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Smallholder Farmers' Perception of Climate Change Resilience in the Bosome Freho District Assembly in the Ashanti Region, Ghana

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ABSTRACT

Climate change and resource depletion disproportionately affect smallholder farmers and the disadvantaged. For example, drought, storms, and floods strain the ecosystems they rely on for sustenance. The research evaluated smallholder farmers' perceptions of climate change and resilience in the Bosome Freho district. Descriptive surveys, questionnaires, focus group discussions (FGDs), and in-depth interviews were used in data collection and analysis. Respondents included 160 smallholder farmers, four Agricultural Extension Officers, and four Chief Farmers from the localities. According to the survey, most smallholder farmers are conscious of the effects of climatic change, such as low agricultural output, extreme weather events, rising temperatures, and pest and species invasion. The study discovered that the farmers' primary sources of climate change data are media (Television, Radio etc.), neighbours (older farmers), and Agriculture Extension Officers. The paper found that farmers' adaptation and resilience to the effects of climate change were generally high. Crop diversification, changing planting dates, changing crops, irrigation, planting short-season varieties, finding off-farm jobs, and reducing farm size are all effective adaptive tactics for most farmers. It is recommended that the Ghana Meteorological Agency provide climate-related information to the District Directorate of Agriculture. The Ministry of Food and Agriculture (MoFA) should sensitise smallholder farmers on specific climate-smart agricultural practices.

Keywords: *Smallholder farmers, Climate change, Resilience, Adaptations, Bosome Freho District*

INTRODUCTION

Climate change is a sustained shift in the meteorological parameter trends of a specific location or territory, as measured by the response of climate factors such as temperature, wind patterns, and rainfall, which causes changes in habitats and socioeconomic practices Intergovernmental Panel on Climate Change (IPCC, 2018). These alterations address doubts concerning agriculture's and agribusinesses' protracted vitality (Urama, 2011). The most severe ecological challenge to farmers currently is global warming. Temperature and precipitation patterns shift as the globe warms, and extreme events such as drought, floods, and bushfires become more pronounced (Yamba et al., 2023; Zoellick, 2009). Climate change has resulted in low and irregular outputs in agricultural and agribusiness sectors (UNFCCC, 2007). Changing climate and food production are worldwide systems that are inextricably linked (Parry et al., 2007). Temperature, precipitation, and glacial run-off are expected to adversely impact rising temperatures (Yamba et al., 2023; Funk et al., 2008; USEPA, 2022). These affect the biosphere's ability to provide enough sustenance for the world's people and farm animals. Rising Co_2 concentration would have undesirable and beneficial consequences on agricultural outputs (Malhi et al., 2021). Balancing these effects will determine the overarching implications of climate change on agriculture (Malhi et al., 2021; Fischer et al., 2002). Remarkably, climate change consequences are much more severe in African countries than in other regions (Urama & Ozor, 2011), owing to insufficient climate change feedback and adaptation strategy. According to studies, climate change will affect Africa's food production in terms of food security due to the prolonged drought, Widespread destruction of farms and homes by flooding, untimely unset and offset rains (Pearce et al., 1996; McCarthy et al., 2001; Dinar et al., 2008; FAO, 2017)

According to a survey conducted in 2021, over 690 million individuals, or 8.9% of the world's population, are chronically malnourished, which has risen by almost 60 million in five years (FAO, 2022). The food production crisis will only be alleviated when the globe generates approximately 70% more food by 2050 to satisfy roughly nine billion people (World Bank, 2021). Climate change is harmful because of rising global temperatures, heightened climatic volatility, altering agro ecological limits, invasion of species and parasites, and increased frequency of severe weather events (World Bank, 2021). Farmers' ability to recognise and respond positively to changes in climate and landscape is crucial for adopting and effectively adapting new ideas and farming practices and adapting to changes in their ecosystems. Most developing nations, including Ghana, face a barrier to long-term agricultural productivity because many farmers lack knowledge about the consequences of climate change on agricultural production (Tetteh et al., 2022).

