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Impact of the rural enterprise programme interventions on smallholder farmers' climate adaptation strategies: Qualitative evidence from Ghana's transitional agro-ecological zone

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ABSTRACT

This paper combines theoretical insights from vulnerability literature and interpretive paradigm using a qualitative approach involving semi-structured interviews and focus group discussions to examine smallholder farmers' climate perception, adaptation strategies, and challenges under the rural enterprise programme interventions in the Kintampo South district of Ghana. The farmers reported rainfall variability and rising temperatures as their key observed changes. The study revealed that climate impacts on farmers and their agricultural systems are multidimensional, which affect their productive capacity and livelihoods. These impacts have pushed them to adopt adaptation strategies with the support of the programme interventions. The farmers benefitted from material and non-material resources, minimizing climate impacts and reducing vulnerabilities. The paper provides critical insights into how future agricultural development interventions could develop effective interventions to build sustainable agricultural systems and livelihoods that are inclusive, sustainable, and responsive to the needs of the most vulnerable communities and obviate smallholder farmers' vulnerability.

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Adaptation strategies; Ghana; rural enterprise programme; smallholder farmers; vulnerability

Introduction

Agriculture is the backbone of African economies, contributing significantly to the growth and development across the continent. This situation is prominent in rural sub-Saharan Africa (SSA) (Alliance for a Green Revolution in Africa AGRA, 2023). Out of the population employed in the agricultural sector, 80% are smallholder farmers – crop farming and livestock rearing – serve as their primary sources of revenue. They own less than two hectares of land, are vulnerable to extreme weather events and lack access to resources (United Nations Development Programme UNDP, 2021; Food and Agriculture Organization [FAO] and International Telecommunication Union [ITU], 2022). However,

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climate change undermines agriculture in SSA because of its susceptibility to climate-related hazards such as rainfall variability, seasonal temperature changes, and extreme events (Epule et al., 2023). SSA countries face heightened vulnerability due to their reliance on rain-fed agriculture systems, smallholder farmers for local food production and the slow implementation of adaptation actions (Campbell et al., 2023). The vulnerability of the agriculture sector in SSA is severe. In recent years, SSA has been hit by extreme weather and climate events, including more unpredictable rainfall patterns, extended dry periods, and shorter crop-growing seasons (FAO, 2022). Given its high exposure, sensitivity, and limited adaptive capacity, this severity will likely increase, coupled with persistent poverty, market asymmetries, including power structures, access to information, and limited infrastructure development (UNDP, 2021; United Nations Framework Convention on Climate Change; UNFCCC, 2023). Because the agricultural sector in developing countries is dominated by smallholder farmers vulnerable to climate change and variability, poverty and food insecurity (Campbell et al., 2023; UNDP, 2021), increasing their productive capacities through agricultural interventions is central to reducing poverty and food insecurity (Asitik, 2023). Many smallholder farmers rely on their governments to address their socio-economic needs (Nordjo et al., 2023). Nevertheless, they often encounter various livelihood hazards due to social, economic, and ecological challenges (Adjei & Adjei, 2016).

Government entities have been developing various rural development intervention initiatives to enhance living conditions and eradicate social exclusion and livelihood risks in rural areas (Ile et al., 2018). Therefore, rural entrepreneurship has swiftly become pivotal in supporting rural economic development (Kurmanalina et al., 2020). Rural entrepreneurship has emerged as a novel research area, gaining prominence since its introduction (Asitik, 2023). It is the capacity to initiate and manage investments in farming and other micro and small rural non-farm enterprises (Asitik et al., 2016). Rural entrepreneurship is poorly understood, particularly in SSA, having received less scholarly attention (Asitik, 2023). Beyond policy rhetoric, many SSA governments and their development partners have committed to poverty reduction and rural development programmes. Through these commitments, they are actively setting agendas and pursuing actions to improve the lives of most rural dwellers (Adjei & Adjei, 2016).

In Ghana, agriculture remains the mainstay of the rural economy (GSS, 2022). Many rural dwellers also engage in other micro and small enterprises to support their agricultural activities (Adjei & Adjei, 2016; Opoku Mensah, Akanpabadai, Diko, et al., 2023). However, Ghana is experiencing an increasing incidence of poverty, particularly in rural areas (GSS, 2022; UNDP, 2023). According to Boukaka et al. (2022), the agricultural sector is experiencing sharp income inequality, narrow intergenerational mobility and limited economic opportunities, especially for vulnerable groups and rural poor. Also, the development of micro and small enterprises has not met expectations, hindered by limitations such as financial services and business management skills, which impede their efficient performance. In response, various pragmatic rural development actions have been promoted to reduce poverty and improve livelihoods, incomes, and well-being in rural areas (Ile & Boadu, 2018; Boukaka et al., 2022). These efforts have led to the implementation of several policies and programmes, including the Rural Enterprises Programme (REP) in 1995 (ADF, 2012; Nordjo et al., 2023). The REP aimed to enhance beneficiaries' capabilities to convert the programme's capacity-building support into productive assets (Adjei &

Adjei, 2016; Boukaka et al., 2022). The REP was implemented to develop rural micro and small enterprises by building capacity and training in on-farm and off-farm agro-industry, creating a favorable environment to generate business and create jobs, and facilitating access to rural finance (ADF, 2012; Boukaka et al., 2022).

Several studies have been conducted on REP in Ghana to date. However, these studies primarily focused on the impacts of the REP on micro and small rural non-farm enterprises and business development services (Adjei et al., 2020; Nordjo et al., 2023). They also examined how rural entrepreneurs select, plan, and implement business development services (Adjei & Adjei, 2016; Adjei et al., 2020; Demedeme & Opoku, 2022; Nordjo et al., 2023). Accordingly, there is a lack of systematic research on the impacts of REP interventions on the adaptation practices of smallholder farmers. Hence, the purpose of this study is to explore the impact of the REP interventions on smallholder farmers' climate adaptation strategies in Ghana's transitional agro-ecological zone. Specifically, the study examined smallholder farmers' climate vulnerability in the Kintampo South district of Ghana, examining smallholder farmers' climate perception and adaptation strategies under the programme interventions. The study also examined the challenges faced by beneficiary smallholder farmers. Such investigation could provide useful information on how the REP and similar future interventions could help scale up poverty reduction and agricultural development among rural smallholder farmers.

Due to the lack of systematic research on the impacts of the REP interventions on the adaptation practices of smallholder farmers who are beneficiaries of the REP interventions, this paper is important for two reasons: First, it can help articulate how the REP's interventions facilitate or reduce vulnerabilities by promoting or supporting farmers' adaptation strategies. This area has yet to receive much attention in Ghana. Second, it will help policymakers and practitioners involved in similar future programmes to develop interventions tailored to the needs of socially and economically marginalized groups facing increasing climate vulnerabilities. A system's vulnerability is influenced by climate change and various social, physical, environmental, economic and institutional characteristics (Füssel & Klein, 2006). Therefore, expanding the literature on climate change and variability and REP's interventions is essential to exploring the vulnerability and adaptation strategies of the beneficiaries of the programme and articulating how it facilitated adaptation among its beneficiaries.

