
Article:
Jamal, A.M., Antwi-Agyei, P., Baffour-Ata, F. et al. (3 more authors) (2021) Gendered perceptions and adaptation practices of smallholder cocoa farmers to climate variability in the Central Region of Ghana. Environmental Challenges, 5. 100293. ISSN 2667-0100

https://doi.org/10.1016/j.envc.2021.100293

Environmental Challenges 5 (2021) 100293

Contents lists available at ScienceDirect

Environmental Challenges

journal homepage: www.elsevier.com/locate/envc

Gendered perceptions and adaptation practices of smallholder cocoa farmers to climate variability in the Central Region of Ghana

Alawi Mohammed Jamal[a], Philip Antwi-Agyei[a], Frank Baffour-Ata[a,*], Elias Nkiaka[b], Kwabena Antwi[a], Antoinette Gbordzor[a]

[a] Department of Environmental Science, College of Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[b] Department of Geography, The University of Sheffield, Sheffield, South Yorkshire S10 2TN, UK

ARTICLE INFO

Keywords:
Climate variability
Perception
Adaptation
Gender
Ghana

ABSTRACT

Understanding gendered adaptation practices among smallholder cocoa farmers is crucial to ensuring sustainable cocoa production in Ghana. This study examined the gendered perceptions and adaptation practices of smallholder cocoa farmers to climate variability in three selected communities (Breman Ayipey, Breman Baako and Breman Kuntanase) in the Asikuma-Odoben-Brakwa District of the Central Region, Ghana. The study adopted a mixed-methods approach including household surveys and focus group discussions with 10 participants in each community. Mann-Kendall trend test was used to determine the rainfall and temperature changes in the study district from 2000 to 2015. Results indicated that there was no significant difference between male and female farmers' perceptions of climate variability ($p > 0.05$). Both male and female farmers perceived an increasing temperature, rainfall, windstorms and flooding for the past 15 years. The Mann-Kendall trend test showed that annual rainfall and temperature had increased over the study period although the trends were not statistically significant ($p > 0.05$). Both male and female farmers had resorted to the use of different adaptation practices to reduce the threats of climate variability. There was a substantial difference between adaptation practices used by male and female farmers such as changing planting dates, use of drought tolerant hybrids, shade management, livestock rearing and income from sale of properties ($p < 0.05$). The study recommends policy formulations that incorporate gender perspectives into climate change adaptation practices among smallholder cocoa farmers in Ghana.

1. Introduction

Ghana's agricultural sector provides employment on an informal and formal basis and currently contributes about 19.7% of the Gross Domestic Product (GDP) in the country (Diao et al., 2019). Agriculture contributed 33.5% of total labor force in 2019 and is ranked the second biggest employer in the economy of Ghana (Diao et al., 2019). The country produces different types of crops including yams, cocoa, grains, kola nuts, timber, oil palms etc. in different agroecological zones ranging from wet forest to dry savannah which run in east-west bands across the country (Ministry of Food and Agriculture, 2016). Agriculture in Ghana provides an important source of raw materials to the manufacturing sector and represents over 30 % of export earnings (Diao et al., 2019). However, the agricultural sector is heavily reliant on rainfall and hence it is anticipated that climate variability will have serious consequences for both staples and cash crops particularly cocoa (*Theobroma cacao*).

Ghana is the second biggest producer of cocoa beans in the world and is recognized as the leader in the quality of cocoa beans (Roldan et al., 2013) with a market share of about 20% (Wongnaa and Babu, 2020). The country obtained 2.71 billion USD from cocoa exportation in 2017 contributing significantly to total foreign exchange earnings (Wongnaa and Babu, 2020). Although the sector's total contribution to the country's GDP is about 3%, it constitutes roughly 20–25% of the overall export receipts, providing about two-thirds of the income of cocoa farmers as well as supporting the livelihoods of about 4 million farmers (Ghana Statistical Service, 2015). Furthermore, cocoa production has alleviated poverty significantly in the country for the past years. For instance, the incidence of poverty among cocoa farmers reduced from 64% in 1991 to 24% in 2006 in contrast to food crop farmers whose poverty incidence reduced from 68 to 46% over the same period (Ghana Statistical Service, 2007; Abbadi et al., 2019). However, the sector is faced with challenges such as insufficient farmable lands, lack of access to extension services, forest encroachment, lack of access to credit and quality farm inputs including fertilizers and seeds (Brobbey et al., 2020). In addition

* Corresponding author.
E-mail address: ata.frank@yahoo.com (F. Baffour-Ata).

https://doi.org/10.1016/j.envc.2021.100293
Received 15 June 2021; Received in revised form 19 September 2021; Accepted 19 September 2021

to that, climate variability has the capacity to substantially affect cocoa production in Ghana. Climate variability has huge consequences for the future of cocoa production and farmers' livelihoods. Hence, government, non-governmental organizations (NGOs) and private sector organizations are steadily investing in strengthening cocoa production levels as a result of the significant threats posed by climate variability.

To mitigate the impacts of climate variability on cocoa production in Ghana, there is the need to revitalize its production by enhancing farmers' adaptation practices. However, the fundamental precondition for adaptation to climate variability is perception (Oluwatusin, 2014). Perception is important because it allows farmers to initiate adaptation practices. To date, limited research has been conducted on the perceptions and adaptation practices of cocoa farmers on climate variability in Ghana (Codjoe et al., 2013; Ehiakpor et al., 2016; Denkyirah et al., 2017). For instance, Codjoe et al. (2013) concluded that cocoa farmers in the country are aware of the changing climate and its effects on their farming activities and as a result have adopted coping strategies including shade management strategy, land preparation strategy and pegging strategy in response to climate change. Also, Denkyirah et al. (2017) identified some adaptation practices (e.g. planting of improved varieties of crops, livelihood diversification, crop diversification etc.) used by cocoa farmers in minimizing climate change in the Brong Ahafo Region of Ghana. However, gender analysis of cocoa farmers' perceptions and adaptation practices to climate variability in Ghana has been relatively underexplored. There is therefore the need to explore cocoa farmers' perceptions and adaptation practices to climate variability through a gendered lens to offer policymakers opportunities to develop gender-responsive adaptation policies and interventions aimed at reducing both male and female cocoa farmers' vulnerabilities to climate variability.

