__Original Research Article__

Understanding Agriculturists' Perception and Adaptation to the Current Climate Patterns in Jaman South Municipality, Ghana

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ABSTRACT

This paper examines agriculturists' perception and adaptation to climate change in Jaman South Municipality of Ghana, utilizing a mixed research approach. The study engaged 150 farmers from five farming communities, alongside 10 local agricultural extension officers. Data were collected through questionnaires and structured interviews administered via face-to-face interactions. The data underwent analysis involving calculations of frequencies, percentages, means, standard deviations, and utilization of the probit regression model. Respondents identified significant changes in rainfall patterns, including shortened planting seasons, reduced rainfall amounts, extreme dry spells, heavy rainfall, erratic patterns, and shifts in onset and cessation. Temperature changes were also reported, with increased daytime and nighttime temperatures. These changes were perceived to have adversely affected crop production in the study area. To this effect, farmers have employed diverse adaptation strategies, such as crop diversification, cover cropping, mulching, crop rotation, composting and use of organic fertilizers, adjusting planting time, land rotation, and use of drought-tolerant crop varieties to tackle these climatic changes. Age, level of education, engagement with extension services, and farmers' experience in farming emerged as the most influential factors for predicting the selection of strategies to adapt to climate change. This study contributes insights to policymakers and practitioners striving to bolster adaptive capacity in the face of climate change.

Keywords: *Adaptation strategies; Climate Change; Climate Variability; Farmers; Jaman South Municipality*

1. INTRODUCTION

According to the latest findings from the IPCC, the Earth's temperature has already risen by more than 1°C compared to pre-industrial levels. If current patterns continue, it is anticipated that this increase could surpass 1.5°C sometime between 2030 and 2050 (IPCC, 2021; Teshome et al., 2022). The 2007 IPCC Regional Climate Projection report highlights that African mean temperatures could rise by 1.5°C to 3.0°C by 2050, with the region facing intensified warming compared to others (Awojobi & Tetteh, 2017; IPCC, 2007). Observable climate changes are evident across Africa, characterized by higher temperatures, shifting rainfall patterns, and increased unpredictability. Notably, the region experiencing the most rapid warming is sub-Saharan Africa. (USAID, 2018). In scenarios where global warming reaches 1.5°C and 2.0°C, sub-Saharan Africa could potentially face delayed onset of rainfall and reduced duration of rainy seasons (Holleman et al., 2020). This volatility in climate will significantly impact agriculture and food security (Gladys, 2017; Mbow et al., 2019; Müller-Kuckelberg, 2012), an area of concern given the sector's substantial contribution to GDP, raw materials, and employment in many developing countries (Nahanga & Bečvářová, 2015). African countries' vulnerability to climate change is worsened by their dependence on rain-fed agriculture and their limited ability to adapt (Baffour-Ata et al., 2021; Cudjoe et al., 2021).

Agriculture is acknowledged as a significant economic sector in Africa, providing livelihoods for approximately 60% of the continent's population and contributing to about 50% of the Gross Domestic Product (GDP) in the majority of countries (Nahanga & Bečvářová, 2015). Agriculture productivity in the African region is dependent on the region's low and highly unpredictable rain, making it extremely vulnerable to climatic changes. Since the 1970s, extreme climatic events have contributed to agricultural losses and recurring food crises in the African region (USAID, 2018). Crop yields in the region have been projected to fall by 10% to 29% in 2050 or up to 50% because of climatic variations (Jones & Thornton, 2015). The livelihoods of farmers in the region are being directly impacted by climate change, leading to significant challenges in achieving the Sustainable Development Goals (SDGs), particularly those focused on eliminating poverty and addressing hunger. (Baffour-Ata et al., 2021; Calzadilla, 2021; Holleman et al., 2020). If effective climate mitigation and development measures are not implemented before 2050, it is projected that a significant portion of the population in Sub-Saharan Africa, particularly in Ghana, could be pushed into poverty due to the impacts of climate change (Jafino et al., 2020).

Agriculture is a dominant sector of Ghana's economy. Approximately 80% of the people in Ghana are involved in agriculture, including both formal and informal employment (Cudjoe et al., 2021). Roughly 20% of the Gross Domestic Product (GDP) and around half of the earnings from exports are attributed to the agricultural sector (Akanni et al., 2020; Essegbey & Maccarthy, 2020). The negative impacts of climate change on Ghana's agricultural sector are readily apparent. The country has been facing pronounced climate fluctuations including changes in rainfall patterns in terms of amount and timing, unexpected floods, higher temperatures, increased prevalence of crop pests and diseases, extended periods of dry spells, soil degradation and intensified winds (Arndt et al., 2015; Asante & Amuakwa-Mensah, 2015; Baffour-Ata et al., 2021). Climate change is expected to lead to reduced production of Ghana's primary staple crops. The country is projected to experience complete crop failure approximately every five years due to prolonged periods of drought and decreased rainfall (World Bank Working Group, 2021). Due to increased climate variability, Ghana's agricultural GDP is projected to decrease by 0.8% to 2.5% in 2035 (Arndt et al., 2015). Averting the challenge of climate change requires that farmers employ climate adaptation strategies to reduce their vulnerability to the negative consequences associated with these variabilities (Wood et al., 2014). The initial step in adapting to climate change for farmers involves acknowledging the shift in climatic conditions before determining necessary modifications to their practices (Fadina & Barjolle, 2018; Wood et al., 2014).

