Influence of demographic characteristics and social network on peri-urban smallholder farmers adaptation strategies - evidence from southern Ghana

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Abstract: With a gamut of climate variability and change literature that examines rural spaces in the global south, and in the case of Ghana, rural spaces in the northern part, this article turns focus to a less targeted empirical space of peri-urban geography to examine demographic factors and the extent to which membership of social networks intersect with adaptation strategies. Specifically, we answer the research question: To what extent do demographic factors and membership of social networks influence smallholder farmers adaptation strategies in a peri-urban space in Ghana? Using a mixed-methods approach involving cross-sectional data on 150 smallholder crop farmers selected through random sampling, complemented by focus group discussions, we find that smallholder farmers’ demographic characteristics such as gender, age, educational level, farming experience as well as membership of Farmer Based Organizations (FBOs) significantly influenced adaptation strategies to climate variability. Gender, however inversely influenced alternate livelihood adaptation strategy. Agricultural advisory and extension services should target addressing specific gender needs, promote, and up-scale crop rotation, tree planting, and alternative livelihoods, as well as its intersection with demographic factors and FBO membership among farm households to improve resilience to climate variability and change in peri-urban spaces.

Keywords: climate change; adaptation strategy; demographic characteristics; southern Ghana

1. Introduction
A plethora of literature exists on factors that affect smallholder farmers adaptation strategies to climate variability and change in the Ghana spanning several decades. This points to the fact that scholarship on climate variability and change is not a myth but a topical reality that confronts the global agro-food systems akin to the devastating negative effects caused by the global pandemic—COVID-19. Indeed, climate variability and change impacts are more pronounced in countries south of the Saharan because they predominantly practice rain-fed agriculture, remain less mechanized and practice subsistence farming, often plagued by erratic rainfall, fluctuating temperatures, floods, and prolonged droughts. Rightly so, this phenomenon has shaped the discourse in the extant literature.
We first set the tone by providing background and working definitions of some relevant terminologies in the article. Peri-urban space generally represents areas that transition from urban to rural areas. It represents the outer limits of urban and the regional centres and the transition to the beginning of the rural areas (Afriyie et al., 2020; Kleemann et al., 2017). Peri-urban areas appear pervasive in both the developed and developing countries. Peri-urban spaces are challenged by urban sprawl, land-use changes through the rapid conversion of arable lands into real estates, land ownership, and land tenure. For instance, urban expansion triggered deforestation that led to loss of 22% in forest between 1975 and 2000 (Kleemann et al., 2017). Ghana’s peri-urban areas are heterogeneous with a clear distinction between the urban and the rural parts. The peri-urban spaces tend to have hybrid features of both rural and urban areas. It however has its own unique identity. For instance, there are differences in customary land tenure in peri-urban spaces, rapid land commercialization and concentration, scattered and uneven developments, and reduced arable lands for farming. This renders peri-urban spaces distinct from either the urban space or rural space. The unique challenges that confront peri-urban spaces create complicated contexts embedded with uncertainties, risks, and vulnerabilities particularly for the resource-poor smallholder farmer. Méndez-Lemus and Vieyra (2017) argued that, the expansion in peri-urban areas translated to re-territorialisation and the de-territorialisation of class, social groups, and livelihood outcomes, that constrains resource access required for a sustainable living. This has an implication for climate variability adaptations in the peri-urban space, given the conflict between real estate development and farming activities.

Christensen et al. (2007) defined climate variability as variations in the average state of the climate that covers all spatial and temporal scales beyond the individual weather events. The IPCC (2014) indicated that climate variability captures all the changes in climate that expand beyond weather events at the individual level. Climate variability is distinct from climate change given that the latter refers to statistical changes over a prolonged period of time in climate spanning several years as a result of both human and natural variability. Ahmed et al. (2016) argued that climate variability adversely affects agricultural production by reducing the area put under cultivated and the quantities of outputs harvested. Williams et al. (2017) specifically indicated that, climate variability poses a major challenge to pineapple production in pineapple growing areas in Ghana. To reduce smallholder farmers’ vulnerability to climate variability and also ensure that land is used to its full potential to increase productivity and also improve household food security, adapting to climate variability is very necessary (Douxchamps et al., 2016). Adaptation could also be described as a way of strengthening an individual’s capacity to adapt and carry out decisions related to adaptation, by carrying out new activities, decisions and attitudes towards social and environmental changes (Williams et al., 2019). The ability of farmers to recognize the negative impact of climate variability and to practice appropriate adaptation methods is essential for adaptation, moreover, farmers need to have a clear understanding of climate variability (Masud et al., 2017).

The IPCC (2018), described adaptation as a way of adjusting to the current or anticipated effects and changes in climate. Adaptation is undertaken to reduce harm or take advantage of favourable opportunities. Climate adaptation is the process through which certain measures and behaviours to avoid, moderate and take advantage of climate events are deliberately taken, improved or developed (Abdul-Razak & Kruse, 2017).

Farmer Based Organizations (FBOs) represents farmer cooperatives or societies, constituted by farmers as members who voluntarily come together for collective action. The purpose of FBOs is for a common goal of harnessing the benefits of farming and also transacting business in a cost-effective manner. For instance, farmers who belong to FBOs are able to purchase farm inputs at a reduced bargained price, given the large quantities that they purchase relative to individuals who purchase fewer quantities. FBOs enable farmers to transact business with external stakeholders in a cost-effective way relative to external stakeholders dealing with individual farmers. The activities of FBOs could be production centered (production FBOs), processing, and marketing. FBOs are farmer-led and operated. There are instances where farmers initiate group formation and
operation in what is known as natural FBOs and occasions where because of impending intervention groups are formed to benefit from an intervention. Such FBOs are known as artificial FBOs and they tend not to be sustainable.

The existing climate variability and change adaptation literature on the global south however tends to focus mainly on rural spaces relative to peri-urban spaces. For instance, Ojo et al. (2021) quantified the factors that influence climate change adaptation strategies in rural spaces in South Africa. Sertse et al. (2021) examined factors that influenced adaptation strategies in Raya Azebo District, Tigray Region in Ethiopia. Atube et al. (2021), and Adeagbo et al. (2021) examined factors influencing adaptation strategies in rural spaces in Uganda and Nigeria, respectively. Even though the trend in concentrating on rural spaces is not out of place, peri-urban spaces equally deserve attention. Given the fact that, rapid urbanization seems to be diminishing arable lands, due to real estate expansion, thus consequently pushing the frontiers of agriculture into rural spaces. Peri-urban farmers appear transient but deserve attention because they produce staples and high value crops (vegetables and non-traditional export crops) that provide substantial farm profits that cannot simply be relegated to the background. Additionally, they complement the food and nutritional security needs of both the domestic and global population in magnitudes that cannot be discounted. Peri-urban farmers are equally confronted with the negative consequences of climate variability and change.

