past climate variability and change, which exceed those predicted by models of future climate change [5,7]. The fact that local communities have survived till today with fast population growth rates testifies that they have developed indigenous mechanisms and strategies to cope with changes in environmental conditions such as climate. It has been recommended that community-based coping strategies to climate change should be supported as farming and climate change are location specific [5].

Unfortunately, despite their relevance in the design and implementation of sustainable development projects, farmers' indigenous knowledge and practices are rarely taken into the requisite consideration in the design and implementation of modern mitigation and adaptation strategies. Such incorporation can promote local participation in the development of sustainable, cost-effective climate change mitigation and adaptation strategies rich in local content which will improve the food security situation of the people [7].

Furthermore, although research is gradually recognizing the importance of IKS in developmental studies, the value of IKS in climate change has received little attention. This is despite the fact that, through continuous adjustments, rural communities have over time exhibited their competence in sustaining livelihoods in both urban and rural sectors as well as contribute to the development of the national economy [8,7]. Literature has shown that one of the enormous challenges facing rural development today is how to recognize, integrate and strengthen the indigenous resource management system of rural people in Nigeria's development policy [9]. This brings to the fore the need for climate change mitigation and adaptation efforts, especially those aimed at combating hunger, to learn from the experiences of other developmental projects by recognizing the role of the IKS. This study aims to investigate factors that determine the use of indigenous coping strategies employed by farmers in Katsina State in response to changing climate. Specifically, the objectives of this study are to:

i. Identify the socio-economic and institutional characteristics of the respondents;
ii. Evaluate factors that influence the use of indigenous coping strategies; and
iii. Identify the constraints to the use of coping strategies against climate change.

The following null hypothesis was tested in this study: Socioeconomic and institutional factors do not influence the use of indigenous coping strategies.

2. METHODOLOGY

This study was conducted in Katsina State, North-Western Nigeria (shown in Figs. 1 A and B). Katsina State has a total land area of 23,938 square kilometres located between longitudes 110 and 130 East; and latitudes 60 and 90 North. The projected population of the state was put at 7,452,629 in 2014 from the 2006 figure. of 5,792,578 at a growth rate of 3.2 percent per annum [10]. Majority of the population are Hausa/Fulani Muslims. The climate is semi-arid with average annual rainfall of about 689mm falling between May and September. The major crops grown are maize, cotton, groundnut, millet, sorghum, cowpea and vegetables among others. The State lies within three agro-ecological zones: Sahel Savanna, Sudan Savannah and Northern Guinea Savannah. Likewise, Katsina State Agricultural and Rural Development Authority, the state apparatus responsible for agricultural and rural development and extension, stratified the state the thirty-four local government areas in the state into three agricultural zones. These are: Zone I (Ajiwa), Zone II (Funtua) and Zone III (Dutsinma).

Multi-stage sampling procedure was applied for the purpose of this research. Zones I and III (Ajiwa and Dutsinma) were randomly selected out of the three agricultural zones of KTARDA. This study targeted household heads who happen to be registered smallholder farmers in the study area as its respondents. After rigorous consultations with the agents of Katsina State Agricultural and Rural Development Authority (KTARDA), a list of 1332 farmers made up of 702 from Ajiwa Zone and 630 from Dutsinma were compiled as the defined population for this study. To ensure representation, fifteen percent of the sample frame was selected via simple random sampling method, using a random number generator, giving rise to a sample of two hundred (200) respondents.

Zone I (Ajiwa) is the largest agricultural zone in the state consisting of sixteen out of the thirty-four local government areas (LGAs) in the state. These are: Batagarawa, Jibia, Katsina, Charanchi, Rimi, Kaita, Mani, Mashi, Bindawa, Ingawa, Dutsi, Daura, Sandamu, Maiadua, Baure and Zango. It is located in the northern-most part of the state neighboring Niger Republic. The vegetation is arid and semi-arid Sahel savannah prone to desert encroachment from the Sahara. Major crops grown consist of millet, sorghum, cowpea and vegetables. Most farmers also keep small ruminants and poultry in their backyard.

A B

Fig. 1. A) Map of Nigeria showing Katsina State. B) Map of Katsina State showing the various LGAs that make up the zones

Across the middle-belt of the state is an area characterized by Sudan Savannah ecology with mainly grassland and shrubs with sparsely distributed trees. This is delineated as Zone III of KTARDA with headquarters in Dutsinma Town close to Zobe Dam and it covers Dutsinma, Kankia, Kusada, Musawa, Matazu, Danmusa, Safana, Batsari and Kurfi LGAs. Majority of its inhabitants are farmers cultivating sorghum, maize, millet, cowpea, groundnut and rearing modest herds of sheep, cattle and goats and poultry.

