DRY SEASON GARDENING AS CLIMATE LEARNING BY RURAL WOMEN

Case Study Final Report

Ghana

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Dry-Season Gardening as Climate Learning by Rural Women | Ghana Case Study[1]

Executive Summary

Climate change impacts are increasingly affecting societies and the livelihoods of people in rural communities of the global south. Thus, adaptation to these impacts is inevitably necessary for livelihood sustenance. Dry-season gardening is one of the ways through which rural communities adapt to inconsistent rainfall patterns and droughts in rural areas. The main goal of this case study was to identify how community-driven climate solutions like dry-season gardening can inform climate change education and communication among rural women in the community of Kuliyaa in northern Ghana. Specifically, this research highlights community-led women's involvement in dry-season gardening as a solution to climate change impacts.

The case study adopted a community-based participatory research design to examine dry-season gardening as a meaningful climate change adaptation education strategy among rural women. Dry-season gardening is a key climate adaptation strategy in many developing countries. In northern Ghana, dry-season gardening is a livelihood source for most rural families. Regarding climate change education, these gardens serve as pedagogical sites for sharing climate-related information.

Guided by a Community Research Advisory Committee (CRAC), consisting of community female knowledge keepers and Elders from the community (see Bourassa et al., 2020), this case study investigated women's participation in climate change adaptation through dry-season gardening. This research helps to understand why community-led climate initiatives are key to climate change adaptation education and communication.

A Community Research Assistant (CRA) from the community of Kuliyaa led the research process, including recruiting 20 female and four male co-researchers and the data collection process. This qualitative case study used multiple participatory approaches for data collection: monthly CRAC meetings, Focus Group Discussions (FGDs), and one-on-one interviews with Elders and other stakeholders. Information from the CRAC meetings informed the design of the focus group discussion questions. Additionally, it emerged from the focus group discussions that there was a need to have additional interviews with other key stakeholders.

This narrative report has five main parts. The first part is the general description of the climate communication and education initiative (CCE) initiative. This research investigated dry-season gardening, including its aims, audience, and the theory of change taken by the initiative. The second part is the research methodology, explaining the research design and methods of the project. The third part presents our findings and explains why this project exemplifies a quality CCE program. The fourth part of this report highlights the most critical impacts of this research. The fifth part of this report discusses the lessons to learn about scaling and the applicability of the CCE initiative in other contexts.

CCE Initiative

Community-based initiatives have been highlighted as the pillars of climate change adaptation solutions. Community gardens, particularly dry-season gardening, have been found to play a key role in climate change education (Walter, 2013). These gardens serve as pedagogical sites where rural women can share climate-related information.

[1] The views in the report are not necessarily endorsed by the MECCE Project, which funded the research. This report was republished in 2025 following additional copy editing to increase the report's clarity.

Climate change has exacerbated the suffering of rural communities in most developing countries including Ghana. Droughts and shorter rainy seasons have impacted negatively on rural livelihoods (Dumenu & Obeng, 2016). Dry season gardening education has long been one of the major adaptation strategies adopted by rural communities in Northern Ghana to adapt to climate change (Nakuja et al., 2012). However, the framing of climate change education has come under intense criticism for silencing community voices and being dominated by western worldviews. The needs of the less wealthy and socially disadvantaged groups in society should be projected in climate change adaptation. Particularly in male-dominated societies, the gender dimension of climate change in the global south has not been widely investigated to showcase the participation of women in dry season farming as an adaptation strategy to climate change impacts on rural agriculture. Climate change initiatives that are taken by governments and international organizations usually gain attention in climate change discussions. However, rural communities within the African context are taking community-led initiatives to adapt to climate change which often go unnoticed. Thus far, some of the most successful climate change initiatives that have occurred in the sub-Saharan region have emerged from communities themselves. This has been shown by Yacouba Sawadogo's initiative to regreen the Sahel region using Indigenous farming methods (see Hertsgaard, 2012).