Using empirical data from Asikuma-Odoben-Brakwa District in the Central Region of Ghana, the study sought to determine the perspectives and adaptation practices of male and female cocoa farmers on climate variability. Specifically, the study answers the following research questions: (i) Do male and female cocoa farmers perceive climate variability differently in the Asikuma-Odoben-Brakwa District? (ii) What is the extent of rainfall and temperature changes in the study district? and (iii) What are the adaptation practices used by male and female cocoa farmers in minimizing the impacts of climate variability in the study district?

2. Gender landscape and perception of climate variability in Ghana

In Ghana, despite supportive legal and policy frameworks, gender inequalities persist as a result of social and economic problems where gender norms and expectations have wide-reaching implications for community and public life across populations and sectors (Britt et al., 2020). Gender gaps exist with respect to financial access, ownership and control of economic resources (African Development Bank, 2019). Social norms opposing females' ownership limit their entitlement to agricultural land, despite females accounting for about 70% of the total agricultural value chain in Ghana (African Development Bank, 2019). While all these evidence suggest females are disadvantaged in access to and control over resources and decision making compared to males, females' power is increasing lately particularly in southern Ghana (Britt et al., 2020). For instance, survey results revealed that the proportion of poor female-headed households in urban and rural areas in northern Ghana rose between 1992 and 2006 but declined in both rural and urban areas in southern Ghana (Japan International Cooperation Agency, 2013; Britt et al., 2020). In addition, females' financial contributions and educational levels have increased in southern Ghana and hence, their positions in decision making have added weight (Britt et al., 2020).

Gendered perceptions of climate variability is critical to understanding and interpreting the disparate impacts of climate variability on male and female farmers due largely to their social construction of gender roles and relations (Ahmed et al., 2016). Furthermore, gender-based perceptions of climate variability will have weight on male and female farmers' decisions to implement adaptation practices thereby reducing their vulnerabilities to the threats of the changing climate (Ahmed et al., 2016). It was therefore hypothesized that male and female farmers would have different perceptions of climate variability based on control and use of resources (Vincent et al., 2010).

The different roles assumed by male and female farmers can affect their susceptibility and their adaptation practices to climate variability (Antwi-Agyei et al., 2017). However, there is a possibility that the most vulnerable groups are those women attached to male-headed households, taking women's limited decision-making power within the households and access to resources such as land and credit into consideration (Japan International Cooperation Agency, 2013). In addition to that, it is now recognized that climate change studies that treat household as a homogenous unit may fail to address the true nature of climate change issues within the household and hence, little gender disaggregated data on perceptions and adaptation practices might be provided (Findlay and Wright, 1996). This study compared perceptions and adaptation practices of male-and-female headed households because it provided headship available on access to resources such as credit and land. Furthermore, it was useful in quantifying vulnerability to climate variability by gender.

3. Materials and methods

3.1. Description of study area

The Central Region is one of the 16 administrative regions of Ghana. The region covers an area of 9826 km^2 making it the third smallest region after Greater Accra and Upper East regions (Ghana Statistical Service, 2013). The region is made up of 20 districts and out of these, Asikuma-Odoben-Brakwa District was purposively selected due to its intensive cocoa farming activities (Ghana Statistical Service, 2013). The district is found between latitude 5° 51″ and 5° 52″ North and longitude 1° 50″ and 1° 5″ West (Fig. 1) and has a total land area of 884.84 km^2 (Ghana Statistical Service, 2013). The district is found in the semi-equatorial climatic zone with monthly temperature ranging from 34 °C in March to about 26 °C in August (Ghana Statistical Service, 2013). The mean annual rainfall in the district ranges from 1200 mm in the South East to 2000 mm in the North West (Ghana Statistical Service, 2013). The district experiences double maxima rainfall which peaks in May, June, September and October. Forest and savannah type of soils are found in the district which are suitable for growing cash crops including cocoa, citrus, oil palm and staple food crops such as yam, cassava, rice, cocoyam, maize and vegetables. This explains why the major occupation in the district is agriculture employing 65% of the labor force (Ghana Statistical Service, 2013). Regarding ethnicity, the Akans form about 93.4% of the district's total population and the remaining 6.6% come from other ethnic groups of the country (Ghana Statistical Service, 2013). These include the Ewes, Gas, Krobos, Guans and other tribes from northern Ghana. The migrants in the district are mostly engaged in farming activities especially cocoa production (Ghana Statistical Service, 2013).

Though gender inequalities such as access to resources exist in the district, the females are more active in agricultural production than the males (Ghana Statistical Service, 2013). Hence, the females in the district play crucial roles in the maintenance and development of the communities. Three communities namely Breman Ayipey, Breman Kuntanase and Breman Baako (Fig. 1) were purposively selected for field data collection after consulting some of the Agricultural Extension Officers in the district. These communities were selected due to their intensive cocoa farming activities.

