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RESEARCH ARTICLE

IMPACT OF CLIMATE CHANGE ON FARMERS IN THE TALENSI DISTRICT OF THE UPPER EAST REGION OF GHANA

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ABSTRACT

This paper focuses on the impact of climate change on the lives of rural farmers in the Pwalugu and Balungu communities of the Upper East Region of Ghana since farmers all over the country have been exposed to various adaptation strategies to climate change. From the study which was conducted in 2017, it was revealed that climate change affected respondents negatively resulting in reduced income level, inability to afford three square meals daily, inability to meet their health needs, inability to meet the educational needs of their children as well as inability to save at bank. Also, lack of finance, land tenure, norms/customs, lack of storage facilities, lack of ready markets, damage to crops by Fulani cattle and difficulty in obtaining seeds for farming were some challenges militating against the adoption of other adaptive strategies to climate change. The farmers therefore practiced crop diversification, adjustment in planting date of their crops, irrigation, change method of production, migration to the southern part of the country during the dry season to work, trading, fishing, among others as their specific adaptive strategies to climate change. The study recommends that, education should be one of the areas for policy intervention by government/stakeholders since access to education is vital in developing specific strategies of rural farmers to the diverse drivers and impacts of climate change on their lives.

KEYWORDS

specific adaptive strategies, climate change, impacts, adaptation strategies, challenges militating adopting specific strategies, barriers, Balungu, Pwalugu

1. INTRODUCTION

Climate is a renewable resource which varies at all-time scales, from year to year, as well as from one decade, century or millennium to the next [1]. Climate change is defined as the gradual change in the weather pattern of the world over a long period of time mainly as a result of human activities with respect to the environment [2]. It has become a developmental issue across the world because of its effects on human lives and the future of the world. Climate change is exacerbated by the increase of greenhouse gas emission caused by human behaviour [3-6].

Climate change is considered one of the most challenging global issues. The most devastating adverse impacts of climate change in most subtropical countries includes frequent drought, increased environmental damage, increased infestation of crop by pests and diseases, depletion of household assets, increased rural urban migration, increased biodiversity loss, depletion of wildlife and other natural resource base, changes in the vegetation type, decline in forest resources, decline in soil conditions (soil moisture and nutrients), increased health risks and the spread of infectious diseases, changing livelihood systems, among others [7,8]. Scientific evidence also suggests that climate change has long term negative impacts on agricultural productivity globally [9]. Resource-dependent livelihoods, such as farming, fishing, herding and hunting, face quite diverse and distinct climate change risks including directly from heavy rains, high winds, drought, fires, invasive species, glacier retreat, ocean acidification and sea level rise [10,11]. The severity of these impacts will ultimately be experienced differently, depending on location. For instance, in the tropics and subtropics, crop yields are likely to fall by 10% to 20% because of increased climate variability [12].

International studies suggest that Africa is particularly vulnerable to climate change and variability [13]. Climate change therefore particularly affects food security, livelihoods and social safety adversely and in so many ways [14]. This is because climate change directly affects agricultural production and food availability. This is primarily due to the fact that agriculture is inherently sensitive to climate conditions and is one of the most vulnerable sectors to the risks and impacts of global climate change [15]. In order to achieve food self-sufficiency and security, impacts of climate change on crop production and food availability should be a priority area for governments around the world [16,17].

Human reactions to climate change are generally classified into two major categories: mitigation through reducing greenhouse gas emissions, and adaptation to the changes posed by climate change. A researcher explains climate change adaptation as the actions that people take in response to, or in anticipation of, projected or actual changes in climate, to reduce or eliminate adverse impacts or to take advantage of the opportunities created by climate change. Studies carried out by IPCC, suggested that adaptation will be necessary to address impact resulting from the warming which is already unavoidable due to past emissions.

Many of the African nation's economies are dependent on sectors that are vulnerable to climate conditions, such as agriculture, fisheries, forestry, and tourism. A group of researchers reported that agriculture and natural resources provide livelihoods for 70% to 80% of the population, and account for 30% of GDP and 40% of export revenue in Sub-Saharan Africa [18]. Agriculture employs about 60% to 90% of the total labor force in Sub-Saharan Africa [19].

In Ghana, agriculture is primarily small-scale and is the backbone of the economy. It contributes about 35% of Ghana's GDP, generates about 30-40% of the foreign exchange earnings, and employs about 55% of the population [20]. Despite its high contribution to the overall economy, this sector is challenged by many climate-related disasters like prolonged dry spells and floods which are most often severe in Northern Ghana. As a result, individuals, households and communities therefore engage in a number of activities and strategies in order to earn a living. Prominent among these livelihood activities and strategies in rural areas is farming which incidentally is the worse hit by climate change. Extensive research carried out on the impacts of climate change on agriculture revealed episodes of late rains for planting, variability in the pattern and levels of rainfall, and intermittent droughts and floods to be the fundamental problems for farmers in Northern Ghana [21-23]. This has become a threat to the livelihoods of farmers in this particular zone.

A researcher observed that, the dry season is increasing in length and becoming more severe [24]. Temperatures are increasing and everyone, including farmers and rural dwellers, are conscious of this fact. Rainfall has become increasingly erratic resulting in frequent droughts and floods within the same seasons. The effect of all these is increase in food and nutrition insecurity. For instance, in 2007, the delayed rains in Northern Ghana were followed by heavy rains resulting in farmers planting the same crop fields several times during the season. Many farmers ran short of seed to plant. There was also extensive flooding that destroyed farms, livestock and poultry. The resultant effect was serious food and nutrition insecurity in almost all farming households in Northern Ghana, particularly the Upper East and Upper West Regions and in other regions of the country in general.

