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Assessing smallholder women farmers' adaptive capacity to climate change and variability in the Northern Region of Ghana: A Composite Index Approach

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Abstract
This study assessed the adaptive capacity of smallholder women farmers to climate change and variability in Northern Region of Ghana using a composite index approach. A multi-stage sampling technique was employed to select 210 smallholder women farmers from Tolon and Central Gonja districts and data on their adaptive capacities solicited using questionnaire. Based on literature, seven adaptive capacity indicators, namely, livelihood diversity, information accessibility, physical, financial, natural, human and social resources were used to determine women farmers' adaptive capacities to climate variability. The empirical results revealed that farmers in Tolon District had higher adaptive capacity than those in Central Gonja District in terms of all the indicators and the overall adaptive capacity, except human resources. In the combined data, most farmers had low adaptive capacity in terms of financial indicators and the overall adaptive capacity; moderate adaptive capacity in terms of physical, human, natural, social, and livelihood diversity; and high adaptive capacity in terms of information accessibility. The study concludes that women farmers have low adaptive capacity to climate change due to low access to financial capital. The study recommends that intervention programs in the region should be directed at enhancing financial ability of women farmers to improve their adaptive capacity to climate change and variability.

Keywords
Adaptive Capacity - Climate Change and Variability - Composite Index - Northern Region - Smallholder Women Farmers.

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1. Introduction

The effect of climate change and variability differs by gender and space. Climate change and variability is adversely affecting food insecure households in diverse

ways depending on socio-demographic factors such as age, education and health [1]. Women are usually engaged in subsistence agriculture and labor-intensive activities that worsens their susceptibility to climatic change, as the ability of women to adapt to climate related risks is low [2]. The implication is that the ability of women to adapt to climate related risks is low. Gender discrimination against women in terms of right abuse, household responsibilities, access to production resources and decision making hinder female farmers' capacity to effectively adapt to climate change [3]. In Northern Ghana, women usually do not have adequate access to and/or control over economic resources such as land [4]. These account for their low adaptive capacity to climatic variability.

The Volta River has its tributaries in the Northern region of Ghana through the Tolon and Central Gonja Districts, with floods and droughts being common in these areas due to climate change and variability. Given the polluter pays principle, absolute mitigation of climate change cannot be achieved through controlled activities of inhabitants in the Northern region of Ghana alone. Hence, adapting to these climatic stimuli is necessary. The preference for long term adaptation measures is lower among women [5]. For instance, whereas males often migrate to cities for wage labour works, women often prefer local wage labour work as an adaptation measure to climate change. The question is, what is the level of smallholder women farmers' adaptive capacity to climate change? To answer this question, this study aimed at assessing smallholder women farmers' capacity to adapt to climate change in the Northern Region of Ghana. The study hypothesized that there is no significant difference in the adaptive capacity of women farmers in Tolon and Central Gonja Districts. In literature, most studies that have attempted exploring farmers' adaptive capacity to climate change usually employ descriptive approach. This study provides a contribution to the existing literature by estimating the level of the farmers' adaptive capacity to climate change and variability.

1.1 Conceptualizing Adaptive Capacity

The term 'adaptive capacity' has been used in various fields and disciplines to portray different interpretations. For example, from the perspective of political economy and geography, it views communities' adaptive capacity as their abilities to act communally [6]. Adaptive capacity is defined as a system's capability of adjusting to climate change and climate variability to restrain the likely harms, use prevailing opportunities, and/or endure the stresses. A society's adaptive capacity is its ability to amend its features and/or actions to enable it withstand the harsh external conditions [7]. Adaptive capacity is also defined as a system's ability to reduce the possible consequences of climate variability through prevailing opportunities or employing measures to deal with these consequences [8,9,10]. Adaptive capacity varies among systems and is influenced by natural, economic and human resources as well as social networks, political power and technology accessible to the system [11]. In this study, adaptive capacity is conceptualized as women farmers' accessibility and usage of resources to enhance their ability to adapt to the adverse consequences of climate stresses such as bush fires, floods and drought.

