Climate Change Adaptation Constraints among Smallholder Farmers in Rural Households of Central Region of Ghana

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Abstract

Agriculture in Africa is reported to be vulnerable to climate change due to high rate of poverty, rain-fed dependent agriculture and low adaptive capacity. Adaptation remains essentially necessary and sufficient condition to reduce the adverse effect of climate change. Smallholder farmers, however, face plethora of constraints in the choice of adaptation mechanisms. The study employed both secondary (daily rainfall from 1994–2014) and primary data to identify the adaptation mechanisms and assess the level of significance and agreement on the factors that constrain the utilization of the identified mechanisms among smallholder farmers in the rural households of Central region of Ghana. A multi-stage sampling technique was used to select 214 households across three agro-ecological zones in the region. Household questionnaire administration was preceded by community focus group discussions and key informant interviews. Kendall's coefficient of concordance and Friedman's test were used to test the level of agreement and significance of mean ranks of identified constraints, respectively. The findings showed that there is a vast intra and inter annual variability of rainfall over the 20-year period and smallholder farmers have embraced adaptation mechanisms such as crop diversification, improved variety and breed, soil and water conservation, soil and plant related strategies, and diversification to non-farming activities. Moreover, there was relatively good agreement (about 50 percent) among smallholder farmers of the identified constraints. The mean ranks of the constraints significantly differ from one another with the three topmost constraints being unreliable water source, lack of information on climate change and limited income. But for crop diversification, poor extension services and lack of credit are factors that cut across all the identified adaptation mechanisms. The study recommends among others that government policies should ensure an extensive accessibility of farmers to extension services.

Introduction

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as any change that occurs in the climate during a period of time which can range from decades to centuries (IPCC, 2007). Other scholars such as Hope (2009), termed climate change as the variability in temperature due to emissions of greenhouse gases produced by human activities. Thus, the change in climate is caused by both natural and human activities (IPCC, 2007). Africa continent is reported to be vulnerable to climate change and variability. The intensity of the vulnerability has been attributed to many factors such as high level of poverty, low adaptive capacity and high agricultural dependence on rainfall (IPCC, 2007; Mishra, 2012). Agriculture in Ghana, like many developing countries, depends on the vagaries of the weather which depict high variability of rainfall and temperature (Ministry of Food and Agriculture, MoFA,

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2011; Rani, Vanaja & Bali, 2011). Global and country level studies, including Ghana, have shown that rainfall variability has a relationship with Southern Oscillation Index (*SOI*), Sea Surface Temperature (SST) and El-Nino Southern Oscillation (ENSO) (Ogallo, 1988; Hulme *et al,* 1992; Adiku and Stone, 1995; Stone, Hammer, & Marcussen, 1996; Adiku *et al.,* 2007). The high dependence on rainfall by smallholder farmers in sub-Sahara Africa renders them vulnerable to the adverse effects of climate change impact.

There is rich knowledge of climate change impact in many sectors including the agricultural sector in sub-Sahara Africa. It is estimated that average temperature in sub-Sahara Africa is expected to increase by 1.5^{o} C to 3^{o} C with major changes in rainfall in terms of annual and seasonal trend by 2050. Moreover, it is projected that between 75 and 250 million people in Africa will be exposed to increased water stress as a result of climate change by 2020. Further, the yield of rain-fed agriculture is also expected to be declined by 50 percent in some countries (IPCC, 2007). The report continues to outline the impending threats of climate change to Africa continent. In Ghana, however, rainfall prediction studies have shown promising results that farmers can minimize the adverse effect of climate change by changing planting date to obtain optimal yield of crops such as maize (MacCarthy *et al.,* 2017). Limited agricultural extension to farmer ratio has been found to limit smallholder farmers' capacity to adapt to the changing climate (Ozor *et al.,* 2010) and this renders them vulnerable (MacCarthy *et al.,* 2017). Thus, the communication of the climate prediction information to the farmers at the household level to adjust the planting time seems to be lacking due to poor/limited agricultural extension services to farmer ratio.

Agriculture remains one of the most significant sectors of Ghana's economy and society. It employs about 57 percent of female-headed households and 73 percent of the male-headed households in the rural communities of the country. Also, it is estimated that about 50 percent of the working population engage directly in agriculture (Ghana Statistical Service (GSS), 2012). Though there are large plantations such as cocoa, oil palm, rubber, etc., the sector is dominated by smallholder farmers with an average farm size of about 1.2 hectares and low use of improved technology. Out of the total agricultural land area of 2,3884,254 hectare, only 0.4 percent is under irrigation (Statistics, Research and Information Directorate, SRID, 2013). The country's agriculture is also characterized by low crop and animal productivity. Yields of most crops are generally low and could remain stable for a long period of time. For instance, the yield of maize crops resonated from 1.5 to 1.6 Mt/Ha between 2002 and 2008 (SRID, 2013). Food, as a basic need for sustenance of life, must be provided in adequate quality and quantity to maintain good health and optimal performance. Thus, ensuring food self-sufficiency in the country. The accessibility of food, however, is likely to be hampered by climate change. The report of the Ministry of Environment, Science, Technology and Innovation

(MESTI) indicates that there is a clear sign of the impact of climate change on the Ghanaian economy. These include high temperatures and unpredictable rainfall, low yield and crop failure (MESTI, 2010). This impact threatens the development prospect of the country.