In the specific case of Ghana, skewed literature exists the overly concentrates on Northern Ghana. It is off course, understandable that Northern Ghana experiences the extremes of climatic variables such as sunshine, rainfall, and temperature but the geographic space’s contribution to the agricultural food needs remains low compared to southern Ghana. Adequate literature has examined how demographic characteristics and FBO membership positively influences climate variability and change adaptation strategies in northern Ghana. For instance, Asante et al. (2021) indicated that age, sex, and access to credit influenced adaptation strategies in northern Ghana. Tambo (2016) found out that age, gender, and FBO membership significantly influenced adaptation strategies in north—eastern Ghana. Yaro et al. (2015) found that sex, age, family size, education influenced adaptation strategies in Northern Ghana. Mwinkom et al. (2021) indicated that factors such as gender, age, household size, FBO membership, farm income, farm size and years of education significantly influenced adaptation strategies in Northern Ghana. Other studies (Clay et al., 1998; Kgosikoma et al., 2018) also presented contrary findings to prove that farmers education had no significant relationship with their adaptation strategies. Ali and Erenstein (2017) and Mulwa et al. (2017) additionally showed that age had a negative effect on adaptation strategies. Pointing to some contradictions in findings in the adaptation literature on how demographic characteristics influence adaptation. In bridging the unbalanced literature in Ghana, few studies (Fadairo et al., 2019; Ofosu et al., 2020; Williams et al., 2017; Yaro, 2013) have focussed on southern Ghana. Specifically, Aidoo et al. (2021) showed that agro-ecological zone, sex, farming experience and household size influenced adaptation strategies in southern Ghana. Oyekale (2020) examined determinants of adaptation strategies in Ahafo-Ano District of Ghana. Denkyirah et al. (2017) indicated that farming experience, gender, household size, educational level, marital status access to loans influenced adaptation strategies among cocoa farmers in the Bono Region.

Antwi-Agyei et al. (2021) argued that age, gender, and marital status had less effect, rather access to credit, extension services, quality of extension services, education, and quality of climate information had a stronger influence on the adaptation strategies in the Nsawam Adoagyi Municipal Assembly. This is the point of departure of this article, where we present a counter argument that farmers’ demographic characteristics such as gender, age, educational level, farming experience as well as membership of FBOs significantly influenced adaptation strategies to climate variability in the Nsawam Adoagyi Municipal Assembly. This article, therefore, answers the question of: To what extent do farmer’s demographic characteristics and membership of Farmer Based Organisations (FBOs) influence climate variability adaptation strategies in peri-urban settings in the Ghana? This question remains an essential focus for both thinking and action.
This article adds to the extant literature in two ways. First, the article attempts to bridge Ghana’s unbalanced climate variability and change literature that mainly focuses on northern Ghana and, by implication, most rural spaces in Sub-Saharan Africa by bringing the peri-urban space into the limelight to ignite further empirical enquiries.

Second, we present some counter findings to Antwi-Agyei et al. (2021) earlier findings to show that gender, age, educational level, farming experience, and membership of FBOs significantly influenced adaptation strategies. We argue that climate variability manifests differentially even in the same geographic space and consequently provides mixed and inconclusive results. For example, it may rain in some parts of a district, county, or province, but not all parts of the spatial location even at the same time. There is, therefore, the need for climate adaptation strategies and practices to have a high level of flexibility, context-specificities, evolution, and dynamism in dealing with the ever-changing and unpredictable climatic factors. Indeed, there are mixed conclusions on the determinants of climate variability adaptation in different geographical spaces. This article, therefore, aims to provide empirical evidence on how demographic characteristics and FBO Membership influences peri-urban smallholder farmers adaptation strategies in southern Ghana.

The rest of the article proceeds as follows: the next section presents a brief review of the relevant literature on how demographic characteristics and FBO membership influence adaptation strategies. Followed by a theoretical framework that underpins the study, the methodology, results, and discussions and the final section which presents the conclusion and policy recommendation worth considering.

2.1. Influence of farmers’ demographic characteristics on adaptation strategies to climate variability and change.

Socioeconomic characteristics like size of households, age, educational level, and gender have been found to influence the adaptation strategies to climate variability (Belay et al., 2017; Dang et al., 2019; Thinda et al., 2020; Ojo & Baiyegunhi, 2020). The decision to select various adaptation strategies to climate variability by households engaged in agriculture is influenced by some demographic characteristics. These characteristics determine specific adaptation strategy(ies) to use and when to use them. The age and experience of an individual are considered important factors. However, different arguments have been raised concerning these two factors. Older farmers are believed to have gained a lot of farming experience through observation and their long-standing exposure to varied situations, consequently they tend to understand the need and the importance of adaptation (Zanmassou, 2017). According to Sadiq et al. (2019) and Marie et al. (2020), adaptation strategies such as irrigation and planting of trees were positively influenced by the age of the household head. The likelihood of farmers to practice adaptation measures increases with more farming experience (Belay et al., 2017). However, older farmers can sometimes be non-receptive to innovations like new improved crop varieties and other farming practices (Gebru et al., 2020). The same authors indicated that the likelihood of some older farmers adopting technological innovations to enable them to adapt to the effects of climate variability was found to be quite low. For instance, age has a negative influence on the adoption of certain technologies and techniques (Enimu & Onome, 2018; Gebru et al., 2020).