Community-led initiatives add a different layer to climate change education. Mearns and Norton (2009) argued that the success of climate change intervention programs depends on the institutional capacities of rural people. This, therefore, enhances self-determination in the fight against climate change. Besides, it has been found that community-led initiatives enhance continuity than interventions introduced by outsiders using a top-down approach (McCarthy, 2014). Climate change interventions have mostly been introduced by government agencies and international organizations. However this CCE initiative is novel as it highlights a case where a community is taking its own initiatives to adapt to climate change. This shows that some rural communities are not just waiting to be saved by international organizations as mostly portrayed in the African context. These critical issues are necessary for climate change education.

Case Study Methods

The case study was done by the Department of Geography Education, University of Education, Winneba, Ghana. Raphael Ane Atanga, Principal Investigator, is the key person in the project.

This research investigated inclusive community-driven climate change adaptation education solutions through dry-season gardens among rural women in Kuliyaa. In answering the main research objective of investigating how community-driven climate solutions through dry-season gardening inform climate change education and communication among rural women in the community of Kuliyaa, we adopted a community-based participatory research (CBPR) theoretical framework. The primary aim of this research was to identify how community-driven climate solutions and dry-season gardening can inform climate change education and communication among rural women in the community of Kuliyaa.

Our target audience included climate change researchers, government agencies, and non-governmental organizations working within rural communities. The need for gendered climate change education informed this research. As a result, our design examined climate change education using a gender lens.

The sub-objectives of this case study included:

1. Investigate participatory communication education and inclusive community-driven climate change adaptation solutions through dry-season gardening in Kuliyaa.

2. Understand female involvement in dry-season gardening in Kuliyaa through communication education and how this affected inclusive community-driven climate change adaptation solutions.

Based on the adopted CBPR framework, a Community Research Advisory Committee (CRAC) from the Kuliyaa community guided the entire research project. The CRAC consisted of female Elders, Knowledge keepers (composed of locally knowledgeable females in the community), and women from the community. On the recommendation of the CRAC, four men were included in the research, as they supported the women in their gardening activities.

The CRAC had many experiences surrounding climate change, dry-season gardening, traditional land tenure systems, and other resources available to women to engage in dry-season gardening. In addition, a Community Research Assistant (CRA) from the community of Kuliyaa led the research process, including recruiting 20 female and four male co-researchers, data collection process, workshops, and focus group discussions. Although the research focused on rural women, the four male co-researchers played significant roles in supporting the women with their community garden. The CRA ensured the research was executed ethically and all community cultural protocols were followed. This research used multiple participatory approaches for data collection: monthly CRAC meetings, Focus Group Discussions (FGDs), and one-on-one interviews with Elders and other stakeholders. Information from the CRAC meetings informed the design of the focus group discussion questions. It emerged from the focus group discussions that there was a need to have additional interviews with other key stakeholders.

Monthly CRAC meetings were held with five female Elders (CRAC members) of the women's organization (the Kabembia Tigisem) to guide and direct the research. Additionally, FGDs were held with 20 women of Kabembia Tigisem who engaged in dry-season gardening. The FGD guide questions were structured under themes/headings that reflected the main and specific research objectives of this research. It emerged during the workshops that there was a need to interview other key stakeholders. As a result, the second data collection phase was a one-on-one interview with three men of Kuliyaa and a male patron who supports the women in their dry-season gardening activities. This helped fill up gaps in the initial data. This brings the total number of research participants to 24. This approach not only added broad perspectives but also brought newer ideas to the discussion. A purposive sampling method was adopted to recruit the 24 co-researchers for this research. The inclusion criteria were women and men above 18 years old living within the community of Kuliyaa who engage in dry-season gardening.

Case Study Findings

The case study found that an inclusive community-driven climate solution through dry-season gardening could inform climate change education and communication among rural women in the community. The dry-season gardens also increased the CRAC members' (co-researchers) knowledge about climate change adaptation, empowered them economically, provided household livelihoods, and led to food security for families. The most important findings relating to CCE that emerged from our case study are as follows:

Our findings indicated that the CCE initiative, gender-inclusive dry-season gardening, enhances women's livelihoods, empowers communities, strengthens community capacity, and improves self-determination. According to UNDP Ghana (2019), "Women in rural communities in most developing countries like Ghana are often vulnerable to climate change because they depend a lot on local natural resources for their livelihoods" (para. 2). Although both men and women suffer from the impacts of climate change, women face a heightened burden because they do not have access to resources. This fact further highlighted the need to

integrate gender issues into climate change adaptation education and communication. The gender dimension of dry-season gardening was highlighted in our case study Socio-cultural, economic, and political factors remain significant barriers, preventing women from accessing formal sector employment within Kuliyaa. As a result, women depend directly on the land and natural resources for survival within the community. Therefore, they are at higher risk of climate change within the community than their male counterparts. Centering gender in climate change education is key to addressing these unique challenges. As UNDP-Ghana (2019) concluded, gender issues are integral to climate change mitigation and adaptation to minimize climate change impacts on women and children.