In view of these fluctuations in the rainfall pattern and corresponding changes in food availability, farmers in Northern Ghana have developed intricate strategies to adapt to climate change. For instance, some farmers use traditional methods of weather forecast like behaviour of plants and animals to predict weather conditions and decide when to prepare lands and sow seeds [25-27]. This indigenous knowledge makes it possible for farmers to adequately prepare in advance for any climatic catastrophe. Some farmers in the Talensi District have adopted the dry season farming along the White Volta as a major farming approach to address the rainfall issues. Crop diversification is also practiced by some farmers as a viable strategy to resist shocks, decrease the risk of crop failure and in so doing reduce their vulnerability of livelihood to climate change [28]. This therefore means that adaptation to climate change is not new to farming households and communities [29]. This study therefore seeks to determine the impact of climate change on farmers particularly in the Talensi district which is located in the Upper East Region of Ghana. Specifically, the study aims to determine the specific adaptive strategies used by farmers in response to climate change and the reasons behind those adaptive strategies as well as determine barriers militating against the adoption of other adaptive strategies to climate change.

2. METHODOLOGY

2.1 Profile of study area

2.1.1 Location and demographic characteristics of the study area

Balungu and Pwalugu are the two communities located in the Talensi district which were used for the study from March to July 2017. The Talensi district came into existence after the Nabdam district was created out of the then Talensi-Nabdam district in 2012. (Establishment instrument 2012) [30]. It is located in the Upper East Region and has Tongo as its capital. It is bordered to the North by the Bolgatanga Municipal, South by the West and East Mamprusi districts (both in the Northern Region), Kassena-Nankana district to the West and Nabdam district to the East. The district lies between latitude 10º 15' and 10º 60' north of the equator and longitude 0º 31' and 1º 05' and west of the Greenwich meridian. It has a total land area of 838.4 km^2. The population of Talensi district as indicated by the 2000 population and housing census was 77,007.00 made up of 38,658 male and 38,349 females representing 50.20 % male and 49.80% female respectively.

2.1.2 Vegetation and climate

The vegetation is Guinea Savannah woodland consisting of sparse short deciduous trees and a ground flora of grass. The most common economic trees are sheanuts, dawadawa, baobab and acacia.

The climate is tropical with two distinct seasons: a rainy season, which is erratic and runs from May to October, and a dry season that stretches from October to April. The mean annual rainfall for the district is 95mm and ranges between 88mm-110mm. The area experiences a maximum temperature of 45 degrees Celsius in March and April and a minimum of 32 degrees Celsius in December.

2.2.1 Study approach and design

A combination of participatory methods, including key informant interviews, household questionnaire surveys and focus-group discussions were employed, allowing local farmers the opportunity to participate by sharing their experiences and knowledge to outline possible solutions to the problem at hand. Multiple methods are good at reducing the inadequacies of a single method [31].

Cross sectional study was used in designing the research. Variables were measured or determined at the same time in a given population in a cross-sectional study. This method allowed the assessment of practices, attitudes, knowledge and beliefs of a population in relation to a particular event or phenomenon [32].

2.2.2 Selection of communities and sampling techniques

Talensi district was used as the study area. Farmers in this area are actively involved in crop production during both the rainy and dry seasons. The communities in this district were purposely selected based on the following criteria; communities highly vulnerable to the impacts of climate change due to the unimodal rainfall pattern and communities whose major sources of livelihoods are highly climate dependent. Two communities namely Pwalugu and Balungu were therefore purposively selected for the study.

This study also employed simple random sampling techniques to identify the respondents in the two communities since a complete list of active farmers in each community was obtained. Numbers were assigned to the names of the farmers and the numbers which were randomly selected were the respondents that the questionnaires were administered to. The total respondents in each community was determined using Yamane table (1967). A sample size of hundred (100), fifty (50) from each community was used for the study which was proportional to the size of their populations (Balungu total population = 754, Pwalugu total population = 1001

2.2.3 Data analysis and presentation

The data obtained from the respondents were coded in Statistical Package for Social Sciences (SPSS) version 20 to enable appropriate statistical analysis to be made. Chi-square tests were also performed at 5% level on all the variables to determine significant differences between the male and female respondents in each community as well as between the two communities.

Quantitative data were analyzed using descriptive statistics whiles

qualitative data from interviews and focus groups were coded and indexed through intensive content analysis in order to identify major themes. Due to the difficulty involved in understanding and interpreting raw data, Microsoft Excel was then used to generate frequency tables, cross tabulations and bar graphs to facilitate easy understanding and interpretations.

3. RESULTS

3.1. Impacts of climate change on respondents in the two communities

Figure 1 describes the impact of climate change on respondents. Changes in climate have affected respondents greatly and in diverse ways. In Balungu community, reduced income level resulting from crop failure was the major impact of climate change (80.0%). This was followed by inability to meet the educational needs of their children (46.0%). In Pwalugu, the impacts of climate change on respondents are the same as in Balungu with reduced income level as the greatest impact of climate change on respondents representing 98.0% and inability to diversify as the least impact of climate change representing 8.0%. Reduced income level (p value=0.004, df = 1, x2 = 8.274) was the only impact of climate change identified to be statistically significant between the male and female respondents in the two communities.