2. Literature Review

2.1 Consequences of Climate Change and Variability

Ghana is already distressed by climate change and variability with the drying up of some major rivers in the dry season which hitherto were perennial. The 2007 flood which rendered over 332,600 people homeless with 56 deaths in Northern Ghana could be attributed to climate change and variability [12]. The erratic rainfall pattern in the form of late or early rains with varied amounts which affects the productivity and output of agriculture negatively in the region are the result of climate change and variability. The high temperatures which were hitherto experienced in March are recently being experienced in January. The onset and offset of rainy season keeps on varying every year. Initially, April was noted for the start of the rainy season in the Northern Region while September always marked the end of the rainy season [13]. But, these have change in recent times. The region now receives its first rain in late June to early July, mostly experiencing heavy rainfalls between September and October with its associated floods which destroys farm produces, lives and other properties. The rains usually end abruptly resulting to drought. Under the Ghana Dry climate scenario, temperatures are expected to increase by 2.1-2.4°C in the three Northern regions of Ghana by 2050 compared to 1.7-2.0°C and 1.3-1.6°C for the forest and transitional zones respectively [3]. The implication is that farmers should expect more floods and droughts in the future. The question that remains unanswered is whether women farmers are capable of adapting to the expected worsening climatic conditions?

2.2 Approaches to Measuring Adaptive Capacity

Different methods have been developed to measure a system's capacity to adapt to climate change. In any case, the type of method or index to be employed depends on the objective of the study. This study used a Composite Index Approach in computing the adaptive capacity as a measure of farmers' capacity to adapt to climate change and variability. Rather than assuming equal weights for all adaptive capacity indicators or relying on macro-level rating of adaptive capacity indicators, this study used a community' self-assessment approach in weighting the indicators of adaptive capacity of farmers to climate change through focus group discussion. This approach

provides specific geographic adaptive capacity of farmers for informed policy directives.

3. Methodology

3.1 Description of Study Area

This study was conducted in two districts in the Northern Region of Ghana: Central Gonja (Yapei and Mpaha) and Tolon (Tali and Kasuliyili). According to [13], female population for Tolon and Central Gonja Districts stand at 37,225 and 43,289 respectively. About 76.7 percent of the female population in Tolon district is illiterate compared to 75.3 percent for Central Gonja District. Over 80 percent of the Tolon and Central Gonja districts are rural. Agriculture employs 92.4 percent and 68.4 percent of the economically active female population in Tolon and Central Gonja districts respectively [13]. The Tolon District records mean annual rainfall of between 950mm and 1200mm and mean annual temperature of 33 – 39°C relative to Central Gonja District with mean annual temperature of 17 – 35°C and mean annual rainfall of 1000 – 1500mm [13]. Majority of female farmers in both districts are peasant and subsistent farmers who cultivate on small-scale basis [13].

3.2 Sampling Procedure and Data Collection Techniques

The study used a multi-stage sampling technique in selecting its respondents. Two samplings were conducted to collect the required data for this study: sampling of women farmers with whom questionnaires were administered to and sampling of participants for the focused group discussion, where a checklist of questions to solicit communal consensus on some issues (weighting of adaptive capacity indicators) were administered.. The first stage in sampling women farmers involved the purposive selection of Central Gonja and Tolon districts due to the perennial occurrence of floods and droughts in the district as a consequent of climate change and variability. In the second stage, two communities were randomly selected from each district. All women farmers in each selected community were ascertain through community listing and based on the number of women farmers in each community, proportionate and simple random sampling techniques were used to select women farmers as respondents for the study. In total, the sample size for this study was 210, comprising of 95 respondents from Tolon District (Kasuliyili-40 and Tali - 55) and 115 from Central Gonja District (Mpaha – 50 and Yapei – 65).

In addition, focus group discussion was conducted using check list and this provided information on weighting adaptive capacity indicators based on community members' point of view. The focused group discussion composed of 12 members: a representative of Ministry of Food and Agriculture, a representative of Non-governmental Organizations into capacity building, two male community leaders and three women farmers from each district. For the three member research team, one asked questions, the other recorded responses, while the third took pictures.