Several pieces of literature describe the ways farmers perceive climate change, including those of Amjath-Babu et al. (2017) in South Asia and South America, Fadina & Barjolle (2018) in Benin, Belay et al. (2017) in Central Rift Valley of Ethiopia, Nwaobiala & Nottidge (2014) in the Abia State of Nigeria, Mngumi (2016) in Mwanga district in northern Tanzania, Toukal Assoumana et al. (2016) in Niger, Asayehegn et al. (2017) in Kenya, Atube et al., (2021) in Uganda, and Noufé et al. (2015) in Comoe River basin in Ivory Coast. These studies collectively indicate that farmers have observed notable shifts and alterations in climate and weather patterns. Key perceptions encompass a decrease in the duration of the rainy season, unpredictability regarding the onset and cessation of rainfall, a decline in annual rainfall amounts, rising temperatures, extended periods of dryness, and intense droughts. Similar investigations into farmers' climate change perceptions have also been conducted in Ghana, as exemplified by the work of Mwinkom et al. (2021) in the Black Volta Basin in Upper West region, Mabe et al. (2014) in Northern Region, Adu et al. (2019) in Brong Ahafo Region, Sadiq et al. (2019) in Eastern Region, Fosu-Mensah et al. (2012) in Sekyedumase district, and Anning et al. (2022) in Adansi South District. The findings from these earlier investigations revealed that how farmers perceive climate change and enact adaptation approaches display variability at both the community and individual levels. This diversity is shaped by factors such as personal experience, cultural beliefs, education, awareness, sex, age, and access to media. Popular adaptation approaches comprise employing drought-resistant crops, conserving soil moisture through mulching, adopting rainwater harvesting for irrigation, crop diversification, agroforestry for ecosystem resilience, and participation in community-based early warning systems for extreme weather preparedness.

While extensive research has been conducted worldwide to explore how farmers perceive climate change and develop strategies for adaptation, there is a notable lack of studies addressing this issue within the distinct context of farmers residing in the Jaman South Municipality of Ghana. Agriculture plays a pivotal role in the local economy of the Jaman South Municipality, involving more than fifty 50% of the workforce. Farming is a prevalent practice among households throughout the area (Jaman South Municipal Assembly, 2021; Ghana Statistical Service, 2010). Notable food and cash crops being cultivated at a commercial scale encompass cassava, yam, maize, oil palm, cashew, chilli-pepper, plantain and cocoa (Jaman South Municipal Assembly, 2021). Considering the continuous worldwide trajectory of climate change, it is anticipated that agricultural production will experience effects. The Jaman South Municipality, like many other regions, will also experience these effects on its agricultural activities. This, therefore, prompts the question: What are the perceptions of local farmers regarding the prevailing climate patterns, and what approaches are they utilizing for adaptation? The objective of this study is to investigate the perspectives of farmers in the Jaman South Municipality concerning climate change and the adaptation strategies they implement. The municipality's reliance on agriculture underscores the importance of understanding these perceptions for effective climate communication and education, to enhance local agricultural sustainability and resilience.

2. MATERIAL AND METHODS

2.1 DESCRIPTION OF THE STUDY AREA

The research was carried out in the Jaman South Municipality of Ghana. The district has a total land area of about 755.37290 square kilometres (km^2). It is located between latitudes $7^0$35' N and $7^0$58'N and longitudes $2^0$47' W and $2^0$78'W. It shares borders with the Jaman North District in the north, Berekum Municipal in the southeast, Dormaa Municipal in the southwest and La Cote d'Ivoire in the west. The terrain is undulating, with elevations ranging from 150 to 600 meters above sea level, featuring prominent hills near Drobo and Bodaa, serving as sources for multiple rivers in the district. The region lies in the wet semi-equatorial zone, with a mean annual rainfall of 1,200 - 1,780mm and a bimodal rainfall pattern. The primary rainy season occurs from April to June, supplemented by minor rains from September to October. A short dry spell is observed in August, followed by an extended dry season from December to March, guiding the local farming calendar. The average yearly temperature is around 25°C, while relative humidity reaches 70% - 80% during the rainy season. The district's vegetation primarily comprises semi-deciduous forest and savanna woodland, with predominant soils including clayey loam, loamy sand, and silky clay, all of which are nutrient-rich and conducive to cultivating crops like cashew, cocoa, citrus, oil palm, maize, vegetables, legumes, sugar cane, and rice (Ghana Statistical Service, 2010).