Besides climate prediction, adaptation and mitigation remain essentially necessary and sufficient conditions to reduce the adverse effect of climate change (Mishra, 2012). The two concepts, nevertheless, are different in terms of scope. In terms of objectives, mitigation deals with the causes of climate change (i.e. reducing the accumulation of greenhouse gases in the atmosphere), whereas adaptation addresses the climate change impacts (Locatelli, 2011). According to Tol (2005), climate change is a global phenomenon. However, adaptation benefits are local. Thus, many international organisations have recognised the need for adaptation policy. In the agricultural sector, smallholder farmers in sub-Sahara Africa have taken up many adaptation measures to cope with the changing climate. It is reported that adaptation is therefore not new to smallholder farmers in Ghana as many rural households have taken up measures such as changing of settlement and agricultural pattern to cope with climate change (Antwi-Agyei *et al.,* 2014). The associated impact of climate change, however, unveils new dimension and urgency of the adaptation challenge. For example, scarcity of land will limit smallholder farmers to move from one place to settle in the other. Also, changing pattern of agriculture (example, from animal to crop production and vice versa) is unsustainable due to the intensity of temperature and variability of rainfall, especially in Ghana.

To achieve a better understanding of the climate vulnerability of smallholder farmers who are rainfall-dependent, it is imperative to explore some factors that constrain the implementation of adaptation strategies. Recent research attention has focused on barriers to climate change adaptation and perceived climatic and non-climatic stressors of climate vulnerability in the developing countries (Ozor *et al.,* 2010; Egbule & Agwu, 2013; Antwi-Agyei *et al.,* 2014; Antwi-Agyei *et al.,* 2017). Several authors, thus, opined that vulnerability is triggered by both climatic (e.g. rainfall, drought, etc.) and non-climatic factors (income, lack of agricultural equipment, etc.) and it is imperative to understand the combination of these stressors (factors) that exacerbate the vulnerability of farming households to climate change and vulnerability (Antwi-Agyei *et al.,* 2017). It is important to stress that most of these studies are only empirical in nature with only few mixed methods. Moreover, the level of agreement among smallholder farmers and relative significant of constraints (both climatic and non-climatic) have not been comprehensively studied in Ghana. As a strength, the present study used mixed methods approach in addition to daily rainfall distribution to identify the adaptation mechanisms practised by smallholder farmers and ascertain the factors that constrain the adaptation of these mechanisms. Thus, the specific objectives of the study are to: (i) analyse the trend of rainfall in the study area over the period of 20 years; (ii) identify the adaptation strategies used by smallholder farmers to mitigate the impact of climate change and (iii) assess the level of agreement and the relative significance (mean ranks) of perceived climate change adaptation constraints among smallholder farmers.

The findings from this will not only shape the designation of effective adaptation policies but will also add to the body of knowledge on climatic constraints in Ghana. The paper is organised into four sections. Section two provides the methodology which embodies the study area, sampling procedure and method of data analysis. Section three presents and discusses the findings of the study. The paper concludes with policy recommendations in Section four.

Methodology

Study area and sampling procedure

Ghana is a country located in Western Africa along the Gulf of Guinea at Latitude 4° 44' N and 11°11'N and Longitude 3° 11 W and 1°11'E. The population and average per capita annual income are, respectively, 24 million and US$ 879 (GSS, 2012). Out of the ten administrative regions, the Central region, capital cape coast, is the third smallest region and occupies 4.1 percent (9,826 square kilometres) of Ghana's land area (GSS, 2012). The rainfall distribution in the region is bi-modal with annual rainfall of 1000 mm along the coast and 2000 mm in the inland. The major farming season spans from April to July while the minor farming season is September to November. Average monthly temperature can peak 24 degrees in the wet season and 30 degrees in the dry/hottest season while the relative humidity falls between 50% and 85% (SRID, 2013). Agriculture remains the predominant occupation employing about two-third of the work force in most districts. Vegetatively, the region is categorised into forest, transitional and coastal zone and a multistage random sampling technique was used to select the rural farm households across the three zones. The first stage of the sampling procedure entailed the selection of three districts from each of the agro-ecological zone using a simple random sampling procedure.

The selected districts were Awutu-Senya (Coastal Zone), Assin South (Forest Zone) and Mfantseman District (Transitional Zone). In the second stage, same technique was applied to select two rural communities (Fig. 1). The universe defined for the study was the total number of registered farming population living in the six communities in the three districts. The list of farmers (1200 farmers) was obtained from the MoFA office in each sampled district. To ensure representativity, 214 farmers were sampled from the six communities.

Data collection methods

This study is based on a cross-sectional survey and secondary source of data. Households' survey was conducted from July 2015 to September 2015 to generate socioeconomic, demographic, agro-ecological and agronomic data for 2014 planting season. A structured questionnaire was administered through face-to-face interviews to gather relevant information.