3.3 Methods of Data Analysis: The Composite Adaptive Capacity Index (CACI)

This study used the Composite Adaptive Capacity Index (CACI) in measuring farmers' adaptive capacity to climate change and variability. The elements of farmers' adaptive capacity were first categorized into seven main indicators: human, natural, physical, financial, social, information accessibility and livelihood diversity [20]. For each main indicator of adaptive capacity, elements were identified from the literature as sub-indicators after critical examination at community engagements. Both main and sub-indicators were weighted by assigning relative score to all sub-indicators constituting each main indicator and also all the seven main indicators. The scores were based on the community's perceived influence of indicators on farmers' capacity to adapt to climate change and variability. Given that each of these sub-indicators are measured on different scales, the first step in computing the Composite Adaptive Capacity Index was to normalise the sub-indicators to a common scale using equation (1):

$$Index_s = \frac{S_s - S_{Min}}{S_{Max} - S_{Min}}$$

Where $Index_s$ is one of the sub-indicators of one of the seven adaptive capacity indicators, S_s is the observed value for sub-indicator s, S_{Min} and S_{Max} are the minimum and maximum values respectively for the sub-indicator in the combined data. The second step involved multiplying the normalised value of each sub-indicator by the respective assigned sub-indicator score obtained from the community self-assessment. Thus,

$$Index_{si} = Index_s{}^* S_w$$

Where S_w is the assigned weight (in %) for the sub-indicator S, and $Index_{si}$ is the weighted index for sub-indicator S. The index for each main indicator of adaptive capacity was ascertained by summing the weighted indices of sub-indicators constituting the main indicator. This was done using equation (3):

$$Index_{mi} = \sum_{i=1}^{N} Index_{si}$$

Where $Index_{mi}$ is the computed index for one of the seven main indicators of adaptive capacity, N is the number of sub-indicators constituting the main indicator.

Given that all indicators do not contribute equally to adaptive capacity, the main indicators were also weighted by multiplying the index for each main indicator of adaptive capacity by its community assessment score as presented in equation (4):

$$M_{wi} = Index_{mi}{}^{*} M_w$$

Where Mwi is the weighted index for main indicator M, and Mw is the assigned weight/score (%) for main indicator M. The Composite Adaptive Capacity Index (CACI) for each district was than ascertained by summing the weighted indices of the seven main indicators. This is presented in equation (5):

$$CACI_d = \sum_{i=1}^{7} M_{wi}$$

Where $CACI_d$ denotes the Composite Adaptive Capacity Index for district d. The $CACI$ is scaled between 0 (least adaptive capacity) to 1 (highest adaptive capacity). According to [14], an adaptive capacity of this scale can be categorized into three levels as presented in Table 1.

Table 1. Categorization of Farmers Adaptive Capacity Levels

Adaptive capacity level	Range of CACI
Low	$0 \leqslant \text{CACI} < 0.34$
Moderate	$0.34 \leqslant \text{CACI} < 0.5$
High	$\text{CACI} \geqslant 0.5$

Table 2 presents community-based scores of main and sub-indicators of adaptive capacity.

The computed adaptive capacity indices for the districts are means and a test for significant difference in the means of the indices for the two districts is important. This paper used the Independent Two Samples Students' t-test (2-tailed) to test for the significant difference in the means of the major indicators of adaptive capacity and the overall $CACI$ because the two districts' samples were randomly selected; the computed CACI is of a ratio scale; and the sample size is large ($N \geqslant 30$) [15].

Given that the sample size is large and the distribution of the difference in means is normal, the standard error was computed using equation (6) with the variances of the two sets of samples (σ_1 and σ_2):

$$\sigma_1 - \sigma_2 = \sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}$$

Where σ_1^2 and σ_2^2 denote the standard deviations for Tolon and Central Districts respectively, N_1 and N_2 denote sample size of Tolon and Central Gonja respectively.