The primary concentration of the research centred on five agricultural communities within the municipality: Abirikasu, Dwenem, Dodoosu, Miremano, and Babianiha. The rationale behind choosing these particular communities for the study predominantly stemmed from their heavy reliance on rain-fed agriculture and their significant contribution to staple food production. Figure 1 shows the map of Jaman South Municipality and its communities.

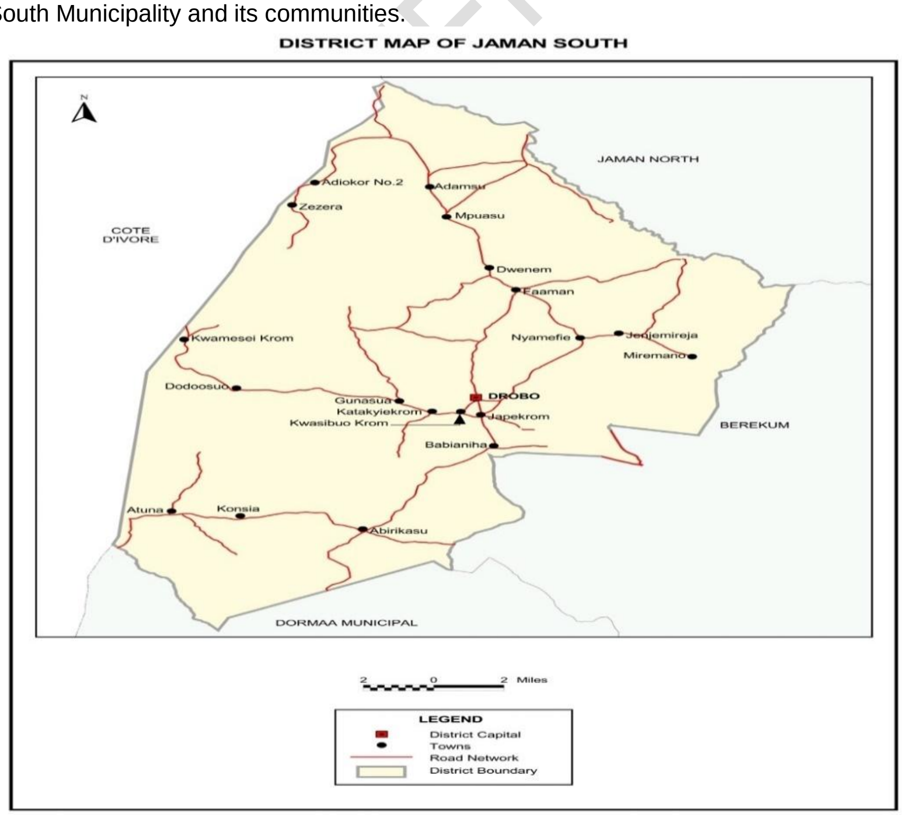

Figure 1: A Map of Jaman South Municipality. Source: Jaman South Municipal Assembly (2021)

2.2 METHODOLOGY

This study employed a mixed-methods approach, amalgamating both qualitative and quantitative data collection methods to offer a comprehensive insight into farmers' perceptions of climate change and adaptation practices in the Jaman South Municipality. To gather data, a systematic random sampling technique was employed to administer a structured questionnaire to a larger sample of farmers (n=150). Each community selected for the study had a sample of 30 farmers. The questionnaire encompassed socio-demographic information, awareness and perception of climate change and adaptation strategies employed by farmers. In addition, Focus Group Discussions (FGD) with key informants, including 10 local agricultural extension officers from the Ministry of Food and Agriculture (MoFA), were conducted to gain insights into the context and dynamics of climate change in the study area. The FGD aimed to validate the findings gathered from individual surveys. Farmers were engaged in interviews concerning the impact of climate change on crop production. To assess their agreement with statements regarding specific effects, a five-point Likert scale was employed. This scale spanned from Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5). Analysis of the collected data included calculations of means and standard deviations. The mean value reflects the average level of agreement among the farmers for each effect. A higher mean indicates stronger agreement, while a lower mean suggests lower agreement. The standard deviation also measures the dispersion responses. A higher standard deviation indicates more diverse opinions, while a lower value suggests more uniformity in responses. Qualitative data from open-ended survey questions were analyzed using thematic analysis to identify recurring themes related to climate change perceptions and adaptation strategies. Quantitative data were analyzed using descriptive statistics and a probit regression analysis. The adoption of climate change adaptation strategies was analyzed using a probit model, which aimed to determine the factors that influence this adoption. The probit regression model utilized for this analysis is outlined as follows:

$$P(S = 1/z) = Q_0 + Q_1Z_1 + Q_2Z_2 + Q_3Z_3 + \dots Q_nZ_n + \mu$$

Where: The variable "S" represents a binary outcome, where the value 1 indicates an individual's adoption of adaptation strategies, while the value 0 signifies an individual's non-adoption of such strategies.