Moreover, many biological systems are impacted by climate change, as evidenced by rising temperatures and shifting rainfall patterns (Intergovernmental Panel on Climate Change (IPCC), 2007). Countless extrapolations show that the consequences will aggravate if appropriate actions to address the issue are not taken early (Harbinson et al., 2006). Several adaptation and mitigation strategies abound, such as diversifying food sources and agricultural production techniques to reduce risk, adopting water management systems that minimise crop damage from floods or droughts, and implementing sustainable farming practices such as no-till agriculture, agroforestry, and cover crops (Lorenzoni et al., 2007). Those specific initiatives will be beneficial when they focus on the conceptions of all societal groups (World Bank, 2021). Thus, it is critical to gather popular sentiment, particularly from remote regions, when developing appropriate environmental legislation because public understanding will probably affect the accomplishment of problem-solving methodologies (Nerlich et al., 2010). Changing climate can harm the environment, subsistence farming, and food security in Ghana and most developing countries, with peasant farmers becoming particularly vulnerable since their income depends on biodiversity resources (Acquah & Onumah, 2011).

Nevertheless, it is sensitive to climate change because Ghana's agricultural production remains vulnerable to weather changes. Weather conditions in Ghana's ecological zones are increasing; these include rainfall and temperature regimes (Yamba et al., 2023), but weather systems are becoming less stable (Ministry of

Environment, Science and Technology [MEST], 2010). Climate change, for example, is expected to have drastic socioeconomic consequences for rural farmers in Ghana, whose living standards are primarily dependent on rainfall (Abeygunawardena et al., 2003; Fosu-Mensah Vlek & MacCarthy, 2012). Notwithstanding the negative consequences of climate change on Ghana's crop output, few are pursuing adaptation strategies (Addaney et al., 2021). The agricultural subsectors of crop and livestock production, fisheries, aquaculture, forestry and the management of land and water resources, and the various stages of food value chains all face specific challenges related to the three objectives of climate smart agriculture (CSA). Still, they are also closely interlinked (Matteoli, 2021).

Moreover, a significant proportion of agricultural actors are argued to have limited or no awareness of climate change because of their degree of awareness. Climate change knowledge, understanding, and people's perceptions are critical because they influence how participants react. Local producers' ability to respond to changing climatic patterns is inspired by their community's comprehension and perception of it. Notably, most researchers (Addaney et al., 2021; Antwi et al., 2022; Tetteh et al., 2022; Fosu-Mensah et al., 2012) concentrate on the country, regions, or individual towns of interest. As a result, this study examined local farmers' perceptions of climate change in the Bosome Freho district of Ghana's Ashanti region. The study explicitly explores farmers' perceptions and understanding of climate change, analyses of farmers' sources of information concerning climatic changes, investigates farmers' perceptions of the impact of climate change in the study area and evaluates farmers' adaptation and resilient strategies in the study area. This research will help researchers fill gaps in their knowledge and guide policymakers in ensuring climate change resilience and adaptation.

MATERIALS AND METHODS

Study area

Description: the Bosome Freho District is located in Ghana's rural rainforest ecosystem category, in the Ashanti Region's south-eastern portion. Figure 1 depicts the districts' geolocation along with their boundary. The municipalities of Bosomtwe and Ejisu-Juaben, in addition to Lake Bosomtwe, are to the north; Asante Akim South District is to the east; Adansi South District and Birim North District in the Eastern Region are to the south; and Bekwai Municipal and Adansi North District. The area covers 630 square kilometres of the Ashanti region's overall surface coverage of 24,389 square kilometres, accounting for approximately 2.6% of the total land size of the region (MOFA, n.d). The District is between latitudes $6^0$00'N and $6^0$26'N and longitudes $1^0$00’W and $1^0$30’W. The Agriculture District Directorate has split the territory into zones. Farming is handled in the District through designated zones and operational regions according to the portion of land, geography, and spread of towns and villages/communities. Four zones have been constituted with 16 operational areas: Asiwa, Tebeso, Nsuta, and Mmorontuo. Each zone is split into four operational zones. Officers are allocated to zones and operational regions in their cities, villages, and communities.

Geology: plains and undulating lands (hilly, rocky, and even lands) make up the terrain of the locality; the environment is mainly sloping, and specific elevations are less than 1% (MOFA, n.d). Even though particular relief has mild gradients, run-off from severe rains creates sheet and gully erosion. The undulating rocky uplands around Lake Bosomtwe, a natural inland water basin, can reach 200 to 400 meters (MOFA, n.d). Four major rivers and tributaries drain the area. The rivers are the

Pra in the north, Fre in the middle, Sunsu and Anuru in the south, and Lake Bosomtwe in the northeast. The Lake continues to have tremendous tourism and fishing prospects, which are progressively exploited to its strategic advantage.

