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Farmers Awareness and Response to Climate Change: A Case Study of the North Bank Region, The Gambia

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Abstract
Rain-fed agriculture, which is the backbone of most sub-Saharan economies is seriously under threat due to climate change. Consequently, for farmers to sustain their livelihoods and increase productivity, there is the need for them to be aware of climate change and how they can sustainably respond to it. This study focused on farmers' awareness of climate change and their response to its effect in the North Bank Region of The Gambia. Data for the study was collected from 258 farmer household heads selected through a multi-stage sampling technique and 9 focus group discussions. Descriptive statistics and climate change awareness index (CCAI) were used to analyze the data obtained from the households. The findings revealed that majority (80.6%) of the farmers were aware of climate change with an average awareness index of 0.586 (58.6%). Also, an overwhelming majority of 93.41% of the farmers used crop diversifications, drought resistant cultivars, early maturing varieties among others as response strategy to climate change. The study concludes that farmers in the study area are fairly aware of climate change. Farmers are recommended to form farmer associations to enable easy access to more climate change education/ training from Donor and Government agencies to improve their climate change knowledge and enhance their adaptive capacity.
Keywords: Climate change, Response, Climate change Awareness Index, The Gambia

1. Introduction

Climate change has been identified as the leading human and environmental crises of the 21st century (Tadesse, 2010). Globally, it adversely affects livelihood activities such as farming through the occurrence of diverse extreme events such as floods, cyclones, droughts, and unpredictable rainfall patterns (Urama & Ozor, 2010). Changes in temperature and rainfall patterns affect agriculture, especially in tropical regions. Consequently, rain-fed agriculture is seriously threatened resulting in an imminent global food insecurity (FAO, 2008). For instance, in 2005, 777 million people experience food insecurity in 70 lower income countries in the world, many of which were African countries (Hùng, 2009).

Although the impact of climate change is global, sub-Saharan Africa (SSA) is noted to be the region that is most vulnerable to many adverse effects of climate change because of her high dependence on rain-fed agriculture for food security, economic growth, coupled with low adaptive capacity (Kotir, 2011). In SSA, 93% of cultivated land is rain-fed (Sharma, 2011) and over 80% of the rural households derive their livelihoods from rain-fed agriculture (Gbetibouo & Mills, 2012) with about a third of the people in this region living in drought prone dry lands (Singh *et al*., 2009). Climate change has resulted in low crop productivity, and climate change related losses in crop yield are projected to reach 50% in some countries of SSA by 2050 (IPCC, 2007). This would severely compromise food security in many African countries (Zinyengere *et al*., 2014).

The results of the changing climate on livelihood activities, especially agricultural activities, tend to impact the entire populations in the continent with women and children being the most affected. This is because their livelihood activities are based on natural resources (Alexander *et al*., 2011). According to Gaard (2015) women produce most of the world's food yet majority of the world's hungry are women and children. Also an estimated 146 million children in developing countries are underweight due to acute or chronic malnutrition and 60% of the world's hungriest are women (FAO, 2013).

Agriculture is the largest sector of the Gambian economy, accounting for 33% of Gross Domestic Product (GDP) and employs 75% of the labor force (NPC, 2009). However, in The Gambia, frequent droughts result in significant loss to agriculture and allied sectors (Yaffa, 2013). Therefore increasing effect of climate change on agriculture has the tendency of aggravating food insecurity, unemployment and loss of livelihoods. This means that the agriculture-based livelihoods of such people and for that matter food security in the country

is under threat. To increase climate change awareness in the country, diverse climate change awareness programmes and campaigns have been conducted in the Gambia to enable farmers make informed decisions to respond to the changing climate. However, there is little empirical evidence on farmers awareness of climate change in the mix of these awareness programmes and campaigns as well as their response to climate change (Oruonye, 2011). With the continuing occurrence of climate change, and no signs of its abatement, the need to assess farmers' awareness and response to climate change has become even more important in order to ensure food security and improved rural livelihoods. The study aims to assess farmers' awareness and their source of climate change information as well as their response (adaptations) strategies to climate change in the North Bank Region of The Gambia.