Rural enterprises programme in Ghana

The government of Ghana initiated the Rural Enterprises Project Phase I (1995 to 2002) and Phase II (2003 to 2011) to reduce rural poverty and improve rural livelihoods. The successful implementation of these phases evolved into the REP (2012 to 2022) (Boukaka et al., 2022; Oladapo et al., 2018), which this study focused on. The REP aligned with Ghana's priorities for agricultural modernization and developing micro and small-scale enterprises to contribute to the broader national objectives of sustainable development, rural development, economic growth, and poverty reduction, particularly in rural areas (ADF, 2012). It aimed to reduce poverty and enhance living conditions in rural communities of Ghana by supporting the creation of viable and profitable agricultural and other rural enterprises that promote skilled-based sources of livelihood and asset acquisition. For example, it responded to meeting Ghana's Shared Growth and Development Agenda

(GSGDA). It emphasized inclusive growth, poverty reduction, youth employment, women's economic empowerment, and improving the livelihoods of rural populations through enhanced agricultural productivity and rural industrialization (ADF, 2012). Similarly, the REP is vital in advancing the sustainable development goals in rural Ghana, contributing to improved livelihoods, economic growth, and environmental sustainability. For example, the REP aimed to reduce poverty in rural areas by enhancing the livelihoods of smallholder farmers and rural entrepreneurs through capacity building, access to financial services, and support for income-generating activities. Again, by promoting climate-smart agricultural practices and resilience-building strategies, the REP supported climate action and helped rural communities adapt to the impacts of climate change (Adjei et al., 2020).

The REP had three components: (a) promote access to business development services, (b) enhance technology transfer and promote demonstrations and technical skills training, and (c) create an enabling business environment, including access to rural finance and policy dialogue and capacity building (ADF, 2012; Boukaka et al., 2022). The first component upgraded the technical and entrepreneurial skills of rural micro and small enterprises. Beneficiaries received management and technical skills training and start-up kits. This component consolidated its gains by creating viable and profitable agricultural and rural enterprises. The second component upgraded the level of technology in the rural micro and small enterprises sector. It achieved this component by promoting and disseminating appropriate technologies through skills training and knowledge transfer in sustainable farm and agro-processing enterprises and the fabrication and design of agricultural equipment, machinery and spare parts. The third component promoted access to rural finance. It facilitated linkages with financial institutions and trained clients in financial literacy for credit (ADF, 2012; Boukaka et al., 2022).

The REP was implemented on a demand-driven basis based on how agriculture was important in the district, the poverty level, and the readiness of the local government to participate. The programme specifically targeted rural entrepreneurs. A key target was to engage smallholder farmers, vulnerable to climate change and variability, in transformed, viable and profitable agriculture, following a value chain approach (ADF, 2012). Within the context of the REP and this study, smallholder farmers are farmers engaged in agricultural activities on a small scale, typically characterized by limited land holdings, often less than two hectares. These farmers primarily rely on family labor and traditional farming methods, and their production is primarily for subsistence, with any surplus sold in local markets (UNDP, 2021). Beneficiaries were selected subject to their ability to contribute a proportion of the cost of services provided. Vulnerable groups, including youth, women, people living with HIV/AIDS and people with disabilities, were directly targeted. Also, there was self-targeting. Here, participation in the programme was opened to eligible beneficiaries. The programme facilitated access and promoted activities using various communication channels and supporting services tailored to the needs of the target population (Boukaka et al., 2022).

The programme is perceived by its implementing partners – the International Fund for Agricultural Development (IFAD), the government of Ghana, and the African Development Bank (AfBD) to develop rural small-scale enterprises, livelihood diversification and poverty reduction (Adjei et al., 2020). The programme targeted the poor and vulnerable rural dwellers, focusing on women and youth smallholder farmers. Its primary

aim was to boost rural production, create employment and increase incomes to reduce poverty through increased outputs (Boukaka et al., 2022). The programme sought to transfer skills and appropriate technology, thereby enhancing the capacities of its beneficiaries. This transfer of skills and appropriate technology is especially crucial as agricultural income in rural Ghana is increasingly threatened by climate change and variability (Adam et al., 2022; Adjei et al., 2020).

Conceptual framework

This study adopted the vulnerability framework as its guiding framework (Johnson & Welch, 2009). Vulnerability arises from the characteristics of properties and activities within interconnected socio-ecological systems (Turner et al., 2003). It exists within a multi-faceted, coupled system characterized by connections that operate across various spatiotemporal scales. By failing to consider this larger context, response opportunities could lead to significant unintended consequences (Kates & Clark, 1996). Vulnerability is the propensity or predisposition to be adversely affected. It encompasses various elements and concepts. These include sensitivity or susceptibility to harm and a lack of adaptive capacity (Adger, 2006; Intergovernmental Panel on Climate Change; IPCC, 2022). More specifically, as shown in Figure 1, vulnerability is a complex characteristic related to sensitivity and exposure to climatic and other environmental hazards and the capacity to adapt, resist, and recover from climate impacts (IPCC, 2022). Ferdous and Mallick (2019) assert that rural communities and poorer populations face higher susceptibility to risks because of their limited access to assets.

Exposure is the degree to which people, ecosystems or species, livelihoods, environmental services, resources, functions, infrastructure, socio-economic and cultural assets are situated in locations that could be adversely affected (Adger, 2006; IPCC, 2022). Sensitivity refers to the degree to which a species or system is either adversely or beneficially affected by climate change or variability. This effect is influenced by the extent of the system's or species' dependence on climate-related resources (IPCC, 2022). The exposure and sensitivity of socio-ecological systems generate impacts that illuminate the perturbations exerted on these systems (Turner et al., 2003). Exposure and sensitivity determine the potential impacts a species or system may experience, which are tempered

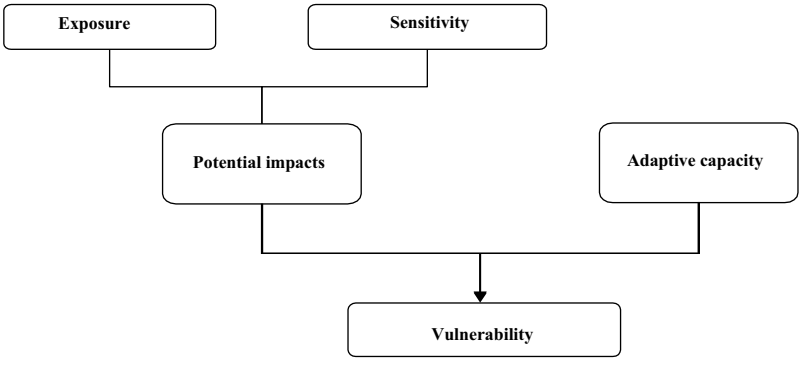

Figure 1. Vulnerability framework adopted by the IPCC. Turner et al. (2003).

by its adaptive capacity (Turner et al., 2003). MA (2005) defines adaptive capacity as the ability of humans, systems, institutions and other organisms to adjust to potential damage, exploit opportunities, or respond to consequences. Adger (2006) states that adaptive capacity can reduce vulnerability and has significant implications for adaptation. By definition, enhancing the adaptive capacity of such a system is a critical factor and integral to undertaking adaptation (Freduah et al., 2018). Local adaptive capacity is built by disseminating technical information and training, enhancing awareness of vulnerability and risk, and accessing local resources and knowledge (Allen, 2006). Keys et al. (2014) note that adaptive capacity is enhanced through several measures: increasing scientific knowledge on climate change, developing informed social networks, and engaging local communities to identify specific sources of vulnerability. Thus, adaptive capacities, expressed through various supportive mechanisms, enable systems to mitigate vulnerabilities (Appiah & Guodaar, 2022).