Another factor that has been described to affect farmers’ decision to adapt to climate variability is gender. How an individual conducts business, receives new technologies or adaptation strategies are said to be determined by his or her gender (Anang & Yeboah, 2019; Enimu & Onome, 2018). According to Enimu and Onome (2018), male farmers tend to be risk-loving in decision-making on new technologies and accordingly adjust their farming practices relative to female farmers. On the other hand, conventional and sustainable farming practices are preferred by female farmers. According to a study conducted by Dang et al., (2019), it was observed that the likelihood of female-headed households to adopt soil and water conservation practices was less. They also observed that
access to information and other resources such as land by female farmers was influenced by social barriers and this did not enable them to adopt innovative technologies. In most rural areas, men have access to resources such as land and credit as compared to women and this leaves them in a disadvantaged position since access to these resources are necessary for adaptation (Dang et al., 2019; Mitter et al., 2019). This could probably hinder smallholder crop farmers’ adaptation to climate variability. Anang and Yeboah (2019), on the other hand found that women were more likely to engage themselves in income-generating off-farm activities as compared to men. According to the authors, women play a more vital economic role in most societies as compared to men and this could explain their findings. The probability of males and females adopting strategies to climate variability depends on the prevailing context rather than gender (Dang et al., 2019).

One other essential factor that influences farmers’ decisions to adapt to climate variability is education (Enimu & Onome, 2018; Gebru et al., 2020). According to the authors, it enables farmers to gain access to and process information and this influences their decision to adopt specific innovations like improved technologies and farming practices. A study by Fagariba et al. (2018) revealed that education, as well as other socioeconomic characteristics (gender, income, and access to extension), significantly influenced farmers’ decisions to adapt to the effects of climate variability and change. Another study by Gebru et al. (2020) found that the probability of a farmer using soil conservation measures and changes in planting dates as adaptation strategies to climate variability was increased by his or her level of education. Farmers’ demographic characteristics have been known to influence their adaptation strategies to climate variability (Belay et al., 2017; Dang et al., 2019; Martey & Kuwornu, 2021). For instance, the likelihood of a smallholder farmer adapting to the effects of climate variability increases when he or she attains a high level of education (Anang & Yeboah, 2019; Getahun et al., 2021). This is because, attaining a high level of education increases a farmers’ ability to access, process and utilize relevant information related to climate variability adaptation. However, most smallholder crop farmers in rural areas do not have access to quality education and this could hinder their adaptation to climate variability and increase their vulnerability.

Clay et al. (1998) showed, however that farmers’ education had no significant relationship with their adaptive strategies to climate variability and change. Essentially, education does not always determine an adaptation strategy. According to Dang et al. (2019), farmers’ household size can influence their adaptation strategy to climate variability. Some studies in the literature (Belay et al., 2017; Diallo et al., 2020) found the household size of a family to positively influence smallholder farmers adaptation strategies to climate variability. Belay et al. (2017) found that an increase in productive members in a household increased the probability of adaption to climate variability and change. The higher the size of a household, the more likely are to adapt. This is because a larger household size is associated with an increase in labour which helps increase productivity. According to Diallo et al. (2020), the demand for food increases when family size also increases, therefore, farmers adapt to climate variability using strategies such as the application of organic fertilizers to increase food production.

Household income is one indicator that is used to represent the level of wealth of farm households. It has also been considered to be a factor that determines whether farmers are willing to conduct adaptive measures or not (Dang et al., 2019). According to the authors, the likelihood of a farmer implementing an adaptation strategy that is expensive and probably more effective in response to the effects of climate variability and change depends on his or her level of income. Income was normally found to contribute positively to the adoption of agricultural technologies (Bedeye et al., 2019; Dasmani et al., 2020). According to the authors, farmers’ income was found to significantly influence their adaptive behaviour such as soil conservation, changing planting dates, and crop variety diversification.
1.1. Theoretical framework of the study
The Action Theory of Adaptation (ATA) was adopted for this study to explain how agriculture and food production are sustained by the use of certain adaptation strategies in response to the negative effects of climate variability (See Figure 1). According to Eisenack and Stecker (2011), the ATA is a theory that describes the process through which adaptive actions are taken by various stakeholders and actors in response to the effects of climate variability and change. These adaptive actions are taken to cope with the impacts of climate variability. Stakeholders and various actors need to manage and reduce the impacts of climate variability by adopting adaptive strategies and mitigation (IPCC, 2018). The ATA consists of four main variables which are; operator, receptor, exposure unit and a stimulus (Figure 1).

Figure 1. Action Theory of Adaptation Framework (ATA).
Source: Adopted from Eisenack and Stecker (2011).

Figure 2. Map of the study area.
Source: (Centre for Remote Sensing and Geographic Information Services [CERGIS], 2020).
According to the authors, a stimulus is referred to as any change in biophysical variables (e.g., meteorological variables) which are activated by climate change. These changes in biophysical variables such as rainfall and temperature are as a result of the impact of climate variability and change. A stimulus can only be seen to be relevant when it affects the exposure unit. In this case, the stimulus refers to the negative effects of climate variability and change such as erratic rainfall patterns, drought and floods.

The stakeholders, actors as well as the non-human systems that depend on climatic conditions, and as a result of these are exposed to the stimulus is what is known as the exposure unit (IPCC, 2018). The exposure unit is not necessarily restricted to human systems only because a wide range of systems or entities are affected and are therefore considered in the assessment of adaptation. Food crop production is considered to be the exposure unit because they are affected by the stimulus (erratic rainfall patterns, drought and floods).

Eisenack and Stecker described any system or actor that is confronted by the purpose of adaptation as a receptor. The receptors are targeted for the intention of the adaptation of the social systems that ultimately exercise the adaptation strategies. Depending on the main focus of analysis, the receptors can either be social systems (the household of the farmer), biophysical entities (the farmer’s crops) or both. The receptors are considered to be smallholder crop farmers and they depend on the exposure unit (crop production) as a source of livelihood.

Operators are the entities or bodies that implement the adaptation strategies. Farming households, organizations or institutions or the government can be considered to be operators. According to the authors, the operators have the intention and the ability to initiate and facilitate the adaptation strategies of the receptors. The receptors and the operators are actors who initiate and exercise the needed actions in responding to the changes and variations in climate. The operators include extension agents, sources of information, formal and informal institutions. They facilitate smallholder farmers’ adaptation to climate variability and change through the provision of training, climate information, and credit. Smallholder farmers adapt to climate variability and change through several adaptation strategies highlighted in the introduction (See Section 1). The adaptation strategies are however affected by demographics (age, farming experience, ethnicity, educational level, marital status) institutional factors (access to farm credit, agricultural extension, and advisory services), etc.