Table 2. Community-Based Weights of Adaptive Capacity Indicators

Main Indicator	Weight/ Score (%)	Sub-Indicator	**Weight/Score (%)**
Physical Resources	11	Average farm size	16
		Access to irrigation	18
		Farm lands Ownership	15
		Access to tractor services	20
		Average distance to farm	7
		Crops Savings	14
		Seeds Saving	10
		Total	100
Financial	18	Receiving of remittance	30
		Access to input credit	25
		Access to financial credit	20
		Average farm income	25
		Total	100
Human	12	Farming Experience	20
		Basic education attainment	25
		Adult population in households of farmer	15
		Farmers from households without orphans	10
		Average age of farmers	18
		Farmers without chronic disease	12
		Total	100
Natural	6	Multiply sources of water	30
		Diversified sources of energy	20
		Non-depletion of forest resources	50
		Total	100
Social	14	Land related conflict	10
		FBO membership	20
		Access to assistance from local assemblies/ community leaders	20
		Male-headed households	12
		Participation in decision making	18
		Farmer's years of stay in community	12
		Type of marriage	8
		Total	100
Livelihood diversity	21	Uncultivated farm lands	10
		Number of livelihood sources	20
		Crop diversification	14
		Agricultural diversification	15
		Non-farm income	16
		Vocational training	10
		Average number of food sufficiency months	15
		Total	100
Information Accessibility	18	Access to climate information	15
		Formal Extension services	40
		Farmer-farmer extension contact	25
		Access to radio or TV	20
		Total	100
Total	100		

Testing for Difference in Adaptive Capacity

The t-statistic was then computed using equation (7):

$$t = \frac{(\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}}$$

The decision rule is to reject the null hypothesis (H_o) if $t_{cal} > t_{cri}$,; otherwise, do not reject H_o.

3.4 Testing for Reliability of Analytical Tool

Given that the $CACI$ consists of indicators and sub-indicators of adaptive capacity, the Cronbach reliability was employed to test for the reliability (inclusion of all relevant sub-indicators) or otherwise (omission of significant sub-indicators)of the adaptive capacity indicators when repeated to measure the same variables with the same sample, but at a different time. The result is presented in Table 3.

Table 3. Results of Reliability Test of Household Questionnaire

Cronbach's Alpha	Standardized Deviation	№ of Items
0.951	44.763	39

The Cronbach's Alpha of 0.951 indicates that the indicators and sub-indicators considered in computing the adaptive capacity of farmers for this study is 95 percent reliable and will produce the same results when repeated with the same respondents at a different time. A Likert

scale index intended for informed policy decision must have a reliability test coefficient of at least 0.9 [16]. This suggests that the $CACI$ can be relied upon for informed policy formulation on women farmers' adaptation to climate change in the study area.

4. Results and Discussion

Farmers' knowledge, access and use of physical, financial, human, natural, livelihood diversification, information and social resources are the main indicators of their capacity to adapt to climate change and variability. Table 3 presents a summary of results on adaptive capacity sub-indicators of farmers.