Although these barriers exist within the community, the findings showed women are making significant efforts to adapt to climate change. The co-researchers described dry-season gardening as an important source of employment for most women within the community. The gardens support families financially, promote self-reliance and enhance access to healthy foods. Further, the women have formed an organization, the Kabembia Tigisem, to enhance women's participation in dry-season gardening.

The community gardens serve as an alternative source of livelihood. The findings supported earlier studies that showed community gardens in dry-season gardening enhance women's resiliency (UNDP Ghana, 2019). However, this research demonstrated the gardens serve as pedagogical sites for learning about climate change and alternative sources of livelihood for women in the community, helping with mitigation and adaptation to climate change within the community. This helps to empower women within the community in the fight against climate change (Wright-Asante et al., 2017). Another important finding is that the women started this livelihood activity of dry-season gardening by themselves. This means they were more than just helplessly waiting for external livelihood support from the government or international organizations for aid, as often portrayed in the African context (Adekoya, 2013; Randolph & DeMulder, 2008). This point must be highlighted as it is key for promoting self-determination in the fight against climate change (Acharibasam, 2022). Community gardens provide an avenue for engaging in climate change adaptation education. The results show that the dry-season gardens serve as pedagogical sites for rural women in the community of Kuliyaa.

The gardens serve as a source of climate change information for rural women to adapt to climate change, helping inform adaptation strategies within the community. The women's organization plays a key role in climate change education within the community of Kuliyaa. The community gardens are open to all women, including new arrivals, providing an opportunity to share climate change information among women. It is an effective way to introduce new community women to the climate change challenges within the community of Kuliyaa. Women new to the Kuliyaa community learn about climate change from the women who already live in the community through personal engagement on meeting grounds and in the gardening processes. The experienced women teach the women new to the community as they all participate in gardening activities and share information about climate change in the community. Following this, the process of teaching new women about climate change is informal, practical, and experiential through the gardening process. The new women learn about climate change as they participate in gardening activities. Besides the peer-to-peer learning, it emerged that due to increasing droughts, the female Elders and Knowledge Keepers provide teachings on the type of crops to grow, raising nursing beds, nursing seeds, transplanting, treating pests traditionally, and watering crops efficiently. Having personally experienced and lived through climate change impacts, these female Elders are a resource that the women rely on for climate change education. Again, these are respected members of the community whose words carry weight. These findings are key to climate change education in the Ghanaian context.

Another finding is that group learning is key to climate change education. Engaging rural women as a group enhances climate change education which has the potential to impact people's mental health. This can be seen in the form of climate anxiety, solastalgia, and ecological grief. We found psychosocial aspects of climate change in this case study as community members had experienced adverse effects from climate change and lost their livelihoods due to floods and droughts. The co-researchers described floods destroying their gardens and expressed despair in the fight against climate change. As a result, social connections and support systems are critical to learning and adapting to climate change. The women reported that gardening and doing things as a group fosters unity and plays a crucial role in how they adapt to climate change. Through this group, women learn how to garden, have access to vegetables even if they do not cultivate a garden or lose their gardens to adverse climatic events, and get support in times of ill-health or climate-related disasters like building collapses. Houses in the community are built with mud, and heavy rains and floods can sometimes lead to houses collapsing. These social supports are key to adapting to climate change within rural communities. Working as a group facilitated access to land as it presented a common front in convincing the area chief to release land for their activities. Since the community is a patriarchal community where men inherit the land, this group is helping break down some of these social barriers related to land tenure systems. Offering climate change education in groups within rural communities like Kuliyaa helps address economic, environmental, and social norms and traditions that reduce women's capacity and prevent accessing resources to adapt to climate change. Working as a group allowed for mentorship from the Elders in the community. Further, environmental signals educated the women about climate change within the community. It emerged that changes in the rainfall patterns, including the length, duration, start and end of the rainfall and dry-seasons, and increases in temperature and amount of rainfall constitute local environmental signals which communicated and educated the women about the changes in the climate of the community. Additionally, the invasion of termites in gardens and poor fruition of wild economic trees like shea nut, dawa dawa, and baobab trees also change due to the impacts of droughts in the community.