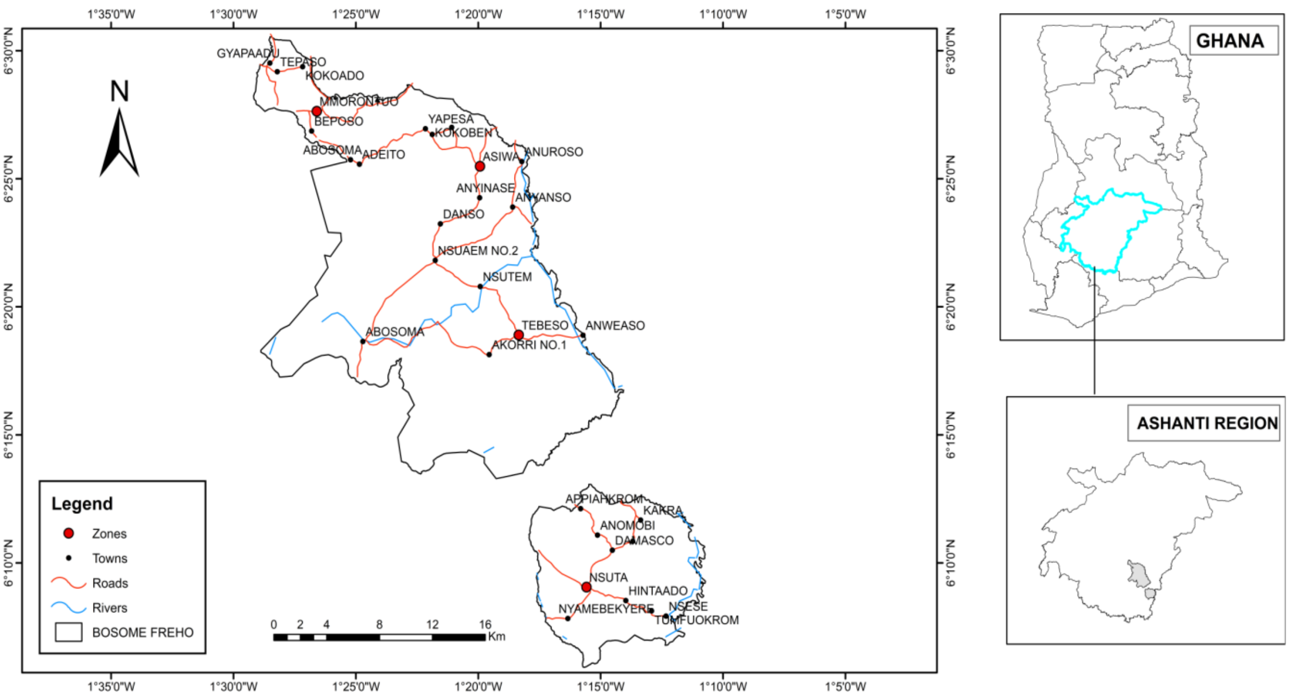

Figure 1: Map of the study area in the regional and national context

Source: Department of Geography Education, UEW (2022)

Soils and major crops: the District, located in Ghana's forest zone, has an ancient rock layer containing vast quantities of quartzite composed of granite and gneiss (MOFA, n.d). The soils of the district support cocoa, fruits (citrus, pineapple, and banana), cereals (maise and rice), legumes (cowpea and groundnuts), vegetables (cabbage, tomato, garden eggs, okro, and pepper), plantain, sugar cane, and other agricultural produce.

Climate: the neighbourhood is in Ghana's tropical and semi-arid climatic regions. During the dry season of December to February, it is predominantly impacted by the hot, arid, sandy northeast trade winds or Harmattan pouring from the Sahara desert. The average annual precipitation ranges from 1600mm to 800mm (MOFA, n.d). Rainfall can reach 2160mm annually, with an average of around 1960mm. Temperatures in August are relatively high and homogeneous, varying between 32^0C and 20^0C (MOFA, n.d). From January to December, temperatures can reach 34 degrees Celsius with infrequent sunshine (MOFA, n.d). The area is predominantly moist, with humidity between 90-98% at night and early mornings, even during wet seasons. It is moderate, ranging between 70 and 80% in the dry season and falling to 75% during the day (MOFA, n.d).

Data collection

A mixed method and survey design were employed to investigate smallholder farmers' views on climate change and resilience. A questionnaire survey (N = 160), focus group sessions (N = 4), in-depth interviews (N = 4), and field observation were utilised to acquire the essential information for the study. This was done to better understand the phenomenon under investigation so as to enhance data triangulation. The data was gathered from both primary and secondary sources. Primary data was sourced through interviews and questionnaires distributed to survey respondents in the field. Secondary sources included data from books, newspaper journal reports, internet sources, and other literature on the subject.