1.2. Methodology and research design
A mixed-method approach was used for the study. The mixed-method approach entails the gathering of quantitative and qualitative data, combining these two forms of data, and also using philosophical assumptions and theoretical frameworks to analyse the data (Creswell, 2018). The author also explained that both quantitative and qualitative data together provide a better understanding of a research problem than either type by itself. Moreover, combining both quantitative and qualitative helps merge their strengths and compensate for their weaknesses and yields more validity and reliability than using either method on its own. Other researchers (Guodaar et al., 2017; Ohene-Asante, 2015) have also used a mixed-method approach in their climate studies. In summary, the combination of both qualitative and quantitative data and using this approach gives more meaning beyond the information provided by either quantitative or qualitative data alone.

2. Population of study
A population is a term used to describe the total members of a defined class of people, objects, places or events that are selected because of their relevance to particular research (Ohene-Asante, 2015). The population of the study consisted of smallholder food crop farmers in the Nsawam Adoagyiri Municipal.
3. Sampling method and sample size
The study district and the type of farmers were purposively selected because of the number of farmers engaged in food crop production. A sampling frame of farmers present in the municipal was also obtained from the Department of Agriculture (DoA), Nsawam Aboaigiri Municipal Assembly where five communities were randomly selected. The communities surveyed included Akraman, Afumkrom, Asantekweku, Sakyikrom and Bowkrom. Based on information provided by the Agricultural Extension Agents (AEAs) that showed the presence of a total of 717 farmers in the selected five communities. The sample size was therefore determined using Slovin’s formula:

\[ n = \frac{N}{1 + N(\alpha^2)} \]

Where \( n \) is the sample size,

\( N \) (total population of five communities) = 717
\( \alpha \) (Alpha level) = 0.05

\[ n = \frac{717}{1 + 717(0.05^2)} \]

\[ n = \frac{717}{1 + 717(0.025^2)} \]

\[ n = \frac{717}{1 + 1.7925} \]

\[ n = \frac{717}{2.7925} \]

\[ n = 256.7 \]

\[ n = 257 \text{ smallholder crop farmers} \]

We sampled proportionate to the community based on the proportions in Table 1. A total of 150 smallholder crop farmers were engaged in the research. Given resource constraints, time and adequate logistics, the researchers sampled proportionate to the number of farmers present in the communities in bringing the total sample to 150 and not the 257 computed. The onset of the production made it practically difficult to interview all the 257 respondents given their unavailability within the limited reference period of conducting the interviews. Specifically, 27% farmers were sampled in Afumkrom given that it represented a community with the highest number of farmers. The next community with the highest number of farmers was Akraman where 21% were

| Town/community | Sample size | Percentage (%) |
|----------------|-------------|----------------|
| Akraman        | 31          | 20.7           |
| Asantekweku    | 18          | 12.0           |
| Afumkrom       | 41          | 27.3           |
| Sakyikrom      | 30          | 20.0           |
| Bowkrom        | 30          | 20.0           |
| Total          | 150         | 100.0          |

Source: Field Work, 2020.
selected. Equal (20%) proportion of farmers were sampled in Sakyikrom and Bowkrom (See Figure 2 for map of study sites). This proportions permitted a fair representation given the total number of farmers in the communities. The crop farmers were randomly selected from a sampling frame that was obtained from the Department of Agriculture, Nsawam Adoagyiri Municipal Assembly. Random sampling enables each individual in the population to have an equal chance of being selected (Creswell, 2017).

4. Sources of data
Data on climate variability, adaptation strategies adopted and institutional support to smallholder farmers in the Nsawam Adoagyiri Municipal were obtained from primary sources through the use of a cross-sectional survey, semi-structured questionnaires and focus group discussions. Secondary data was accessed through books, articles, conference papers, dissertations as well as web reports to review literature. Searches were refined to keywords such as “smallholder farmers”, “climate variability adaptation strategies”, “agricultural extension and climate variability”. Secondary data on the district profile were also obtained from the Municipal Assembly in the Nsawam Adoagyiri Municipal to give a vivid description of the study site.

5. Focus group discussion
Focus Group Discussions (FGDs) were carried out to generate conversations that uncover individual opinions regarding the effects of climate variability on food crop production. Participants of the FGDs were purposively selected from the respondent of the survey to provide useful information on the trend of climate variability and issues regarding adaptation in the area with the help of an AEA. According to Moser and Korstjens (2018), key participants of FGDs are purposively selected because they hold expert knowledge about the phenomenon to be studied. Some participants not showing up as well as time constraints limited the number of FGDs that were conducted. In all, two FGDs were conducted. Each FGD was made up of six participants consisting of three men and three women. This is supported by Stewart (2015) who stated that the ideal size for a focus group discussion is usually between five and eight participants.

5.1. Method for data analysis
Analysis of research data gathered through the questionnaire was analysed using Stata version 14. Descriptive and inferential analyses were used in the analysis of data gathered. Descriptive statistics were presented in the form of bar graph, percentages and tables. Inferential statistics were presented in terms of the output of multiple regression analysis. Qualitative data obtained from the FGDs were transcribed, sorted into major and sub-themes that reflected the key research objectives and questions and analysed manually. Narratives from the FGDs were used as direct quotations to explain some results.

5.2. Field data collection
Both quantitative and qualitative field data were collected from 10 February 2020 to 9 March 2020. Field data were collected by conducting a face-to-face interview with respondents and also
engaging in Focus Group Discussions. This method of data collection provides in-depth data that is both qualitative and quantitative.

5.3. Specification of variables
6. Gender
Male smallholder crop farmers were denoted by 1 and women as 0.

7. Level of education
The level of education describes the highest level of education that the smallholder farmers in the Nsawam Adoagyiri Municipal have attained currently. This may be in the form of formal or informal education. The levels of education identified include primary education, secondary, technical or vocational education and tertiary education (university or polytechnic). Farmers who are said to have completed any of the educational levels are those that have the appropriate certificates.

8. Farming experience
Farming experience describes the number of years that a farmer has spent engaging in farming. Farmers gain experience through their exposure and interactions with many situations that they are faced with (Zanmassou, 2017).

9. Household size
Household size consists of the total number of people who live in the same housing unit, aid in the preparation and consumption of food and also perform certain defined roles in the household. A person who shares the same household unit with a group of people but prepares and consumes food separately from the group is not considered a part of that household. Farmers were asked to indicate the number of people in their household who fit the above description.