Accordingly, informed by Kelly and Adger (2000) and Turner et al. (2003), this study adopted the vulnerability framework to integratively analyze the impacts of climate change and how such impacts influenced farmers in the Kintampo South district to adapt with the support of the REP interventions. The main crux of vulnerability is a system's susceptibility to adapt to socio-ecological risks, mainly due to adaptive deficiencies (Smit & Wandel, 2006). It presupposes that limited access to assets (indicative of weak adaptive capacity) among smallholder farmers, as examined in this study, engenders a higher level of vulnerability (Appiah & Guodaar, 2022; Ferdous & Mallick, 2019). The purpose of this study is to explore the impact of the REP interventions on smallholder farmers' climate adaptation strategies in Ghana's transitional agro-ecological zone. Specifically, the study examined smallholder farmers' climate vulnerability in the Kintampo South district of Ghana, examining smallholder farmers' climate perception and adaptation strategies under the programme interventions. The study also examined the challenges faced by beneficiary smallholder farmers. Appiah and Guodaar (2022) state that exposure to socio-ecological and agricultural systems in rural communities in southern Ghana will force smallholder farmers to make critical decisions to adapt and obviate their vulnerability.

Material and methods

Study area description

Fieldwork was carried out in the Kintampo South district in the forest-savannah transitional agro-ecological zone of Ghana (see Figure 2). The district was selected drawing on circumstantial evidence of climate impacts on smallholder farmers, who have benefitted from the REP since 2013 (GSS, 2014). The agriculture sector employs 80% of the district's population. They are mainly smallholder farmers dependent on rain-fed agriculture (Antwi-Agyei & Amanor, 2023; GSS, 2014). The farmers cultivate food crops (e.g. yam, cassava, cocoyam, maize, plantain), vegetables (e.g. pepper, garden eggs, tomato, cabbage) and cash crops (e.g. cashew, mango, ginger). Also, livestock production (e.g. goat, sheep, cattle, pig and poultry) is practised. The district experiences a double-maxima rainfall regime, with the wet season starting in March and reaching its first peak in June, followed by a decrease in rainfall until July (Antwi-Agyei & Amanor, 2023). The dry season

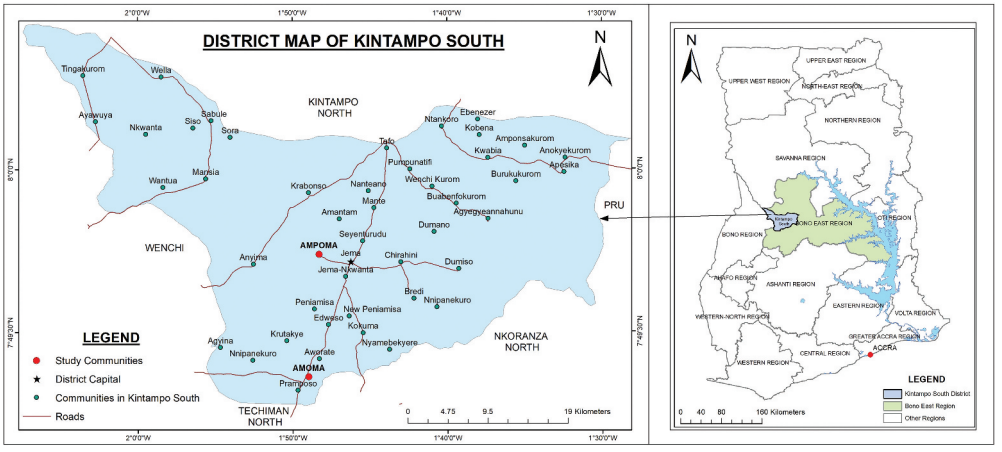

Figure 2. Map of the Kintampo South district, showing the locations of Ampoma and Amoma.

intensifies toward the end of August and peaks between September and November (GSS, 2014). The district receives a mean annual rainfall ranging from 1,400 mm to 1,800 mm. The mean monthly temperature is between 24°C in August and 30°C in March (GSS, 2014). While high poverty levels limit smallholder farmers' adaptive capacity (Appiah & Guodaar, 2022), high temperatures and rainfall variability increase the sensitivity and exposure of rural households to climate impacts (Sraku-Lartey et al., 2020).

The paper draws on empirical fieldwork in the Kintampo South district between January 2022 and June 2022. Using an analytical case study approach (Yin, 2018), two study sites, Ampoma and Amoma (cf. Figure 1), were purposively selected. These communities were at discrete locations in the district, had similar sizes and populations, and mirrored the characteristics of the district. There were also the very first communities to benefit from the REP interventions. Due to the study's exploratory nature, the analytical case study approach (Yin, 2018) was crucial to provide a deep, nuanced, and context-specific understanding of the programme and ensure that the study is thorough, reflective of local realities, and contributes to broader learning and innovation in rural development and climate adaptation.

Data collection

For the inclusion of smallholder farmers in this study, a nonrandom sampling technique, specifically purposive sampling, was employed (Creswell & Creswell, 2018). Purposive sampling is a non-probability sampling strategy frequently used in qualitative research (Erwin et al., 2021). In purposive sampling, study participants are recruited based on their relevance to the research questions rather than their representativeness of the overall population. Purposive sampling reveals people's distinctive characteristics and helps to understand their complex personal experiences in their social settings (Corbin & Strauss, 2015; Neuman, 2021). Respondents were sought from diverse age groups, genders, and groups that benefitted from the programme. These beneficiaries included men, women, youth, people living with HIV/AIDS, people with disabilities, micro and small

entrepreneurs, as well as community groups and cooperative members. Data collection was conducted qualitatively through semi-structured interviews and focus group discussions. It is widely recognized that to effectively understand and address the complexities of physical and social processes, research methods must go beyond quantitative data and experimental models to detect the complexities of human behavior (Strijker et al., 2020). Qualitative research is a tool to capture the details and depth of social phenomena, allowing researchers to conduct in-depth and detailed studies of subjects, samples, and events. This approach yields accurate and comprehensive information about smaller samples, capturing the nuanced details often missed in broader quantitative analyses (Murtonen, 2005; Strijker et al., 2020). Semi-structured interviews enable researchers to gather information about experiences, events and opinions and better understand how different respondents perceive and interpret these meanings (Dunn, 2021).

With the support of agriculture extension staff, eligible respondents were invited based on their experience and local ecological knowledge and benefited from the REP interventions. These agriculture extension staff worked with the beneficiaries and were able to introduce programme beneficiaries. To ensure broad representation of the beneficiaries (Kirchherr et al., 2018), the staff were asked to recommend beneficiaries from diverse age groups, genders, and groups. The beneficiaries were not allowed to make referrals to minimize the potential for selection bias and to avoid over-representing a particular group (Opoku Mensah et al., 2024). Additionally, to prevent the clustering of participant samples in specific locations, the agriculture extension staff were asked to recommend beneficiaries from multiple locations in each community, including sections that we further removed from major landmarks and roads. Such selection criteria provide information-rich cases for in-depth study (Hamelin et al., 2011). The interviews were stopped in each community when data saturation was reached – the point at which additional interviews no longer add new information or allow the researcher to identify new themes (Bailey, 2018) – in total, 31 semi-structured interviews (16 in Amoma and 15 in Ampoma).