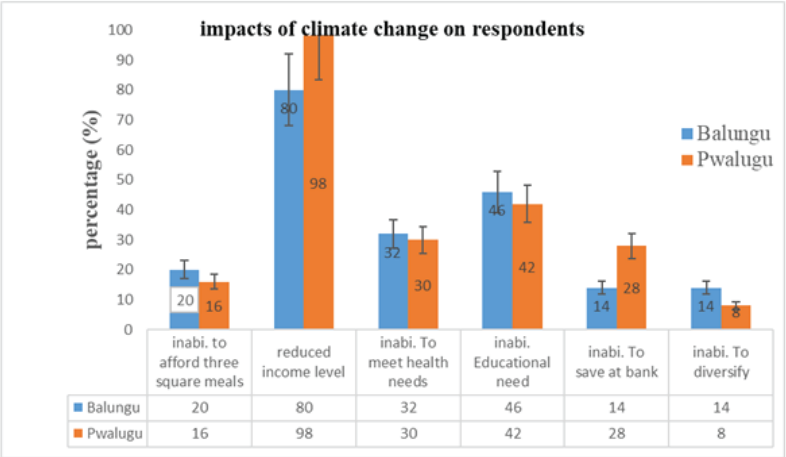

Figure 1: Impacts of climate change on respondents in the two communities

3.2 Adaptation strategies employed by respondents and the reasons behind those adaptive strategies

3.2.1 Adaptation strategies of respondents

Various adaptation strategies have been used by farmers to reduce the impact of climate change on them. Crop diversification (representing 99%) was the major adaptation strategy embraced by the two communities with migration (representing 2%) being the least adopted strategy. Similar adaptation strategies were employed by respondents in both communities. In Balungu, crop diversification was the most adapted strategy (98%), followed by trading (74%), with the least been migration (2%) and 100%, 84% and 2% respectively in Pwalugu.

Irrigation (p value=0.015, df = 1, x2 = 5.894), trading (p value=0.024, df = 1, x2 = 5.109) and fishing (p value=0.001, df = 1, x2 = 10.212) were the adaptation strategies that were statistically significant between the male and female respondents in Balungu whiles only fishing (p value=0.009, df = 1, x2 = 6.832) was statistically significant between the male and female respondents in Pwalugu. The details of the various adaptation strategies are shown in Table 1 "Others" as in adaptation strategies in the Table 1 refers to hunting, driving, fishing, menial jobs, collection of fruits, establishment of tree plantations and other construction works.

Focus group discussions and key informant interviews from both communities also revealed that, the men are into the establishment of tree plantations whiles the women are into the collections of fruits such as guava, black berries, among others and tree products as long-term strategies to climate change.

Table 1: Adaptation strategies of respondents

Community	Sex	Adaptation strategies							
		Adjustment in planting date	Crop diversification	Irrigation	Change method of production	Migration	Trading	Fishing	Others
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Balungu	Male	14 (28.0)	29 (58.0)	7 (14.0)	13 (26.0)	1 (2.0)	18 (36.0)	11 (22.0)	10 (20.0)
	Female	11 (22.0)	20 (40.0)	0 (0.0)	4 (8.0)	0 (0.0)	19 (38.0)	0 (0.0)	3 (6.0)
N=50	Total	25 (50.0)	49 (98.0)	7 (14.0)	17 (34.0)	1 (2.0)	37 (74.0)	11 (22.0)	13 (26.0)
	P value	0.774	0.235	0.015*	0.058	0.390	0.024*	0.001**	0.108
Pwalugu	Male	19 (38.0)	36 (72.0)	28 (56.0)	5 (10.0)	1 (2.0)	30 (60.0)	13 (26.0)	5 (10.0)

N=50	Female	4 (8.0)	14 (28.0)	11 (22.0)	1 (2.0)	0 (0.0)	12 (24.0)	0 (0.0)	2 (4.0)
	Total	23 (46.0)	50 (100.0)	39 (78.0)	6 (12.0)	1 (2.0)	42 (84.0)	13 (26.0)	7 (14.0)
	P value	0.123	-	0.951	0.510	0.529	0.837	0.009**	0.971
Total	Male	33 (33.0)	65 (65.0)	35 (35.0)	18 (18.0)	2 (2.0)	48 (48.0)	24 (24.0)	15 (15.0)
N=100	Female	15 (15.0)	34 (34.0)	11 (11.0)	5 (5.0)	0 (0.0)	31 (31.0)	0 (0.0)	5 (5.0)
	Total	48 (48.0)	99 (99.0)	46 (46.0)	23 (23.0)	2 (2.0)	79 (79.0)	24 (24.0)	20 (20.0)
	P value	0.450	0.171	0.032*	0.129	0.295	0.085	0.000***	0.295

(N= sample size, % = sample percentage, *= significant at 0.01, **= significant at 0.001, ***= significant at 0.0001)

3.2.2 Reasons for adaptation strategies

Different reasons were given by respondents for their choice of adaptation strategies. Avoiding crop failure (80.0%) and getting different food for the family (82.0%) were the major reasons respondents adapted specific adaptation strategies to climate change in Pwalugu and Balungu communities respectively. Avoiding crop failure (p value=0.171, df = 1, x2 = 1.871) as well as some plants supply nutrients (p value=0.153, df = 1, x2 = 2.041) were the only two reasons for adapting specific strategies to climate change by respondents that were statistically insignificant between the male and female respondents in the two communities. Table 2 gives a summary of the reasons given by respondents on the specific adaptation strategies they have adapted as well as the significant differences (p value) that exist between the two communities.