10. Demographic characteristics of smallholder farmers in the Nsawam Adoagyiri Municipal

10.1. Demography of Nsawam Adoagyiri Municipal
The Nsawam Adoagyiri Municipal is located approximately 23 kilometers from Accra, the nation's capital. It lies between longitude 0.07°W and 0.27°W and latitude 5.45°N and 5.58°N and covers a land area of about 175 square kilometres. The Municipality shares boundaries with other four municipalities which are Suhum Municipal Assembly to the North, Ga West Municipal Assembly to the south and West Akim District to the west, and the East by Akwapim South District. The proximity of the Municipality to Accra and Tema is a potential for development (Ghana Statistical Service, 2014).

The Nsawam Adoagyiri Municipal has a population of 86,000 people. Within this population, males and females are considered to be 42,733 (49.7%) males and 43,267 (50.3%) females. The Municipality is densely populated with a density of 465 persons per square kilometre. Nsawam which is the capital of the Municipal has the largest population of 32,531 people. The population density of the Municipality is 465 persons per square kilometre. Population growth is estimated at 1.6% per annum which is lower than that of the country at 2.7% but slightly higher than the regional population growth rate of 1.4% per annum (Ghana Statistical Service, 2014).

The weather conditions in the Municipality are generally cool due to its location in the wet between 125 cm and 200 cm. The first rainy season is from May to June, with the heaviest rainfall experienced in June and a second rainy season from September to October, accounting for the all-year-round farming practice of two farming seasons based on rain-fed agriculture. The highest temperatures averaging 30°C are recorded between March and April. With the lowest average temperature of 26°C recorded in August (Ministry of Local Government and Rural Development, 2017).
11. Agriculture
Over 34% of households in the study area are engaged in agriculture unlike the trend observed in a typical rural area. Pineapple production is notable in the municipal assembly, and it contributes immensely to farmers livelihoods. Most (94%) farmers are crop farmers followed by livestock rearing. Fish farming is rarely practiced in the study area and only accounts for a small (0.2%) proportion (Ghana Statistical Service, 2014).

The cross-sectional survey covered 150 farmers in total, consisting mainly of food crop farmers. The table below provides a summary of the demographic characteristics as well as the institutional attributes of the farmers.

12. Gender
Table 2 and 3. below shows an uneven distribution of men and women to crop farming in the five communities that were sampled for the survey with 80.7% being men and 19.3% being women (Ankrah, Freeman and Afful 2020). Ankrah (2020) confirmed male dominance in farming in their study in southern Ghana. National statistics by the Ghana Statistical Service (GSS) by that showed the majority (70%) of men engaged in arable crop farming exceeds that of females (30%) in peri-Ghana’s peri-urban areas, such as the Nsawam Adoagyiri Municipal Assembly GSS (2020).

13. Educational level
The majority of the farmers (74%) possessed some form of formal education at the primary and junior high, secondary and technical as well as university and polytechnic level and 26% had no formal education. Kwapong et al., (2021) showed that educational level of secondary and tertiary positively influenced the scale of operation of cassava farmers in Ghana.

14. Farming experience
The average years of farming experience of the farmers that were interviewed were 19 years. This signifies a relatively good years in pineapple cultivation.

| Demographic characteristics | Frequency N =150 | Percentage (%) |
|-----------------------------|-----------------|----------------|
| Sex of respondents           |                 |                |
| Male                        | 121             | 80.7           |
| Female                      | 29              | 19.3           |
| Age (Mode(41–50 years))     | 52              | 34.7           |
| Educational level           |                 |                |
| No Formal Education         | 77              | 51.3           |
| Primary Education           | 33              | 22.0           |
| Secondary/Technical/Vocation| 18.91           | 2.0            |
| University/Polytechnic      | 5.36            | 32.7           |
| Average farming experience  |                 |                |
| (years)                     | 3               | 65.3           |
| 49                          | 37.3            |
| Average Household Size      |                 |                |
| (people)                    | 98              | 17.3           |
| Farm Labour                 | 56              |                |
| Household labour only       | 26              |                |
| Hired labour only           |                 |                |
| Both                        |                 |                |
| Livestock activities        |                 |                |
| Farmers who rear animals    |                 |                |
| FBO activity                |                 |                |
| Farmers who participate in FBO activities | | |

Source: Field data, 2020.
15. Farm labour
Few (2%) smallholder crop farmers indicated that they depended on household labour only as their source of labour. About 33% of the farmers indicated that they depended on hired labour only and 65% depended on family and hired labour for their crop production.

16. Livestock activities
A small percentage (37.3%) of smallholder crop farmers owned livestock. Poultry was the most popular livestock that was owned by smallholder crop farmers in the Nsawam Adoagyiri Municipal. This finding is consistent with the finding of the Ghana Statistical Service (2014). Farmers who owned livestock had an additional source of income from animal products which made this an important strategy to increase income and also diversify food sources. The application of poultry manure to farms was widespread in the area because it served as an alternative source of fertilizer for crop production.

16.1. Results and discussions
We bring into perspective smallholder practices used to adapt to climate variability and change in the study site. Figure 3 shows the percentage of smallholder crop farmers who apply various adaptation strategies to climate variability in the Nsawam Adoagyiri Municipal. The major adaptation strategies used by smallholder crop farmers included improved seed varieties, inorganic fertilizers, crop rotation, early or late planting, and mixed cropping. Even though farmers used improved seed varieties on their farms, they sometimes mixed them with local seed varieties and this was carried out by maize farmers. The use of inorganic fertilizers was mainly to supplement farms that were low in nutrients. Mixed cropping was carried out to reduce the chances of crop failures. Indeed Adeagbo et al. (2021) confirmed adaptation strategies such as crop management practices including early/late planting, land use and management including crop rotation, irrigation, water and soil management in South West Nigeria. In the coastal communities in Ghana, Owusu & Andriesse, 2022 showed how fishfolks adapt to climate variability through migration, building protective barriers, and retreating to safer inlands places. In the coastal communities in Ghana, Owusu and Andriesse (2022) showed how fish folks adapt to climate variability through migration, building of protective barriers, and retreating to safer inland places.
The least used adaptation strategies according to Figure 3, were farm insurance, migration, and reduction in the quantity of food consumed. Indeed, Ankrah et al., (2020) indicated low access and acceptability of agricultural insurance among smallholder farmers. Farmers did not insure their farms against certain disasters and hazards like fires and floods because it was costly. It was also observed that the planting of trees by smallholder farmers was low. Planting new trees and replacing the trees which are cut down with new ones is part of the puzzle in dealing with the impacts of climate change and variability. These findings are similar to Stefanovic et al. (2017) findings that indicated that most of the adaptation strategies put in place by farmers were intended to intensify crop production such as early maturing varieties, drought-tolerant varieties, mixed cropping, and intercropping.