Primary data was used in this study. The data was obtained through survey using complementary methodological approach combining the conventional approach in form of structured questionnaire and the participatory methodologies of inquiry, such as focus group discussion (FGD) as used by [9]. The questionnaire was administered by well-trained enumerators supervised by the authors while the FGD was conducted in each community by the authors and assisted by village extension agents. Descriptive statistics were used to achieve objectives i and iii, while multiple regression analysis was used to achieve objective ii of the study and test the hypothesis. The study was carried out between March, 2013 and April, 2014.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic and Institutional Characteristics of the Respondents

The respondents in this study are middle-aged to elderly irrigation farmers aged 42 to 79 years old with a mean age of 55.34 years and a standard deviation of 7.9 as shown in Table 1. The respondents in this group were expected to have acquired substantial knowledge and understanding of the subject matters of this research: Indigenous coping strategies, irrigation farming and climate change in their environment. Furthermore, all the respondents are household heads who are major stakeholders in the decision making processes of the household-farm socio-economic unit and are believed to have the required information for this study. This is compounded by the farming experience of the respondents accumulated between 21 to 63 years of active involvement in agricultural activities.

The mean years of formal education are 4.66 which imply that the average respondent does not have up to complete primary education. The range of 0 to 23 years indicates that though some farmers have not acquired any formal education there others that have obtained up to tertiary education among the respondents. Further investigation showed that all the farmers have acquired various levels of Qur'anic education via the traditional *Tsangaya* system.

The study area is characterized by relatively large households ranging from 3 to 31 members with a mean of 14 and standard deviation of 5.93. Large households have more hands to partake in the rigors of irrigation agriculture even though smaller households have fewer mouths to feed which could influence their food security.

Even though agricultural lands in the study area have been subjected to fragmentation, the average total farm (irrigated and rainfed) size of a household is 3.35 hectares with a hectrage range of 1 to 12 and standard deviation of 1.07. Land is a vital resource in agriculture; hence, larger farm sizes are expected to enable farmers to experiment with different coping strategies and technologies and to enhance their food security. The household cumulative annual income has an average of ₦242,085.00, a range of ₦76,000.00 to ₦760,300.00 and a standard deviation of 106361. Meanwhile, the average credit obtained by a household in the last production cycle from all sources – formal and informal – and for all purposes was ₦ 22,620.00 with a range of ₦0.00 to ₦300,000.00 and standard deviation of 57142.03.

The average respondent received less than 1 extension visit in the production cycle. The number of visits ranges from 0 to 5 with a standard deviation of 0.99. This implies that none of the farmers acquired the recommended 24 visits per year. The mean duration of membership of cooperative group was 5.63 years with a range of 3 to 16 years and a standard deviation of 7.15.

3.2 Indigenous Coping Strategies against Climate Change Employed by the Respondents

The respondents have identified the strategies they employ in adapting to and mitigating the adverse effects of climate change on their agricultural production. This information was

obtained using the participatory rural appraisal approach (PRA) of pairwise scoring and ranking the results of which are shown in Table 2. Mixed cropping was identified as the most important strategy used. This is because different crops have different climatic requirements. Hence, several crops on a plot reduce the risk of loss due to unfavourable climatic conditions. Other important strategies in the study area include change in date of sowing, seed selection and prayers and supplication. Farmers in the study area, as in most rural societies, are religious and spiritual people. Hence, they seek spiritual intervention to ameliorate problems threatening their well being. For instance, during periods of dry spell and droughts all members of the affected community – including men, women, children and livestock – move to the outskirts of the village for a special prayer in the Islamic tradition known as *salatul-istisqa'a*. They also practice *Rokon ruwa*; where old women dressed in their husbands' attire go round town chanting songs, seeking forgiveness from God while children follow them clapping and drumming. Other strategies employed such as Shadouf irrigation system, afforestation, household fuel conservation and minimum tillage could help in minimizing green house effect through use of clean energy sources and enhancing carbon and overall mitigation of climate change.