Table 2: Reasons for adapting specific adaptation strategies

Reasons for adapting specific strategies	**Balungu N=50**	**Pwalugu N = 50**	**Total N = 100**	**P value**
	N (%)	N (%)	N (%)	
To avoid crop failure	34 (68.0)	40 (80.0)	74 (74.0)	0.171
Get different food for the family	41 (82.0)	30 (60.0)	71 (71.0)	0.043*
Avoid buying foodstuffs outside	8 (16.0)	0 (0.0)	8 (8.0)	0.003**
Income for family	23 (46.0)	36 (72.0)	59 (59.0)	0.008**
Get seeds for the next season	7 (14.0)	0 (0.0)	7 (7.0)	0.006**
Some plants supply nutrients	2 (4.0)	0 (0.0)	2 (2.0)	0.153
Avoid problems with no market	0 (0.0)	4 (8.0)	4 (4.0)	0.041*

(*= significant at 0.01, **= significant at 0.001, ***= significant at 0.0001).

3.3 Barriers militating against the adoption of other specific adaptive strategies

3.3.1 Challenges faced in adapting to climate change

The challenges faced by respondents in adapting to climate change are common or vary among communities (Table 3). Uncertainties in Table 3 refers to floods, droughts, insect invasion and wildfires. In Balungu community, the major challenge faced by respondents was lack of finance (representing 92%), with the least challenge been difficulty in obtaining seeds (2%). In Pwalugu, lack of finance (constituting 82%) is the most difficult challenge in adapting to climate change, whiles lack of storage facilities (representing 18%) was identified as being their least challenge in adapting to climate change.

There was statistical difference in norms/customs (p value=0.000, df = 1, x2 = 12.702) of the male and female respondents in Balungu. In Pwalugu, land tenure, (p value=0.016, df = 1, x2 = 5.821) lack of storage facilities (p value=0.000, df = 1, x2 = 20.184) and lack of ready markets (p value=0.006, df = 1, x2 = 7.562) were identified to be significantly different between the male and female respondents. When the two communities were combined, there was significant difference between the male and female respondents in norms/customs (p value=0.016, df = 1, x2 = 5.801), land tenure (p value=0.025, df = 1, x2 = 5.022), lack of storage facilities (p value=0.002, df = 1, x2 = 9.495) and lack of ready markets (p value=0.013, df = 1, x2 = 6.176).

Table 3: Challenges faced by respondents in adapting to climate change

Community	Sex	Challenges faced by respondents in adapting to climate change								Total
		Finance	Land tenure	Uncertainties	Norms/ Customs	Lack of storage facilities	Lack of ready markets	Damage to crops by fulani cattle	Difficulty obtaining seeds for farming	
Balungu N=50		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
	Male	26 (52.0)	21 (42.0)	17 (34.0)	3 (6.0)	2 (4.0)	3 (6.0)	12 (24.0)	1 (2.0)	29 (58.0)
	Female	20 (40.0)	13 (26.0)	9 (18.0)	12 (24.0)	1 (2.0)	2 (4.0)	11 (22.0)	0 (0.0)	21 (42.0)
	Total	46 (92.0)	34 (68.0)	26 (52.0)	15 (30.0)	3 (6.0)	5 (10.0)	23 (46.0)	1 (2.0)	50 (100.0)
	P value	0.473	0.432	0.271	0.000***	0.754	0.924	0.441	0.390	
Pwalugu	Male	28 (56.0)	30 (60.0)	17 (34.0)	18 (36.0)	1 (2.0)	14 (28.0)	9 (18.0)	10 (20.0)	36 (72.0)
N=50	Female	13 (26.0)	7 (14.0)	9 (18.0)	8 (16.0)	8 (16.0)	0 (0.0)	1 (2.0)	5 (10.0)	14 (28.0)
	Total	41 (82.0)	37 (74.0)	26 (52.0)	26 (52.0)	9 (18.0)	14 (28.0)	10 (20.0)	15 (30.0)	50 (100.0)
	P value	0.213	0.016*	0.278	0.650	0.000***	0.006**	0.156	0.582	
Total	Male	54 (54.0)	51 (51.0)	34 (34.0)	21 (21.0)	3 (3.0)	17 (17.0)	21 (21.0)	11 (11.0)	65 (65.0)
N=100	Female	33 (33.0)	20 (20.0)	18 (18.0)	20 (20.0)	9 (9.0)	2 (2.0)	12 (12.0)	5 (5.0)	35 (35.0)
	Total	87 (87.0)	71 (71.0)	52 (52.0)	41 (41.0)	12 (12.0)	19 (19.0)	33 (33.0)	16 (16.0)	100 (100.0)
	P value	0.112	0.025*	0.933	0.016*	0.002**	0.013*	0.841	0.731	

(N= sample size, % = sample percentage, *= significant at 0.01, **= significant at 0.001, ***= significant at 0.0001).