$Z_1 - Z_n$ pertain to various categories of socio-demographic characteristics, institutional support, and other influencing factors, respectively.

Q_0 is the intercept of the function.

$Q_1 - Q_n$ are the coefficients of the respective parameters.

μ represents the error term, assumed to adhere to a standard normal distribution characterized by a mean of zero and a variance of 1. The regression equation is expressed as follows:

$$S = Q_0 + Q_1Z_1 + Q_2Z_2 + Q_3Z_3 + Q_4Z_4 + Q_5Z_5 + Q_6Z_6 + Q_7Z_7 + Q_8Z_8 + Q_9Z_9 + Q_{10}Z_{10}$$

Where Z_1 = Age; Z_2 = Sex; Z_3 = Farm Size; Z_4 = Education Level; Z_5 = Extension Contact; Z_6 = Support Services; Z_7= Farming Experience; Z_8 = Household Size; Z_9 = System of beliefs; Z_{10} = Media Access

Table 1: Explanation of the Variables Used in the Probit Regression

Variable	Description	Measurement
Dependent variable		
Adoption	Utilization of strategies for adapting to climate change (dummy)	1 = adoption, 0 = otherwise
Independent Variable		
Age	Age of farmer	Number of years the farmer
Sex	Sex of farmer (dummy)	1 = Male; 0 = Female
Farm Size	Farmer's land size impacts his/her decision to adopt (dummy)	1 = adoption, 0 = Otherwise
Education Level	If a farmer has formal education (dummy)	1= Formal education; 0 = Otherwise
Extension Contact	The farmer receives an extension service (dummy)	1 = Yes; 0 = Otherwise
Support	Support from an institution (government/private) influences the adoption of strategy (dummy)	1 = Yes; 0 = Otherwise
Farming Experience	The number of years in farming influences the adoption of strategy (dummy)	1 = Yes; 0 = Otherwise
Household Size	The total number of household member influence the adoption of the strategy (dummy)	1 = Yes; 0 = Otherwise
Belief System	Cultural and religious faith influence the adoption of strategy (dummy)	1 = Yes; 0 = Otherwise
Media Access	Accessibility to media influences the adoption of strategy (dummy)	1 = Yes; 0 = Otherwise

The responses captured various perspectives and formed an integral part of the narrative to comprehend respondents' awareness and climate change adaptation strategies. The analysis of Likert Scale data and the utilization of Probit Regression Analysis were carried out using the STATA software. Microsoft Excel (MS-2016) was employed to generate tables, bar charts, and pie charts, facilitating data comprehension and interpretation.

3. RESULTS AND DISCUSSION

3.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF FARMERS

The study gathered comprehensive socioeconomic characteristics of the respondents, encompassing gender distribution, age, marital status, education level, household and farm sizes, types of crops grown, and farming experience. Men comprised 74.3% of the sample population, predominantly assuming the role of heads of farming households. Female heads of households were mainly widows or divorcees. The age range of the farmers was 21 to 72 years, with an average age of 48 years. Approximately 50.4% of the sampled population was classified as illiterate. Every respondent was engaged in crop production, while 17.6% also practised livestock farming. The farming experience varied, with the most experienced respondents having 52 years of experience and the least experienced with three years. On average, respondents had 18.3 years of farming experience. Farm sizes ranged from 2 to 10 acres, with 30% owning more than 5 acres. Household sizes fluctuated between 3 to 8 members, with an average of 4.2 members. In terms of quantity, farmers reported an average harvest ranging from 1000kg to 20000kg of farm produce.

Table 2: Socioeconomic Characteristics of Farmers

Socioeconomic Characteristics	Details
Gender Distribution	Men: 74.3% (112); Women: 25.7% (38)
Role of Male Respondents	Predominantly heads of farming households
Female Heads of Households	Mainly widows or divorcees
Age (years)	Range: 21 – 72; Average: 48
Education Level	Illiterate: 50.4% (76); Literate: 49.6% (74)
Engagement in Crop Production	All respondents involved in crop production
Engagement in Livestock Farming	17.6% (26) also practised livestock farming
Farming Experience (years)	Most experienced: 52 years; Least experienced: 3 years; Average: 18.3 years
Farm Sizes (acres)	Range: 2 – 10; Average: 3.4 Acres
Ownership of More than 5 Acres	30% (45) of respondents
Household Sizes	Range: 3 - 8 members; Average: 4.2 members
Average Harvest (kg)	Range: 1000kg - 20000kg; Average: 12000 kg