Sampling and sample size

The study's primary population includes farmers with at least ten (10) years of cropping experience in the research region. The research sample size was one hundred and sixty (160). Simple random and purposive sample approaches were utilised in this investigation. Considering the four zones of Asiwa, Tebeso, Nsuta, and Mmorontuo, which have 16 operational regions (MOFA, n.d). Each zone has four operational areas, and personnel were assigned to parts and functional regions based on the towns, villages, and communities in which they live. Ten (10) farmers were chosen randomly from the District's 16 operational zones, yielding a total sample of (160) respondents. These communities were selected because most residents are agrarian, as agriculture is the backbone of their livelihood and sustenance. A purposive sampling technique was used to determine the District, four (4) operational officers, and the four (4) chief farmers. Regarding gender balance, each community was assigned an equal number of male and female farmers, as shown in Table 1.

Table 1: Total number of respondents for the study

	Gender		Total
	Male	**Female**	
Asiwa	20	20	40
Tebeso	20	20	40
Nsuta	20	20	40
Mmrontuo	20	20	40
Total	**80**	**80**	**160**

Source: Fieldwork, (2022)

Data analysis

Quantitative information was analysed using descriptive statistical tools engrained in the Statistical Package for Social Sciences (SPSS) v.23 for Windows applications, such as cross-tabulation and frequencies. This procedure readily recounted distinct variables explicitly in the distribution of attributes it consists of (Babbie, 2007). The qualitative information gleaned from the in-depth and focus group discussions was coded and transcribed. The transcribed data set was organised into narratives to represent the main research objectives and questions. Interview data provided additional relevant information and rationalisations to the analytical survey results.

RESULTS AND DISCUSSION

Socio-demographics of respondents

This segment presents the bio-demographic characteristics of respondents, such as gender, educational attainment, and length of time in agriculture.

In Table 2, the 40-49 age cohort makes up the highest number of respondents, with 57 (35.6%) of overall samples, followed by people over 50 and above. On the other hand, the lowest group of respondents ranged in age from 21 to 30 years. This shows that most farmers are old and susceptible to climate change. The older farmers could not abandon farming because it was their primary source of income. Nonetheless, a few enthusiastic young farmers may be capable of overcoming the difficulties of their professions in a climate change-driven world.

Table 2: Socio-demographic background of respondents

The ages of the respondents	Freq.	Per. (%)
20-29	20	12.5
30-39	29	18.1
40-49	57	35.6
50+	54	33.8
Total	**160**	**100**

Years of farming experience	Frequency	Percentage (%)
Less than 10 years	10	6.0
11-20 years	55	34.6
Above 20 years	95	59.4
Total	160	100

Source: Fieldwork, (2022)

The respondent's years of farming experience were categorised into three groups; below ten years, 11-20 years, and above 20 years. The data analysed indicate that, out of the total number of 160 respondents, 10(6.0 %) were between 1-10 years, 55(34.6%) were between 11-20 years, and 95(59.4 %) were above 20 years of farming experience. The research found that most survey participants had worked in agriculture for more than 20 years, suggesting they may have more knowledge and experience in the climate change context. The available information may also improve their perception of global warming.

Education is essential in inspiring people to transition to a more environmentally friendly future. The world can see more effective and faster change by enhancing the standard and accessibility of education and continuing to develop awareness levels, attitudes, and behaviours toward climate change. The significant proportion, 76 (95%) of the farmers in Table 3 below, had some official education, while 4 (5%) did not, and 55 (68.75%) of the female respondents also had academic training. The remaining 25 (31.25%) had no formal education. The data also shows that many respondents had some minimum educational background, with most female respondents having to truncate school at the primary level.

In contrast, the male respondents did not drop out of high school compared to their female counterparts. Table 3 shows that men in the research region have more academic training than women, suggesting they may have better perceptions and understandings of climate science. According to a joint study conducted by the Ghana Statistical Service (GSS), Noguchi Memorial Institute for Medical Research (NMIMR), and ORC Macros (2004), females lag behind boys in academic achievement. Once more, the educational attainment of smallholder farmers was discovered to be crucial in terms of its connection to landowners' perceptions of climatic changes. Farmers with more advanced education know and recognise climate variability (Alidu et al., 2022).