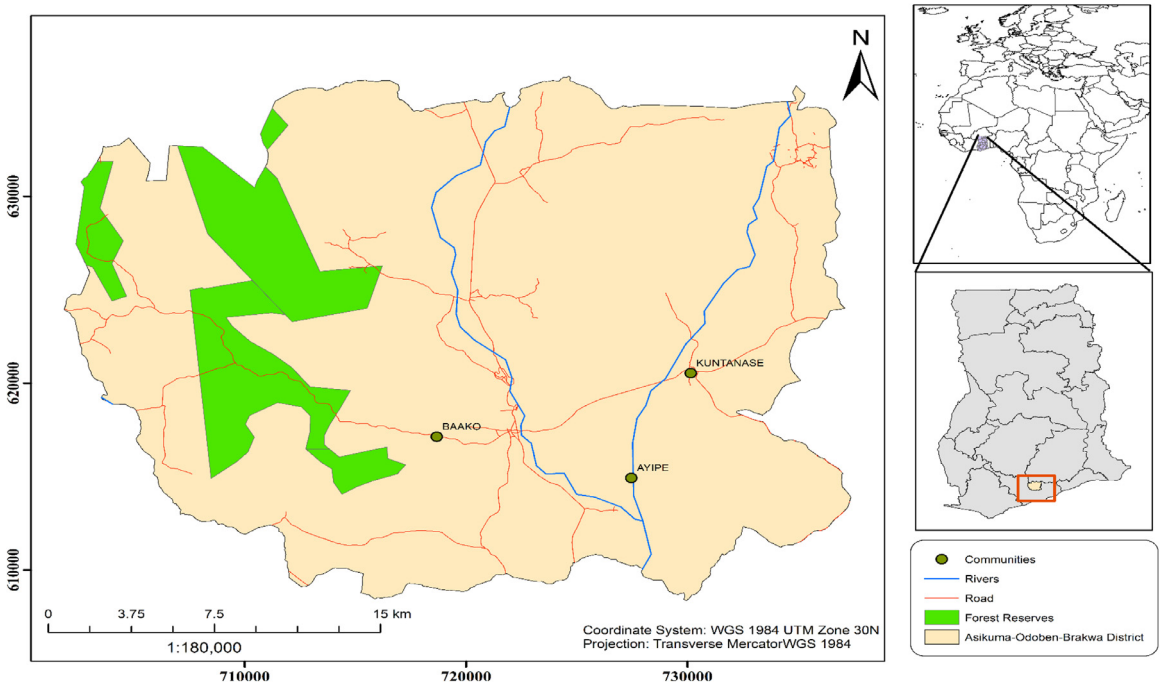

Fig. 1. Study district showing the study communities.

3.2. Data collection

The district's rainfall and temperature data for the period 2000 to 2015 were collected from Ghana Meteorological Agency (GMet). Field data was collected through household surveys and focus group discussions (FGDs). During the household surveys, a mixture of closed-ended and open-ended questions were used to explore farmers' socio-demographic characteristics, their perceptions on the changes in temperature, rainfall, windstorms and flooding as well as the key adaptation practices used to minimize the negative consequences of climate variability on their cocoa production. One hundred and fifty cocoa farming households were selected for the study using simple random sampling technique by the lottery method. The male or female head from each household was personally interviewed. The purpose of the study was briefly explained to the respondents and an informed consent was obtained. The interviews were conducted in March 2019 in their local language (Fante) with the assistance of Research Assistants recruited from each of the communities.

Three focus group discussions (one in each community) consisting of 10 participants (5 males and 5 females in each community) were conducted to generate gender specific information. The participants were chosen as a result of their farming experience and comprehensive knowledge of climate variability noticed during the household surveys. The discussions were audio-recorded after seeking their consent. Each discussion lasted for about an hour. Confidentiality of response was ensured for both the household surveys and FGDs.

3.3. Data analysis

The Mann-Kendall (MK) trend test was carried out to analyze the trend of rainfall and temperature in the district. The MK test is a non-parametric test to identify trends in time series data. An advantage of the test is that the data need not to conform to any particular distribution (Khambhammettu, 2005). The test statistically quantifies the significance of the trend whilst Sen's slope quantifies the magnitude of the trend. The procedure to compute the MK trend test has been documented in previous studies (Khambhammettu, 2005; Baffour-Ata et al., 2021a, 2021b) and we used it to evaluate temperature and rainfall trends in their sampled time series data. The variability in temperature and rainfall was assessed using coefficient of variation (CV). The procedure for calculating CV has been documented in previous studies (Panda and Sahu, 2019; Baffour-Ata et al., 2021a, 2021b).

Data collected from household surveys were analyzed using frequencies and percentages. Chi-square statistic was employed to test the relationships between gender and their perspectives on climate variability as well as the key adaptation practices used in the study communities to reduce the impacts of climate variability. The significance level (α) was set to 0.05 (95%). The formula for computing chi-square statistic is:

$$x_c^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad (1)$$

Where:

C = degree of freedom
O = observed value
E = expected value

With the help of Statistical Package for Social Sciences (SPSS) version 21, the chi-square statistic was computed. Data collected from the FGDs were assessed using thematic analysis where the data were closely examined to identify common themes (Braun and Clarke, 2019).

4. Results

4.1. Socio-demographic characteristics of respondents

Results showed that most of the respondents were males (n = 122; 81%) as opposed to the females (n = 28; 19%). In terms of age, majority of the females (n = 23; 82%) were within the age category of 41–60 years in contrast to the males (n = 65; 53%). With education, 85 of the respondents (57%) had attained primary education and the male population within this category constituted 59% (n = 72) whilst the females formed 46% (n = 13). Most of the males (n = 63; 52%) had above 20 years of farming experience relative to females where majority of them (n = 16; 57%) had 11–20 years of experience. Majority of the respondents (n = 79; 53%) rented the land for cocoa farming (Table 1).

Table 1
Socio-demographic characteristics of respondents.