3.2 RESPONDENTS' OBSERVATION OF RAINFALL TREND

This section examines how farmers perceive rainfall changes in the study area. As agriculture in this municipality like any other area in Ghana is predominantly rainfed, the agricultural calendar is designed to the seasonal rainfall patterns. For this reason, it is quite normal for farmers to notice any shift in the rainfall pattern. When farmers were asked about variations in rainfall, they all stated that they had observed several changes in the general trend of the rainfall (Figure 2). The following were the major changes observed: shortening of the planting season, reduction in rainfall amounts, extreme dry spells, heavy rainfall, erratic rainfall pattern, and late-onset and early cessation of rainfall. According to the majority of the farmers (97.8%), the seasonal rains started later and terminated earlier. A greater proportion of the farmers (96.2%), reported that rainfall trends have been erratic over the years. In addition, 95% of the farmers reported that the duration of the rainy season over the years has reduced which has affected the general planting season. Also, 90% of the farmers indicated that they often experience heavy rainfall during the short rainy season. 96.2% of the farmers also indicated that the short rainy season is often followed by prolonged dry spells. Last but not least, 78.70% of the farmers opined that though they often experience heavy rainfall, the general seasonal and annual rainfall amounts have decreased.

The agricultural extension officers have also observed changes in rainfall patterns over the years in the study area. They reported that the rains come either later or earlier than anticipated, and the amount has also reduced. This was confirmed by a 61-year-old farmer in *Dwenen* who lamented in a personal interview that:

"…*When I was young, our water bodies (rivers and streams) were usually full in the rainy season, enabling us to access water in the dry season, and getting water from these sources for our farming operations was not challenging, but currently, the water bodies have little water even in the rainy season...The rains aren't falling as they used to. My main concern is that it is unpredictable...*" (Face-to-face interview, December 2022).

The respondents' concern about the unpredictability of rainfall patterns is a common issue faced by farmers in various regions. Similar perceptions have been observed in other studies conducted in different regions in Ghana. Specifically, studies conducted by Mwinkom et al. (2021), Mabe et al. (2014), and Mensah et al. (2012) have reported similar findings regarding the challenges of predicting the appropriate time for sowing due to unpredictable rainfall patterns. Additionally, a study conducted by Toukal Assoumana et al. (2016) in Niger also highlighted the concerns of farmers regarding the variability of rainfall patterns and their impact on agricultural productivity. Collectively, these studies highlight the challenges faced by farmers in diverse regions in effectively managing their agricultural activities due to the uncertainty of rainfall patterns.

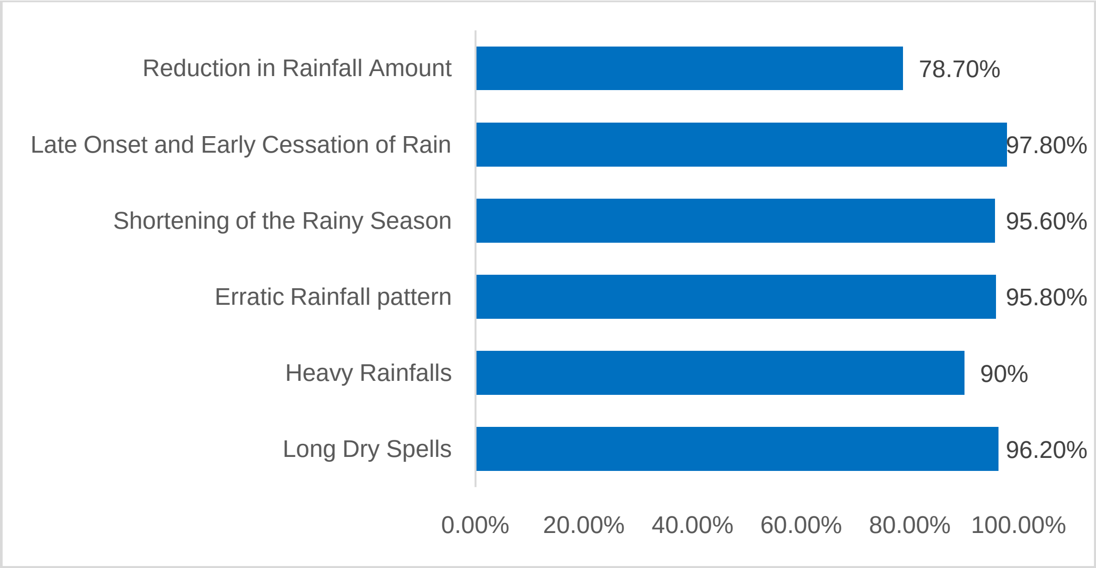

Figure 2. Respondents' Observation of Rainfall Trend in Jaman South Municipality

3.3 RESPONDENTS' OPINION OF TEMPERATURE TREND

This section also assesses how the farmers perceive temperature changes. Farmers who were questioned about temperature fluctuations and changes all claimed to have noticed significant changes in the overall pattern of the temperature in the study area (Figure 3). The common changes are increased daytime temperatures, increased nighttime temperatures, and the lengthening of the dry season. About 98.1% of the farmers have noticed an increase in daytime temperatures and a reduction in cold days. On the other hand, 74.9% also asserted that night temperatures have increased over the years. The majority (95.6%) of the farmers claimed that the length of the dry season has also increased over the years.