Table 3: Cross-tabulation between the level of education and gender

Level of Education	Gender			
	Male		Female	
	Freq,	%	Freq	%
None	4	2.5	25	15.6
Primary	28	17.5	34	21.2
JHS	34	21.2	16	10
SHS	10	6.3	5	3.2
Tertiary	4	2.5	0	0
Total	80	100	80	100

Source: Fieldwork (2022)

Perception of smallholder farmers about some climatic variables

The study investigated respondents' knowledge of rainfall and temperature changes in the field survey. It was performed to elicit the farmers' depth of knowledge on the subject under investigation. The findings revealed that 154 (96%) farmers perceived climate change as a significant shift, while 6 (4%) did not. Most (150) of the 154 farmers who perceived climate change said they noticed the changes more than 20 years ago, while the least (4) saw the changes less than ten years ago. This observation is similar to the findings of Nhemachena and Hassan (2007), who found that most African farmers have become concerned about increasing surface temperatures and varying rainfall patterns for growing crops. Such views were equally expressed at the recent climate conference in Egypt, the 27th Conference of Parties (COP 27). The smallholder farmers in Bosome Freho hold the same opinion as said above concerning the incidence of temperature increases and reduction in rainfall. The ideas espoused by the farmers have called for diversification and adaptation of approaches to ensure sustenance and resilience.

A 46-year-old farmer at Asiwa, when asked whether he has noticed any changes in the climate, said;

"*Yes, the early morning rains that used to come around October and moisture in our crops no longer come. Conversely, the blistering sunlight heats the few plants that experience difficulties sprouting, and you often see parched leaves chucking off crops," says one farmer.*

There was evidence that respondents observed variations in temperature and precipitation patterns.

The outcomes of this research are comparable to the results of Gbetibouo, (2009) and Alidu et.al, (2022); according to his findings, most farmers, reflecting 94% of the total participants, agreed that temperatures are rising, while a few, approximately 6%, observed a reduction in temperature.

Table 4: Perception of smallholder farmers about some climatic variables

Items	Change in temperature		Changes in precipitation	
	Freq.	**Per.**	**Freq.**	**Per.**
Agree increase	154	96	6	3.75
Disagree decrease	6	4	130	81.25
Undecided (irregular)	0	0	24	15
Total	160	100	160	100

Source: Fieldwork (2022)

Concerning changes in precipitation, the study revealed 130(81.25%) perceived a decrease in rainfall pattern, 6 (3.75%) perceived an increase in rainfall, 20 (12.5%) perceived an irregular rainfall pattern and 4(2.5%) farmers undecided with change in rainfall pattern. Even though some farmers expressed negative opinions about the characteristics of previous rainfall patterns, a substantial percentage also stated that the last rain had a high consistency. They made a point that the rain was ideal for agricultural production, according to an old farmer from Nsuta, 68 years of age.

"the primary rainy season, which used to come from May to August, and the minor wet seasons that usually arise from September to November, have altered now; they no longer come at these correct times ".

Most survey participants who could not forecast when the rains would arrive next commented that the commencement of planting seasons was erratic. The unpredictability of the rains has a severe influence on their livelihood. Some respondents also pointed out that rainfall is not as intense as it was some decades back. These findings are congruent with those made previously by Dhaka et al. (2010) and Sofoluwe et al. (2011), who highlighted a decline in rainfall and changes in rain timing.

In terms of temperature changes, the majority of farmers, 154(96.3%), felt temperature extremes (thus increasing temperature), while 2(1.2%) perceived no change in temperature and 4(2.5%) perceived an irregular pattern of temperature. Most respondents saw climate change as a prolonged temperature increase resulting from intense heat in the atmosphere or their environment. These findings are consistent with Fosu-Mensah et al. (2010), who found an upsurge in heat while measuring the reliability of farm owners' impressions in Ejura.

Perceived impacts of climate change on indigenous livelihoods-farming practices

Climate change impact on indigenous agricultural techniques is shown in Table 4, as 36(22.5) of the study participants reported a decrease in crop yields; while 32(20.0) reported a temperature rise. Another 28 (17.5%) reported an invasion of crops and pests on their farmlands. Weather variability and extreme weather events were also documented (10.6 and 10%, respectively). Others also reported lowering livestock productivity and shifting agroecosystem boundaries as some of the consequences of changing climate. The findings support the World Bank's (2021) assertion that agriculture's intense frailty exacerbates the threat of climate change-related problems. The detrimental repercussions of changing climate include rising global temperatures, increased weather unpredictability, altered agricultural systems, invasion of exotic species, and more recurrent severe weather. The scenario above conforms to (Dethier & Effenberger, 2012) who stated that climatic variability impedes developing economies, such as Africa, where agriculture employs 55% of the total working population.