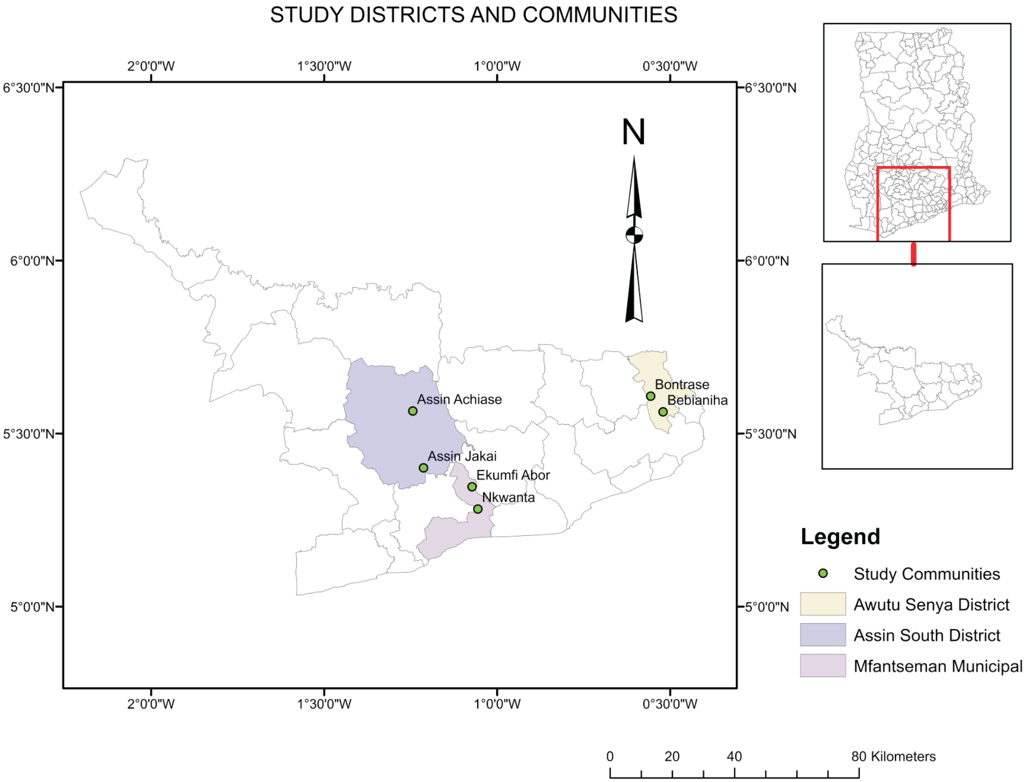


Fig. 1. Sampled districts and communities

Moreover, one focus group discussion was held in each of the districts prior to the administration of the questionnaire. Purposive sampling was employed to select 12 farmers to participate in each focus group conducted and this was done to ensure that farmers with different socio-economic profile (e.g. age, sex, land size, plant cultivated, etc.) are represented. Daily rainfall data from 1994 to 2014 for three synoptic weather stations in the Central Region were sourced from Ghana Meteorological Agency (GMet). The synoptic weather stations located in Assin Fosu, Saltpond and Awutu-Senya were used to represent the forest, transitional and coastal zone, respectively.

Data processing and analysis

A comprehensive literature review was undertaken to identify climatic constraints facing smallholder farmers across Africa. This was complemented with community level focus group discussions. Thus, constraints identified through the focus group discussions were added to the constraints obtained from the literature. It is important to stress that some of the constraints identified during the focus group discussions (e.g. lack of credit, income) were non-climatic in nature. These factors, as pointed out by Antwi-Agyei *et al.* (2017), exacerbate climate vulnerability. The constraints were given to the households to rank. The more serious constraint was assigned the value 1 while the least constraint was assigned the value 10. Moreover, a five-point likert scale was developed from not serious to more serious to ascertain constraints pertaining to each of the identified adaptation strategies.

The literature identifies number of methods for testing rankings. Among these are the Garrett's rank scoring technique, Friedman's two-way analysis of variance without replication by ranks and Kendall's coefficient of concordance (W). The Garrett's rank scoring technique is used to rank preference of respondents on attributes under study. The principle behind this technique is that it converts ranks into percent positions which are then converted into scores by referring to the Garrett's table. Thus, for each attribute the scores of the individual rankers are aggregated and the average score is estimated. The scores are then arranged in either ascending or descending order (Loganathan *et al.,* 2009). As a limitation, this technique involves a plethora of steps and does not test the level of agreements between rankers. Moreover, it does not test any specific hypothesis (Kuwornu *et al*., 2013). The other two techniques, Friedman's two-way analysis of variance without replication and Kendall's coefficient of concordance operate almost in the same manner with exception of the hypothesis formulation. Thus, there is a close relationship between these two techniques (Legendre, 2005). Both address hypotheses concerning the same data and use the same chi-square statistic for testing. However, the null hypothesis of the Friedman's test focuses on the items being ranked whereas the Kendall's test focuses on the rankers themselves. This study, therefore, adopts both Friedman's two-way analysis of variance without replication and Kendall's coefficient of concordance.