The views of the farmers were also supported by the extension officers who also indicated that the average number of cold days and cold nights have reduced in the municipality in recent times. Similar views have been reported in other studies including those of Mcsweeney et al. (2010) and Morice et al. (2012) in Ghana. Sylla et al. (2018) argued that under these warming scenarios, nearly everyone in Africa, including Ghana, is in danger of heat exhaustion, heat cramps, and heat stroke, posing a major risk to those who work outside, particularly farmers.

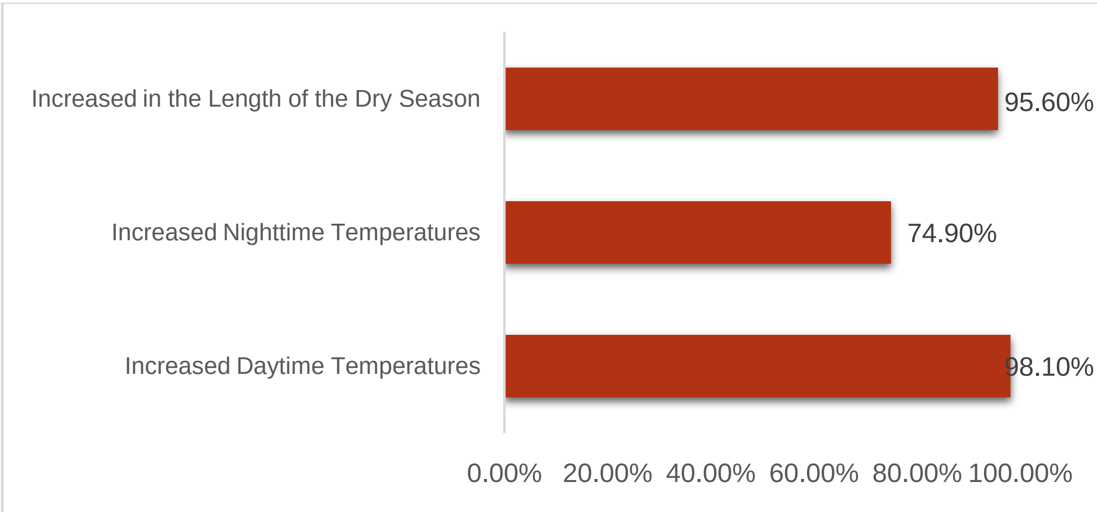

Figure 3. Respondents' Opinion of Temperature Trend in Jaman South Municipality

3.4 IMPACT OF CLIMATIC TRENDS ON CROP PRODUCTION

Based on their personal experiences, the majority of the farmers indicated that changes in the pattern of rainfall have negatively affected crop production in the municipality, especially staple food crops such as maize, yam, cassava, cocoyam, and vegetables such as tomatoes, pepper, garden eggs, and cabbage. This situation is excavating food insecurity in the area. The farmers posited that heavy rainfall causes crop damage, soil erosion, and an increase in flood risk which all affect crop production. A male farmer aged 68 explained that:

"..*I planted my crops after the first rain, but the rain stopped abruptly after just two weeks and all my crops died. When the rain finally returned, I decided to refrain from planting seeds due to my worry about the rain stopping once more, but this time it rained continually. As a consequence of my delayed planting, I couldn't get enough farm produce the last year..."* (Face-to-face interview, January 2023).

Farmers also cited low germination rates, growth retardation, and frequent plant death as some of the effects associated with high temperatures in the study area. An interview with the local extension officers revealed that increased temperatures during the major planting season result in lower yields due to stunted growth. According to agricultural extension officers, high temperatures during the planting season enhance evapotranspiration, reducing water availability for plant growth.

Table 3 presents the Likert scale analysis of the sampled farmers' perceptions of the impact of climate change on crop production in the study area. The analysis revealed that farmers tend to show the highest agreement (Means > 4.0) with the perception that frequent plant death due to temperature changes, crop damage due to rainfall variability, and soil erosion caused by rainfall variability are significant concerns. Farmers' agreement levels are slightly lower (Means between 3.5 and 4.0) for the effects of temperature changes on low germination rates, growth retardation, and the flood risk associated with rainfall variability. It's notable that while some effects garner stronger agreement, others exhibit more diverse responses. This could be due to variations in local contexts, individual experiences, and differing degrees of awareness among the sampled farmers. Notwithstanding, these findings generally align with the existing literature (Arndt et al., 2015; Baffour-Ata et al., 2021) that emphasizes the adverse impacts of climate change on crop production.