Table 4. Access to Resources by Farmers for Adaptation to Climate Change

Sub-indicator of Adaptive Capacity	Tolon	Central Gonja	Combined Data
Physical Resources			
Average farm size (Hectares)	2	1.82	1.9
Percentage of farmers with access to irrigation	23	28	25.5
Percentage of farmers owning their farm lands	39	41.3	40.38
Percentage of farmers with access to tractor services	71.82	74.67	73.46
Average distance to farm (Km)	24.1	17.6	44.13
Percentage of farmers who save crops	71	75	73
Percentage of farmers who save seeds	91.8	83.3	86.9
Financial Resources			
Percentage of farmers who received remittance	31	8	18
Percentage of farmers who received credit in the form of inputs	8	6	7
Percentage of farmers with access to financial credit (formal and informal)	19.1	3.3	11.61
Average annual income (GHC)	4196.35	1434.88	2603.2
Human Resources			
Farming Experience	11.77	10.43	11
Percentage of farmers with basic education	14.55	15	17.3
Percentage of adult population in households of farmer	54.91	56.01	55.56
Percentage of farmers from households without orphans	72.73	64.67	68.08
Average age of farmers	39.46	43.67	41.89
Percentage of farmers without chronic disease	68	69	69
Natural Resources			
Percentage of farmers who rely on natural water source	90.9	91.3	91.2
Percentage of farmers who do not only source fuel from the forest	21	9	15
Percentage of farmers reporting non-depletion in their forest resources	34	26	30
Social Resources			
Farmers who have never experienced land related conflict	69.1	38	54.8
Percentage of farmers who belong to an FBO	56.2	47.4	51.8
Percentage of farmers who have gone to their local assemblies for assistance	2.7	0.7	1.2
Percentage of farmers who are heads of their households	25	27	26.5
Percentage of farmers who participates in decision making	90	92	91.2
Farmer's years of stay in community	28.3	32.5	30.4
Percentage of farmers from monogamous households	32	44	38
Livelihood Diversification			
Uncultivated farm lands (hectares)	2.1	1.8	1.9
Number of livelihood sources	2.3	1.7	2
Crop diversification	1.91	2.45	2.24
Agricultural diversification	2.33	1.98	2.13
Percentage of Non-farm income	76.49	63.83	71.95
Percentage of farmers with vocational training	36.2	24.6	30.4
Average number of food sufficiency months	1.2	2.3	1.8
Information Accessibility			
Percentage of farmers who received climate information	41	42	42
Percentage of farmers with contact with extension official	70	50	60
Percentage of farmers with farmer-farmer extension contacts	68.2	42	53.1
Farmers with access to radio or TV	90	84	87.3
Percentage of farmers who received farming-related training	24	18	21

Women farmers' adaptive capacity to climate change and variability is influenced by the availability and accessibility of resources by farmers. Farmers' knowledge and usage of such resources determine their resiliency to climate variability or change shocks such as drought, floods and bush fires. Ceteris paribus, farmers with higher knowledge, access to and usage of these resources will possess higher capacity to adapt to climate change and variability than farmers who do not [17].

4.1 Physical Resources

Physical resources consist of infrastructure, farming machinery, fertile farm land and other assets. Four sub-indicators constitute the physical resource indicator.The average farm size for farmers in Tolon District (2 ha) is higher than farmers in Central Gonja District (1.82 ha) and in the combined data (1.9 ha). On the contrary, more farmers in Central Gonja District have access to irrigation and tractor service (i.e. 28% and 74.67%, respectively) than farmers in Tolon District (i.e. 23% and 71.82%, respectively). In the combined data, about 25.5 percent and 73.46 percent of farmers had access to irrigation and tractors respectively. Irrigated farming is more reliable than rain-fed. Also, farmers with access to tractors are capable of cultivating relatively larger farm sizes than those who use rudimentary tools such as hoes and machetes for farming.

The findings revealed that about 41.3 percent of farmers in Central Gonja District owned their farm lands relative to 39 percent of farmers in Tolon District. Yet, farmers in Tolon District travel relatively longer distance on average (24.1 km) to their farms than farmers in Central Gonja District (17.6 Km). Whereas more farmers in Central Gonja District (74.67%) saved crops for consumption and/or sale than farmers in Tolon District (71.0%), more farmers in Tolon District (91.8%) saved seeds than farmers in Central Gonja District (83.3%). In the combined data, about 73.0 percent and 86.9 percent of farmers saved crops and seeds respectively (Table 4).

4.2 Financial Resources

Financial resource as an indicator of adaptive capacity represents farmers' ownership of and access to financial wealth which is crucial for climate change adaptation. Most climate change adaptation measures require some level of financial sacrifice and access to credit/funds can increase farmers' capacity to adopt coping measures to recover from climate change risks. Most resource or adaptive indicators such as physical, human and livelihood diversity depend on the financial ability of the farmers. About 18 percent of respondents in the combined data reported to have received remittance in the last 12 months. Relatively, a higher percentage of farmers in Tolon District (31%) received remittance than farmers in the Central Gonja District (8%).