2 Methods and Materials

2.1. Description of Study Area

The study was conducted in three randomly selected districts in the North Bank Region of the Gambia (Figure 1). The study area lies between Latitude 13° 25' N and 13° 40 and latitudes 16° 00' W and 16° 35' W. The North Bank Region falls within Sudan-Sahelian zone with 600-900 mm rainfall per annum. The area experienced below- national average rainfall in 29 out of the 40 years between 1972 and 2011 (Yaffa, 2013). The meteorological station located in the regional capital (Kerewan) records the lowers amount of rainfall as compared to other parts of the country. The dominant soil type in the region were sandy loam and clay soils characterized by poor soil structure, fertility and less vegetative cover compared to the rest of the country and hence exposed to extreme climate conditions.

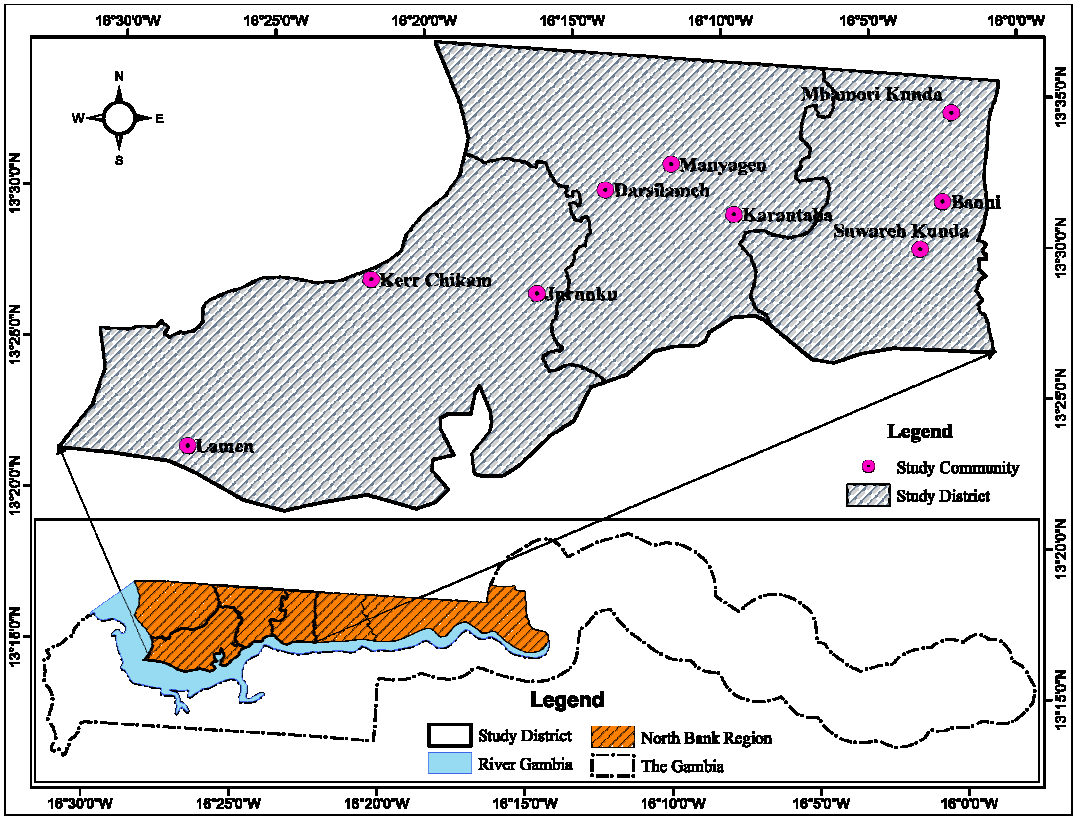

Figure 1: Map of Study Area

2.2. Sampling and Sample Size

A multistage cluster sampling technique was employed to select respondents for the study. The first stage was the selection of one region in the country. The Gambia has five regions, but the North Bank Region was purposively selected because it is the region most affected by drought, unpredictable rainfall and high temperatures in the country. Hence, farmers in this region are more vulnerable to climate change compared to other parts of the country. Simple random sampling technique was then used to select three districts from the six districts in the North Bank Region and three communities from each district for the data collection. In the last stage, simple random sampling was used to select households from each community. In each selected household, the head was interviewed but in the absence of the household head, any adult member (more than 18years) was interviewed. Krejcie & Morgan (1970) sample size formula (Equation 1) was used in computing the sample size

for the study. In all 258 farmer household heads were interviewed for the entire study.

$S = X^2NP (1-P) /d^2 (N-1) + X^2 P (1-p)$ ..... [1]

Where: S = required sample size

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841) that is 1.96 *1.96 = 3.841

N = the population size.

P = the population proportion (assumed to be 0.50 since this would provide the maximum Sample size)

d= the degree of accuracy expressed as a proportion (0.05)

To obtain the number of respondents from each village, the total number of households in each community obtained earlier were divided by the total households for the study (781) and the value multiplied by 258. Table 1 indicates the sample size for each selected community.

Table 1: Sample for the Study

Region	District	Communities	Total households	Sampled households	Percentage (%)
North Bank Region	Lower Badibbu	Mbamori Kunda	29	9	4
		Banni	117	39	15
		Suwareh Kunda	139	46	18
	Jokadu	Munyagen	151	50	19
		Karantaba	33	11	5
		Darsilameh	137	45	17
	Upper Niumi	Lamen	112	37	14
		Jurunku	34	11	5
		Kerr Chikam	29	10	4
Total	**3 districts**	**9 communities**	**781**	**258**	**100**

2.3. Data Collection and Analysis