Table 3: Respondents' Views of the Impact of Climatic Trends on Crop Production

Effect of Climate Change	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Mean	Standard Deviation
Temperature Variability							
Low Germination Rates	6	12	27	75	30	3.53	1.24
Growth Retardation	7	11	30	70	32	3.87	1.17
Frequent Plant Death	4	9	25	80	32	4.07	1.21
Rainfall Variability							
Crop Damage	5	10	30	65	40	4.00	1.29
Soil Erosion	4	9	32	70	35	3.93	1.23
Flood Risk	5	8	33	75	29	3.83	1.25

3.5 FARMERS' ADAPTATION STRATEGIES TO CLIMATE CHANGE

Climate adaptation practices play a critical role in enhancing the resilience of farmers to changing climatic conditions and ensuring food security. This section analyzes the adoption of various adaptation practices by farmers in the Jaman South Municipality, ranking them from the most dominant strategy to the least, based on the prevalence of adoption among respondents.

Among the strategies, mulching emerged as the most dominant adaptation practice among the surveyed farmers, with an impressive adoption rate of 96.4%. Mulching involves covering the soil with organic materials to retain moisture, suppress weed growth, and regulate soil temperature. Its widespread adoption reflects its effectiveness in improving soil health and water conservation. The second-highest adopted strategy is composting and the use of organic fertilizers, with a significant adoption rate of 94.9%. This practice enhances soil fertility, structure, and water-holding capacity while reducing reliance on synthetic chemicals. Its popularity underscores the growing awareness of sustainable farming practices. Adjustment in planting date also ranks third, with 89.2% employing it. The farmers who cited adjusting planting time as their most effective adaptation strategy indicated that they wait for the first rain before sowing or planting their crops. This approach allows them to adjust their planting calendar based on the onset of the rain, which can help to reduce the risk of crop failure. Crop diversification ranks fourth in adoption, with 79.1% of farmers practicing it. By cultivating a variety of crops, farmers mitigate the risks associated with climate variability, pests, and diseases. This strategy contributes to stable yields and income sources. Nearly 78.8% of farmers engage in crop rotation, placing it in the fifth position. Crop rotation involves alternating different crops on the same land to prevent soil depletion and break pest cycles. Its adoption reflects its proven ability to maintain soil health and boost crop yields. Cover cropping secured the sixth spot, with 70.6% of farmers adopting this practice. Planting cover crops helps in soil erosion control, nutrient retention, and weed suppression. The moderate adoption rate suggests its recognized benefits, although there is room for further awareness. Approximately 59.7% of farmers utilize improved crop varieties, placing this strategy in the seventh position. Improved varieties often possess traits such as drought resistance, disease tolerance, and higher yields. This practice showcases the integration of technological advancements in agriculture. Drought-tolerant crop varieties are adopted by 46.7% of farmers, placing them eighth. Given the increasing frequency of droughts, this strategy becomes crucial for maintaining productivity in changing climatic conditions. Land rotation is among the least adopted strategy, with only 32.6% of farmers practicing it. This practice involves alternating land use to enhance soil fertility and reduce pest buildup. Efficient irrigation techniques are embraced by only 18.1% of farmers, positioning this strategy as the tenth adopted strategy. Despite its relatively lower adoption rate, optimizing irrigation practices is vital for sustainable water management. Its limited adoption could stem from factors such as a lack of awareness or logistical challenges.

Overall, the adoption of the various adaptation strategies by farmers in the study area is encouraging, as it suggests that they are taking proactive measures to cope with the effects of climate change. The variation in adoption rates suggests that there is potential for further promoting certain practices to enhance resilience and sustainability in agricultural activities within the municipality. The results presented are consistent with those reported by Akinnagbe & Irohibe (2014); Aniah et al. (2019); and Wood et al. (2014), who found that mixed cropping, adjusting planting dates, planting early-maturing crops, and the adoption of soil and water conservation techniques are some of the methods used by farmers in Ghana to adapt to climate change. Table 4 presents adaptation strategies adopted by farmers in response to the effects of climate change in the study area.

Table 4. Adaptation Strategies Used by Farmers in Response to Climate Change

Adaptation Practice	No. of Farmers	Yes	No. of Farmers	No	Rank
Crop diversification	119	79.1%	31	20.9%	4th
Cover cropping	106	70.6%	44	29.4%	6th
Use of improved crop varieties	90	59.7%	60	40.3%	7th
Mulching	145	96.4%	5	3.6%	1st
Crop rotation	118	78.8%	32	21.1%	5th
Efficient irrigation techniques	27	18.1%	123	81.9%	10th
Composting and use of organic fertilizers	142	94.9%	8	5.1%	2nd
Adjusting planting time	134	89.2%	16	10.8%	3rd
Land rotation	49	32.6%	101	67.4%	9th
Use of drought-tolerant crop varieties	70	46.7%	80	53.3%	8th