Women's participation in dry-season gardening is helping to change (neutralize) gender roles. Previously, gender roles were well-defined within the community of Kuliyaa. Men did physically challenging tasks like digging wells for dry-season gardening while women transported vegetables to the market for sale. However, these roles are changing as women now also dig wells. According to the Female Elders, women do not get the needed support from men anymore, and they now dig wells as a result. This finding, changing gender roles resulting from climate change, is key to CCE education. The findings suggest that dry-season gardening seems to play a role in reshaping gender roles in the Kuliyaa community. Gardening in the community used to be largely a male practice. Given the patriarchal nature of the community, the men mainly owned gardens, and their wives and children assisted with light activities such as preparing food, selling garden produce, bringing fencing materials, and watching over vegetables against destruction by stray animals. While the traditional role of women in the community was limited to domestic chores in the past, dry-season gardening in adaptation to climate change seems to be changing this tradition in terms of women's role. Through the women's group, the women currently own gardens and engage in gardening activities in addition to domestic activities, such as household chores. While this increases the burden on women's roles, it provides them with more economic freedom to earn income to support their families. Additionally, climate change has led to the seasonal migration of men from the community to other parts of Ghana, especially southern Ghana, in search of jobs. This has resulted in a situation where most households have only women and children to feed. To support themselves and their children, the women have started engaging in dry-season gardening. With the men gone, it has become difficult to find men to assist in digging wells for dry-season gardening. To fill this gap, women have taken up the responsibility of digging wells

and being the primary breadwinners for their families in the absence of their male partners.

The case study revealed gaps in current climate adaptation strategies introduced by the (Ghana) governments and other organizations in the form of early maturing crops and how this has led to shortages in fencing materials (millet stalks) for dry-season gardens. Due to rainfall variability, the Ghana government is rolling out programs encouraging farmers to switch from traditional crops like millet to early-maturing crops like maize. Cereals like millet require much water and long maturity periods to grow, but they play significant cultural roles within the community. The millet stocks are fencing materials for dry-season gardening and can also be used as roofing materials for huts and fuel for cooking in households. As the CRAC described, fencing is an issue because climate change impacts, including shortage of rainfall, have affected millet growth. Thus, they all grow maize now. As a result, they do not produce fencing materials for the gardens. Unfortunately, community members have resorted to felling the few trees within the community to fence their gardens, leading to deforestation and loss of traditional medicinal trees in the community. Climate impacts on traditional crops and how this impacts rural communities' health and wellness are key to CCE. Addressing how to adapt to climate change and maintain cultural practices is also important for quality CCE. Again, highlighting insufficiencies of government climate change policies is key to effective CCE. The community members communicated the need for community-led solutions and broader consultation before governments introduced climate change solutions. In the case of this policy, the community members were not consulted before the climate solution was introduced. The provision of alternative fencing and roofing materials and energy sources for cooking would have supported community members to adjust better to government policy. The policy influence from the community level seems ineffective because the many years of efforts from the community to get electricity from the national electricity grid did not succeed.

The women of Kuliyaa have adopted an innovative communication channel for communication and knowledge sharing related to climate change. Realizing many of the members do not own cell phones, oral forms of communication became the most common and effective means of dissemination of climate change information among the women group:

> *We communicate among ourselves mostly by word of mouth. Should we have a meeting, our leader will pass the information to us through word of mouth. One person sends it to the other, and then it is passed to the other person all by word of mouth. We sometimes also use mobile phones to communicate among ourselves, but that is not too common since many of our members do not have a handset.* (*FGD, Kuliyaa, December 16, 2022*)

This form of participatory communication is key to climate change education among the women of Kuliyaa. This relates to the participatory communication model, where dialogue, information sharing, perceptions, and opinions among various stakeholders facilitate empowerment, especially for the most vulnerable (Tufte & Mefalopulos, 2009). Again, using person-to-person communication, as demonstrated in this research, builds trust in climate information and allows the women to ask further questions from knowledgeable members.