Respondents who are into fruit and tree product collection are also faced with numerous challenges. The major challenge faced by respondents in both communities is wild animals (about 94.0% and 86.0% in Balungu and Pwalugu respectively). The least challenge cited by respondents in Balungu is accidents (constituting 4.0%) whiles beaten by heavy rains (constituting 6.0%) is the least challenge faced by respondents in Pwalugu. These major (wild animals, p value= 0.034, df = 1, x2 = 4.504) and least (accidents, p value=0.007, df = 1, x2 = 7.162) challenges faced by respondents were statistically significant of the male and female respondents in the two communities. Focus group discussions revealed other challenges such as been lost in the bush/forest due to its thick and vast nature, heavy rains flooding foot paths and sometimes carrying people away. Table 4 gives a summary of the various challenges affecting fruit and tree product collectors in adapting to climate change.

Table 4: Challenges faced by respondents in assessing fruit and tree products

Challenges faced by respondents in collecting fruits and tree products	Balungu N=50	Pwalugu N = 50	Total N = 100	Chi-square P value
	N (%)	N (%)	N (%)	
Wild animals	47 (94.0)	39 (78.0)	86 (86.0)	0.034*
Storage problems	8 (16.0)	11 (22.0)	19 (19.0)	0.444
Eating of fruits by animals	12 (24.0)	17 (34.0)	29 (29.0)	0.271
Low prices of products	7 (14.0)	6 (12.0)	13 (13.0)	0.766

Lack of transport/bad roads	13 (26.0)	14 (28.0)	27 (27.0)	0.822
Beaten by heavy rains	7 (14.0)	3 (6.0)	10 (10.0)	0.182
Accidents	2 (4.0)	11 (22.0)	13 (13.0)	0.007**

(*= significant at 0.01, **= significant at 0.001, ***= significant at 0.0001).

3.3.3 Suggested solutions by respondents in mitigating climate change

Suggested solutions presented by respondents in mitigating climate change and improving their livelihoods are presented in Table 5. Majority of the respondents suggested the provision of financial assistance (94%) as a way of responding to climate change in both communities. Avoidance of tree felling (representing 2%) and discouraging farming in waterlog areas (representing 4%) were the least solutions by respondents in Balungu and Pwalugu communities respectively.

Chi-square tests also revealed that, in Balungu, provision of financial assistance (p value=0.036, df = 1, x2 = 4.504) and supporting women who are into farming (p value=0.008, df = 1, x2 = 7.059) were statistically significant between the male and female respondents. There was also significant difference in provision of financial assistance (p value=0.004, df = 1, x2 = 8.207) and supporting women who are into farming (p value=0.000, df = 1, x2 = 24.490) between the male and female respondents in Pwalugu.

When respondents from both communities were combined (N=100), provision of financial assistance (p value=0.001, df = 1, x2 = 11.854), supporting women who are into farming (p value=0.000, df = 1, x2 = 27.275) and when lands are easily accessible (p value=0.016, df = 1, x2 = 5.801) were the only suggested solutions found to be significantly different between the male and female respondents.

Table 5: Suggested solutions by respondents in mitigating climate change

		Ways of mitigating climate change by respondents						
Community	**Sex**	**Controlling of fulani herdsmen**	**Provision of finance**	**Discourage farming in waterlog areas**	**Support women who are into farming**	**When lands are easily accessible**	**Avoid tree felling**	**Total**
Balungu		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
N=50	Male	13 (26.0)	29 (58.0)	4 (8.0)	3 (6.0)	11 (22.0)	1 (2.0)	29 (58.0)
	Female	10 (20.0)	18 (36.0)	1 (2.0)	9 (18.0)	13 (26.0)	0 (0.0)	21 (42.0)
	Total	23 (46.0)	47 (94.0)	5 (10.0)	12 (24.0)	24 (48.0)	1 (2.0)	50 (100.0)
	P value	0.845	0.036*	0.293	0.008**	0.094	0.390	
Pwalugu	Male	12 (24.0)	36 (72.0)	2 (4.0)	0 (0.0)	10 (20.0)	6 (12.0)	36 (72.0)
N=50	Female	6 (12.0)	11 (22.0)	0 (0.0)	8 (16.0)	7 (14.0)	5 (10.0)	14 (28.0)
	Total	18 (36.0)	47 (94.0)	2 (4.0)	8 (16.0)	17 (34.0)	11 (22.0)	50 (100.0)
	P value	0.529	0.004**	0.368	0.000***	0.136	0.106	
Total	Male	25 (25.0)	65 (65.0)	6 (6.0)	3 (3.0)	21 (21.0)	7 (7.0)	65 (65.0)
N=100	Female	16 (16.0)	29 (29.0)	1 (1.0)	17 (17.0)	20 (20.0)	5 (5.0)	35 (35.0)
	Total	41 (41.0)	94 (94.0)	7 (7.0)	20 (20.0)	41 (41.0)	12 (12.0)	100 (100.0)
	P value	0.482	0.001**	0.233	0.000***	0.016*	0.569	

(N= sample size, % = sample percentage, *= significant at 0.01, **= significant at 0.001, ***= significant at 0.0001).