A multiple regression analysis was used to estimate how farmers demographic characteristics influence their adaptation strategies to climate variability (Please see Table 2 for the framework for the measurement of the variables). The results of the regression models are presented in Table 4. The findings showed that respondents’ gender, age, level of education, farming experience and FBO membership significantly influenced adaptation strategies to climate variability.

16.1.1. Gender
The regression results displayed in Table 4, show an estimated coefficient of the gender of smallholder farmers and their decision to engage in an alternative source of livelihood to be inverse (β = −0.331) and statistically significant at the 5% significance level (p =0.01 <0.05). The negative coefficient implies that gender had a negative influence on smallholder farmers’ decision to engage in an alternative source of livelihood as an adaptation strategy to climate variability. Male farmers constituted 80.7% of the total respondents, and female farmers constituted 19.3%. This implies that an increase in male farmers resulted in a corresponding decrease in their participation in alternative livelihood activities by 0.331, holding all other variables constant. As males increased off-farm adaptation strategies to climate variability such as the engagement in alternative sources of livelihoods decreased, and as females increased, off-farm adaptation strategies to climate variability increased. Although male crop farmers participated in some off-farm activities (carpentry and masonry work), female crop farmers were more likely to engage in off-farm activities as an adaptation strategy to climate variability than male crop farmers. This result agrees with the findings of Anang and Yeboah (2019) who conducted a study on the determinants of off-farm income among rice farmers in Northern Ghana. The authors also found gender to negatively influence off-farm activities. According to the authors, women are generally entrepreneurial and play vital economic roles in most Ghanaian societies by engaging in other income-earning activities to supplement household income. Antwi-Agyei et al. (2021) and Kinuthia (2018) found that gender, had a positive influence the choice of climate adaptation strategies. Female participants supported this during a FGD:

“Most of the women in the Municipal combine farming with other activities like petty trading, hairdressing, bread baking, and mobile money vending. I have my piece of land that I farm on and I am also a hairdresser. Through this, I can support my family with some extra money” (Female participants, FGD, 5 March 2020).

Other authors (Antwi-Agyei et al., 2021; Kinuthia, 2018) however found that gender positively correlated with crop diversification as a climate variability and change adaptation strategy. Asante et al. (2021) argued that gender positively influenced adaptation strategies to climate risks. Males are generally more dominant in farming activities relative to men. For instance, Asrat and Simane (2017) showed that more males participate in farming activities in northern Ghana. Lawson et al. (2020) indicated that the more masculine activities on the farm is undertaken by men whereas women prefer to partake in off-farm activities. (Asrat & Simane, 2018) indicated that women have limited financial resources that permit them to engage in climate variability and change adaptation strategies that involves money. Owusu and Andriess (2022) showed that females also migrated to other parts for better economic opportunities as an adaptation strategy in their study on the coastal communities in...
Table 4. Multiple Regression estimates for demographic factors influencing smallholder farmers’ adaptation to climate variability

| Adaptation strategies       | Constant $\beta_0$ (S.E) | Gender $\beta_1$ (S.E) | Age $\beta_2$ (S.E) | Level of education $\beta_3$ (S.E) | Household size $\beta_4$ (S.E) | Farming experience $\beta_5$ (S.E) | FBO membership $\beta_6$ (S.E) |
|----------------------------|---------------------------|------------------------|---------------------|-----------------------------------|-------------------------------|------------------------------------|-------------------------------|
| Crop rotation              | 0.657*** (0.127)          | 0.004 (0.056)          | -0.030 (0.037)      | 0.104*** (0.032)                  | 0.015 (0.009)                 | 0.005 (0.004)                     | 0.038 (0.060)                  |
| Double row planting        | -0.190 (0.109)            | -0.044 (0.048)         | -0.204 (0.032)      | 0.104*** (0.028)                  | 0.009 (0.008)                 | 0.007** (0.003)                   | -0.391 (0.051)                 |
| Organic fertilizers        | -0.039 (0.225)            | -0.078 (0.100)         | 0.025 (0.065)       | 0.134*** (0.057)                  | 0.005 (0.016)                 | -0.001 (0.006)                    | 0.263*** (0.106)               |
| Inorganic Fertilizers      | 0.915*** (0.099)          | -0.080 (0.044)         | -0.006 (0.029)      | 0.039 (0.025)                     | 0.005 (0.007)                 | 0.001 (0.003)                     | 0.042 (0.046)                  |
| Early/late planting        | 0.998 (1.001)             | -0.028 (0.044)         | -0.008 (0.029)      | 0.029 (0.025)                     | -0.011 (0.007)                | 0.002 (0.003)                     | -0.013 (0.047)                 |
| Irrigation                 | -0.268* (0.144)           | 0.004 (0.064)          | 0.028 (0.042)       | 0.100*** (0.036)                  | -0.006 (0.010)                | 0.004 (0.004)                     | 0.588*** (0.067)               |
| Rainwater harvesting       | -0.013 (0.042)            | 0.012 (0.019)          | 0.008 (0.012)       | -0.001 (0.011)                    | -0.001 (0.003)                | -0.001 (0.001)                    | -0.009 (0.020)                 |
| Planting trees             | -0.080 (0.120)            | 0.045 (0.053)          | 0.071 *** (0.035)   | -0.006 (0.030)                    | -0.011 (0.009)                | -0.006 (0.003)                    | 0.073 (0.056)                  |
| Alternative livelihood     | 0.951 (1.232)             | -0.377*** (1.03)       | 0.067 (0.067)       | -0.009 (0.058)                    | -0.029 (0.016)                | -0.012 (0.007)                    | -0.088 (1.09)                  |

Source: Authors’ analysis, 2020 ** Significant at 5% ($p < 0.05$), *** Significant at 1% ($p < 0.01$), Nagelkerke $R$ square = 0.10–0.47
Ghana's Western Region. Indeed, this has been corroborated by several studies (Hassan & Nhemachena, 2008; Maddison, 2007) in the sub-Saharan Africa. Mwinkom et al. (2021) showed that gender had a positive influence on planting drought-resistant varieties as an adaptation strategy, specifically household heads who are males planted drought-resistant and different crops as an adaptation strategy to climate variability and change. Mulwa et al. (2017) earlier observed this finding. Mwinkom et al. (2021) also showed that gender positively influenced changing planting time as an adaptation strategy to climate variability and change in Ghana. Our finding contributes to the extant literature to show how gender negatively correlates with alternative livelihood as an adaptation strategy towards climate resilience within alternative livelihood as an adaptation strategy towards climate resilience within the framework of our conceptual framework on action theory of adaptation where receptors adjust to risks and vulnerabilities through rational adaptation strategies.