A semi-structured interview guide was developed to capture (i) perception of climate change and variability, (ii) experience, motivation, and benefit for participating, (iii) whether or not the REP interventions help mitigate smallholder farmers' climate vulnerability, and (iv) the challenges they faced in participating in the REP. Although an interview guide was utilized to maintain consistency, respondents were motivated to share their experiences on their own terms. The lead researcher conducted all interviews to clarify discrepancies, minimize interpretation bias, and validate responses (Lawless et al., 2022). The interviews were conducted in Twi, the dominant language in the two communities and beneficiaries' homes and farms, where there was a need for field-based observations. This strategy ensured that the smallholder farmers were comfortable and freely shared their experiences. The interviews, which lasted an average of 60 minutes, were audio-recorded with permission from the respondents.

Following the interviews, four focus group discussions, two in each study community, were conducted to facilitate collective dialogs and gather diverse perspectives (Boafo & Lyons, 2023; Opoku Mensah et al., 2024). Respondents who exhibited a depth of knowledge in the semi-structured interviews were selected for the focus group discussions. Each focus group discussion was comprised of eight discussants on average. Participants were grouped by gender: men-only and women-only to provide a comfortable environment that allowed everyone to express their views and potentially highlight any social

differences in perspectives (Opoku Mensah, Akanpabadai, Addaney, et al., 2023). Such organization was necessary to moderate cross-gender and cross-cultural sensitivities (Nyantakyi-Frimpong, 2020). In many farming communities in Ghana, socio-cultural barriers have resulted in power dynamics between women and men. Such socio-cultural barriers hinder women from speaking up in constellations to capture social differences in perspectives. Men dominate conversations in mixed-gender groups, potentially marginalizing women's voices. Organizing separate groups gave both genders equal opportunities to contribute their insights and experiences (Opoku Mensah, Akanpabadai, Addaney, et al., 2023). The lead researcher co-moderated the focus group discussion. One research assistant supported each community, serving as co-moderator and note-taker. The issues discussed in the focus group discussions were similar to those covered in the interviews. They were, however, more open-ended to suit all discussants (Dapilah, 2023). Additionally, they focused on themes emerging from the interviews, facilitating rigorous cross-checking of information (Miles et al., 2019).

Discussions were held in the local Twi dialect, each lasting approximately two hours. The discussions were audio-taped with the consent of the discussants. FGDs were conducted in an open and relaxed manner in the communities' social gathering places in late afternoons after farmers had completed their daily activities to ensure maximum participation. The FGDs offered valuable insights from the discussants' lived experiences regarding the investigated topics (Yeleliere et al., 2023). Multiple sources of data help achieve a higher degree of accuracy in responses and for accuracy in conclusions (R. Wang et al., 2018).

Ethics approval

The Human Research Ethics Committee (HREC) approved the research at the University of Technology Sydney (UTS), with the approval number UTS HREC ETH21–5803. Before administering questionnaires, interviews and FGDs, all participants provided informed consent for their involvement. This research adhered to principles of academic excellence and integrity (Gaworek-Michalczenia et al., 2022). Before the data collection, community entries were conducted in the selected communities. The community entries were used to familiarize the community, establish the necessary contacts, and seek permission from the community leaders to ensure easy access to the communities (Abunyewah et al., 2024). All ethical procedures were adhered to, ensuring that the rights and dignity of the research participants were prioritized. All respondents were informed about the research purpose and conditions and obtained informed consent before the interviews. Data protection was strictly maintained, with confidentiality and anonymity guaranteed, and participants were assured of their right to withdraw from the study at any time.

Data analysis

The data were analyzed using thematic and narrative analysis. Audio recordings were transcribed verbatim into text. Together with the recorded interviews, all texts were translated into English and meticulously read several times to identify and thoroughly understand the raw data (Møller et al., 2018). The texts were put together and compared against the recorded audio files to understand the varying opinions within the text and to

ensure the accuracy of the data (Dapilah, 2023). NVivo 14 was used to code the transcripts to identify recurrent and interconnected themes from the interviews and discussions. In doing this, the transcripts were imported into NVivo 14. Nodes were created for themes, and text segments were coded to the nodes. The nodes were grouped as themes. Also, the software's query and visualization tools helped to identify and analyze the recurrent and interconnected themes. In emphasizing stories articulated by discussants, narrative analysis was employed using quotations to substantiate claims and illustrate the interconnections between themes (Bryman, 2012; Opoku Mensah et al., 2024). To ensure rigor and trustworthiness, participants' own words were maintained with low use of inference descriptors (Baxter & Eyles, 1997). While the individuals interviewed did not represent the entire population, the sample size was sufficient for qualitative research. Saturation was reached as no new information or insights emerged from the data, and previous findings started to be repeated (Miles et al., 2019). Based on their frequency of occurrence in the transcripts, three major themes emerged and are presented in the following order: (a) beneficiary smallholder farmers' climate perception, (b) REP's contribution to beneficiary smallholder farmers' adaptation strategies, and (c) challenges faced by beneficiary smallholder farmers' in participating in the REP.

Results and discussion

Beneficiary smallholder farmers' climate perception

Climate parameters such as rainfall and temperature directly affect agricultural productivity (Guodaar et al., 2023). The study, therefore, assessed the smallholder farmers' perception of these climate parameters. The smallholder farmers reported significant changes in rainfall and temperature patterns over the last 10 years. Addaney et al. (2021) report that communities have become aware of climate changes, characterized by increasing temperatures and rainfall variability. The farmers primarily reported key observed changes such as the late onset of the rainy season, early cessation of the rains, erratic rainfall, and rising temperatures accompanied by high sunshine intensity. These findings corroborated those of Wrigley-Asante et al. (2019) and Addaney et al. (2021), who found similar climate perceptions within the same forest-savannah transitional agro-ecological zone. Like Yeleliere et al. (2023), the rainfed smallholders were particularly worried about the erratic rainfall patterns and temperature, affecting their planting regimes and productivity.

A female farmer expressed these uncertainties during a focus group discussion in Ampoma: *"These days, the rain does not come as expected. The heat from the sun, too, is unbearable. Things have changed a lot. For example, our main cash crop, cashews, no longer fruits at the right times. When they fruit, we do not get our expected yields, and the fruits are small with less weight, affecting their market prices"*. Another female farmer in Ampoma expressed the following sentiments during the interviews: *"The rains have been our biggest challenge. The weather has changed so rapidly. In the last two years, the rains were better. It changed entirely last year. We do not know what is coming this year. We put in all efforts to cultivate our crops, but nature conspires to fail us"*. A male livestock farmer in Amoma lamented: *"When it does not rain, it affects our livestock too. The grass dries up,*

making getting fodder for our livestock difficult. As you can see, most livestock in this community are stunted. Because of this, we do not get good prices to sell our livestock".