It emerged that women faced unique barriers in participating in dry-season gardening. The co-researchers reported inadequate water supply, lack of fencing material, and limited funds as some of the barriers preventing them from participating in dry-season gardening. Particularly, the co-researchers noted that the water table has become very low because of droughts. As a result, it has become difficult to dig the wells they rely on to water their gardens. The women also complained about how difficult it is to draw water from some of these wells to water their gardens because of the deep water table. These exhausting activities negatively impact the health and wellness of the women. Irrespective of these challenges, the women in Kuliyaa still engage in gardening to feed their families, as the following describes:

> *We currently depend on the gardens to feed our families and also earn some income to take care of our children in school. Without dry-season farming, hunger and starvation will be serious in our communities. (FGD, Kuliyaa, December 16, 2022)*

The last outcome from this case study emerged in how the community-based participatory research approach helped address gender inclusivity in dry-season gardening in climate change adaptation. The main concern about research within remote communities in Africa has always been the adoption of helicopter research, creating a situation where researchers' voices outweigh those of community members. As a result, the community-based participatory research created the space for the community to lead and guide the research through their CRAC. It addressed the power relations in the research, presenting the researchers as learners and the community members as experts. This created a safe space for the women to share their experiences with climate change and dry-season gardening. Additionally, the methodology helped build capacity as this was the first time the community engaged in a research paradigm where a CRAC and CRA were formed and recruited. The community's knowledge was prioritized in the research process. The CRA guided the researchers on cultural protocols within the community while the researchers also mentored the CRA on how to do research and apply for and hold grants. This created the space within the research process for reciprocal and iterative learning. The methodology also helped build respectful relationships within the community where research power was with the community. The community decided on the workshop dates, reviewed and approved PowerPoint slides, and all focus group and interview questions. Integrally, they were included in the data analysis process, ensuring the community was involved in all research processes from its inception and proposal design stage to its completion. The findings were presented to the community members before being shared with other agencies. All resources for the research remained in the community, and CRAC members were given honoraria for their time. The CRA was also employed locally and paid a salary. All research equipment for the research is left with the community of Kuliyaa. This reflected an entirely different approach to doing research in a good way. The relationship with co-researchers further built trust, which enabled the researchers to obtain shared knowledge about dry-season gardening. CRAC meetings provided an opportunity for the community to lead the research, ensuring their knowledge is upheld. Through the CRAC meetings and the knowledge obtained, the research came out with relevant questions for further discussion during focus group discussions. This was an additional platform to include other women in the discussion.

Besides, further recommendations through snowballing extended the learning platform to include a few men who played a critical role for the women in their gardening activities in the community. This provided an avenue to know that men and women primarily have specific roles to play in gardening where energy-demanding jobs and providing security for the garden are male jobs, while the women do the other jobs in the garden. Thus, this collaborative, participatory approach to research provided an avenue to understand how inclusive participation of women in dry-season gardening in adapting to climate change. The community members described the research process as a good way to do things and something different from previous research. The CBPR framework adopted has helped to build trust with the community further.

Psychosocial Learning Dimension

The case study findings showed some co-researchers were struggling with the psychosocial aspects of climate change impacts. Most of the women had lived experience with the adverse effects of climate change. This emerged as either losing their livelihoods to floods or housing facilities due to floods. Bringing the women together through this research process helped build the capacity and social connections needed to support them in adapting to climate

change. The CRAC meetings and the FGDs brought the women together and helped to share climate change information, which was crucial to climate mitigation and adaptation. Again, other gaps were identified through this research where the researchers and the community members may apply for further funding to support the women to adapt to climate change. For example, the case study researchers are supporting the women in putting together an application to a local NGO for fencing materials for their gardens.

Action Learning Dimension

The case study incorporated action-learning with the community, where the Elders led gardening activities with the co-researchers. Activities included a nursery, transplanting activities, composting and organic manure, effective watering, and mulching to conserve moisture. These were hands-on practical activities led by the Elders and other knowledge keepers in the research. This also created the space to engage in discussions surrounding using fertilizers and genetically modified seeds that have been approved in the neighbouring country of Burkina Faso. This created the space for the researchers and Elders to engage co-researchers on the need to stick with traditional seeds within the community.