Table 5: Perceived impacts of climate change on indigenous livelihoods-farming practices

Variables	Freq.	Per.	Mean	SD
Increasing temperatures	32	20	20.0	10.65
weather variability	16	10		
Shifting agroecosystem boundaries	7	4.38		
Invasive crops and pests	28	17.5		
Extreme weather events	17	10.63		
Reducing crop yields	36	22.5		
Reduction in the nutritional quality of major cereals	10	6.25		
Lowering livestock productivity	14	8.75		
Total	160	100		

Source: Fieldwork, (2022)

During Focus Group Discussion (FGD), one of the farmers from Mmrontuo revealed that;

"According to him, the years with the highest temperatures were 2016 and 2017. During those years, the sun (temperature) was so hot that it destroyed or burned all of his farm's food crops and cocoa".

Another farmer also reported that;

"The uncertain rain trend causes severe crop failure and makes the process more complicated for people. The flood events have primarily impacted root crops such as cassava and yam. Depending on the severity of the flood, a farmer may lose the total yield or its quality ".

The farmers also acknowledged that;

"These increasing temperature conditions give them little time to accomplish their agricultural operations.

The discussion with the extension officers and other farmers illustrates a typical perspective. Farmers commonly believed that rainfall is unpredictable and infrequent and that the modification sequence is natural. As stated by Mmrontuo, the chief farmer:

"The transition between dry and wet seasons is shifting and uncertain. The rainy season, known as 'Nsutobre,' usually starts in May and ends in March, but this year is different. For example, in the year (2020), we had continuous rain from November to February 2021 and a pleasant temperature. These factors alter planting patterns and influence rain period."

In terms of frequency and intensity, this disrupted rainfall decreased agricultural output, leaving farmers impoverished and with insufficient food. As a result, farmers struggle to rely on substantial rains and blame precipitation and temperature fluctuations for yield loss (Clarke et al., 2022, Kyei-Mensah et al., 2019). All climate change's effects on agricultural activities result in lower yields, low income and poor living conditions. The comments in response of all farmers surveyed demonstrated that financial stress and a poor quality of life are the consequence of all the impacts they face.

Smallholder farmers' source of information about climate change

Figure 2 shows that mass media (Radio, Television, Newspaper, Telephone, etc.) was the most common source of knowledge, with 78% (124) of respondents citing it as the source from which they learned about the effects of climate change. Another 16% (26) of respondents heard it from their neighbours, while 6% (10) had heard it from the Agriculture Extension officer in their community. The mass media is the highest source due to the proliferation of Radio and other digital television stations; as a result, they use Radio as a medium for obtaining essential details related to their livelihoods and daily lives. Those with access to electricity used radios, televisions, and cell phones. Agriculture Extension Officers in their command and control regions were expected to convey climate and weather data to their farmers; however, extension officers provided farmers with meteorological and climate advice, accounting for only 6% of respondents.

These outcomes agreed with the research commissioned by Jha and Gupta (2021), who stated that the media is a significant and well-known source of information about climate change and farmer resilience. This posits that the media is a viable means for educating farmers about climate adaptation. According to Antwi et al. (2022), radio, television, and advice from agricultural officers are the principal data sources. Yohanna et al. (2014) unearthed that among survey participants, friends, relatives, and colleagues, farm owners constituted the most common forms of climate change news, which opposes the present study and others. According to Junsheng et al. (2019), the mass media has influenced knowledge, beliefs, and understanding of environmental issues and is the primary source of information for farm households. Widiyanti et al. (2020) found that the primary sources of data employed by agriculturalists were friends or neighbours (N-84), farmer associations (N-65), and mass media (N-49). According to the findings, farmers obtain information on climate change and environmentally sustainable agriculture more consciously from neighbours, friends, and farmer organisations than from mass media, contrary to what other studies have shown. It could be due to the unavailability of social media as a mode of information in the study area. It also suggests that using multiple approaches to educate farmers will be helpful.