The farmers mentioned that the unpredictable rainfall and high temperatures primarily promoted crop and livestock diseases and pests, which reduced their productivity. Similarly, Bautze et al. (2022) found that although pests and disease are part of the natural farming system, their activities can negatively impact crop health, quality and yields. The situation described above is a testament to the fact that the variations in rainfall patterns and temperature adversely affected cash crops, food crops, and livestock production, which are the mainstays of the farmers in the Kintampo South district. Such occurrences were found to bring much distress to the smallholder farmers as they resulted in food insecurities (Opoku Mensah, Akanpabadai, Addaney, et al., 2023), reduced trading activities (Wrigley-Asante et al., 2019) and caused psycho-social impacts (Abunyewah et al., 2024).

The farmers attributed the observed changes in rainfall and temperature to several factors: deforestation, resulting from agricultural extensification, poor soil management, bush burning, and felling of trees for timber and fuelwood; land use changes driven by population growth and urbanization; and poor agricultural practices linked to agricultural extensification and intensification. In addition to these human-induced changes, smallholder farmers identified natural climate variability, attributing it to the increasing influence of the dry Harmattan winds from the Saharan Desert affecting the forest-savannah transitional agro-ecological zone. Addaney et al. (2021) found that the dry Harmattan winds increase dryness and rise in temperature. The comment from a male crop-livestock farmer in a focus group discussion in Amoma encapsulated: *"As a smallholder farmer with over 30 years of farming experience, I have witnessed first-hand the changing patterns of our weather. The rains are no longer as predictable as they used to be. We used to know exactly when to plant, but now, it is a gamble. Our forests are disappearing, making way for farms and towns. I see more tractors and hear of new farming methods, but our soils are tired, and the heat is too much for our crops. All these changes are beyond just the ways of nature; we are altering the balance"*.

Local farmers' climate perception provides valuable local knowledge to adopt strategies to deal with climate change and variability and make critical agricultural decisions (Acheampong et al., 2023). Incorporating farmers' perceptions of climate change into policy development is therefore crucial to ensure that the perspectives and needs of farmers are adequately addressed. Doing so will help create effective and locally relevant strategies that will lead to more sustainable agricultural practices in the face of climate change.

Rep's contribution to beneficiary smallholder farmers' adaptation strategies

The changing climate and variability challenges have pushed smallholders to adopt adaptation strategies to mitigate climate impacts. The smallholder farmers reported receiving assistance from the REP to help adapt to climatic impacts. This section discussed how the REP impacted the adaptation practices of the smallholder farmers in the Kintampo South district.

Access to credit to support improved farm management practices

The REP supported the smallholder farmers with credit to expand and improve their farming activities. Unlike commercial banks that charge high interest and require collateral in various forms before credit is advanced to rural farmers, the REP interventions offered credit to farmers with no stringent requirements. Additionally, the study found that the smallholder farmers leveraged their association with the REP to access the needed assets. A case in point was when farmers were supported in buying tricycles to support their production activities. A female cashew farmer in Amoma remarked: *"I was assisted in getting a matching grant to purchase a tricycle. The tricycle has been instrumental in helping me transport my harvested produce to the market easily and quickly. This support has drastically helped me reduce post-harvest losses"*. Another male cashew farmer in Amoma shared his perspective during one of the focus group discussions: *"My farm is far from my home. Hitherto, I went to the farm with a small motorbike. That was what I used to transport water from my home to my farm, and that was extremely difficult. With the support of the REP, I got a tricycle. I can now fetch more water in just one trip, which greatly relieves me. Previously, when I hired labourers, they were reluctant to go to my farm due to the distance. With the help of my tricycle, I can easily transport them to the farm"*. Additionally, a male poultry farmer in Ampoma recounted how his tricycle from the REP has assisted his poultry farming activities. He commented: *"I was also given a tricycle through the REP to support my poultry farm. The tricycle assists me in transporting feed and other raw materials from the market centres to the farm and then transporting products like eggs from the farm to my point of sale. Also, I use the tricycle to transport poultry droppings to fertilise my maize farm. My cost of production has reduced drastically"*.

Implementing improved farm management practices requires robust policy support that incentivizes and educates farmers on sustainable agricultural techniques. Policies should focus on providing resources to train and build capacities to adopt environmentally friendly practices. It should also be tailored to offer financial incentives or credit to encourage farmers to adopt more sustainable farming methods. For example, Yeleliere et al. (2023) and Opoku Mensah, Akanpabadai, Diko, et al. (2023) found that, in Ghana, farmers with access to credit at lower interest rates through institutional interventions are better equipped to adapt to climate shocks. Access to credit is especially crucial during a climate crisis, enhancing farmers' financial capabilities to respond effectively. Access to credit results in increased financial capital for farmers. This increase supports them in purchasing necessary farm inputs, such as tricycles, in this study's context. This financial boost enhances their ability to implement improved agronomic practices and adaptation interventions, thereby reducing the impact of climate variability on agricultural livelihoods (Campbell et al., 2016). Following Hansen et al. (2019), the significance of credit access in influencing farmers' decisions to adapt highlights the critical role of institutional support. This support is essential for providing the necessary funding to implement adaptation measures that mitigate the climate impacts on agriculture in rural Ghana.

Changing cropping practices

The smallholder farmers reported that through the REP interventions, they had adopted the use of drought-resistant and early-maturing crops and planted various crops at different times. The smallholder farmers were also trained to plant in lines and spacing between plants to prevent "haphazard planting." A female maize farmer in

Amoma commented: *"Previously, I was doing haphazard planting. However, I have adopted the 'single seed in a line.' I remember that with the haphazard planting, I could only harvest one truck of maize. But after adopting to plant to lines, I now harvest three trucks of maize on the same farmland"*. Another female maize farmer in Ampoma remarked: *"After the REP trained us on proper planting methods and the use of drought-resistant maize, I am now able to harvest 70 bags of maize as opposed to my previous 30 bags of maize"*. Similarly, a male beans farmer in Ampoma reiterated: *"Before REP came in, I was not intentional to plant in rows and sometimes I broadcasted the seeds to save time. At the time, I could only harvest six bags of beans. However, after adopting to plant in lines, I can harvest at least 25 bags of beans."* A male cashew farmer in Ampoma commented*: "I was planting my cashew 20 seeds by 20 seeds. Later, it came to 30 by 30. Later, the REP taught me that it must be done 40 by 40 to have enough air circulation within the farm to increase my yields. My farm now looks 'better and healthier.' I hope to get more than a 100% yield increase over last year."*

Through these practices, smallholder farmers can adapt to climate and ecological changes in their livelihoods, increase yields, manage pests and disease attacks and minimize the risk of crop failure (Aniah et al., 2019). These cropping practices are described as important adaptation strategies in areas where changes in rainfall patterns pose significant challenges to farmers (Antwi-Agyei & Nyantakyi-Frimpong, 2021). By integrating these cropping practices, farmers can significantly reduce their vulnerabilities and ensure a more stable and reliable food production system in the face of environmental challenges. It is vital to prioritize funding for agricultural innovation, promote the dissemination of climate-resilient crop varieties, and provide training and support to farmers for effective cultivation practices.