Variables	Gender		
	Males(n = 122)	Females(n = 28)	All(n = 150)
Age (years)			
< 20	8 (6.6)	0 (0.0)	8 (5.3)
21 – 40	47 (38.5)	5 (17.9)	52 (34.7)
41 – 60	65 (53.3)	23 (82.1)	88 (58.7)
> 60	2 (1.6)	0 (0.0)	2 (1.3)
Education			
Non-formal education	41 (33.6)	15 (53.6)	56 (37.3)
Primary education	72 (59.0)	13 (46.4)	85 (56.7)
Secondary school education	9 (7.4)	0 (0.0)	9 (6.0)
Household size			
< 5 individuals	6 (4.9)	8 (28.6)	14 (9.3)
6–10 individuals	57 (46.7)	11 (39.3)	68 (45.3)
> 11 individuals	59 (48.4)	9 (32.1)	68 (45.3)
Farming experience (years)			
< 5	4 (3.3)	2 (7.1)	6 (4.0)
5 – 10	11 (9.0)	10 (35.7)	21 (14.0)
11 – 20	44 (36.1)	16 (57.1)	60 (40.0)
> 20	63 (51.6)	0 (0.0)	63 (42.0)
Land tenure system			
Inherited	38 (31.1)	10 (35.7)	48 (32.0)
Purchased	20 (16.4)	3 (10.7)	23 (15.3)
Rented	64 (52.5)	15 (53.6)	79 (52.7)
Access to extension services			
Yes	101 (82.8)	25 (89.3)	126 (84.0)
No	21 (17.2)	3 (10.7)	24 (16.0)

Numbers in and outside parentheses are percentages and respondent count, respectively.

Table 2
Perception of farmers on climate variability.

Variables	**Gender**				
	Males(n = 122)	Females(n = 28)	All(n = 150)	X^2	$p - value$
Receive more rain today compared to 15 years ago	109 (89.3)	23 (82.1)	132 (88.0)	1.118	0.290
Noticed changes in duration of rainfall compared to 15 years ago	117 (95.9)	26 (92.9)	143 (95.3)	0.474	0.491
Noticed rainfall season has become shorter	21 (17.2)	5 (17.9)	26 (17.3)	0.007	0.935
Compared with my childhood, the rains come earlier	119 (97.5)	28 (100.0)	147 (98.0)	0.703	0.402
There has been increase in windstorms over the past 15 years	116 (95.1)	28 (100.0)	144 (96.0)	1.434	0.231
Temperatures of the growing season have increased over the past 15 years	118 (96.7)	28 (100.0)	146 (97.3)	0.943	0.331
There has been increased incidence of flooding over the past 15 years	118 (96.7)	28 (100.0)	146 (97.3)	0.943	0.331

X^2 = Pearson Chi-square.
Numbers in and outside parentheses are percentages and respondent count, respectively.

4.2. Gendered perceptions of climate variability by smallholder cocoa farmers

Results indicated that there was no significant difference ($p > 0.05$) in both male and female farmers' perceptions of climate variability in the study communities (Table 2). They both observed changes in rainfall, temperature, windstorms and flooding. With regards to the amounts of rainfall, majority of the respondents (n = 132; 88%) reported receiving more rains presently compared to 15 years ago. In terms of the duration of rainfall, majority of both males and females (n = 143; 95%) noticed changes in the duration of rainfall presently compared to 15 years ago. Nonetheless, majority of all the respondents (n = 124; 83%) reported rainfall season to be longer nowadays as compared to 15 years ago. With temperature, most of the males and females (n = 146; 97%) reported an increase in temperature over the past 15 years. Furthermore, about 144 of both males and females representing 96% observed an increase in windstorms over the past 15 years. The variability in climate were also highlighted in the focus group discussions. For example:

> *"The heavy rains in my community have increased flooding over the past years and as a result sometimes prevent us from working. The floods often kill off flowers and small cocoa pods"* – (Male focus group participant, Breman Ayipey, March 2019)

> *"Temperature has been rising over the years. It is very hot these days and this reduces the water in the soil thereby killing our cocoa seedlings"* – (Female focus group participant, Breman Baako, March 2019).

4.3. Extent of rainfall and temperature changes in the study district

Results showed an inconsistent rainfall pattern in Asikuma-Odoben-Brakwa District from 2000 to 2015 with a variability of about 19% (Fig. 2A). The highest annual rainfall (1757.8 mm) was recorded in the year 2008 while the lowest annual rainfall (926.1 mm) was recorded in 2015. The positive magnitude of the Sen's slope indicates that amounts of rainfall had increased in the district over the study period although the trend was not significant ($p = 0.822$). On the other hand, the temperature variability in the district over the study period was about 1% with the highest annual temperature (34 °C) recorded in the year 2015 (Fig. 2B).

The p-value of 0.172 showed that temperature had increased in the district from 2000 to 2015.

4.4. Adaptation practices used by male and female cocoa farmers in the study district

Results indicated that both male and female cocoa farmers used a variety of adaptation practices to reduce the effects of climate variability.

Table 3
Farmers' adaptation practices.

Adaptation practices	Gender				
	Males(n = 122)	Females(n = 28)	All(n = 150)	X^2	$p-value$
Changing planting dates	51 (41.8)	25 (89.3)	76 (50.7)	6.679	**0.010**
Use of drought tolerant hybrids	109 (89.3)	21 (75.0)	130 (86.7)	4.055	**0.044**
Land fragmentation	88 (72.1)	18 (64.3)	106 (70.7)	0.676	0.411
Soil and water conservation practices (e.g. mulching, cover cropping etc.)	101 (82.8)	17 (60.7)	118 (78.7)	6.611	0.100
Shade management	111 (91.0)	19 (67.9)	130 (86.7)	10.540	**0.001**
Off-farm jobs (e.g. basket weaving, petty trading, tailoring, carpentry, masonry etc.)	109 (89.3)	22 (78.6)	131 (87.3)	2.389	0.122
Livestock rearing	101 (82.8)	4 (14.3)	105 (70.0)	50.887	**0.000**
Relying on family and friends	41 (33.6)	7 (25.0)	48 (32.0)	0.775	0.379
Income from sale of properties (e.g. sale of land and renting of shops)	80 (65.6)	4 (14.3)	84 (56.0)	24.312	**0.000**
Migration	9 (7.4)	2 (7.1)	11 (7.3)	0.002	0.966

X^2 = Pearson Chi-square.
Numbers in and outside parentheses are percentages and respondent count, respectively.