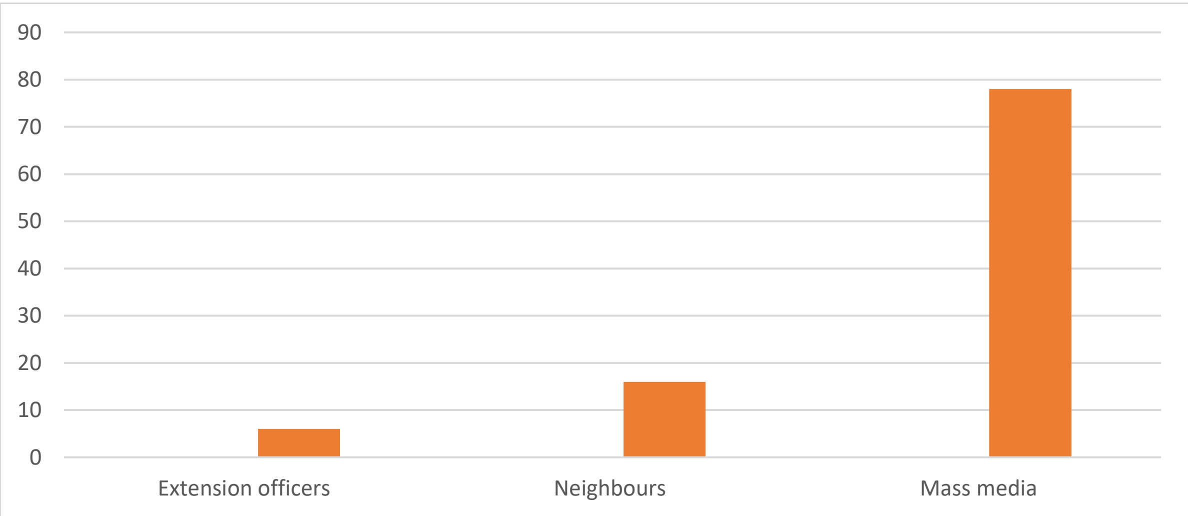

Figure 2: Sources of information to smallholder farmers
Source: Fieldwork, (2022)

The focus groups provided insight into why older farmers could be a data source. According to one Tebeso respondent:

"Our older farmers never had formal education but are more knowledgeable on issues of changing climate than some of us with formal training. I'm not sure how they do it, but they can look into the sky and anticipate if the weather will be good for farming that day. If the report is pleasant, anyone farming will work hard and bring back a bountiful harvest. If, on the other hand, the report is negative and you do not follow their advice, you will be solely responsible."

The above signifies that some older farmers who have never attended a school could accurately predict the weather more effectively than those who have. Indigenous knowledge systems continue to gain policy focus as vehicles for effective climate adaptation. Moreover, as older people often hold such knowledge, it is important to document it and encourage older people to share it with the younger generation, so they are not lost. These could assist them in combating climate change constructively. These outcomes agree with the results of Harvey et al. (2012), who reported that citizens could act when they understand climate change and its ramifications for their livelihoods. It will assist with identifying problems, raising awareness, encouraging dialogue, and influencing behavioural change. In the same vein, understanding farmers' views on changing climate is crucial in alleviating the negative consequences of global warming (Acquah et al., 2019). It aids agricultural policy outcomes and defines modifications in responding well to the implications of climate change (Damodar & Nibal, 2020; Tambo & Abdoulaye, 2013). Evaluating farmers' perspectives on climate change provides insights that can influence public policy and address problems with sustainable farming (Arunrat et al., 2018).

Adaptations or adjustments to climate change

Survey participants were queried whether they had made any adjustments to their farming techniques due to the changing climate. Regarding this, 92% (147) of respondents said they had adopted a new approach to their day-to-day agricultural operations due to changing weather patterns. Despite their perception of changing climatic conditions, 8% (13) had not taken any action to lessen the negative consequences of climate change on their farmlands. These farmers (8%) attributed the destructive effects of climatic modification to God and minor gods. Thus, they believe in sanctity and spirituality as the driving mechanisms for climate change. Therefore, they think prayers, rituals and changes in people's negative attitudes are the ultimate solutions to climate change. These outcomes confirm the results of Akponikpè et al. (2010), who opined that people seek the opinions of religious institutions, mosques, and rainmakers; prayers are executed to engage with prolonged droughts, one of the climatic parameters. This opines that faith-based organisations can be vital stakeholders in climate adaptation education.