Proper use of agrochemicals

Agrochemicals collectively mean synthetic chemicals, including pesticides and fertilizers, in agricultural practices to control pests, weeds, and diseases, improve yields and protect crops from post-harvest losses. However, their environmental and human impacts cannot be overstated (Demi & Sicchia, 2021). Therefore, the farmers were trained to adopt effective agrochemical applications as part of the REP interventions. For example, a private company called Plant Pests and Diseases Company Limited was contracted by the REP to support smallholder farmers in applying the right amount of chemicals on their mango farms to control pests and diseases. Even though the farmers were getting the right chemicals, there were problems with their application. The REP, therefore, in collaboration with the Plant Pests and Diseases Company Limited, trained the farmers on effective chemical application. Additionally, the farmers were trained in biosecurity to help prevent diseases affecting livestock and poultry. Here, they were trained in isolation, proper hygiene and good sanitation practices, and traffic control in rearing livestock and poultry. A male livestock farmer in Amoma stated: *"I am a beneficiary of REP's disease control and biosecurity training. Through the training, I can prepare my site to prevent the introduction and spread of harmful organisms"*.

Also, the farmers were trained to use chemical fertilizers to improve yields. The farmers reported that their planting practices in lines and spacing between plants supported efficient agrochemical application. During a focus group discussion in Amoma, a female

farmer echoed: *"The training in the proper use of agrochemicals has been a game changer for us. It has helped us fight off pests and diseases that used to destroy a large part of our crops. With these chemicals, our yields have significantly improved, ensuring we can feed our families and have surpluses to sell"*.

Training in effective agrochemical application positively impacts pests and disease control and improves total output (Boafo & Lyons, 2023). Wrigley-Asante et al. (2019) found that applying agrochemicals is a critical agronomic adaptation strategy. Though improper handling of agrochemicals could harm human health and the environment, they represent the best option under the changing climate when properly applied. They provide a more immediate return on farmers' investments (Boafo & Lyons, 2023; Wrigley-Asante et al., 2019). Integrating agrochemicals as an adaptation strategy necessitates comprehensive policy oversight to ensure sustainable and safe practices. There is a need to enforce strict regulations on their usage, promote research and development of environmentally friendly alternatives, and train farmers on their responsible and efficient use to minimize environmental and health impacts and safeguard crop yields and ecosystem health.

Intensification of livestock and myciculture production

Most smallholder farmers in the Kintampo South district depended on crop farming to support their livelihoods. However, due to climate change challenges, The REP promoted the intensification of livestock, bee, mushroom and poultry production as other viable livelihood activities. A female mushroom farmer in Amoma commented: *"Turning to mushroom farming has been beneficial. Mushrooms do not require much space or water, so I grow them year-round, providing a steady source of food and income for me and my household. This shift has diversified my livelihood, allowed me to adapt to the changing climate and ensured my household's security in these uncertain times."* Also, the focus group discussions revealed that although mushrooms could be collected in the wild, they are becoming minimal due to environmental changes. This situation confirms that environmental degradation reduces the availability of ecosystem products, especially mushrooms (Wrigley-Asante et al., 2019).

Some livestock farmers also benefited from the REP training, which gave them more insights into managing their livestock. A male piggery keeper in Ampoma remarked: *"I have been enlightened a lot. I now know I must de-worm my pigs regularly and give them healthy feed and much water. It is a popular notion in this community that pigs eat anything. I know that is a wrong notion. My pigs are bigger and healthier than before."* Another male piggery keeper in Ampoma added: *"I used to house my pigs in a structure that was predominantly built with cement. I went for a month's training, where I was informed that if I wanted my pigs to multiply very fast, I needed to change the housing structure. Also, I was trained in how to administer injections to my livestock. The REP training has significantly helped me to improve my piggery management practices"*. Also, a poultry farmer in Amoma reported consistent increases in his poultry production when he got involved in the activities of the REP. He stated: *"The REP gave me training in effective poultry management. This training has helped to increase my productivity. Initially, I increased my poultry by 100 birds. Later, I increased it to 1001 birds. I now have 2,000 birds. All thanks to the REP interventions."*

Livestock rearing or poultry supports farmers in diversifying their livelihoods amidst climate challenges, reducing the vulnerability that arises from solely depending on crops (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Opoku Mensah, Akanpabadai, Diko, et al., 2023). Integrating crop and livestock systems is vital to maintaining high food production levels and minimizing agricultural impacts on the environment. Therefore, understanding the impacts of climate change and the effects of adaptation options on crop-livestock systems necessitates a systems approach. This approach should consider the interactions among various farm components and processes across scales (Garrett et al., 2020).

Livelihood diversification and asset acquisition

In the dynamic and changing world of agriculture, skills and asset acquisition for smallholder farmers have become important. This study, therefore, sought to delve into how the REP promoted skills and asset acquisition of the smallholder farmers, exploring how these elements contribute to vulnerability reduction, sustainability and growth in the agricultural sector. The smallholder farmers reported improvements in their entrepreneurial skills and livelihood diversification. As part of smallholder farmers' livelihood and income diversification strategies, they were trained in livelihood activities such as cassava and palm oil processing. During a focus group discussion in Amoma, a comment from a female beneficiary summarized these impacts: "*I have been able to diversify my livelihood into other productive activities (cassava processing) and access productive assets (processing equipment). I have diversified my income sources and become financially independent*". Another commented: *"Diversifying my livelihood into agro-processing is not just about surviving; it is about thriving and growing. It enabled me to invest in my farm, improved my farming practices, and plans for future expansions"*.

Similarly, Adjei et al. (2020) found that REP's skills and technology transfer packages impacted beneficiaries' entrepreneurial skills and knowledge in basic technology application. These skills and knowledge enabled them to organize into groups, strengthening their human and social capital. This organization also facilitated their access to microcredit. They could then apply these skills and technologies to engage in small-scale livelihood activities, diversifying their livelihoods and household income. This finding aligns with expectations, considering that the REP's operations aimed to enhance the incomes and livelihoods of rural micro and small entrepreneurs across Ghana. The underlying assumption of the programme was that focusing solely on agricultural activities would not suffice for substantial rural poverty reduction or support the actualization of the sustainable development goals in rural Ghana (Adjei & Adjei, 2016; Ministry of Trade and Industry; MoTI, 2023). Nordjo et al. (2023) and Adjei et al. (2020) note that diversifying the economic streams in rural areas is a critical step toward a diversified rural economy by promoting rural industrialization for long-term socio-economic development.

Also, the study found that the REP promoted and formed cooperatives through which the REP interventions were carried out. The study found that these groups fostered a sense of ownership and commitment among the members. More importantly, the groups built and strengthened social networks and relationships, facilitating knowledge and skill transfer. A male group leader in Ampoma commented: *"Working together in our community group has brought us closer and made the REP much more effective. Through this group, we have managed to use our resources more wisely and ensure everyone benefits.*

Sharing knowledge and skills among ourselves has been empowering, and it is incredible to see how much more we have achieved together. This group has improved our livelihoods and strengthened our unity. We now feel more prepared to sustain these benefits for the long run".

Group formation at the community level is a vital catalyst for enhancing members' productive capacity and joint assets acquisition to support their livelihood diversification and contribute to improved well-being (Abunyewah et al., 2024). REP associations strengthen members' social and human capital and help members acquire other necessary livelihood assets (Adjei et al., 2020; Nordjo et al., 2023). Due to the potency of the REP to support smallholder farmers' livelihood strategies and asset acquisition, policymakers and development agencies must continually promote such skills and technology transfer policies and economic group formation to enhance the productive capacities and livelihood diversification of smallholder farmers, reduce their climate vulnerabilities and improve their well-being and overall socio-economic status.