Following Legendre (2005) the rankings were first subjected to the Kendall's coefficient of concordance. Each respondent or rater was assigned a range of weights or scores that ranges from 1–10 to the constraints and each number represents various degrees or magnitudes of the constraint. The Kendall's W is modelled to output a coefficient which ranges from 0-1, whereas, 0 means no absolute agreement, a random response among raters, 1 means absolute agreement (unanimity) among raters and intermediates between the two (0 and1) indicate the degree of greater or lesser agreement (unanimity) among the responses. Thus, the Kendall's coefficient of concordance measures the degree of agreement of rankings by different rankers. Mathematically, the Kendall's W is depicted as:

$$W = \frac{12S}{p^2(n^3 - n) - pT} \quad \text{.....................} (1)$$

Where: S = is the sum of squared deviations for each constraint and is given as:

$$S = \sum_{i=1}^{n} (R_i - \overline{R})^2 \quad \text{................} (2)$$

The rankings were also subjected to Friedman's two-way analysis of variance to assess the level of significance among the mean rank of the climatic constraints.

To compute the Friedman statistic, *Fr*, the following formula is used (Buskirt *et al.*, 2013):

$$Fr = \left[\frac{12}{Nk(k-1)}\sum_{j=1}^{k} R_j^2\right] - 3N(K+1) \qquad \ldots (3)$$

From equation (1) and (2), R_i is the total rank for the i^{th} constraint; $\bar{R}$ is the mean value for each total ranked constraint; p = refers to the number of respondents (raters); n = refers to the number of objects or constraints to be ranked. T – is the correction factor for ties. In equation (3), k represents the number of constraints, N represents the total number of respondents, and R_j is the rank sum of i^{th} climate change adaptation constraints.

The level of agreement in the Kendal's W was tested based on the following hypothesis:

H_0: There is no significant agreement among smallholder farmers in the ranking of different climatic constraints.

H_1: There is significant agreement among smallholder farmers in the ranking of different climatic constraints.

On the other hand, Friedman Hypothesis on the level of significance of the mean ranks of constraints among the respondents was tested on the following hypothesis.

H_0: There is no difference in the distributions of mean ranks of climate change adaptation constraints among smallholder farmers.

H_1: There is difference in the distributions of mean ranks of climate change adaptation constraints among smallholder farmers.

The $Fr \sim X^2_{(k-1)}$ in equation (3) follows approximately the chi-square distribution with k-1 degrees of freedom. The null hypothesis (H_0) is rejected if:

$$Fr > X^2_{(k-1,1-\propto)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Further, the perceived and identified climatic constraints were presented to the farmers on a five-point likert scale, from *not serious* (coded as 1) to *more serious* (coded as 5) to assess. Descriptive Statistics was used to compute the mean score rating of each identified constraints. Data coding and analysis was accomplished using Statistical Package for Social Science (SPSS). The daily rainfall data from 1994 to 2014 in the study area was analysed graphically using trend analysis in Microsoft Excel.

Analysis of the qualitative data was based on content analysis (Bryman, 2008). Responses undertaken with regards to climatic constraints were summarized according to emerging themes and presented as counts. Qualitative analysis of information from focus group discussions is a continuous process. This starts during data collection on the field with identification of major themes and ends with an in-depth description of the results. Following (Newing, 2011), data from the focus group discussions was summarized according to key themes and illustrated by direct quotes, recounting particularly relevant experiences and views of smallholder farmers, essential for authenticity of findings.

Results and discussion

Socio-economic profile of respondents

The proportion of male and female respondents interviewed is 55.2 percent and 44.8 percent, respectively. The ages of the household heads were classified into four categories. About 41 percent of the respondents are between the ages of 36–50 years while only 4 percent are above 70 years. Those between the ages of 51–70 years form about 40 percent. Relatively, young farmers (those within the age bracket 18–35 years) who form future producers form about 15 percent. This could be a threat to future agriculture productivity as young and energetic farmers seem not to be much involved in agriculture.

Most of the respondents (about 58 percent) have had basic education and very few (about 1 percent) have had tertiary education. Respondents who have had secondary education constitute about 12 percent while about 29 percent had no formal education. The proportion of household who own radio and Television set (TV) by gender is presented in Table 1. Overall, more than half of the respondents own radio set or TV set. Proportionately, more male-headed households own radio set, TV set or both than female-headed households. It is reported that most farmers in the rural households with limited social capital are denied access to extension services (Dinh *et al.,* 2012). Thus, besides social relations established by farmers, TV and radio will, therefore, serve as the main source of information on climate change adaption strategies in the rural households.

Trend of rainfall distribution and climate change adaptation strategies

As raised earlier, there are two main planting seasons in the Central region of Ghana: the major season which start from April to July and the minor season which start from September to November. Based on this, daily rainfall in April, May, June, July, September, October and November was used to compute an average daily rainfall. The trend of average daily rainfall distribution in the three climatic zones is presented in Fig. 2. There is a vast inter and intra annual variability of rainfall pattern over the period. The computed mean daily rainfall for the forest, transitional and coastal zone is 5.54 mm, 3.88 mm and 3.28 mm, respectively.