3.3 Factors Influencing the Use of Indigenous Coping Strategies against Climate Change in the Study Area

Furthermore, the study found that some of the socioeconomic and institutional factors discussed in Section 3.1 determine the use of indigenous coping strategies in the study area. This was achieved using a linear regression analysis. The analysis depicted that the parameters regressed are responsible for 59.1% of variation in the coping strategy indices (CSIs). Therefore, the null hypothesis is hereby rejected as the analysis indicates that certain socioeconomic and institutional factors influence the use of indigenous coping strategies.

Table 1. Statistical distribution of socio-economic characteristics of respondents

Variable	Mean	Standard deviation	Min	Max
Age of the respondents	55.34	7.90	42	79
Educational attainment	4.66	5.25	0	23
Farming experience	39.43	9.09	21	63
Household size	14.17	5.93	3	31
Land size	3.35	1.07	1	12
Income (₦)	242085	106361	76000	760300
Extension visit	0.53	0.99	0	5
Credit obtained (₦)	22620	57142.03	0	300000
Membership of cooperative	5.63	7.15	2	16

Table 2. Result of pairwise scoring and ranking of indigenous coping strategies used by irrigation farmers in the study area

Indigenous coping strategy	Ajiwa zone	Dutsinma zone	Pooled data	Rank
Mixed cropping	10	11	21	1
Changed sowing date	10	10	20	2
Seed selection	9	9	18	3
Prayers and supplication	7	8	15	4
Animal husbandry	6	7	13	5
Traditional irrigation system	5	6	11	6
Afforestation	5	5	10	7
Seasonal migration	4	4	8	8
Changed harvest date	4	3	7	9
Organic manure use	4	1	5	10
Fuel conservation	1	2	3	11
Minimum tillage	1	0	1	12
Total	66	66	132	N/A

The Coping Strategies Index is a relatively new concept. It was developed by East and Central Africa Regional Management Unit of the World Food Programme (CARE/WFP) in 2003 as an indicator of household food security that is relatively simple and quick to use, straightforward to understand and correlates well with more complex measures of food security. A series of questions about how households manage to cope with a shortfall in food for consumption results in a simple numeric score. In its simplest form, monitoring changes in the CSI score indicates whether household food security status in declining or improving. It is much quicker, simpler, and cheaper to collect information on coping strategies than on actual household food consumption levels [11,12]. It basically involves:

(i). Asking respondents a set of simple questions to capture people's basic consumption related coping responses to inadequate access to food in a given culture or location. The questions should be based on the right list of coping behaviours as there is no universal set of coping strategies;
(ii). Then, respondents are asked how often they use those strategies to obtain a frequency value); and
(iii). Then, questions are asked to find out how "severe" each of these individual coping strategies is perceived to be. This information is collected from community-level focus groups and provides a weight for the perceived severity of each strategy.
(iv). The product of the frequency and severity of each coping strategy provides the CSI for that household.

Since then, the CSI has been adapted and used as a tool in various researches and studies involving coping strategies. For instance, it has been used by [13] where they estimated the use of Ethno-veterinary medicine in livestock management and rearing. Furthermore, it was modified and used by [14] to study the implications of gender considerations in decision making on households' food security in rural Ekiti state, Nigeria. In this fashion, it was used in this study to score the various strategies used by farmers to resist the vagaries of climate change according to frequency of usage and severity. The a priori expectation is that the higher the CSI of a household the more resilient (and less vulnerable) it is to climate change.

Individually, as shown in Table 3, each of age of respondents, total land size, total annual income and years of membership of farmers' cooperatives were found to be positive and significant at 1% probability. It is noteworthy that figures. less than 0.01 in the Sig column in Table 2 depict that the estimate in Column B can be said to be true with 99% level of confidence. Age was found to be positively related to CSI and significant at 1%. The coefficient of 20.407 means that a farmer who is a year older would have a CSI that is higher by 20.407. This implies that older farmers tend to have higher CSIs than younger ones. This is because elderly people are the custodians of indigenous knowledge and practices. Also, the CSI is a factor of duration of usage of indigenous coping strategies which is related to age. This supports the findings of [15] that age, educational level, and amount of farm credit received were found to be significant in managing effects of climate change among farmers.

However, contrary to [15], this study found that farm size is highly significant and positively related to CSI. This implies that an increase in one hectare of farm size results in a higher CSI by 68.582. Likewise, level of income is positively related to CSI and significant at 1%. This implies that more well to do households have a higher tendencies of using indigenous coping strategies against climate change. This is in line with findings of [15,16] in separate studies in Nigeria (Nasarawa State) and Tanzania respectively.