A semi-structured questionnaire was administered to the sampled farmers. This was used to seek information on farmers' awareness, source of climate change information and response strategies. A total of nine Focus Group Discussions (FGD) were conducted for the entire study, one in each community. The method was adopted to provide more detailed explanations on the data that was collected during farmers' individual interviews. It also provided the opportunity to affirm and served as a cross check on the answers from the interview.

Quantitative data collected through individual interviews was analyzed in MINITAB16.0 statistical software. The qualitative data collected during the FGD were processed to supplement the quantitative information. Descriptive statistics such as frequencies, means, modals, standard deviations, maximum, minimum values were used to characterized farmers' demographic and socioeconomic data. This was also employed to analyze data on farmers' awareness, source of climate change information and response to climate change.

In addition to the descriptive statistic, an awareness index was calculated to further assess farmers' climate change awareness. In this study climate change awareness was calculated as a composite index of three indicators: i) conceptual awareness; ii) experiential awareness; and iii) engagement. Conceptual awareness is about the individual's knowledge on the causes of climate change and their impacts. Experiential awareness is about experiencing and knowing long term changes in climate and their impacts whiles engagement is about frequency with which an individual talks or hears about climate change (Gbetibouo & Mills, 2012).

To compute the awareness index, answers to nine questions relating to climate change awareness were assigned numerical scores, which were summed up for each respondent to obtain their awareness index. The responses to the nine questions were used to compute a climate change awareness index. The minimum and maximum total scores a respondent got was between 0 and 17 respectively to get an index between 0 and 1, the total score that a respondent got was then divided by 17. To get the awareness in percentage, the index was multiplied by 100 as shown in Equation 2 below.

Equation 2: Climate Change Awareness Index Formula.....[2]

$$CCAI = {}^{AS}\!/_{MS} * 100$$

Where CCA: Climate change awareness index

AS: Awareness score

MS: Maximum score

3. Results and Discussion

3.1. Demographic Characteristics of Farmer Household Head

From the 258 sampled households surveyed 39.9% were female-headed while 60.1% were male-headed. The results also revealed that majority of the farmer household heads (89.1%) were married and 3.1% were single (Figure 2). Figure 2 further showed that 2.3% of them were divorced whiles 5.4% were widowed. This has a positive implication for crop production as married farmers engage in supportive efforts in their farming activities, thus, their spouse could be a source of support in terms of labor and also help supplement the income needed to acquire agricultural inputs.