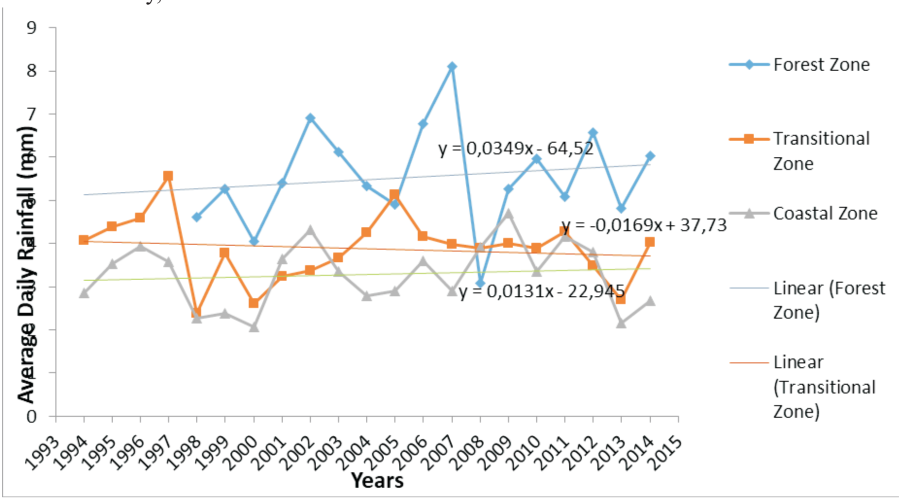
The forest zone depicts a positive trend of average daily rainfall over the period. The zone, however, showed a sharp decrease in rainfall in 2008. Thus, rainfall decreased by 62 percent from 2007 (8.10 mm) to 2008 (3.09 mm). The rainfall pattern in the transitional zone, on the contrary, showed a decreasing trend. The zone recorded the highest average daily rainfall in 1997 (5.56 mm) and reduced by 57 percent in 1998 (2.39 mm). Finally, there has been noticeable change of rainfall in the coastal zone of the region. The highest average daily rainfall was recorded in 2009 (4.70 mm) and has followed a decreasing rainfall trend thereafter. In a nut shell, smallholder farmers in the transitional and coastal part of the region can be argued to perceive a consistent decrease in rainfall from 2009 onward and this has high potential of affecting crop and animal production as they are rainfall dependent, thereby, increasing their vulnerability.

The identified climate change adaptation strategies during the focus group discussions and household questionnaire administration are presented in Fig. 3. The dominant practice among

TABLE 1
Ownership of radio and TV set by gender of respondents

Variables	*Female*		*Male*		
	Frequency	*Percentage (%)*	*Frequency*	*Percentage (%)*	*Overall (%)*
Ownership of radio set					
Yes	47	48.0	89	76.7	63.6
No	51	52.0	27	23.3	36.4
Ownership of TV set					
Yes	52	53.1	81	69.8	62.1
No	46	46.9	35	30.2	37.9
Ownership of both TV and radio set					
Yes	36	36.7	68	58.6	48.6
No	62	63.3	48	41.4	51.4

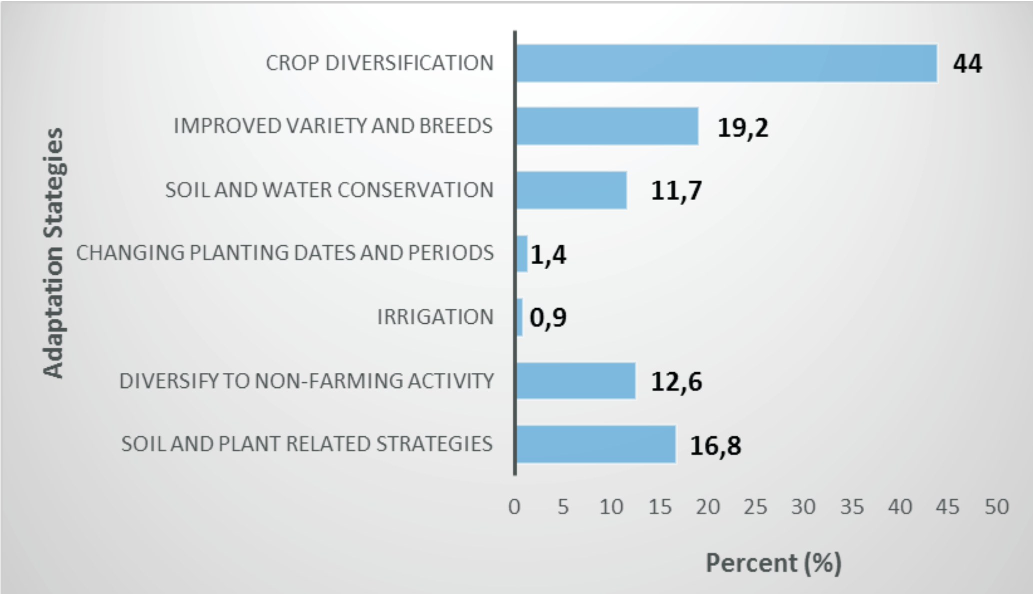
Source: Field Survey, 2015



Source: Author's computation
Fig. 2. Trend of average daily rainfall distribution in the three sampled climatic zones

smallholder farmers is crop diversification (44 percent) followed by improved varieties and breeds (about 19 percent). The least adopted practice is irrigation as less than 1 percent of the respondents do use the traditional method of irrigation. The study also revealed, during the focus group discussions, that farmers who practice crop diversification usually plant maize (*Zea mays*) and intercropped with cassava (*Manihot esculentum*), cocoyam (*Xanthosoma spp*), plantain (*Musa spp*) or vegetables.