4. DISCUSSION

4.1.2 Impacts of climate change on respondents in the two communities

Changes in climate poses a lot of problems to farmers. A researcher stated that, resource-dependent livelihoods, especially farming face quite diverse and distinct climate change risks. In both communities, reduced income level by respondents was found to be the most devastating impact of climate change on them. Other impacts cited by them include; inability to meet the educational needs of their children, inability to save at a bank and inability to afford three square meals in a day leading to food insecurity. From the focus group discussion, it was realised that majority of respondents' everyday meals come from millet, groundnut and maize. For instance, both millet and maize can be used to prepare porridge in the morning and Tuo Zaafi (T.Z) in the afternoon and evening. However, the impacts of climate change have resulted in low yields of these valuable crops hence making it difficult to afford three square meals in a day. For most households in Northern Ghana, the attainment of food and nutrition security has been a mirage, and climate change has exacerbated the situation. This is consistent with the finding by a scholar who described reduced food security as the impacts of climate change in Northern Ghana, and another scholar who observed serious food and nutrition insecurity in Northern Ghana when they were hit by floods and droughts [33]. Also, the impacts of climate change on respondents justifies the conclusion by a researcher and another researcher that poor, natural resource-dependent rural households will bear a disproportionate burden of adverse impacts of climate change [34,35]. Consistent with all focus groups discussions, it was observed that climate change has adversely affected the livelihoods of respondents and this goes a long way to support the suggestion by Nellemann et al. [9] that climate change has long term negative impacts on agricultural productivity globally. It also agrees with the generalization by a researcher that the effects of climate change are already in play with potentially disastrous consequences on farmers [36].

4.2.1 Adaptation strategies employed by respondents and the reasons behind those adaptive strategies

Adaptation strategy is defined as a situation in which farmers address the adverse effects of climate change. In order to reduce the impacts of climate change, respondents in both communities have various adaptive strategies in which they undertake, and these strategies differ from one community to another. Among these strategies is crop diversification which is seen as the most adapted strategy to climate change in both communities and the reason for adapting this strategy is simply to avoid crop failure. This main strategy (crop diversification) has replaced monoculture farming in the two communities. Farmers are now planting different varieties of crops such as maize, rice, millet, groundnuts, rice, calabash, water/yellow melon, among others as a way of addressing the adverse impacts of climate change. Crop diversification is the addition of new crops on a farm taking into account the different returns from value-added crops with complementary marketing opportunities. Thus, it is a concept which is opposite to crop specialization [37]. It enhances plant productivity, quality and health as well as builds crop resilience to diseases and environmental stresses. Crop diversification as adopted by farmers in the two communities is consistent with the findings by a group of researchers where they observed that farmers in Ethiopia adapted extensive crop diversification by planting different varieties [38,39]. A previous researcher also observed planting different varieties as an adaptive strategy to climate change [40].

In Pwalugu, irrigation is seen as the third extensively adapted practice by farmers in response to climate change than in Balungu. This supports the findings by a researcher that crop irrigation has seen some success and should be more widely implemented. Also, it does not deviate from the findings by several scholars that, irrigation has the potential to improve agricultural productivity through supplementing rainwater during dry spells and lengthening the growing season [41,42]. The main reason accounting for the variation in the two communities in adapting irrigation as an adaptive strategy is the availability of constant supply of water in Pwalugu as compared to Balungu where the river dries up sometimes. The availability of constant supply of water in Pwalugu is due to its closeness to the White Volta.

Migration is the least adapted strategy in both communities. None of the female respondents adapted migration as an adaptive strategy. This is consistent with a researcher who noticed an increase in men migrating to South Africa and other places in search of jobs due to successive droughts in that country [43]. From the focus group discussion, migration is seen by respondents as the last resort to adapting to climate change and those who migrate are mostly young farmers who can do any manual or hard work. According to them, migrating to other places is very lucrative as they make money from it and are able to adapt to climate change. This supports the findings by a recent researcher that farmers embark on migration to escape the adverse effects of climate change [44,45]. It is also consistent with the conclusion by a researcher that, migration serve as a means of alleviating predicted challenges to agricultural livelihoods such as declines in harvest yields brought on by climate change [46].

Change method of crop and animal production as an adaptive strategy to climate change was practiced more in Balungu than in Pwalugu. Also, the number of women practicing this strategy were more in Balungu than in Pwalugu. With regards to change method of crop production, this finding is consistent with a researcher who identified regular weeding and crop rotation as indigenous adaptation strategies in northern Ghana [47]. A researcher in their study observed change in method of animal production as a viable strategy to successful adaptation in the Northern Savanna zones [48].

From the focus group discussion, it was realized that establishment of tree plantations, collection of fruits and tree products, among others were identified as long-term strategies in adapting to climate change. These strategies are captured as "others" in Table 1. Collection of fruits especially the shea nuts, mangoes, guava, cashew, berries, among others is a good strategy to climate change since they provide women with food especially in the dry season. Collection of fruits traditionally is women's business and a source of income for many families in rural areas [49]. It is therefore, one of the greatest potentials that can be exploited to improve their adaptive strategies to climate change. The nuts from the shea tree are used in preparing shea oil and butter which are used in almost every house for cooking. Shea butter and the other fruits gathered are also traded in the market for income because of their numerous benefits. This is consistent with findings by a researcher who observed that, fruit collection especially shea in some cases contributes more than half of annual income of households in the Upper West region. They added that shea has a significant demand on the international market which is important for income generation.

The male respondents were also into plantation establishments especially moringa (Moringa oleifera) and mango (Mangifera indica). This finding is consistent with a scholar who observed that, farmers in south Asia were engaged in plantation establishment as an adaptation strategy to climate change [50]. According to the respondents, these trees serve as food for both man and animals. In the dry season where forage is scarce, they rely on the leaves of moringa to feed their animals. Firewood and a variety of fruits are also gotten from these trees which are sold to make money sufficient enough to sustain them in the dry season. This buttresses the findings by a previous scholar who observed that, the income accumulated from tree products exceeded the accumulated value of crop yield in Kenya [51].