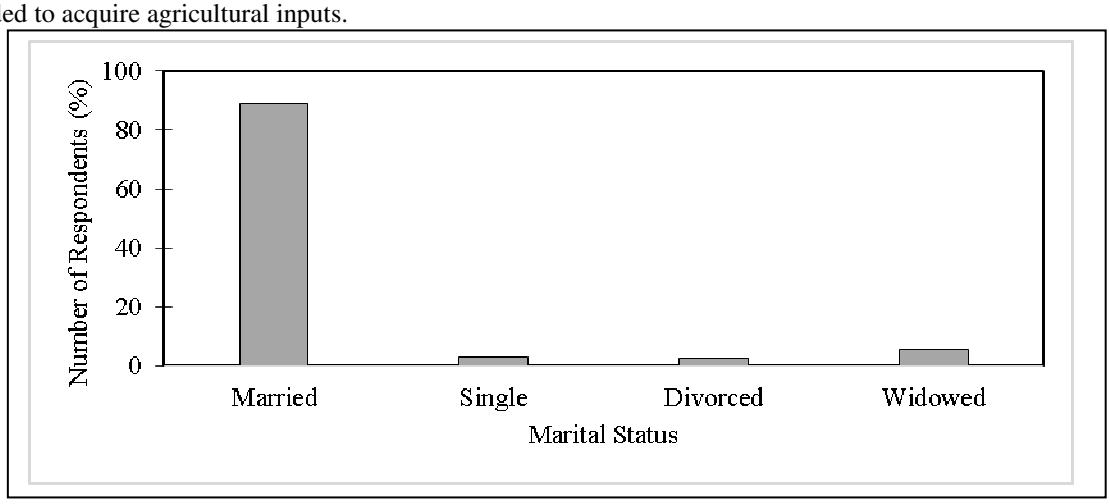

Figure 2: Marital Status of Farmer Respondents

In addition, results from the demographic characteristic of the respondents (Table 2), indicated that the youngest and oldest ages of household heads were 20 and 85 years respectively with a mean age of 51 years. Majority representing 23.64% of the respondents were within the age bracket of 31-40 years old. This implied that farmers in the study area were predominantly in their middle ages hence, are economically active and thus, can undergo stress and have the man-power to carry out labor intensive response strategies. This has a positive corollary for productivity of the farmers (Otitolaiye *et al*., 2009). Also most of the respondents had a household size between 6-11 member (34.11%) with the highest and lowest household size being 35 and 2 members respectively and an average of 14 members per household. This suggests that large sized rural households would be capable of supplying the labor necessary for their crop production due to abundance of own labor. This therefore, has a positive repercussions for crop production. On farmers years of experience the results indicated that majority representing 27.13% of the farmers have been farming for 33-43 years with only 12.7% having the least years of experience in farming that is less than 11 years. This indicates that majority of the farmers' have being farming for a long period and their experience could help them in making good decisions and choices in their crop production process hence, has a positive implication for crop production. The results also revealed that 46.90% of the respondents had farm land size between 1-3 hectares, with 2.7% having a land size less than 1 hectare (Table 2). This showed that, farmers in the study area were generally subsistence farmers making them vulnerable to climate change as reported by Idrisa *et al.* (2012) in their study in Borno State, Nigeria.

Majority of the household heads representing 82.6% had no formal education whilst 17.4% of them had formal education ranging from basic, secondary and Quaranic education. The findings of this study are in consonance with that of Yegbemey *et al.* (2014) in which they found that the educational status of farmer household heads was low in Northern Benin. Low educational level of farmer household heads in the study area has implication for climate awareness and response to climate change as well as the adoption of new agricultural technologies and innovations. For instance, Idrisa *et al*. (2012) reported that a minimum threshold in terms of educational qualification is necessary for understanding the scientific and technical nature of modern agriculture. Maddison (2007) in his study also indicated that educated and experienced farmers are expected to have more knowledge and information about climate change and adaptation measures to use in response to climate challenges.