This mechanism, according to the responses of the farmers, is practised due to weather uncertainty, thereby, ensuring



Source: Field Survey, 2015.
Fig. 3. Adaptation strategies among smallholder farmers

food security. Improved crop varieties used by farmers in the study area include high yielding crops, early maturing varieties, drought tolerant and improved breeds. A typical example of improved maize used by farmers is *Obaatanpa*. Typical soil and water conservation mechanisms identified includes mounds, ridges, mulching, small scale dam in the farm, hand dug trenches, and intentionally leaving out of big trees on the farm. Farmers who farm close to water (about 46 percent of the respondents) rely heavily on the water bodies for manual irrigation. Thus, farmers pull out water from the dug trenches, rivers and small dams using watering can to irrigate the crops. The water bodies, however, dry out during the dry season. A 48 year-old farmer from the forest zone explained why irrigation is not feasible:

> *We do not have any reliable source of water in our community and its surroundings. I usually dig a small well in my farms and use the water for irrigation, pesticides application, drinking, cooking, among others... I cannot afford the cost of the equipment for irrigation.*

Beside unreliable source of water, lack of financial resources compels the farmers to engage in manual farm practices such as irrigation. The water bodies which serves as source of drinking water has high probability of getting contaminated with leached chemicals such as nitrates. This is likely to have serious health implication among the farmers in the future. Farmers who undertake soil and plant related strategies responded that they receive inorganic fertilizers from the government. The disadvantaged farmers, however, purchase fertilizers from the agrochemical stores. Farmers, especially in the forest zone, apply sawdust and other organic (compost) materials to improve crop yield. The uncertainty of climate change and low yield of crops have also compelled most of the farmers, especially the female farmers, to engage in other non-farming activities for livelihood. Among the non-farming activities identified include 'gari' processing and petty trading. These findings lend credence to that of Kuwornu *et al.* (2013) and Mishra (2012).

Climate change adaptation constraints

Many constraints were identified during the focus group discussions and the key informant interviews and these vary from climatic to non-climatic factors. Ten main constraints were identified and these were given to the farmers to rank. The result of the ranked constraint is presented in Table 2. In ranking these challenges, it is envisaged from the Kendall's coefficient of 0.495 (about 50 percent) that there was relatively good agreement among smallholder farmers regarding the seriousness of constraints in farming activities which is in favour of the alternative hypothesis ($p = 0.000$). Moreover, there was significant difference among the mean rank of the constraints identified (based on the Friedman's test, $X^2(9) = 952.499$, $p = 0.000$). Thus, the null hypothesis is not accepted. The three most climatic constraining challenges emerged in the rural areas are unreliable water source (with a mean of 2.53), lack of relevant information on climate change (with a mean of 2.99), and limited income (with a mean of 3.25). The three least serious constraints identified are lack of support from the government, credit constraint, and land constraints and their mean values are 6.55, 6.68 and 8.49, respectively. As pointed out by Antwi-Agyei *et al.* (2017), the least serious factors identified are not directly related to climatic constraints. Nevertheless, these factors have been found to exacerbate climate vulnerability at the households, community and the district level. Elsewhere, scholars have found similar results (Ozor *et al.,* 2010; Egbule & Agwu, 2013; Munhande, *et al.,* 2013).

Extension services to smallholder farmers seem to be lacking in most rural parts of Central region of Ghana. It is reported that most smallholder farmers are unregistered and are scattered across the country. Thus, it needs large number of extension officers to reliably reach the farmers. Statistics shows that the ratio of Agricultural Extension Agent to farmers is 1:2500. This situation is worse in some districts in the Northern region where the ratio is estimated to be 1:3000 (Owusu-Baah, 2012; Duo & Bruening, 2007). Further, it is reported that only 10 percent of farmers in the country are receiving extension services and smallholder farmers who constitute about 70 percent of the labour force in the country are not receiving adequate extension services. Owusu-Baah (2012) writes that the attempt of MoFA to reduce the ratio to 1:800 has not materialized. The World Bank, in an attempt to bridge this gap, partnered with the government of Ghana and introduced a unified agricultural extension system whereby cocoa, crops, and livestock were fused together so that extension officers can deliver information to all sub-groups of farmers at the same time. Evaluation of the unified agricultural extension system on cocoa production indicates that the system has underperformed (Owusu-Baah, 2012; Asuming-Brempong, *et al*., 2005). The challenge of extension services also emerged during the focus group discussion. A 72 year-old farmer from the transitional zone lamented on the situation of extension services. This farmer explained:

> *The Agricultural extension officer who used to visit us in this community has stopped the visit for the past 3 years. All the operations carried out on the farm to reduce the adverse effect of climate change are as results of my own experience. I do not receive any guidelines from extension officers any longer…*

TABLE 2
Ranking of climate change adaptation challenges by smallholder farmers

Challenges	*Mean Rank*
Unreliable water source	2.53
Lack of Information on climate change	2.99
Limited Income	3.25
High cost of farm inputs (i.e. fertilizer, Pesticides, improved seeds)	4.59
Poor agricultural extension service Delivery	5.32
High cost of irrigation facilities	6.34
Lack of support from government	6.55
Credit Constraints	6.68
Shortage of Labour	8.25
Land constraint	8.49
Test Statistics	
Number of Observation	214
Chi Square	952.499
Degree of Freedom	9

Kendall's W Test		*Friedman's Test*	
Kendall's W[a]	0.495		
Asymp. Significance	0.000	Asymp. Significance	0.000

Source: Field Survey, 2015

The hazardous effect of climate change renders most smallholder farmers poor. This is because it provides an additional threat that complements and reinforces the existing risks (IPCC, 2007). The short and long run effect is the placement of additional strains on the livelihoods and coping strategies of the poor. A 35-year old female farmer in the coastal zone posited that she has no money to buy improved varieties let alone irrigation.