Challenges faced by beneficiary smallholder farmers

Despite the successes of the REP in the Kintampo South district for the smallholder farmers, like many adaptation initiatives (Eriksen et al., 2021), its implementation was not without challenges. The smallholder farmers reported confronting setbacks in participating in the REP interventions. They reported financial constraints and access to credit, socio-cultural barriers, limited access to information and awareness and infrastructural deficiencies. A female farmer in Amoma captured this quote: *"Before joining the REP, I struggled with the limited resources and knowledge to expand my farm. However, the programme provided me with training and access to better farming techniques. Initially, adapting was tough, and getting the funds to invest was a real challenge. The support and training from REP interventions opened doors I did not even know existed. I learned how to manage these issues better. It was not easy, and I can tell you that many of us are still struggling with these challenges"*.

Regarding the financial constraints, the study found that because beneficiaries were expected to contribute a proportion of the cost of services provided as part of the inclusion and selection (ADF, 2012), the smallholder farmers who were impeded by this challenge reported that they operated with limited capital and struggled to afford the initial investment required. Also, similar to (Eshetu & Yimer, 2024), their access to credit and financial services was often restricted due to unfavorable conditions, making it difficult to secure the necessary funding. Again, because the targeting strategy of the REP involved direct targeting of specific sub-groups, including youth, women, people living with HIV/AIDS and people with disabilities (Boukaka et al., 2022), there were socio-cultural challenges. Specifically, traditional beliefs, social norms, and structures posed significant barriers to participation by these vulnerable groups. These societal constraints limited their access to resources and opportunities provided by the programme. For example, the study found that traditional land tenure systems prevailed in the district. These systems created complexities around land ownership and access, particularly challenging for women and youth. In congruence with Stavi et al. (2021), the cultural and traditional norms limited their access to land, which impacted their participation. The affected women and youth reported that they did not have secure land rights, which

affected their willingness to invest in and adopt new agricultural practices promoted by the REP.

The study found that the people in the Amoma community were not well represented. This situation was attributed to the Amoma community being further from Jema, the district capital where the REP office was located. This challenge was compounded as the REP staff lacked the needed logistics to visit the remote communities frequently. Similarly, due to the self-targeting strategy of the REP (Boukaka et al., 2022), limited access to information and awareness about the REP was identified as a major challenge. Some smallholder farmers in Amoma reported they were not fully aware of the programme's objectives, benefits, participation procedures and available resources. This lack of awareness was attributed to inadequate outreach and sensitization efforts. Like Eriksen et al. (2021), the existing communication channels were ineffective in reaching all segments of the rural population, particularly those in more remote areas. Finally, as also identified by Adeagbo et al. (2023), infrastructural deficiencies, such as roads, irrigation systems, storage facilities, and accessible markets, were identified as major challenges. Poor road networks made it difficult for farmers to access markets and input supplies, while inadequate storage facilities led to post-harvest losses. These infrastructural deficiencies limited the farmers' ability to participate in the REP effectively and to capitalize on the opportunities it offered.

The engagements with the farmers revealed that addressing these challenges requires a multi-faceted approach. Such an approach includes improving information dissemination, enhancing financial support systems, providing targeted training and capacity-building programmes, upgrading infrastructure, and fostering an inclusive environment that respects local socio-cultural customs and values while promoting equitable participation. For example, the farmers highlighted the need for improved communication channels (Eriksen et al., 2021), such as local radio stations, information centers, help desks, community meetings, mobile technology, and extension services to ensure that information about the programme's objectives, benefits, participation procedures, and available resources reaches all segments of the rural population, including those in remote areas. Again, they indicated the need for the programme to address infrastructure deficiencies Adeagbo et al. (2023), including improving road networks, developing irrigation systems and storage facilities and market access. For example, they indicated that constructing adequate storage facilities and improving market access will reduce post-harvest losses and increase profitability. They suggested that the REP should support the development of local storage solutions and facilitate better linkages between farmers and markets.

The farmers called for the need to address socio-cultural barriers that hinder the participation of women, youth, and other vulnerable groups (Foo, 2018). By raising awareness about the importance of inclusive participation, the programme can foster a more supportive environment for all community members. Similarly, as traditional leaders can play a crucial role in advocating for more equitable land distribution and supporting initiatives that empower women and youth (Tahiru et al., 2019), there were calls to engage with traditional leaders and involve them in the programme's activities to address land tenure and ownership issues. Furthermore, the farmers recommended the establishment of more favorable credit terms and conditions tailored to their needs. They called for lowering interest rates, extending repayment periods, and providing financial

literacy training to help them manage loans effectively. Additionally, they suggested creating partnerships with microfinance institutions and banks that understand the agricultural sector's unique challenges will facilitate better access to credit (Ndiwa et al., 2024).

Implications of REP interventions for community development

The REP interventions in the Kintampo South district have several implications for community development, affecting various aspects of rural life and economic activities. The programme significantly contributed to community development through climate change adaptation interventions (ADF, 2012; Boukaka et al., 2022). It enhanced adaptive capacity and bolstered rural communities' resilience against climate change's adverse impacts by equipping them with the necessary skills, knowledge, credit, and support networks. As Ghana continues to face the challenges posed by climate change and variability (World Bank, 2021), the lessons learned, successes achieved and challenges of the REP offer valuable insights for future development and adaptation initiatives. The results show that the REP interventions are a beacon of how integrated development initiatives can significantly contribute to community development, particularly in climate change adaptation, as in this study.

First, the REP's emphasis on capacity building and training was pivotal in community development (Adjei & Adjei, 2016). Through various training sessions, smallholder farmers were equipped with the knowledge and skills to adopt innovative agricultural practices and diversify their income sources (Boukaka et al., 2022). These efforts are critical in the study communities where agriculture forms their backbone and is also highly vulnerable to climate change and variability (Antwi-Agyei & Amanor, 2023; GSS, 2014). By fostering a knowledgeable and skilled rural workforce, the REP interventions have laid the groundwork for more resilient communities capable of adapting to changing climatic conditions. Moreover, the provision of credit enabled rural entrepreneurs to invest in climate-resilient technologies and infrastructures, such as drought-resistant crop varieties, and assets such as tricycles. These investments are essential for mitigating the impact of climate change and variability on agricultural productivity and food security (Adeagbo et al., 2023). The REP interventions have empowered the rural communities to take proactive steps toward adaptation by facilitating access to credit and enhancing their overall development and sustainability.

The REP interventions also recognized the importance of fostering collective action and community engagement. The REP established associations through which interventions were carried out. These groups provided a platform for sharing knowledge, resources, and labor, fostering a sense of solidarity and mutual support among members. They also empowered the communities to advocate for their needs and interests, enhancing their participation in local governance and decision-making processes. In congruence with Abunyewah et al. (2024), such a collective approach strengthened the social capital within communities, making them more cohesive and better prepared to face the challenges of climate change and variability. Thus, this REP intervention ensured collective action in implementing community-based adaptation initiatives that contributed to the communities' climate resilience efforts and promoted environmental conservation and sustainable natural resource management (Adjei et al., 2020).