Table 3 revealed that 65.50% of the respondents did not belong to any farmer organization whilst 34.50% were members of farmer organizations. Also, majority representing 86.05% of the farmers had no access to credit for their crop production whilst 13.95% had access to credit from Cooperative Unions, Farmer Organizations, Department of Agriculture and Agency for the Development of Women and Children (ADWAC), a Non-Governmental Organization. This has repercussion for crop productions as credit is needed to acquire farm inputs such as seeds, fertilizer and efficient farm machines and tools for production. The findings also revealed that 80.62% of the respondent did not have access to any source of support in the form of farm inputs such as seeds and fertilizer for their crop production. Thus, farmers' inability to belong to any farmer

organization is a disadvantage as many at times organizations who support farmers prefer to deal with them in groups. However, 19.38% of the respondents had access to seeds fertilizer and other farm tools from Departments of Agriculture of the Gambia, ADWAC, and other NGOs for their crop productions. According to Gbetibouo & Mills (2012) access to resources (physical and human) and credit are the key determinants of adaptive capacity. Hence, the adaptive capacity of farmers who had access to credit, farm inputs and organizational membership would increase compared to those without access to credit and resources.

Table 2: Age, Household Size, Farmer Experience and Farm Size of Respondents

Age	**Frequency**	**Percent**
20-30	22	8.53
31-40	61	23.64
41-50	60	23.26
51-60	51	19.77
61-70	38	14.73
>70	26	10.08
Total	**258**	**100**
Household size	**Frequency**	**Percent**
<6	38	14.73
6-11	88	34.11
12-17	50	19.38
18-23	49	18.99
>23	33	12.79
Total	**258**	**100**
Farmer Years of Experience	**Frequency**	**Percent**
<11	33	12.79
11-21	41	15.89
22-32	57	22.09
33-43	70	27.13
>43	57	22.09
Total	**258**	**100**
Size of Farmland (acres)	**Frequency**	**Percent**
<1	7	2.71
1-3	121	46.90
4-6	78	30.23
>6	52	20.16
Total	**258**	**100**

It has been reported that, farmers who have access to extension service are more likely to adapt to climate change (Maddison, 2006). In this study, only 48.45% of the respondents in the study area had access to extension services whilst majority representing 51.55% did not have access to extension services. A similar study by Oduniyi (2013) in Mpumalanga province of South Africa also revealed a high percentage of farmers without access to extension service. This will adversely affect farmer's adaptation to climate change in the sub region as extension officers are responsible for educating and training farmers on climate and agricultural issues especially on how farmers can sustainably respond to climate change to increase crop yields. Therefore, the lack of extension service by most farmers have adverse implication for farmers climate awareness and sustainable adaptation as they are deprived climate change information and appropriate response strategies needed to increase productivity.

Table 3: Organizational membership, Access to Credit, Access to other forms of Support and Access to Extension Service

Farmers Organizational Membership	**Frequency**	**Percent**
Non- member	169	65.50
Member	89	34.50
Total	258	100
Access to credit	**Frequency**	**Percent**
No access to credit	222	86.05
Access to credit	36	13.95
Total	258	100.0
Access to other forms of Support	**Frequency**	**Percent**
No access to support	208	80.62
Access to support	50	19.38
Total	258	100
Access to Extension Service	**Frequency**	**Percent**
No access to extension	133	51.55
Have access to extension	125	48.45
Total	258	100

3.2. Awareness of Climate Change in the North Bank Region

Most of the respondents (80.6%) were aware of climate change whilst 19.4% were not aware of climate change. This awareness can be attributed to the fact that even though most farmers lacked access to extension services they accessed agricultural and climate information from other sources. These findings are similar to the findings of Oruonye (2014) and Idrisa *et al*. (2012) in which there was a high level of climate change awareness among farmer household heads in their different studies in Taraba and Borno States, Nigeria. In addition, the average awareness index for the study was 0.586 (58.6%). This index was in line with the average awareness index of 0.54 (54%) found in a study conducted by ATPS (2013b) in Seke and Murewa Districts of Zimbabwe.