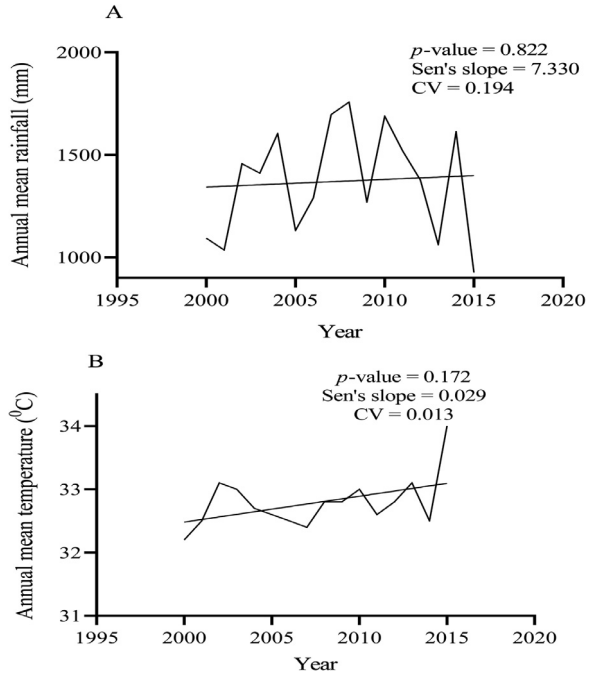

Fig. 2. Annual rainfall (A) and temperature (B) for the study district from 2010–2015.

However, gender significantly influenced some adaptation practices including changing of planting dates, the use of drought tolerant hybrids, shade management, livestock rearing and income from sale of properties ($p < 0.05$) (Table 3). Nonetheless, majority of both male and female farmers relied on off-farm jobs such as basket weaving, petty trading, tailoring, carpentry and masonry to adapt to climate variability. For instance, some farmers reported these in the focus group discussions.

"*When the farming season is over, I engage in myriad of trading activities such as sale of groceries, second-hand clothes and mobile network credits as a quick strategy to earn money*" – (Female focus group participant, Breman Kuntanase, March 2019)

"*Apart from the cocoa farming, I also depend on tailoring to get additional income to support my household members especially in this era of inconsistent rainfall patterns where it is difficult to rely solely on income generated from the farm*" – (Male focus group participant, Breman Ayipe, March 2019)

5. Discussion

Results showed that gender did not influence the farmers' perceptions of climate variability in the study communities (Table 2). The possible reason for this could be the similar socioeconomic characteristics shared between both male and female farmers in the study communities (Table 1). As climate variability affects both male and female cocoa farmers, it is anticipated that there may be no significant difference in their perceptions of the phenomenon (Partey et al., 2020). However, there may be differences in the scale and gravity of impact as a result of vulnerability differences (Partey et al., 2020). Despite the gender indifferences with perception of climate variability, majority of both male and female farmers perceived an increase in temperature, higher amounts of rainfall, changes in the duration of rainfall and longer rainfall season. These findings are consistent with previous studies (Ehiakpor et al., 2016; Denkyirah et al., 2017) conducted in other parts of Ghana. The higher amounts of rainfall perceived by the respondents could be the possible reason for perceived increased incidence of flooding in the study communities (Table 2). Erratic rainfall patterns, increased temperature, increased windstorms and increased flooding could have significant implications for cocoa production in the district. For instance, higher temperatures are mostly associated with water stress and dryness.

High temperatures are connected with reduced photosynthesis (Zuidema et al., 2005). High temperatures reduce the life expectancy of cocoa leaves, increase the rate of pod ripening thereby increasing the hardness of cocoa butter (Zuidema et al., 2005). Furthermore, variability in temperature increases mortality rates of cocoa seedlings which may adversely influence yields and reduce the size and quality of cocoa beans (Najihah et al., 2018). Increase in windstorms can collapse shade trees and cause substantial destruction to cocoa trees (Hutchins et al., 2015). The high vulnerability of cocoa leaves to strong winds is expected to result in reducing yields through lower light interception and higher plant stress (Bridgemohan and Mohammed, 2019). Additionally, increased windstorms accelerate the spread of cocoa diseases over long distances, particularly under low air humidity (Bridgemohan and Mohammed, 2019). Moreover, erratic and higher amounts of rainfall can trigger extreme events such as flooding which according to the respondents, had increased in the study communities. Floods hinder the capacity of cocoa farmers to manage their crops, enhance leaching of soil nutrients and alter the interaction between leaves, connecting tissues and absorbing roots (Bridgemohan and Mohammed, 2019).

Trend analysis of rainfall and temperature conformed to the perceptions of the farmers. The trend analysis showed no significant change in the trend of rainfall and temperature from 2000 to 2015 (Fig. 2). However, the positive magnitudes of Sen's slope indicated that there has been an increase in the amounts of rainfall and temperature has been rising in the study district over the study period. These observations have been

reported in previous studies in other parts of Ghana (Ameyaw et al., 2018; Asare-Nuamah and Botchway, 2019). The accurate observation of increasing amounts of rainfall and temperature in the study district highlights that the cocoa farmers precisely perceive changes in climate in terms of their cocoa production and tend to modify their farming practices appropriately (Niles and Mueller, 2016).