16.1.2. Age of farmer
The estimated coefficient for the age of smallholder crop farmers was positive ($\beta = 0.071$) and had a statistically significant relationship with their tree planting behaviour at 5% significance level ($p =0.04 <0.05$). This implies that as smallholder crop farmers' age increased by one, there was also a 0.071 increase in the likelihood to plant trees holding all other variables constant. A farmers age therefore increased the propensity to plant trees. A plausible reason could be that as farmers age, their understanding about afforestation tends to improve hence their willingness to plant trees. Antwi-Agyei et al. (2021) also observed that farmers age had a positive significant influence on adjusting planting time for crops. Danso-Abbeam et al. (2018) indicated that farmers age significantly influenced the adoption of climate adaptation strategies specifically soil and water conservation, as well as crop diversification. During a focus group discussion, farmers indicated that:

“Over time, as we have advanced in years we have understood why we need to plant trees to save our environment. We have grown and understood that growing trees help with rainfall”
(Mixed group participants, FGD, 7 March 2020).

The older a farmer was, the higher the probability of the farmer planting trees as an adaptation strategy to climate variability. This result is similar to findings found in the literature (Belay et al., 2017; Marie et al., 2020). The authors also found age to positively influence farmers' adaptation strategies to climate variability. Farmers age appears to be a proxy for farmers experience given that age tends to go in line with farming experience. Adeagbo et al. (2021) showed that climate adaptation strategy decreases by 4% as a farmers age increased among young farmers. This has been confirmed by other studies (Ochenje et al., 2016; Thinda et al., 2020) that showed that age had a negative influence on climate adaptation strategies given that young farmers are less likely to adopt adaptation strategies. Specifically, Denkyirah et al. (2016) indicated a negative relationship between age and pesticides use as an adaptation strategy. Kgosikoma et al. (2018) also showed that age inversely influenced smallholder adaptation strategies. Our finding, however, contributes to the literature on how age positively correlates with tree planting as an adaptation strategy.

16.1.3. Level of education
Table 4 shows some estimated coefficients for the level of education of the respondents that were positive and found to be statistically significant with the use of crop rotation ($\beta = 0.104$) and row planting ($\beta = 0.104$) at the 5% significance level respectively ($p =0.001 <0.05$). This indicates that holding all other variables constant, an increase in the level of education of smallholder farmers significantly increased the use of crop rotation and row planting as adaptation strategies to climate variability by 0.104 respectively. As farmers attain a higher level of education, the rate at which they adapt to the effects of climate variability by using some adaptation strategies such as crop rotation and row planting is much higher compared to when they do not attain a higher level of education. This implies that higher level of education is necessary for smallholder farmers to adapt to the effects of climate variability. Education affords individuals the knowledge and the ability to continuously search for appropriate adaptation strategies given an analytical mind. More level of education tends to improve an individual's
analytical capacity to seek solutions to problems that confronts. It must be noted however that higher education does not necessarily translate to higher analytical ability. It is a necessary but not a sufficient condition. Antwi-Aguye et al. (2021) showed that farmers level of education influenced their use of crop diversification as an adaptation strategy. The authors however indicated that level of education had a negative significant effect on the climate adaptation strategy of early or late planting. Moreover, some estimated coefficients of smallholder farmers’ level of education were positive and also statistically significant with the use of organic fertilizers (β = 0.134) and irrigation (β = 0.100) as adaptation strategies to climate variability at the 5% significance level respectively (p =0.002 <0.05, p =0.01 <0.05). The positive estimated coefficients imply that holding all other variables constant, an increase in the level of education of smallholder crop farmers led to a corresponding increase in the use of organic fertilizers and irrigation by 0.134 and 0.100 respectively. In a male only focus group discussion farmers indicated:

“Members who gained more education, particularly through formal education system tend to adopt crop rotation, irrigation, and organic fertilizer use because they broaden their understanding about such adaptation practices. They indicated that education tends to trigger their level of curiosity. Hence they tend to read materials that convince them to incline to such adaptation practices “ (Male group participants, FGD, 10 March 2020).

The more farmers get educated, the more likely they are to adapt to weather risks. This is as a result of the fact that educating farmers is a good way to enhance the adoption of technology among farmers (Abdulai & Huffman, 2014; Nonvide, 2017). These results confirm findings in the literature (Enimu & Onome, 2018; Gebru et al., 2020). Their findings also proved that farmers’ level of education positively influences their use of some adaptation strategies to climate variability. Antwi-Agyei et al. (2021) showed that farmers educational level had a positive influence on pineapple farmers crop choices. The authors showed that farmers educational level positively influenced the choice of crop diversification as an adaptation strategy. A high level of farmers education generally positively correlates with a farmers adaptative capacity. It is therefore generally useful to have educated farmers given that the literature shows that it positively correlates with climate variability and change adaptation strategies. It is also established in the literature that educational level positively influences technology adaptation. It might therefore be useful if governments incentives for young graduates to venture into agriculture since higher educational levels can positively contribute to farmers adaptation strategies. Our study adds evidence to show how educational level significantly positively contributes to using crop rotation and row planting as an adaptation strategy to climate variability.

16.1.4. Farming experience

The estimated coefficient for the respondents’ experience and the use of double row planting as an adaptation strategy to climate variability was positive (β = 0.007) and was found to be statistically significant at the 5% significant level (p =0.03 <0.05). This positive coefficient implies that as smallholder crop farmers’ farming experience increased by one unit, they resorted to double row planting as an adaptation strategy to climate variability (increased by 0.007), holding all other variables constant. In a focus group discussion, farmers indicated that:

“The more experience they gather inclines them to practice double row planting because they get convinced about the added benefits that it brings “ (Mixed group participants, FGD, 10 March 2020).