To compare farmers' awareness of climate change across the three districts selected for the study. Table 4 revealed that Jokadu and Lower Badibbu districts had an awareness index of 0.58 (57.5%) and 0.54 (53.7%) respectively. Farmers in the Upper Niumi district had the highest awareness index of 0.68 (68.4%) for the entire study. The results also indicated that the least aware farmers' were found in Jokadu and Lower Baddibu and the most aware farmers were in Upper Niumi district. The awareness index for this study implies that farmers in the North Bank region are aware of climate change. This has positive implications for food security and sufficiency as farmers have adequate knowledge about climate change and can therefore respond sustainably to it since climate change awareness/perception is a prerequisite first step to response (Gbetibouo, 2009).

Table 4: Climate Change Awareness Index according to Districts

District / Awareness Index	Jokadu	Lower Badibbu	Upper Niumi
Average Awareness Index (%)	0.575 (57.5%)	0.537 (53.7%)	0.684 (68.4%)
Minimum	0.059 (5.9%)	0.059 (5.9%)	0.294 (29.4%)
Maximum	0.882 (88.2%)	0.765 (76.5%)	0.882 (88.2%)

3.3. Preferred Sources of Climate Change Information for Farmers

Although farmers had diverse sources of climate change information, 45.91% of them preferred radio broadcast as their source of climate change information (Table 5). The justification for their preference was that they have confidence and trust in the climate change information from the radio broadcast because experts discuss on the radio. Others also indicated that, radio broadcast was their only source of climate change information and for its capacity to reach uneducated farmers with matters associated to crop production in comprehensible language. This finding collaborated with the findings of Churi *et al.* (2012) in which majority of the farmers preferred radio broadcast as their source of climate and agricultural market information. Also, out of the 125(48.45%) farmers who had access to extension services 19.84% of them preferred extension services to other sources of climate change. Colleague farmers was the preferred source for 19.46% of the farmers. The farmers who preferred extension service advanced the reason that the extension workers were directly given the responsibility and knowledge to educate, train and advise farmers on farming and climate issues whiles for those who preferred their colleague farmer claimed that they are closer to their colleague farmers and can get information on climate change and crop production from them easily and quickly without waste of time. The least preferred source of climate change information for the study was farmer association representing 1.17%. This could be attributed to the fact that majority of the sampled farmers respondents were not members of any farmer organization. Hence, since different people have different preference, the importance of identifying the appropriate communication source/channel for a specific targeted group cannot be over emphasized in the diffusion of climate change and agricultural innovations.

Table 5: Farmers Preferred Source of Climate Change Information

Preferred Source of Climate Change Information	Frequency	Percent
Radio Broadcast	118	45.91
Extension service	51	19.84
Colleague farmer	50	19.46
Farmer association	3	1.17
Project/NGO	35	13.62
Total	**257**	**100**

3.4 Response Strategies to Climate Change

Findings from the field survey revealed that an overwhelming majority of 93.41% of the farmers responded to the climate change by adopting one or more response strategies to reduce their vulnerability to climate change and increase crop yields. The results revealed in this study is in line with the findings of Uddin *et al*. (2014) in which 84% of the respondent adapted to climate change in Bangladesh. However, 6.59% of the respondents did not adopt any response strategy to the changing climate despite its effects on their crop production. To them Allah (God) was solely responsible for the climate changes and yields in production hence, when Allah decided

to bless them they will get good yields and heavy rains. This therefore, has a negative implication for crop production since such farmers would not adapt to climate change and thus, increasing their vulnerability.