The farmers in the study communities have resorted to the use of adaptation strategies including changing planting dates, use of drought tolerant hybrids, land fragmentation, soil and water conservation practices etc. (Table 3) to reduce climate risks. Land fragmentation refers to farmers operating two or more geographically separated tracts of land, taking account of the distances between those parcels (Alemu et al., 2017). Dominant challenge connected with land fragmentation is the small size, irregular shape, and dispersion of parcels (Alemu et al., 2017). However, the farmers employed this as an adaptation practice because it allowed them to grow a variety of crops with different ripening time so that they could concentrate their labor at different plots at different time, thereby avoiding the period of labor intension and household labor bottlenecks (Todorova, 2005; Alemu et al., 2017). Majority of both male and female farmers relied on off-farm jobs such as basket weaving, petty trading, tailoring, carpentry and masonry to adapt to climate variability (Table 3). Off-farm jobs by cocoa farmers have been reported in previous studies (Onumah et al., 2014; Ali et al., 2018) as another strategy that cocoa farmers employ to reduce the impacts of climate risks on cocoa farming household income. Not only can off-farm income adjunct household income, it may also provide a more reliable stream of income than farm returns. In essence, off-farm income can offer a form of diversification. The least adaptation practice used by both male and female farmers in the study communities was migration (Table 3). This is not surprising because comparatively, it is farming households in northern Ghana that tend to migrate to the southern parts of the country because of the scarcity of fertile land, low crop yields and food security problems in the north (Van der Geest, 2011). Furthermore, it was revealed in the focus group discussions that the males in the study communities tend not to migrate because male migration often enhances the workload of the females, as they are usually left behind to manage the household in addition to usual tasks. This often leads to the increase in females' exposure to other risks, such as HIV infection and gender-based violence.

Gender played a key role in the use of adaptation practices such as changing planting dates, use of drought tolerant hybrids, shade management, livestock rearing and income from sale of properties in the study communities (Table 3). This is in line with a previous study conducted in north-eastern part of Ghana (Antwi-Agyei et al., 2021). For changing planting dates, majority of the female farmers employed this strategy as opposed to their male counterparts. This could be due to the fact that females are more vulnerable to climate variability than the males. Hence, they will have a high likelihood of adopting this adaptation practice as a necessary intervention to respond to inconsistent and late onset of rainfall. The use of drought tolerant hybrids has been described in previous studies (Atayese et al., 2012; Ofori et al., 2015) as an adaptation practice adopted by cocoa farmers to overcome the threat of seedling mortalities through prolonged dry season and incidence of diseases such as black pod. On gender specific difference, majority of the males used this adaptation practice as opposed to the females. This is in line with the findings of Wrigley-Asante et al. (2019) who reported that male farmers were adopting drought tolerant varieties of crops than their female counterparts. The possible reason that could be attributed to this is that male cocoa farmers particularly in Ghana tend to have the financial resources to purchase the drought tolerant hybrids from private sector companies.

Shade management was another adaptation practice used by the farmers to reduce water loss by the young cocoa plants during dry season. The shade trees also protect cocoa plants from heat stress and damaging winds (Carr and Lockwood, 2011). This practice has also been reported in previous studies (Graefe et al., 2017; Abdulai et al., 2018) in other parts of Ghana as a key adaptation practice employed by most cocoa farmers. However, most of the males used this practice as compared to the females and this could be attributed to the males possessing land and labor to implement this strategy. Adaptation practices which require little resources in terms of money and labor have a chance to engage large number of female farmers in Ghana. Consistent with a previous study by Yisehak (2008), livestock rearing and income from sale of properties were adaptation practices used mostly by the males as opposed to the females in the study communities (Table 3).

Livestock rearing serves as a form of agricultural diversification for most of the male farmers. This is because, the livestock species play very important economic and socio-cultural roles for the wellbeing of rural households, such as food supply, source of income, asset saving, source of employment, soil fertility, transport, agricultural traction and sustainable agricultural production (Bettencourt et al., 2015). Males are largely the decision makers for livestock production and are in charge of general herd management (Bettencourt et al., 2015). Males' ownership rights over animals are guaranteed by a near universal set of inheritance rules that are gender biased and rooted in religion and patriarchal kinship systems (Bettencourt et al., 2015). Females in general have less access to the means of production in comparison with the extent of their labor contribution (Bettencourt et al., 2015). Regarding income generated from sale of properties, the males in Ghana tend to own properties such as land, buildings and shops as compared to the females. While females' rights to own and inherit land are protected under law in Ghana, in reality their customary rights to properties especially land are insecure and they cannot practice land ownership.

6. Conclusions and policy implications

The effects of climate variability on cocoa production in Ghana is noticeable and documented. Cocoa farmers have perceived variability in climate and resorted to adaptation practices to minimize climate risks and enhance their adaptive capacity. Hence, a study on cocoa farmers' perceptions and adaptation practices to climate variability from gender perspectives remain significant especially at the household level. This study determined the perspectives and adaptation practices of male and female cocoa farmers to climate variability in the Asikuma-Odoben-Brakwa District in the Central Region of Ghana. Results showed that both male and female farmers perceived a variable but increasing trends in rainfall and temperature and increased incidence of windstorms and flooding in the study communities. Trend analysis results were consistent with the perceptions of the farmers. Findings also showed that both male and female farmers have used different adaptation practices to reduce the threats of climate variability. However, gender was crucial in the implementation of adaptation practices with majority of the female farmers employing changing of planting dates while most male farmers employed the use of drought tolerant hybrids, shade management, livestock rearing and generating income from sale of properties. Findings contribute to advancing knowledge in gender literature by highlighting that climate change adaptation practices among smallholder cocoa farmers is different among males and females as a result of different socioeconomic factors including labor, financial resources and land ownership. It is therefore suggested that policy makers formulate policies that incorporate gender perspectives into climate change adaptation practices among cocoa farmers. Cocoa farmers are also encouraged to diversify into off-farm jobs to help enhance their adaptive capacity to climate variability.

Funding

The authors received no external funding.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors are thankful to Ghana Meteorological Agency for providing rainfall and temperature data. The authors appreciate the contributions and warm reception of the people of Breman Ayipey, Breman Baako and Breman Kuntanase.