4.3 Barriers militating against the adoption of other specific adaptive strategies

4.3.1 Challenges faced in adapting to climate change

Respondents faced various challenges in adapting to climate change. These challenges become barriers thereby preventing respondents from fully adapting specific strategies to climate change. Barriers are defined as factors, conditions or obstacles that reduce the effectiveness of adaptation strategies [52,53].

Among all the challenges listed by respondents, lack of financial assistance/support was the most important challenge affecting farmers' adaptation strategies to climate change. This is consistent with findings by a previous scholar that, lack of adequate financial resources is an important factor constraining farmers' use of adaptation measures [54]. It also goes to buttress the findings of several scholars who reported that financial constraints are major setbacks for farmers and institutions to adapt to climate change [55-57]. In Ethiopia, a researcher identified financial barriers due to lack of credit facilities as one of the most important obstacles hindering the implementation of climate adaptation strategies by farmers [58].

Land tenure was also cited by respondents as the second important factor militating against the adoption of specific strategies to climate change. This condition may prevail when they have insecure rights to land. Tenure security can contribute to adoption of technologies linked to land such as irrigation equipment or soil conservation practices. Access to land is influenced by a number of factors which includes the behavior of tenants, high demands by landowners, lack of money, limited fertile lands, number of acres required, among others as presented in Table 3 Access to fertile land, among others are factors identified by a researcher to influence adaptation at the farm level.

Also, lands are mostly owned by family heads and this societal norms/custom prevent women from owning their own lands/animals and adapting specific strategies to climate change. This was cited by respondents as the fourth most important challenge impeding their adaptation. This societal norm results in women having fewer capabilities and resources than men [59-61]. This therefore goes a long way to affect their access to land for farming hence making them more vulnerable to the impacts of climate change. This is consistent with the observation made by a scholar, societal norms and values act as a major barrier to successful climate adaptation in Western Nepal [62]. Several studies by a researcher

also highlighted the constraints imposed by socio-cultural barriers on adaptation actions in several communities. Also, norms in the community that inhibit men from collecting fruits in the community pose another challenge to men in adapting successfully to climate change. This actually impedes the capacity of men who want to go into shea butter and shea pomade production.

Fulani cattle are a big challenge to farmers adapting to climate change. From the focus group discussion, Fulani herdsmen deliberately bring their cattle to feed on their crops especially maize crops at night when they go to sleep. These animals can destroy a whole farm. Because of these animals, farmers can no longer leave their produce on the farm like they used to do some time ago. Some farmers even tried sleeping on the farm to avoid this problem, but the enormous difficulties associated with sleeping at a lonely farm has discouraged them. Been faced by heavy rains and wild animals have prevented them from sleeping there at night. The most painful problem is, farmers do not always know the particular Fulani herdsmen who do that since they are many in the community. When farmers report the problem to the appropriate authorities, these herdsmen easily bribe the authorities with one or two cows and that ends the matter. The presence of these Fulani cattle in the communities are reducing the potential of farmers to adapt to climate change.

Lack of ready markets is seen as another challenge to farmers in developing their capacity to adapt to climate change. This is most severe for farmers who are not into any farming corporative within the communities. This is supported by a researcher who acknowledged that certain factors such as market conditions influence farmers' response to climate change [63]. According to a previous researcher, for effective adaptation to climate change to take place, access to marketing facilities is important [64]. Lack of ready markets especially for tomato has resulted in farmers diversifying. Tomato according to the farmers, cannot be stored for longer periods and easily gets rotten. Lack of ready markets can be attributed to the availability and abundance of tomato in the rainy season thereby accounting for the low prices. This observation is not different from the view of a researcher when they noticed that, commodity prices, financial markets, among other factors affect the adaptive capacity of farmers [65]. The NGOs supporting farmers in the communities like Wienco is interested in onions. Since this NGO buys from the farmers, there is always an assurance of ready markets hence the reason most of them are diversifying in onions and other crops that can be stored for longer periods.

Women who are into fruit and tree product collection are also faced with a number of challenges. From the focus group discussion, women who collect shea nut travel long distances into the forest in search of these fruits in the rainy season. The major challenge encountered by respondents in both communities is wild animals such as snakes and scorpions. Snakes especially, are very common in the morning and is difficult seeing them especially when the weather is not clear making them vulnerable to snake and scorpion bites. Their vulnerability is attributed to the fact that, they do not have protective cloths such as raincoats, wellington boots and hand gloves to protect themselves during collection. This was indicated by all the respondents that they do not have such protective clothes. Therefore, cases of snake and scorpion bites during fruit collection are often common and this produces some fear in many of the women.

Eating of shea nut fruits by animals is another major problem. According to the women, these animals eat the fruits and sometimes destroy the seed. This is always very painful when they travel long distances and do not get any fruits in return. Some respondents also narrated how bad roads/lack of transport to and fro the forest is affecting them negatively. These roads are not accessible by vehicles (motor king). This makes it difficult for them to transport their fruits back home in larger quantities.