The preference of response strategies depends on a farmer's perception and willingness to adapt as such response to climate change differs from farmer to farmer. Findings from the study on the strategies employed by farmers to respond to climate change revealed that farmers implement diverse adaptation measures to increase productivity and cope with the change in the climate. From Figure 3, majority of the farmers representing 74.42% used Strategy A as response to climate change for the past 3 years. The least used was Strategy B by 2.33% of the farmers to respond to climate change. However, 6.20% of the respondents interviewed never responded to climate change. To them God is the only one that can bring rains and increase their crop production as such apart from prayers they have never changed their farming activities or crop as a way of responding to climate change.

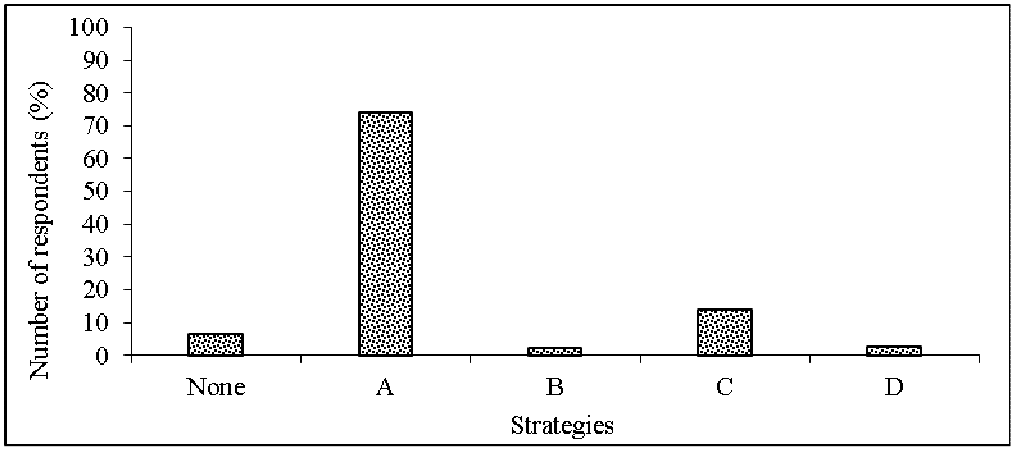

Figure 3: Farmers Response Strategies to Climate Change

Note:

None*: Farmers who never changed to respond to climate change*

Strategy A: *Response strategy that involved the practiced of crop diversification, used different planting dates, use drought resistant crops, used chemical fertilizers, prayer/ritual offerings, implemented soil and water conservation methods, practiced crop rotation, early maturing varieties*

Strategy B: *Response strategy that involved the practiced crop diversification, used different planting dates, used drought resistant crops, practiced crop rotation, and changed area/size of farm land.*

Strategy C: *Response strategy that involved the use of different planting dates, chemical fertilizer, prayers/ritual offerings, crop rotation, early maturing crop varieties, migrated to different locations*

Strategy D: *Response strategy that involved the use of drought resistant crops, prayers/ ritual offerings, chemical fertilizers, early maturing crop varieties, acquired credit*

On the effectiveness of the response strategies implemented by farmers during the past 3 years, majority of the farmers representing 88% indicated that the response strategies they implemented were effective whilst 12% of them indicated that even though they responded by implementing diverse response strategies these strategies were ineffective as they still experienced low crop yields due to the low amounts of rainfall coupled with increased temperatures.

Figure 4 revealed that, out of the 227 respondents who claimed that their response strategies were effective, 61.1% of them realized an increase in crop production, 4.4% of them crops matured early and 5.8% of the respondents indicated that their response strategies were effective because diversifications provided alternative whilst 26.1% respondents indicated that with the response strategies their crops matured early and production also increased. Lastly, 1.3% respondents indicated an increase in crop production with diversified alternatives and early matured crops with diversified alternatives respectively. Tesfay (2014) argued that improving adaptation to current climate variability is not an alternative to preparing for adaptation to longer term changes in climate. It is an adjunct, a useful first and preparatory step that strengthens capacity now to deal with future circumstances. Hence, farmers should be educated and trained on improved and sustainable response strategies for crop production due to its implication for increase yields and food security.