Climate Justice

This case study addresses the marginalization of women's voices in CCE as a social justice issue within the global south. Within male-dominated societies, the voices of rural women, their perspectives, and climate change adaptation activities are marginalized in climate change education, especially in international discussions about climate change.

Meanwhile, women face a heightened burden from climate change due to socio-cultural and economic reasons forcing them to depend directly on the Land for survival. According to UNDP Ghana (2019), "Women in rural communities in most developing countries like Ghana are often vulnerable to climate change because they depend a lot on local natural resources for their livelihoods." (para.2). Although both men and women suffer from the impacts of climate change, women face a heightened burden because they do not have access to adequate resources. Therefore, women's climate change educational needs differ from men's, and climate change education must consider some of these gendered responses. Evidence shows dry-season gardening education has become rural women's major climate change adaptation strategy in northern Ghana (UNDP, 2019).

Indigenous Knowledges/Participatory Methods Influences

The CCE initiative, engaging rural women in dry-season gardening, was centred on Indigenous knowledge. Adopting a CBPR framework, our case study brought the community's Indigenous knowledge to the forefront. Discussions involving Female community Elders and Knowledge keepers through CRAC meetings and FGDs about dry-season gardening were centred on Indigenous knowledges and cultural protocols. Based on this, the female Elders and Knowledge Keepers led all knowledge sharing on gardening activities, drawing on their traditional knowledges about climate solutions to dry-season gardening. Specific activities included traditional approaches to composting, nursing seedlings, transplanting plants, watering, and traditional approaches to mulching and conserving moisture for plants, and traditional approaches to controlling pests. Besides, the research shows that the CBPR framework created a platform to investigate and understand the form of participatory communication education and inclusive community-driven climate change adaptation solutions through dry-season gardening in Kuliyaa. The approach further allowed the researchers to understand female involvement in dry-season gardening in Kuliyaa through communication education and inclusive community-driven climate change adaptation solutions.

Cultural and Regional Contexts Influences

Cultural and regional contexts influenced the case study design, development and implementation in several ways. The community of interest, Kuliyaa, is a rural farming community with patriarchal ways of life and traditions that position men as decision-makers, heirs to family resources and decision-makers in the society, similar to the regional context in Africa. Women are seen as secondary to men in this patriarchal context, which means women cannot be heirs to land, and they need men (husbands) as leads to acquiring land. Access to the community land for the garden is free, following the traditional land acquisition procedures. The patriarchal and traditional nature of the community required the researchers to go through the patriarchal traditional community entry process. This further legitimatized and strengthened the case study in the community. However, the FGD and the CRAC meetings involved only women to avoid any potential dominance of men in such discussions due to this tradition. The language of the community also influenced the research design. The rural context determined the schedules of data collection and CRAC meetings to ensure successful research processes. Dry-season gardening as a climate change adaptation solution further fits into the regional context where farming is the primary source of activity for the people. Rural people's adaptation to climate change, where rainfall has been the mainstay of agriculture, turns to see dry-season gardening as an alternative source of food production. The implementation involved men and women executing the project because women work in collaboration with their husbands. Thus, the community sees gardening activities as supportive of family livelihoods that require the collaboration of both men and women.

Sharing Learnings Across Geographies

Geographically, the research findings benefit countries in the global south engaging in CCE. The primary learning outcome is how governments, organizations, and private individuals can support women in rural communities in adapting to climate while maintaining indigenous cultural practices which support the environment and sustainability.

Case Study Impacts

Internal Impacts

To achieve quality CCE, community-led approaches must be adopted where community voices are prioritized. Our case study has transformed how climate change research is conducted within the community of Kuliyaa. By adopting a CBPR framework, we created the space for the community to lead the climate change education process. Critically, the case study helped equalize power imbalances within research, build trust between researchers and communities, and foster a sense of ownership over the research (Castleden, Garvin, & Huu-ay-aht First Nation, 2008). The CBPR ensured ample collaboration between the research team, researchers and Elders, Knowledge Keepers, and community members. The framework allowed for relationship building, co-learning, and mutual capacity building in CCE. The focus of the case study, its innovative conceptualization, design, and approach have influenced individual researchers and organizations alike in CCE from local, national and international levels. Within the local community, individuals, women in general, and organizations in the community of Kuliyaa and beyond grasped relevance in our research focus, concepts, methods, and approach to the quality CCE research we undertook in the community.