References

Abbadi, S., Senadza, B., Lieuw-Kie-Song, M., Abebe, H., 2019. Assessing the Employment Effects of Processing Cocoa in Ghana. International Labor Organization, Geneva, Switzerland.

Abdulai, I., Jassogne, L., Graefe, S., Asare, R., Van Asten, P., Läderach, P., Vaast, P., 2018. Characterization of cocoa production, income diversification and shade tree management along a climate gradient in Ghana. PLoS One 13, e0195777. doi:10.1371/journal.pone.0195777.

African Development Bank, 2019. Republic of Ghana country strategy paper (CSP) 2019-2023, (June), 82. https://www.afdb.org/ (Accessed 3 August 2021).

Ahmed, A., Lawson, E. T., Mensah, A., Gordon, C., Padgham, J, 2016. Adaptation to climate change or non-climatic stressors in semi-arid regions? Evidence of gender differentiation in three agrarian districts of Ghana. Environ. Dev. 20, 45–58. doi:10.1016/j.envdev.2016.08.002.

Alemu, G.T., Berhanie Ayele, Z., Abelieneh Berhanu, A., 2017. Effects of land fragmentation on productivity in Northwestern Ethiopia. Adv. Agric., 4509605 doi:10.1155/2017/4509605.

Ali, E.B., Awuni, J.A., Danso-Abbeam, G., 2018. Determinants of fertilizer adoption among smallholder cocoa farmers in the Western Region of Ghana. Cogent Food Agric. 4, 1538589. doi:10.1080/23311932.2018.1538589.

Ameyaw, L.K., Ettl, G.J., Leissle, K., Anim-Kwapong, G.J., 2018. Cocoa and climate change: insights from smallholder cocoa producers in ghana regarding challenges in implementing climate change mitigation strategies. Forests 9, 742. doi:10.3390/f9120742.

Antwi-Agyei, P., Amanor, A.K., Hogarh, J.N., Dougill, A.J., 2021. Predictors of access to and willingness to pay for climate information services in north-eastern Ghana: a gendered perspective. Environ. Dev. 37, 100580. doi:10.1016/j.envdev.2020.100580.

Antwi-Agyei, P., Quinn, C.H., Adiku, S.G.K, Codjoe, S.N.A, Dougill, A.J., Lamboll, R., Dovie, D.B.K., 2017. Perceived stressors of climate vulnerability across scales in the Savannah zone of Ghana: a participatory approach. Reg. Environ. Change 17, 213–227. doi:10.1007/s10113-016-0993-4.

Asare-Nuamah, P., Botchway, E., 2019. Understanding climate variability and change: analysis of temperature and rainfall across agroecological zones in Ghana. Heliyon 5, e02654. doi:10.1016/j.heliyon.2019.e02654.

Atayese, M.O., Olaiya, A.O., Adedeji, A.R., Hammed, L.A., 2012. Evaluation of the three cocoa varieties for drought tolerance in Nigeria. Niger J. Hortic. Sci. 17, 177–187.

Baffour-Ata, F., Antwi-Agyei, P., Apawu, G.O., Nkiaka, E., Amoah, E.A., Akorli, R., Antwi, K., 2021b. Using traditional agroecological knowledge to adapt to climate change and variability in the upper east region of Ghana. Environ. Chall., 100205 doi:10.1016/j.envc.2021.100205.

Baffour-Ata, F., Antwi-Agyei, P., Nkiaka, E., 2021a. Climate variability, land cover changes and livelihoods of communities on the fringes of Bobiri Forest Reserve, Ghana. Forests 12, 278. doi:10.3390/f12030278.

Bettencourt, E.M.V., Tilman, M., Narciso, V., Carvalho, M.L.D.S., Henriques, P.D.D.S., 2015. The livestock roles in the wellbeing of rural communities of Timor-Leste. Rev. Econ. Sociol. Rural 53, 63–80. doi:10.1590/1234-56781806-94790053s01005.

Braun, V., Clarke, V., 2019. Reflecting on reflexive thematic analysis. Qual. Res. Sport Exerc. Health 11, 589–597. doi:10.1080/2159676X.2019.1628806.

Bridgemohan, P., Mohammed, M., 2019. The ecophysiology of abiotic and biotic stress on the pollination and fertilization of cacao (Theobroma cacao L.; formerly Sterculiaceae family). In: Abiotic and Biotic Stress in Plants, 524. IntechOpen, pp. 141–157.

Brobbey, L.K., Agyei, F.K., Osei-Tutu, P., 2020. Drivers of cocoa encroachment into protected forests: the case of three forest reserves in Ghana. Int. For. Rev. 22, 425–437. doi:10.1505/146554820831255533.

Britt, C., Ivankovich, M., Essah, S., Fiscian, V., 2020. USAID/Ghana gender analysis report, (April), 1–114. https://banyanglobal.com/ (Accessed 3 August 2021).

Carr, M.K.V., Lockwood, G., 2011. The water relations and irrigation requirements of cocoa (Theobroma cacao L.): a review. Exp. Agric. 47, 653. doi:10.1017/S0014479711000421.

Codjoe, F.N.Y., Ocansey, C.K., Boateng, D.O., Ofori, J., 2013. Climate change awareness and coping strategies of cocoa farmers in rural Ghana. J. Biol. Agric. Healthc. 3, 19–29.

Denkyirah, E.K., Okoffo, E.D., Adu, D.T., Bosompem, O.A., 2017. What are the drivers of cocoa farmers' choice of climate change adaptation strategies in Ghana? Cogent Food Agric. 3, 1334296. doi:10.1080/23311932.2017.1334296.

Diao, X., Hazell, P., Kolavalli, S., Resnick, D., 2019. Ghana's Economic and Agricultural Transformation: Past performance and Future Prospects. Oxford University Press doi:10.1093/oso/9780198845348.001.0001.