> *I planted half acre of maize last year and did not even obtain 50kg bag of maize. All my crops failed last year due to the lack of rain. This year is even worse as it has not rained…. In this situation how can I get money to buy improved seeds or equipment for irrigation.*

It is important to emphasise that crop failure cannot be solely attributed to lack of rainfall. Other possible causes which are not captured by the study include poor soil fertility, infestation by insect and rodents, inability to plant at optimum time, among others. However, the erratic nature of rainfall, especially, in the transitional and coastal zone cannot be undermined. The issue of land, which is regarded as a non-climatic factor (Antwi-Agyei *et al.,* 2017) was not among the critical constraints in the overall ranking. However, the focus group discussions revealed that the smallholder farmers in the coastal zone face serious land constraints. The proximity of Awutu-Senya districts to the capital city -Accra- serves as a marketing avenue for farmers' produce. Unfortunately, agricultural activities in these areas have been characterised by an influx of investors of commercial pineapple production in the area pushing out smallholder farmers from cultivating arable crops on the land. This situation has high probability of intensifying the climate vulnerability of smallholder farmers as farmers are rendered landless. It emerged, during the focus group discussion, that farmers are evacuated from the land by landowners without prior notification. The case was very sensitive to discuss in the community, according to some respondents. The study did not delve into how they acquired the land and the binding tenure agreement. They could not take any action against the land owners. Most of the women in this area have therefore diversified into non-farming activities due to this incidence. A young mother (27 years) has this say:

I do not have land to cultivate any longer. I am currently into 'gari' processing, besides my table top grocery store. I go to the nearby market and purchase the cassava…

Converting land into commercial pineapple production will certainly have an adverse effect on the rural household food security, and an increased poverty. Thus, an absence of land for arable crop production will catalyse the adverse effect of climate change in the livelihood of the people in the communities. The result of the mean score rating of constraints facing smallholder farmers on each of the identified adaptation mechanism is presented in Table 3. The unreliable water source and lack of income significantly explains why farmers in the study are not using irrigation as a means of reducing the effect of climate change. Unreliable or non-availability of adequate water has been identified as a major constraint to irrigation practice among farmers in other part of the world (Bharamappanavara *et al.*, 2013). Thus, the three most pressing constraints that cut across all the specific adaptation mechanism are unreliable water source, lack of funding, and lack of credit. Except crop diversification mechanism, poor extension service impedes the adaptation of all the climate change adaption mechanisms as the mean score rating was greater than 3.

In summary, there is high significant mean score and agreement (50 percent) among smallholder farmers concerning the identified constraints. Thus, the null hypothesis for the Kendal's W and the Friedman's test are not accepted.

Conclusion and recommendations

The study examined constraints faced by smallholder farmers regarding climate change adaptation. The analysis of the study aimed at understanding the level of significance and agreement on constraints among smallholder farmers to inform policy. The results of the study revealed that most of the smallholder farmers in the study area have embraced at least one adaptation mechanism and the most dominant among these is crop diversification i.e. multiple cropping). Due to climatic uncertainty smallholder

TABLE 3

Mean score rating of climatic constraints identified by smallholder farmers

Constraints	*Crop diversification*		*Improved variety and breeds*		*Changing planting date and periods*		*Soil and water conservation mechanism*		*Irrigation*		*Soil and plant related strategies (pesticides, fertilizer application)*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Lack of relevant information	2.01	1.40	3.13*	1.54	2.18	1.55	3.43*	1.50	3.67*	1.53	2.93	1.61
Lack of seed and fertilizer	2.40	1.56	2.71	1.62	2.07	1.50	2.30	1.54	1.91	1.39	2.75	1.68
Labour shortage	2.25	1.41	2.40	1.55	2.19	1.50	2.30	1.37	2.38	1.50	2.33	1.51
Unreliable water source	3.93*	1.35	3.64*	1.50	3.70*	1.51	3.85*	1.51	3.76*	1.58	3.58*	1.57
Pests and diseases	3.15*	1.43	3.06*	1.55	2.87	1.58	2.32	1.39	2.17	1.51	2.98	1.62
Lack of credit	3.26*	1.51	3.37*	1.56	3.80*	1.60	3.16*	1.47	3.58*	1.53	3.45*	1.56
Poor quality seeds/equipment	2.07	1.56	2.28	1.65	2.01	1.50	2.16	1.58	2.41	1.69	2.44	1.67
Theft of produce/material	1.94	1.38	2.32	1.63	2.06	1.50	2.18	1.55	2.43	1.59	2.09	1.50
Lack of funding	3.37*	1.57	3.67*	1.41	3.18*	1.65	3.60*	1.51	3.80*	1.51	3.40*	1.62
System of land tenure	2.12	1.49	2.50	1.72	2.16	1.57	2.57	1.60	2.78	1.69	2.42	1.60
High Cost of Farm land	2.20	1.53	2.36	1.61	2.28	1.67	2.25	1.55	2.50	1.69	2.47	1.66
Shortage/lack of drought power /tractor (plough)	1.99	1.53	2.26	1.65	2.09	1.55	2.40	1.68	2.03	1.61	2.18	1.60
Shortage of farm inputs (seeds, fertilizer, pesticides etc.)	2.14	1.53	2.61	1.74	2.20	1.61	2.29	1.59	1.94	1.44	2.77	1.73
High cost of farm input	3.06*	1.51	3.40*	1.55	2.83	1.55	3.30*	1.54	3.63*	1.62	3.69*	1.49
Poor agricultural extension service delivery	2.96	1.53	3.38*	1.54	2.90	1.55	3.26*	1.52	3.56*	1.53	3.27*	1.54