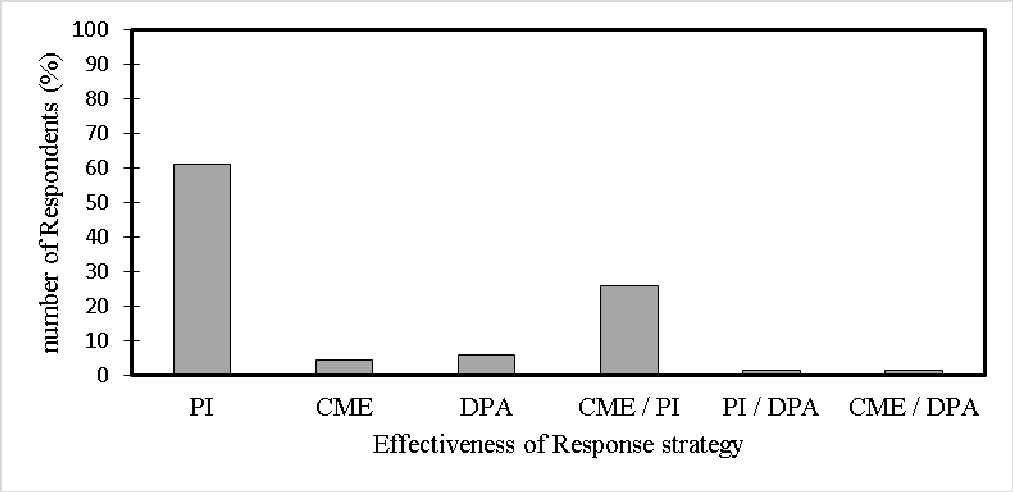

Figure 4: How Effective were Farmers Response Strategies

Note:
PI: *Production Increased*
CME: *Crops Matured Early*
DPA: *Diversification provided Alternatives*
CME/PI: *Crops Matured Early and Production Increased*
PI/DPA: *Production Increased and Diversification provided Alternatives*
CME/DPA: *Crops Matured Early and Diversification provided Alternatives*

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

Most farmer respondents are in their economically active age group, which has positive implications for crop production and food security in the area if they are aware of negative effects of climate change and adapt sustainably. However, majority of the farmers did not have any kind of formal education. Although farmers in the North Bank Region are aware of climate change, their awareness level is low since the index is just slightly above average. The main conclusion drawn from the study is that farmers have a wide pool of sources through which they access climate change information from hence, farmers' climate change awareness may be attributed to their diverse sources of climate information. Radio broadcast, extension service and colleague farmers were the most preferred sources of climate information for farmers in the North Bank Region. Hence, agricultural information targeted at farmers in the near future should be channel through these sources for effective communication and adoptions.

5.2. Recommendations

Climate change, its causes and effects are fairly known by farmers in the North Bank Region. However, this is inadequate for sustainable adaptation and mitigation to climate change. It is recommended that Government, NGOs and other stakeholders should embark on more climate change awareness campaigns' with emphasis on sustainable adaptation/response measures and mitigation to climate change among farmers.

It is also recommended that agricultural innovations, climate change information and other issues pertaining to farmers should be communicated through farmer preferred sources such as radio, extension agents and neighbor farmers. Communicating an innovation through farmers accepted and trusted sources would increase the rate of acceptability and dissemination of that innovation or information.

The study recommends that farmers collaborate to form farmer associations to enable them have easy access to farm inputs and training from donor and government agencies to improve their climate change knowledge and enhance their adaptive capacity to climate change.

Government and other stakeholders need to make climate change adaptation (response) as a priority area of its political agenda since climate change is multi- sectorial and the priority of sub-Saharan countries is on adaptation. Policies to reduce hunger, poverty and ensure food security and sufficiency needs to address issues of climate change since agriculture is predominantly rain-fed.

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