Meanwhile, only 7 percent of farmers in the combined data reported to have received input credit within the last 12 months. This is weigh too low to augment farmers' capacity to adapt to climate change and climate variability. Though only 11.6 percent of farmers in the combined data received financial credit within the last 12 months, a relatively higher percentage of farmers in Tolon District (19.10%) received financial credit than farmers in Central Gonja District (3.3%). The average annual income of farmers in the Tolon District, Central Gonja District and

combined data were GHC4,196.35, 1,434.88 and 2,603.20, respectively.This result is consistent with the considerably low levels of the ability of farmers in communities around the Protected Areas in the Coastal Savannah and Transitional Zones of Ghana to save and obtain long term and sufficient finances (credit) from informal and formal sources to assist them adopt climate related adaptation measures [18].

4.3 Human Resources

Human resources relate to the education, age, skills and general qualities of labor including training on agronomic practices for enhanced productivity [17]. Longer farming experience, higher education and healthy human resource suggest more knowledge and skills for effective adaptation to climate related risks, hence, higher adaptive capacity.Farmers in both districts have more than 10 years' experience of farming and an average age of 39.46 years and 43.67 years for Tolon District and Central Gonja District, respectively. These suggest that sampled farmers are youthful to adopt adaptation strategies that require more strength and are also experienced enough to deal with the effects of climate stimuli such as drought, flood and bush fire. The adaptive capacity of women farmers in Northern region of Ghana reduces as they increase in age [4]. Almost 15 percent of farmers in both district reported to have had basic education, which is required to read farm input labels and directive for usage. Both study districts reported an average of almost 55 percent adult population with almost 69 percent of respondents belonging to households without orphans. Households with many orphans and adults imply more dependency and farmers from such households will have to work extra to contribute in feeding such orphans (Table 4).

4.4 Natural Resources

The results revealed that over 90 percent of farmers rely on nature as a main source of water. This suggests that the frequent drying up of water bodies hinders farmers' source of water. Even though only 15 percent of the combined respondents source their fuel from the forest, relatively higher percentage of respondents in Tolon District (21%) rely on nature for fuel than Central Gonja District (9%). Approximately 34 percent of respondents in Tolon District reported non-depletion in their forest resources compared to 26 percent in Central Gonja District and 30 percent in the combined data (Table 4).

4.5 Social Resources

Many farmers in Tolon District (69.1%) reported land related conflicts than farmers in Central Gonja District (38%). In the combined data, more than 54 percent of farmers reported land related conflicts. Conflict triggered by land issues disintegrates social cohesion and threaten peace and stability of communities which is required for communal adaptation to climate change. About 56.2 percent of farmers belong to a Farmer-Based Organization (FBO) compared to 47.4 percent of farmers in Central Gonja District. However, almost 1.2 percent of farmers reported to have gone to their local or traditional assemblies (Member of Parliament, assembly person, chiefs or community elders) for assistance. More farmers in Central Gonja District (27%) reported to be heads of their households than farmers in Tolon District (25%). In the combined data, about 26.5 percent of farmers are heads of their households. Over 90 percent of farmers interviewed women farmers reported having a stake in decision making in their households. Being head of a household affords women the stake in decisions affecting their livelihood including how to effectively adapt to climate change. Averagely, women farmers in Central Gonja District have stayed long in their communities (32.5 years) than farmers in Tolon District (28.3 years). Yet, many women in Central Gonja District (44%) are from monogamous matrimonial homes than women farmers in Tolon District (32%). In the combined data, the average period of farmers' stay in their communities is 30.4 years while 38 percent of farmers are from monogamous matrimonial homes. Monogamous families are usually small and feeding does not require much food from farmers' own production. Also, farmers who have stayed in their communities for long effectively adapt to climate change through joint adaptation and being acquainted with the climatic conditions in their communities to effectively adapt.