The co-researchers appreciated our research focus on gender, dry-season gardening as an adaptation to climate change impacts and the collaborative qualitative approach to the study where the researchers, CRAC, CRA and other stakeholders shared knowledge in monthly meetings for one year in addition to FGDs and key informant interviews in the data collection process. The focus on climate change and gender made women's actions in adaptation to

climate change visible in the community. This also improved women's confidence in their group approach to tackling the problems of climate change in rural settings instead of addressing them individually. The approach to this project lends positive and innovative influences on research approaches at personal and organizational levels because these collaboratives and CRAC approaches to research, where the members of the CRAC are co-researchers rather than being mere participants, give the co-researchers collaborative power and ownership of the project and the research process. Therefore, the impact at the individual and organizational levels can be seen as positive and could influence the scientific approaches and concepts of local and international researchers and policymakers. Unlike the usual helicopter research, this case study was produced thanks to healthy and ongoing collaboration between the research team and the Kuliyaa community. Implementation of practical recommendations from the case study in the local community has local support. Besides, the impacts on local and international perceptions about women's roles in rural communities in adaptation to climate change can begin to broaden and shift towards gender inclusivity and group learning.

As noted earlier, women are disproportionately impacted by climate change. Gender, therefore, plays a key role in climate change education. The climate-change educational needs of women differ from those of men. The main objective of our work is to reduce negative climate change impacts on rural women. This case study created the space to address rural women's climate change-related educational needs by having their voices heard. The findings from this case study have wide applications. In addition to addressing women's immediate climate educational needs, the findings also have national and international significance. For example, the findings have revealed gaps in climate change policy at the national level in the introduction of early maturing crops. In addition, we have raised questions to inform climate change education globally. How can climate change education help adapt to climate change while maintaining Indigenous crops and other significant cultural practices?

External Impacts

Another important impact of this case study is on the climate change education of women in the Kuliyaa community and other rural people at the local, regional, national and intergovernmental level policies and initiatives. Our case study findings go beyond local knowledge sharing and CCE at community levels, involving researchers, governments and organizations interested in climate issues. Our study applied a qualitative case study approach to investigate women's inclusion in dry-season gardening in adapting to climate change. The impacts of this study on CCE are related to climate adaptation practices and group learning among rural women in Kuliyaa and similar rural areas in a broader context. The case study design involved women in CCE, which helped to project the role of women in climate change education research, adaptation, and sustainable rural livelihood.

Applicability and Scaling of the CCE Initiative

There is potential to scale up this project to further address the climate educational needs of women within other rural communities in northern Ghana. Given the work done with the Kuliyaa community, women from our other community partners (neighbouring communities) have expressed the need to engage the researchers in similar CCE initiatives. For example, the results from this research can be expanded to explore more sustainable fencing materials for dry-season gardening to prevent deforestation.

In terms of applicability, because this case study adopted a qualitative research approach, we caution against generalizing our findings. Through our community-based research work, we have learned that communities are different, and we do not adopt a pan-Indigenous approach to working with our community partners. However, there exists the possibility of implementing similar CCE initiatives in communities with similar sociocultural features to the

community of Kuliyaa. The main results from this study suggest that scaling this research to a broader scope and rural context in the application of its findings and future research could be very impactful in CCE.

The application of the results and recommendations from this project to a broader geographical scope with similar socioecological conditions as Kuliyaa should be done with care. The results from our case study create an opportunity to conduct future research using multiple case studies with a bigger sample size plus qualitative and quantitative research methods so that the results can be more usable for both empirical and theoretical generalizations. This qualitative case study is based on a single case study set in a community in Ghana, and the results are most relevant to this context. Results from a single case study might be applied in other contexts for conceptual generalization rather than empirical generalization since the sample size is too specific for the results to be relevant to the general context (Yin, 2014).

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