Source: Field Survey, 2015; *Mean value > 3.0

farmers undertake this practice to guarantee food security. Ghana's agriculture is rainfall dependent and this raises critical concern about the vulnerability of the smallholder farmers. The study revealed that only about 0.9 percent of the sampled rural households practice bucket system of irrigation. Thus, farmers closed to water bodies dig out small pond or dam for irrigation purposes, besides other uses. Moreover, smallholder farmers are not able to optimize planting time as less than 2 percent in the study area undertake this practice. Besides the constraints identified during the focus group discussion, there is relatively strong agreement (about 50 percent) among the smallholder farmers and the mean ranks showed high level of significance. The three most serious climatic constraints facing smallholder farmers in the study area include: unreliable water source, lack of relevant information on climate change and limited income. At the individual adaptation mechanisms level, limited/poor extension service, lack of funding, high cost of farm input, are among other factors that impede adaptation at the household level. The cumulative impact of these is increased vulnerability and crop failure resulting in food insecurity.

The issue of unreliable water source and inability to optimise planting time (weather forecasting) greatly affect farming operations in Ghana as respondents assigned high significant ranking. As raised earlier, many scholars have established ample evidence on the relationship between country level rainfall pattern and global circulation phenomenon. Moreover, optimization of the planting time has been shown to increase crop yield (Adiku *et al.*, 2007; MacCarthy *et al.,* 2017). The challenge that arises is how to effectively communicate these findings to the smallholder farmers. Thus, poor extension service, which cut across almost all the identified adaptation strategies, renders smallholder farmers vulnerable to climate change. Ghana's extension services, nevertheless, have undergone several phases of development in terms of policy and approach over the past decades. For instance, cocoa extension was unified under MoFA in 1998, followed by decentralization, involvement of private sectors, demand-driven approach, among others (Sigman, 2012). The effectiveness of these developments as well as the limited number of extension officers to farmer ratio with its consequences have not been fully exploited in Ghana. Betru and Hamdar (1997) write that the most common challenge in the developing world is where extension officers are ignorant of the current knowledge products of researchers. The constraints on climate information and extension services suggest number of policies. The link between research institutions and the extension officers should be strengthened by the relevant institutional body. For instance, MoFA can put appropriate mechanism in place to organise annual workshop or conference for Extension officers and climate research institutions. In doing so, extension officers will be updated with current information on climate change (e.g. optimal planting time, month of expected rainfall, etc.) to keep the smallholder farmers informed about the current knowledge. In addition, there is the need to make agricultural extension services widely available to smallholder farmers in the rural parts of the Central region of Ghana. This will not only create more awareness on climate impact but also enhance the adaptation of improved variety and breeds and other mechanisms, especially, among young farmers who are into agriculture but with no experience. Further, government in collaboration with the private sector should embark on dissemination of climate forecast information via TV and radio programme. To ensure efficient and effective use of this programme, several adaptation mechanisms as well expected period of rainfall (and optimal planting periods) can be fused together to reach mass of the smallholder farmers scattered across the country.

The study also showed that smallholder farmers heavily rely on natural rainfall for farming and unreliable water source poses a threat to the adaptation of climate change. Smallholder farmers have therefore embraced soil and water conservation measures to reduce the adverse effect of climate change. Ghana, as a country is in a transition to climate smart agriculture where soil and water conservation measures are optimised to improve yield (German Corporation for International Cooperation GmbH (GIZ), 2014). However, the project seems to be confined to certain part of the country. As a policy, the government should encourage the private sector (e.g. producer organisations, buyers, processers, etc.) to invest in the soil and water conservation mechanisms, especially, with the registered farmers. In addition, smallholder farmers, especially those who farm close to water bodies and confined within certain radius can collectively construct mini dams to harvest excess water for agricultural operations during the period of no or minimal rains. This will cut down cost per capital and ensure sustainable agriculture production.

Finally, government policies should ensure that smallholder farmers have access to affordable credit, affordable irrigation facilities and other farm inputs. Access to these can help smallholder farmers change production strategies in response to climate uncertainties. With affordable irrigation facilities, farmers close to water bodies and with the construction of collective dams/pond, can undertake simple irrigation to minimise the risk of climate change.

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