4.6 Livelihood Diversification

A range of livelihood sources constitute livelihood diversification. It could be growing different crops or relying on more than a single income source. Livelihood diversification enables farmers to build a livelihood portfolio with varied risk attributes for easier and faster recovery from all sorts of risks including climate related risks (Reardon and Vosti, 1995, cited in [19]. On livelihood diversification, the average size of uncultivated farm land is high in Tolon District (2.1 ha) than Central Gonja District (1.8 ha). In the combined data, about 1.9 ha of farm lands are uncultivated. Larger size of uncultivated farm land suggest that farmer can rotate land and increase farm size or even cultivate more diversified crop to adapt to climatic stimuli. The number of livelihood sources among women farmers in Tolon District (2.3) is higher than farmers in Central Gonja District (1.7). In the combined data, farmers have an average of 2 sources of livelihood. More livelihood sources guarantees farmers' ability to adapt in times of crop failure resulting from erratic climatic conditions. Whereas women farmers' in Central Gonja District (2.45) reported higher diversified crops than farmers in Tolon District 91.91), agricultural diversification is higher among women farmers in Tolon District (2.33) than those in Central Gonja District (1.98). Due to the

difference in crops maturity duration, growing more crops is necessary to avert the effects of crop failure due to drought or floods. Accordingly, aside rain-fed farming, engaging in other agricultural activities such as rearing of animals, irrigated farming, and agro-processing is a surer strategy to withstand the shock of climate stimuli. Averagely, the percentage of non-farm income of farmers' total income is higher for Tolon District (76.49%) than Central Gonja District (63.83). Higher non-farm income cushions farmers' livelihoods in times of crop failure due to non-conducive climatic condition. Though less than a third of farmers reported to have vocational training, Tolon District (36.2%) have more farmers with vocational training than Central Gonja District (24.6%).Dress making, weaving, tie and die making, bread baking and hair dressing are vocation which supplement farmers farm income to avoid complete climatic shock on farmers. The average number of food sufficiency months is higher for Central Gonja District (2.3) than Tolon District (1.2) and even for the combined data (1.8). Food sufficiency months refer to the number of months farmer have the required staple for consumption. Higher food sufficiency months indicates more ability to withstand climatic stimuli such as flood, drought and bushfires, and hence, the higher the adaptive capacity.

4.7 Information Accessibility

These include all the channels through which farmers can access requisite information to strengthen their ability to adapt to climate change, either directly from training, sources of climate information, or indirectly through interactions and knowledge-sharing with other farmers [19]. The information accessibility indicator of farmers' adaptive capacity consists of four sub-indicators. Approximately 42 percent of farmers in both districts reported to have received climate information. Access to climate information such as weather forecast assist farmers to plan for adaptation. Usually, farmers source climate information through the radio and television. More farmers in Tolon District (90%) had access to radio and television than farmers in Central Gonja District (84%). In the combined data, about 87.3 percent of farmers had access to radio or television. Also, more farmers in Tolon District had more formal extension and farmer-farmer contacts (70 and 68.2, respectively) than farmers in Central Gonja District (50% and 42% respectively). Access to extension services is crucial in farmers' adoption of recommended agronomic practices for the effects of climatic change.

4.8 Differences in Adaptive Capacity of Women Farmers

The computed adaptive capacity indices revealed that, in terms of physical, financial, natural and social resources, livelihood diversification and information accessibility, women farmers in Tolon District have higher capacity to adapt to climate change and variability than their counterparts in Central Gonja District. On the other hand, farmers in Central Gonja District have higher capacity to adapt to climate change and variability than farmers in Tolon District in terms of human resources. The results of the Independent Two Sample t-test indicate that the differences in the seven indicators of adaptive capacity and the overall adaptive capacity between the two districts are statistically significant. This is consistent with the findings of [18] who reported significant difference in the adaptive capacity indicators (physical, social, financial, human and natural capitals) and the overall adaptive capacity of farmers in two protected communities in the Coastal Savanna and Transitional Zones of Ghana. These differences emanates from the differences in the adaptive capacity sub-indicators as discussed above (Table 5).