Climate change adaptation and indigenous resilient strategies

The paper recognised three important climate-resilient and environmentally sustainable approaches among the four agricultural zones in the District. The resilient system is around soil conservation and management, organic or sustainable farming and maintaining local agro-biodiversity. This portion of the paper describes the method in depth. The central climate variation adaptation and resilient strategies identified by smallholder farmers include changing planting dates, crop diversification, irrigation, reduction in land size, shifting crops, engaging in off-farm jobs, and planting new plant varieties. According to the findings in Table 6, the majority of smallholder farmers, 42 (26.25%), have adapted to changing planting dates as their primary adaptation measure, and 23(14.375%) are adopting mixed cropping or crop diversification as a resilient measure against climate change. Another important resilient strategy was the application of indigenous farming methods (thus planting short-season crops and dry weather-resistant crops) recorded by 26 (16.25) respondents. Off-farm jobs and reducing the size of the farm accounted for (8.125 and 7.5%) bio-conservation, usage of weather forecasting, soil conservation and management as well as irrigation were also mentioned as strategies. Improving smallholders' climate resilience, according to Thompson et al. (2022), is critical not only for their health (incomes, food security, and livelihoods). Climate resilience may help to mitigate the severity of environmental stress on the growing economy by strengthening supply stability and discouraging farmers from exploring new agricultural lands. The data corroborate that producers have used resilient mechanisms to adjust to shifting environmental conditions. The smallholder farmers interviewed agreed that increased competition for new types of crops was a measurable influence of reacting to changes in the climate. According to the farmers, the new strains progressed faster than deep-rooted varieties. The early maturation of the current varieties allowed the plants to escape severe drought. Some farmers also reported that they engage in hunting, fishing, gathering and selling firewood and other trading activities such as buying and selling. These developments have enabled participants to earn money to buy food and survive harsh weather conditions. The results also show that if farm owners respond vigorously to climatic fluctuations, the national government may be able to minimise the effect of changing climate on them to a bare minimum.

Table 6: Climate change adaptation and indigenous resilient strategies

Indigenous resilient agricultural practices	Freq	Per	Mean	SD
Off-farm jobs	13	8.125	17.78	10.95
Bio conservation	11	6.88		
Usage of weather forecasting	8	5		
Changing planting dates	42	26.25		
Mixed cropping of crop diversification	23	14.38		
Soils conservation and management	16	10		
Reduce farm size	12	7.5		
Irrigation	9	5.63		
Indigenous methods of farming (planting short-season crops)	26	16.25		
Total	160	100		

Source: Fieldwork, (2022)

Thompson et al. (2022) discussed the sustainability certificate as a major resilient climate change mechanism. According to them, sustainability certifications (independent ethical and environmental criteria implemented at the farm, factory, or cooperative level that third parties assess) have emerged as an influential component in enhancing the climate resilience of smallholder farmers. This was not observed among the District's smallholder farmers, who typically use properly installed to mitigate the consequences of climate transformation. Thompson et al. (2022)

advocate that sustainability certification be viewed as a component of a legislative framework that encourages agronomic systems instead of focusing on mostly a single asset. He expands on widening collaborative efforts between accreditation bodies, the formal and informal parts of the economy, and other stakeholders to bridge gaps in adjustment mechanisms.

CONCLUSIONS AND RECOMMENDATIONS

Based on the survey's main insights, the following conclusions have been drawn: the paper advocates for climate-innovative agricultural practices, with an interconnected method to overseeing lands, crops, livestock, plantations, and fish stocks, to resolve the interrelated agricultural production and climate change concerns. Significant proportion of smallholder farmers perceived rising temperatures and decreased precipitation as the climatic variables that are rapidly changing. The media, neighbours, and agriculture extension officers are the principal sources of information for local farmers about weather and climate change. As per smallholder farmers, climate change is causing rising temperatures, increased weather uncertainty, altering agro ecological borders, exotic crops and parasites, and more recurrent weather extremes. As primary adaptation measures to climate change impact, these initiatives encompass: changing planting dates, crop diversification, irrigation, decreasing farm size, altering crops, finding off-farm jobs, and developing brief-crop varieties. To ensure that smallholder farmers can maintain their livelihoods while adapting to changing climate scenarios. The government must make deliberate efforts to build the capacities of smallholder farmers to be absorptive, adaptive, and transformative, all of these critical contributors to resilience endeavours. To improve adequate information on climate change in the Bosome Freho District, the Ghana Meteorological Agency should be stimulated to continue providing information on climate-related issues through the District Directorate of Agriculture. Farmers should receive financial assistance from banks and microfinance institutions because it improves adaptation to climate change.

Competing interest

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