Years of membership of cooperatives also are positively related to CSI and significant at 1%. This implies that the more years a farmer spends in cooperative group, the more (s)he would learn and get exposed to beneficial knowledge and practices abound in the society.

3.4 Constraints to the Use of Indigenous Coping Strategies against Climate Change in the Study Area

The respondents identified what they believed are constraints militating against efficient utilization of indigenous coping strategies against climate change. As shown on Table 4, the first was poverty which was identified by a total of 175 respondents (87.5%). Dearth of resources constrains any venture, inhibits diversification and minimizes options for survival.

Table 3. Factors influencing the use of indigenous coping strategies in the study area

Model	Unstandardized coefficients		Standardized coefficients	Sig.
	B	Std. error	Beta	
(Constant)	1248.278*	176.017		.000
Age	20.407*	3.350	.357	.000
Educational attainment	27.256	33.977	.037	.423
Farming experience	-1.020	2.470	-.021	.680
Household size	1.501	3.541	.020	.672
Land size	68.528*	20.637	.162	.001
Income	.001*	.000	.144	.005
Extension visit	-27.945	21.161	-.061	.188
Credit	.000	.000	-.017	.715
Cooperative membership	23.533*	3.689	.373	.000

*a. Dependent variable: coping strategy index. * = significant at 1% level of probability*

Table 4. Constraints to the use of indigenous coping strategies in the study area

Constraint	Ajiwa zone (n=105)		Dutsinma zone (n=95)		Pooled data (n=200)		Rank
	Frequency	%	Frequency	%	Frequency	%	
Poverty	93	88.57	82	86.32	175	87.5	1
Poor record keeping and documentation of IK	90	85.71	78	82.11	168	84	2
Poor access to information on climate change	91	86.67	53	55.79	144	72	3
Low level of education	70	66.67	49	51.58	119	59.5	4
High level of uncertainty in agricultural enterprises	56	53.33	37	38.95	93	46.5	5
Land tenure system	35	33.33	23	24.21	78	39	6
Poor physical and social infrastructure	26	24.76	23	24.21	49	29.5	7

This supports the findings of [11]. Following poverty was poor record keeping and documentation. Farmers commit happenings, activities and experiences to memory and oral transmission. This makes information to become faded out, distorted and, in some cases, lost completely. Proper documentation is required for effective reference to environmental challenges encountered and best possible remedies tested, thereby enabling transmission to subsequent generations and improvement.

Poor access to information on climate and climate change was identified by a total of 144 respondents (72%). This was followed by low level of education (59.5%), uncertainty in the agricultural enterprises due to reliance on natural conditions (46.5%), land tenure system (39%) and inadequate physical and social infrastructure in the rural areas (29.5%) in that order.

4. CONCLUSION

It is evident that rural farmers in the study area are among the victims of the global danger of climate change. Fortunately, they are aware and have even identified indicators of the environmental phenomenon. It is also clear that despite the constraints hindering effective use of indigenous coping strategies among smallholder farmers in the study area, they were able to, over time, develop and fine-tune such strategies. Socioeconomic and institutional factors affect the use of such strategies significantly in the study area.

5. RECOMMENDATIONS

Based on the findings of this study it is apparent that there is need for capacity building and advisory services that enhance and complement the use of indigenous and modern strategies against climate change particularly in areas of information accessibility and weather prediction. This should target both the extension personnel and the farmers. Also, governmental, intergovernmental and non-governmental organizations involved in intervention projects and programmes should take into cognizance the documentation and prioritization of indigenous coping strategies as used by farmers for further development and utilization. This is because; it has been found that the indigenous practices are working for the communities and starting from there would enhance participation and sustainability in the projects/programmes. Likewise, it has also been found that poverty is a major constraint in using coping strategies against climate change. However, the problem of poverty can be resolved by pooling resources in form of cooperative groups. Also, farmers can access loans from government and commercial banks easier through cooperative groups. Although most farmers these days belong to one cooperative group or the other, they are not involved in cooperative activities. They joined such groups when they are expecting certain benefits from intervention projects. Therefore, farmers are enjoined to imbibe the idea of group formation with the aim of cooperation. Though majority of the farmers possess little or no formal education, they are mostly literate in Arabic and Ajami (Hausa language written in Arabic transcription). Hence, farmers should endeavor to keep records of their indigenous knowledge and practices for future use, comparisons and improvements. Also, agencies responsible for adult literacy should intensify their efforts especially in rural areas.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=921&id=37&aid=7747