3.6 FACTORS INFLUENCING ADOPTION OF CLIMATE CHANGE ADAPTATION STRATEGIES

The factors influencing the adoption of climate change adaptation strategies among farmers were estimated using a probit model. The results presented in Table 5 highlight that the adoption of these strategies is influenced by a range of factors, including Age, Sex, Farm Size, Education Level, Extension Contact, Support, Farming Experience, Household Size, Belief System, and Media Access. Notably, age, education level, extension contact, and farming experience exhibited a positive association with the adoption of climate change adaptation strategies. Conversely, variables such as sex, farm size, support, household size, and belief system showed a negative correlation with adoption. These findings align with broader research suggesting that age, knowledge, experience, and access to extension services play vital roles in shaping farmers' adaptive capacities in the face of climate change.

Age _(Coef. 0.0304515, P>|z| 0.004):_* The positive coefficient for Age (0.0304515) indicates that as farmers' age increases, there is an associated increase in the log odds of adopting climate change adaptation strategies. This might be due to older farmers having accumulated more experience and knowledge over time, making them more likely to adopt strategies that help them cope with changing conditions. Literature often supports the influence of age on adaptation as older farmers may possess more traditional knowledge and practices, affecting their willingness to adopt new strategies (Smith et al., 2019).

Education Level _(Coef. 0.1857123, P>|z| 0.037):_* The positive coefficient for Education Level (0.1857123) indicates that farmers with higher education are more likely to adopt climate change adaptation strategies. This aligns with findings in various studies that show a positive link between education and the adoption of innovative practices. Educated farmers tend to have better access to information, are more open to change, and are better equipped to understand the benefits of adaptation strategies (Smith & Johnson, 2019).

Extension Contact _(Coef. 0.2894376, P>|z| 0.023):_* The positive coefficient for Extension Contact (0.2894376) suggests that farmers who have more frequent contact with extension services are more likely to adopt adaptation strategies. This finding is consistent with studies emphasizing the role of extension services in disseminating information, providing training, and facilitating technology transfer to farmers. Access to extension services has been associated with higher adoption rates of innovative agricultural practices (Adams et al., 2021).

Farming Experience _(Coef. 0.0523146, P>|z| 0.009):_* The positive coefficient for Farming Experience (0.0523146) indicates that farmers with more experience are more likely to adopt adaptation strategies. This aligns with studies that emphasize the importance of experiential knowledge and learning-by-doing in shaping farmers' decisions. Experienced farmers are often more attuned to changes in their environment and are more willing to adopt strategies that enhance their resilience (Black et al., 2018).

Table 5: Factors Influencing the Adoption of Strategies for Adapting to Climate Change

Variable	Coef.	P>|z|
Age	0.0304515	0.004*
Sex	0.0013274	0.989
Farm_Size	-0.0006821	0.748
Education_Level	0.1857123	0.037*
Extension_Contact	0.2894376	0.023*
Institutional_Support	-0.0376436	0.864
Farming_Experience	0.0523146	0.009*
Household_Size	-0.0332014	0.489
Belief_System	0.0128789	0.867
Media_Access	0.1258201	0.161
Number of obs	150	
Log pseudolikelihood	-240.31151	
LR chiChi^2	35.92	
Prob > Chi^2	0.0000	
Pseudo R^2	0.0667	

Note:* is the level of significance at 5%.

4. CONCLUSION

Climate change has become a critical factor influencing agricultural productivity on a global scale, including Ghana. A substantial portion of Ghanaian agriculture depends on rain, making it vulnerable to unpredictable climate patterns. Consequently, policymakers and scientists must collaborate to identify the factors that harm agricultural productivity and efficiency. Understanding how farmers perceive climate change, the factors shaping these perceptions, and the resulting negative effects on agriculture is essential for promoting effective adaptation strategies. This comprehension is crucial for fostering sustainable agricultural growth and ensuring food security.

The current research revealed that majority of the farmers perceived changes in temperature and rainfall patterns in the study area. They demonstrate a sound grasp of its various aspects, such as rising temperatures, erratic rainfall, prolonged dry spells, and more. The study further revealed that the farmers have taken proactive measures to cope with the effects of climate change. The types of climate change adaptation strategies that have been adopted by farmers included crop diversification, cover cropping, use of improved crop varieties, mulching, crop rotation, efficient irrigation techniques, adjusting planting time, land rotation, and use of drought-tolerant crop varieties.

Nonetheless, a considerable number of the farmers still lack adequate awareness and knowledge about strategies for adapting, mitigating, and building resilience against climate change's adverse impacts on agriculture. Hence, it is vital to initiate continuous and impactful communication campaigns aimed at educating farmers about climate change and appropriate adaptation approaches. These campaigns should particularly target educated young farmers and involve extension service providers to effectively counter the negative effects of climate change on agricultural productivity.

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