Table 5. Two Sample t-test Results of Difference in Adaptive Capacity

Adaptive Capacity Indicator	Mean			t	P – Value
	Tolon	Central Gonja	Difference		
Physical Resource	0.49	0.47	0.02 ***	4.759	0.000
Financial	0.18	0.06	0.13 ***	27.261	0.000
Human	0.45	0.46	-0.01 ***	-2.656	0.008
Natural	0.49	0.42	0.07 ***	9.4723	0.000
Social	0.5	0.49	0.01 ***	2.842	0.003
Livelihood Diversification	0.35	0.33	0.02 ***	3.063	0.001
Information accessibility	0.61	0.49	0.12 ***	25.981	0.000
Adaptive Capacity Index	0.44	0.39	0.05 ***	5.417	0.000

In terms of the seven adaptive capacity indicators, the computed indices indicated that most farmers have less financial resources (0.11) which account for their low adaptive capacity to climate change.Farmer's adaptive capacity is largely the result of information accessibility (0.54). Most adaptation strategies such as creating of bunds, application of fertilizer and chemicals, tractor service, improved seeds, ridging, harrowing and threshing involved cost and with low access to finance, farmers are unable to adopt such practices for effective adaptation to climate change and variability. Yet, farmers have moderate adaptive capacity in terms of human resources (0.46), physical resources (0.48), information accessibility (0.54), social resources (0.46), livelihood diversification (0.35) and natural resources (0.45). This is presented in Fig. 1. This contradicts the finding of [19] who reported that financial and human resources were respectively the major and minor contributors of farmers' adaptive capacity in Dumangas rice farming communities in the Hoilo Province in Central Philippines. This could be attributed to the difference in spatial resource endowments.

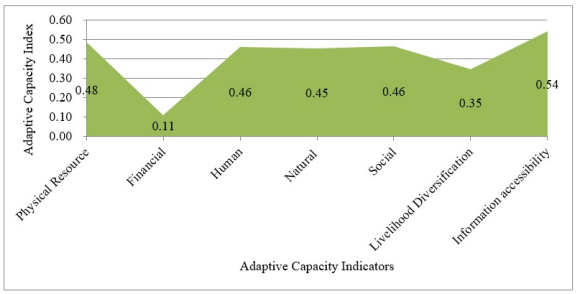

Figure 1. Farmers' Adaptive Capacity Indicators Compared

4.9 Categorization of Farmers' Based on Adaptive Capacity Index

Based on the computed adaptive capacity index, only 1 percent of women farmers (all in Tolon District) had high capacity to adapt to climate change and variability. Majority of the women farmers interviewed (63.5%) have low capacity to adapt to climate change. More women farmers in Central Gonja District (67.3%) had low adaptive capacity relative to Tolon District (59.7%) while moderate adaptive capacity was higher among farmers in Tolon District (38.2%) than farmers in Central Gonja District (32.7%). Table 5 presents farmers' levels of adaptive capacity. The findings of this study agrees with [1 9] who reported that over 60 percent of farmers in Damangas Agricultural Communities in Philippines had low capacity to adapt to climatic risks..

Table 6. Levels of Adaptive Capacity of Farmers

Adaptive capacity level	Tolon	Central Gonja	Pooled Data
Low	59.70%	67.30%	63.50%
Moderate	38.20%	32.70%	35.50%
High	2.10%	0.00%	1.00%

5. Conclusion and Recommendations

The empirical results revealed that majority of smallholder women farmers (63.5%) have low capacity to adapt to climate change in the Northern Region of Ghana. There is a significant difference in the capacity levels of women farmers in Tolon and Central Gonja Districts in adapting to climate change and variability. Farmers in Tolon district possessing significant higher adaptive capacities than those in Central Gonja district in terms of livelihood diversification, information accessibility, social, physical, natural, and financial resources as well as the overall adaptive capacity, but not human resources. In terms of the contributors of adaptive capacity, women farmers have a very low financial ability to adapt to climate change and variability. Based on this, the study recommends that intervention programs should be targeted at improving the financial capacity of women through women livelihood empowerment programs to boost women farmers' climate change adaptation, more especially for women farmers in the Central Gonja District.

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