Low prices were also a challenge confronting woman in fruit collection. Thus, the price at which the shea products (processed nuts and butter) are usually being sold is too small as compared to their expectations. Related to this was the issue of fluctuation in the prices of the processed nuts and butter which could sometimes result in losses as well as reduction in profit margins of the butter processors, nut traders and butter traders. Beaten by heavy rains, lack of storage facilities, felling of trees for charcoal, scarcity of fruits and accidents such as tree branches falling on you, climbing and falling from the trees were cited by respondents as other challenges faced in collecting fruits and tree products. Bushfires, cutting of trees for firewood and destructive farming methods are all factors that affect the availability of shea nuts [66]. This reduces the ability of these women to successfully adapt to climate change.

4.3.2 Suggested solutions by respondents in mitigating climate change

A recent study emphasized that successful climate change adaptation hinges on the availability of effective adaptation strategies and the extent to which those strategies are adoptable. Whether a farmer takes adaptive actions will depend on his willingness to adopt, as well as to the system's adaptive capacity [67,68].

In response to how these challenges could be resolved, majority of the respondents in both communities cited financial assistance as a way of mitigating climate change. Access to finance will enable them get access to lands as well as the materials needed in production.

Controlling of Fulani herdsmen was the second important way of adapting to climate change. According to respondents, the devastating effects of these animals are unbearable. When appropriate punishments are meted out to them, it will serve as a deterrent to the other herdsmen in the community. This will prevent the destruction of their crops and will lead to high productivity.

Other respondents were of the view that supporting women who are into farming, avoiding tree felling, among others are ways of mitigating climate change.

From the focus group discussion, prohibition of the felling of shea trees for charcoal was the major solution suggested by respondents who were into fruit and tree product collection as a way of mitigating climate change. According to them, most charcoal producers utilize the shea trees in the bush for their businesses. This intend reduces the availability of shea trees hence leading to a reduction in the quantity of shea fruits collected. Their (fruit collectors) adaptive capacity will be enhanced when there is a prohibition of the felling of shea trees.

Provision of protective clothing was also suggested by respondents as a way of improving their adaptive capacity. According to them, provision of protective clothes will prevent them from been bitten by snakes and scorpions as well as protect them from the dangers of other wild animals. It will also eliminate fear in them.

A few of the respondents also suggested that, a fixed/ standard price for their products like shea nuts and butter will impact positively on their adaptive capacity. According to them, this fixed price will aid prevent them from selling their products at a relatively cheaper prices just to make ends meet.

Provision of storage facilities and training on better preservation and processing skills were also cited by respondents as a way of mitigating climate change.

Among all the non-farm activities, trading was the most viable non-farm adaptation strategy employed by respondents in both communities. This observation is consistent with findings by a researcher who observed petty trading including (shea butter and dawadawa), charcoal production, pito brewing, among others as non- farm strategies in Northern Ghana. Trading was however more intensive in Pwalugu than in Balungu. Access to markets in Pwalugu is more accessible than in Balungu due to the presence of the toll booth which creates conducive opportunity for respondents to go into trading. This is justified by a group of researchers who explained that, communities closer to markets adapt intensive activities such as trading as adoption options to climate change whiles the

likelihood of communities farther away from markets adapting climate change adaptation options decreases [69]. Non-farm income earning activities such as trading therefore offers opportunities for diversification in the midst of challenges faced in agriculture. This is confirmed by a researcher who reported that 40% of rural household income originated from non- farm activities in 11 Latin American countries [70]. This indicates how essential income generated from this source is to farmers. According to a study, non-farm activities help people to cope with temporary adversity in the agricultural sector and also represent a longer-term adaptation strategy when another options fail [71].

Generally, most of the adaptation strategies employed by the respondents are consistent with findings of other researchers. Crop diversification, irrigation, migration, change method of production, trading, adjustment in planting dates have all been observed by several researchers as strategies that have positively impacted on farmers in adapting to climate change [72,73].

Avoiding crop failure, getting different food for the family, income, getting seeds for the next planting season, among others were the reasons farmers adapted the various adaptation strategies in the two communities.

5 CONCLUSION

The findings of the study revealed that, climate change affected respondents negatively resulting in reduced income level, inability to afford three square meals daily, inability to meet their health needs, inability to meet their educational needs of their children, inability to save at bank as well as their inability to diversify. Respondents have therefore developed specific strategies to reduce/cope with these negative impacts. The adaptation strategies include adjustment in planting time, crop diversification, irrigation, change method of crop/animal production, migration, trading and "others" such as fruit collection, plantation establishment, driving, hunting and construction work were the specific adaptation strategies employed by respondents.
Income for the family, avoiding crop failure, avoiding buying foodstuffs outside the family, among others were the reasons respondents employed the various adaptation strategies. Lack of finance, land tenure, norms/customs, lack of storage facilities, lack of ready markets, damage to crops by Fulani cattle and difficulty in obtaining seeds for farming were the challenges militating against the adoption of other adaptive strategies to climate change.

Fruit and tree product collectors also faced challenges such as; wild animals, storage problems, eating of fruits by animals, low prices of products, lack of transport/bad roads, been beaten by heavy rains as well as accidents.

5.1 Recommendation

Since lack of financial assistance/support was seen as the most important challenge affecting farmers' adaptation strategies to climate change in the two communities. Thus, it is recommended that government and relevant stakeholders should collaborate with financial institutions to ensure that funds are readily available to farmers to enable them effectively adapt to climate change as well as provide training/workshop programmes to farmers in order to enhance their capacity in planning and implementing effective strategies to climate change.

Education should be one of the areas for policy intervention by government/stakeholders since access to education is vital in developing specific adaptive strategies to the impacts of climate change.

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