This means that the higher the farming experience of a farmer, the more likely the farmer will be better adapt to climate variability. This result is also similar to the findings of (Belay et al., 2017). According to the authors, farmers with more experience in farming have better knowledge about weather information and its implication on agricultural practices. Aidoo et al. (2021) found that
farmers’ experiences positively influenced the adaptation of indigenous strategies including shift in planting dates and external-induced strategies including weather forecasts. Experienced farmers have learnt useful lessons in farming over a period of time, hence recognize the importance of adapting to climate variability and change using effective adaptation strategies. It is insightful to know that some of these adaptation strategies are indigenous strategies handed over from generation to generation. This implies that current indigenous adaptation strategies appear effective given that they have been tried and tested for its efficacy. Indeed, Ankrah, Kwapping and Boateng, 2022 Ankrah (2020) advocated for the integration of indigenous knowledge into science-based approaches (Ghana Meteorological Agency weather prediction) for predicting climate in Ghana. Sadiq et al. (2019) and Diallo et al. (2020) give credence to the finding that farming experience positively influenced climate adaptation strategies. However Aidoo et al. (2021) observed that experience squared had a negative influence on adaptation strategies. This is because beyond a point, the influence of farming experience on adaptation strategies becomes marginal. Experienced farmers may lack the needed physical strength, and financial resources to embark upon climate variability strategies that are labour and capital intensive, therefore the farming experience at this point may not significantly positively influence the adaptation strategy. Indeed, other studies (Falola & Achem, 2017; Uddin et al., 2014) have confirmed this finding. For instance, Alhassan et al. (2018) showed that experienced farmers were not inclined to labour-intensive climate adaptation strategies in their study in Ghana. Our study, however, provides evidence to deepen understanding about how farmers experience positively correlates with double row planting as a climate variability adaptation strategy within the framework of our conceptual framework on action theory of adaptation framework where receptors will always put in place rational adaptation strategies to adjust to climate variability.

16.1.5. FBO membership

Table 4, shows an estimated coefficient for FBO membership of the respondents was positive ($\beta = 0.263$) and statistically significant with the use of organic fertilizers at the 5% significance level ($p = 0.02 < 0.05$). The estimated coefficient of FBO membership of smallholder crop farmers was also positive ($\beta = 0.100$) and was statistically significant with the use of irrigation at the 5% significance level ($p = 0.01 < 0.05$). The positive estimated coefficients imply a positive relationship between smallholder farmers’ FBO membership and their adaptation to the effects of climate variability. An increase in smallholder crop farmers’ FBO membership by one, also has the likelihood of using organic fertilizers and irrigation as adaptation strategies to climate variability significantly by 0.263 and 0.100, respectively, with all other variables held constant. During focus group discussions, farmers indicated that:

“We discuss among ourselves as a group the need for us to make use of our crop residues as organic manure. The prices of inorganic fertilizers keep on increasing, given the fact that most of them are imported. Organic fertilizers are environmentally friendly as well” (Mixed group participants, FGD, 7 March 2020).

The quote above shows that farmers who belong to groups are able to discuss among themselves common challenges that they face as individuals and as a group, by providing solutions to their common challenges. The use of organic fertilizers remains even more important given the disruption caused by the Covid-19 pandemic which has radically disrupted fertilizer supply chains. The has been worsened by the Ukraine-Russia war. FBOs proposing the use of organic fertilizers in the Ghana, remains a step in the right direction. Government support to upscale commercial production of organic fertilizers will remain useful. In this regard, government policy that will discourage the structural dependence on fertilizer imports should be discouraged to safeguard local production and consumption of organic fertilizers.

The related literature establishes that FBOs through collective action, benefit from the sharing of relevant agricultural information, receive technical, and financial assistance from external actors, receive farm inputs at subsidized or reduced costs. FBOs are able to reduce transaction costs in
operations for members relative to individual operating. Farmers who belong to FBOs, generally stand a higher likelihood of better adapting to climate variability. Indeed, our findings showed that membership of FBOs positively influenced the use of organic fertilizer and irrigation as a climate variability adaptation strategy. This result is in line with some studies in the literature (Stefanovic et al., 2017; Enimu & Onome, 2018) that found a positive relationship between group membership and farmers’ adaptation strategies to climate variability. When farmers join groups and contact each other, they exchange information and get access to resources such as credit, market information, innovations that they might not have had access to individually (Guodao, 2015; Salifu, 2015; Stefanovic et al., 2017). Farmer groups enable farmers access resources that they may not have had access to individually (Enimu & Onome, 2018). Mwinkom et al. (2021) found that FBO membership positively influenced drought-resistant varieties as a climate variability and change adaptation strategy in Ghana. Efforts should therefore be channeled towards encouraging farmers to join FBOs since it inures positively towards adaptation strategies. Ashby et al. (2012) however showed that membership of FBOs did not positively influence climate adaptation strategies in Vietnam given that such FBOs were focused on market integration. On the whole, membership of FBOs inure positively towards climate variability adaptation strategies. Governments in sub-Saharan Africa are encouraged to encourage farmers to form or join existing FBOs to harness fully the potential in collective action.

16.2. Conclusion and policy recommendation
The study findings revealed that respondents’ age, educational level, and FBO membership significantly and positively influenced most of their decisions to use specific practices as adaptation strategies to mitigate the adverse effects of climate variability and change. Specifically, age positively influenced tree planting as an adaptation strategy. Farmers level of education significantly positively influenced crop rotation, farming experience positively influenced row planting, and FBO membership positively influenced the use of organic fertilizers and irrigation as adaptation strategies. The gender of smallholder crop farmers, however had a negative relationship with alternative livelihood activities including off-farm activities as adaptation strategies to climate variability. Women were found to be more likely to engage themselves in off-farm income-generating activities relative to men. This finding aligns with Anang and Yeboah (2019), who explained that women are more entrepreneurial and play a vital economic role in most Ghanaian societies. The negative relationship between gender and alternative livelihood activities however varies with the wider literature (Antwi-Agyei et al., 2021; Asante et al., 2021; Hassan & Nhemachena, 2008; Maddison, 2007; Mulwa et al., 2017; Mwinkom et al., 2021) in sub-Saharan Africa that indicated a positive relationship.

The article recommends that agricultural advisory and extension services target the promotion and up-scaling of crop rotation, tree planting and alternative livelihoods, and its intersection with farmers years of experience, age, educational level, and FBO membership among farm households to improve resilience to climate variability and change. This study was limited to just one district to illustrate a peri-urban location in Ghana, hence not adequately representative of peri-urban areas in Ghana. Future studies are encouraged to broaden the scope and include more peri-urban locations in Ghana.

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