Another significant contribution of the REP to community development is its direct targeting of specific sub-groups, including youth, women, people living with HIV/AIDS and people with disabilities. The programme has ensured that climate change adaptation efforts are inclusive, sustainable and equitable by targeting these sub-groups (Boukaka et al., 2022). This emphasis on inclusivity promoted empowerment and enhanced the overall resilience of communities to climate change and variability (Foo, 2018). Thus, the programme fostered a more inclusive approach to community development and climate change adaptation. Despite the socio-cultural challenges stated above, women, in particular, have been empowered to take on leadership roles within their communities and enterprises, challenging traditional gender norms and promoting gender equality. Also, youth involvement introduced fresh ideas and energy into adaptation initiatives, ensuring the transfer of knowledge and skills to future generations (Sumberg et al., 2024). Lastly, the REP's interventions have spurred innovation and entrepreneurship in adapting to climate change and variability. By encouraging the development of non-farm income-generating activities and supporting the growth of agro-based enterprises, the programme has diversified rural economies and reduced their dependency on climate-sensitive agricultural practices. This economic diversification is crucial for building resilient communities that withstand climate-induced economic shocks (Ndiwa et al., 2024).

Conclusion, policy and practical implications

Although the rural enterprise programme has been implemented in Ghana since 1995 to develop rural micro and small enterprises in on-farm and off-farm agro-industry, there has been a lack of systematic research on the impacts of the programme interventions on climate adaptation practices of its beneficiaries. Accordingly, this study utilized primary data from 31 semi-structured interviews and four focus group discussions to examine the smallholder farmers' climate perception, adaptation strategies, and challenges under the programme interventions in the Kintampo South district of Ghana. Drawing from the paper's conceptual framework, the findings highlighted the vulnerability context within which smallholder farmers operated in the district. The study found significant changes in rainfall and temperature patterns over the last 10 years, such as the late onset of the rainy season, early cessation of the rains, erratic rainfall, and rising temperatures accompanied by high sunshine intensity. The unpredictable rainfall and high temperatures adversely affected cash crops, food crops, and livestock production, which are the mainstays of the farmers in the Kintampo South district. The observed changes in rainfall and temperature were attributed to several factors: deforestation, resulting from agricultural extensification, poor soil management, bush burning, and felling of trees for timber and fuelwood; land use changes driven by population growth and urbanization; and poor agricultural practices linked to agricultural extensification and intensification. In addition to these human-induced changes, the smallholder farmers identified natural climate variability, attributing it to the increasing influence of the dry Harmattan winds from the Saharan Desert affecting the forest-savannah transitional agro-ecological zone.

The findings revealed the role REP interventions played in reducing the vulnerabilities among smallholder farmers through adaptation practices. The findings of this study suggested that the programme has played a key role in agriculture and agro-enterprise development within the vulnerability context of the Kintampo South district. These were

achieved through access to credit to support improved farm management practices, changing cropping practices, proper use of agrochemicals, intensifying livestock production and livelihood diversification and asset acquisition. Fujisawa et al. (2015) argue that combining institution-led and farmers-initiated approaches facilitates widely accepted and more flexible practices involving diverse actors in response to climate change and variability. This approach renders the adaptation process more innovative and dynamic. Furthermore, practical analysis of agricultural vulnerability is fundamental to developing viable adaptation options to manage anticipated climatic impacts and supporting adaptation planning (Ndamani & Watanabe, 2017).

Contrary to the burgeoning literature that links institutional forces to the exclusion of vulnerable and marginalized farmers, increased production risk, indebtedness and loss of autonomy (Dapilah, 2023; H. H. Wang et al., 2014), this study's results revealed a different scenario. Smallholder farmers who benefitted from the REP interventions accessed essential material and non-material resources, including agricultural inputs, financial capital, capacity training, and technology. These findings are consistent with REP's aim to develop rural micro and small enterprises. This objective was achieved by building capacity and training in on-farm and off-farm agro-industry, creating an enabling environment to generate businesses, create jobs and facilitate access to rural financial services. Despite the successes of the REP in the Kintampo South district for the smallholder farmers, like many adaptation initiatives, its implementation was not without challenges. The smallholder farmers reported financial constraints and access to credit, socio-cultural barriers, limited access to information and awareness and infrastructural deficiencies as the main challenges in participating in the REP interventions. Addressing these challenges requires a multi-faceted approach. Such an approach includes improving information dissemination, enhancing financial support systems, providing targeted training and capacity-building programmes, upgrading infrastructure, and fostering an inclusive environment that respects local socio-cultural customs and values while promoting equitable participation.

The accomplishments of REP have significant policy implications, highlighting the importance of integrated approaches to community development and climate adaptation. For policymakers and development practitioners, the programme underscores the need for initiatives that address the interlinked challenges of economic development, social equity, and environmental sustainability. The REP represents a comprehensive model for community development in the face of climate change and variability. Through its multi-faceted interventions, the REP enhanced the adaptive capacities of rural communities and contributed to their climate adaptation and overall development. As the world continues to grapple with the challenges of climate, the lessons learned from the REP interventions offer valuable insights for designing and implementing effective adaptation strategies that are inclusive, sustainable, and responsive to the needs of the most vulnerable communities and obviate smallholder farmers' vulnerability. Accordingly, our findings offer five major policy takeaways for future interventions to support smallholder farmers in their adaptation strategies.

First, future interventions should focus on market access and value chain development. Implementing policies that facilitate better market access for smallholder farmers is important to enable them to sell their products at fair prices. Additionally, future interventions should focus on developing the entire value

chain, from production to processing and marketing, to increase the profitability and sustainability of agricultural activities. Second, the paper advocates for future programmes to invest in rural infrastructure development, such as improving irrigation systems, constructing storage facilities, and enhancing transport networks. These are essential to facilitate efficient farm operations, reduce post-harvest losses, and ensure that products reach markets efficiently. These are all critical for adapting to and thriving in changing conditions. Third, policymakers and development practitioners must embrace skills and technology transfer policies and programmes. These initiatives are essential to empower smallholder farmers, enhance their productive capacities, and ensure their autonomy while reducing production risks and indebtedness. Fourth, there is a need to strengthen policy measures that improve smallholder farmers' access to financial services. This access includes providing microfinance options, subsidies, or low-interest loans for purchasing inputs, adopting new technologies, or investing in farm improvements, which are critical for adapting to changing environmental and market conditions. Most importantly, there is a need for decisive government intervention to support micro and small-scale enterprises in accessing credit. Fifth, since secure land tenure is crucial for long-term agricultural investments, future interventions must recognize and work within the existing land tenure frameworks and broader socio-cultural barriers to help mitigate potential challenges. The study found that if smallholder farmers face uncertainties regarding traditional beliefs, social norms, and structures such as land rights, it could hinder their engagement in interventions such as the REP, especially in activities that require significant changes to land use or long-term investments.

Despite the positive findings of the study, we recognize that it has some limitations that should be addressed in future research: (a) a deeper systems study of paired beneficiaries and non-beneficiaries could strengthen the case for the success of the REP interventions, and (b) a robust and empirically mixed method of quantitative and qualitative approaches could provide rich evidence of emerging issues and share in-depth understandings and allow for generalization across similar contexts.

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