Ehiakpor, D.S., Danso-Abbeam, G., Baah, J.E., 2016. Cocoa farmer's perception on climate variability and its effects on adaptation strategies in the Suaman district of western region, Ghana. Cogent Food Agric. 2, 1210557. doi:10.1080/23311932.2016.1210557.

Findlay, J., Wright, R.E., 1996. Gender, poverty and the intra-household distribution of resources. Rev. Income Wealth 42, 335–351. doi:10.1111/j.1475-4991.1996.tb00186.x.

Ghana Statistical Service, 2015 'Annual gross domestic product', https://www.statsghana.gov.gh/ (Accessed 1 May 2021).

Ghana Statistical Service, 2007. Pattern and trends of poverty in Ghana: 1991-2006, Ghana living standards survey round five (GLSS5), Accra, https://www2.statsghana.gov.gh/ (Accessed 1 May 2021).

Ghana Statistical Service, 2013. Central Region's Population and housing census. www.ghanastatisticalservice.com/ (Accessed 15 May 2021).

Graefe, S., Meyer-Sand, L.F., Chauvette, K., Abdulai, I., Jassogne, L., Vaast, P., Asare, R., 2017. Evaluating farmers' knowledge of shade trees in different cocoa agro-ecological zones in Ghana. Hum. Ecol. 45, 321–332. doi:10.1007/s10745-017-9899-0.

Hutchins, A., Tamargo, A., Bailey, C., Kim, Y., 2015. Assessment of climate change impacts on cocoa production and approaches to adaptation and mitigation: a contextual view of Ghana and costa rica. Int. Dev. Stud. 2015, 1–22.

Japan International Cooperation Agency, 2013. Country Gender Profile: Republic of Ghana: final report. https://www.jica.go.jp/ (Accessed on 3 August 2021).

Khambhammettu, P., 2005. Mann-Kendall Analysis For the Fort Ord Site. HydroGeoLogic, Inc., pp. 1–7.

Ministry of Food and Agriculture, 2016. Agriculture in Ghana: Facts and Figures, 1st Ed. Ministry of Food and Agriculture, Accra http://mofa.gov.gh/site/ (Accessed 29 April 2021).

Najihah, T.S., Ibrahim, M.H., Hadley, P., Daymond, A., 2018. The effect of different day and night temperatures on the growth and physiology of theobroma cacao under controlled environment condition. Annu. Res. Rev. Biol. 1–15. doi:10.9734/ARRB/2018/40413.

Niles, M.T., Mueller, N.D., 2016. Farmer perceptions of climate change: associations with observed temperature and precipitation trends, irrigation, and climate beliefs. Glob. Environ. Change 39, 133–142. doi:10.1016/j.gloenvcha.2016.05.002.

Ofori, Padi, Acheampong, Lowor, 2015. Genetic variation and relationship of traits related to drought tolerance in cocoa (Theobroma cacao L.) under shade and no-shade conditions in Ghana. Euphytica 201, 411–421. doi:10.1007/s10681-014-1228-8.

Oluwatusin, F.M., 2014. The perception of and adaptation to climate change among cocoa farm households in Ondo State, Nigeria. Acad. J. Interdiscip. Stud. 3, 147. doi:10.5901/ajis.2014.v3n1p147.

Onumah, J.A., Williams, P.A., Quaye, W., Akuffobea, M., Onumah, E.E., 2014. Smallholder cocoa farmers access to on/off-farm support services and its contribution to output in the eastern region of Ghana. AJARD 4, 484–495. doi:10.22004/ag.econ.198429.

Panda, A., Sahu, N., 2019. Trend analysis of seasonal rainfall and temperature pattern in Kalahandi, Bolangir and Koraput districts of Odisha, India. Atmos. Sci. Lett. 20, e932. doi:10.1002/asl.932.

Partey, S.T., Dakorah, A.D., Zougmoré, R.B., Ouédraogo, M., Nyasimi, M., Nikoi, G.K., Huyer, S., 2020. Gender and climate risk management: evidence of climate information use in Ghana. Clim. Change 158, 61–75. doi:10.1007/s10584-018-2239-6.

Roldan, M.B., Fromm, I., Aidoo, R., 2013. From producers to export markets: the case of the cocoa value chain in Ghana. J. Afr. Dev. 15, 121–138.

Todorova, A., 2005. Economic and social effects of land fragmentation on Bulgarian agriculture. J. Cent. Eur. Agric. 6, 555–562. doi:10.5513/jcea.v6i4.335.

Van der Geest, K., 2011. North-South migration in Ghana: what role for the environment? Int. Migr. 49, e69–e94. doi:10.1111/j.1468-2435.2010.00645.x.

Vincent, K., Wanjiru, L., Aubry, A., Mershon, A., Nyangdiga, C., Tracy, C., Banda, K., 2010. Gender, Climate Change and Community Based Adaptation, United Nations Development Programme. New York Google Scholar.

Wongnaa, C. A., Babu, S, 2020. Building resilience to shocks of climate change in Ghana's cocoa production and its effect on productivity and incomes. Technol. Soc. 62, 101288. doi:10.1016/j.techsoc.2020.101288.

Wrigley-Asante, C., Owusu, K., Egyir, I.S., Owiyo, T.M., 2019. Gender dimensions of climate change adaptation practices: the experiences of smallholder crop farmers in the transition zone of Ghana. Afr. Geogr. Rev. 38, 126–139. doi:10.1080/19376812.2017.1340168.

Yisehak, K., 2008. Gender responsibility in smallholder mixed crop–livestock production systems of Jimma zone, South West Ethiopia. Livest. Res. Rural Dev. 20, 12.

Zuidema, P.A., Leffelaar, P.A., Gerritsma, W., Mommer, L., Anten, N.P., 2005. A physiological production model for cocoa (Theobroma cacao): model presentation, validation and application. Agric. Syst. 84, 195–225. doi:10.1016/j.agsy.2004.06.015.