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Using participatory videos in understanding farmers experiences with climate smart agricultural practices: reflections from Ghana

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Climate-smart agriculture (CSA) has gained traction as one of the effective strategies in tackling the climate crisis. Many CSA practices have been promoted by development agencies to smallholder farmers based on the assumption that farmers would adopt these innovations for their potential benefits. However, the adoption of CSA practices in Ghana and much of Africa remains low and decision making and on-farm innovation processes are poorly understood. This study seeks to provide empirical and participatory insight into how smallholder farmers innovate. Based on a novel application of a participatory video methodology, in farming communities in the Upper West Region of Ghana, that have been exposed to multiple CSA intervention programmes, the paper analyses farmers' own self-curated accounts of experiences with CSA innovation. The findings show that farmer's motivation to adopt CSA innovations is driven by their concerns for food security, economic gains, and the environmental impact of climate change on their farming activities and livelihood. The study reveals a mismatch between the CSA technologies and practices advanced by the development agencies and what farmers perceive as relevant and important in addressing their farming challenges. In particular, the findings show that in a pool of more than 12 CSA technologies and practices that had been promoted through three donor-driven intervention programmes in the communities, farmers selected less labour intensive, less costly, and CSA technologies and practices that fitted to their current farming practices and the local context. Agricultural extension agents served as an important information source on the CSA innovation and their practical implementation and farmers' social groups played a crucial role in facilitating learning about the CSA technologies and practices. There is the need to integrate farmers voices using innovative methodologies such as participatory videos to better understand farmers' experiences in the innovation process which will help inform the design of effective interventions and promote adoption of innovations aimed at enhancing the productivity of smallholder farmers and reducing environmental impacts in African food systems. By focusing on the innovations that farmers perceive as beneficial and adaptable to their local contexts, development organizations can use their resources more efficiently and promote adoption of contextually appropriate CSA innovations.

KEYWORDS

climate smart agriculture, participatory video, innovation process, adoption, smallholder farmer, Ghana

1 Introduction

Climate change has emerged as a major threat to agriculture, food security and livelihoods for millions of people in the world especially smallholder farmers, as a result of their limited economic resources that restrict access to alternative livelihoods (Antwi-Agyei, 2012; Zougmoré et al., 2018). Sub-Saharan Africa (SSA) is particularly vulnerable because of its low adaptive capacity and high dependency on climate-sensitive sectors including agriculture (Niang et al., 2017). Addressing climate change is crucial as it threatens food systems and the attainment of the Sustainable Development Goals (SDGs 13 & 12[1]) and Africa Agenda 2063 goals 5 and 7.

In a changing climate, smallholder farmers can benefit from innovations that improve their adaptive capacity and build resilience (Partey et al., 2018; Zougmoré et al., 2018). Climate-smart agriculture (CSA) has been promoted as a solution to the challenge of transforming agricultural systems to support food security in increasingly unpredictable climate conditions. CSA has the potential to achieve the levels of innovation needed to increase smallholder farmer productivity and reduce environmental impacts in African food systems (Jellason et al., 2021). With CSA, the form of agriculture practiced should sustainably increase agricultural productivity, build resilience, and reduce Greenhouse Gases (GHGs) where possible (Lipper et al., 2014). The most commonly promoted CSA technologies and practices in Ghana are conservation agriculture, agroforestry practices, climate information services, water conservation, composting, making ridges and many others, all of which help mitigate the adverse effect of climate change (Partey et al., 2018; Antwi-Agyei et al., 2021).

Despite the great potential of adoption of CSA technologies and practices, their adoption by smallholder farmers in Ghana and much of Africa remains low, and decision making and on-farm innovation processes poorly understood (Nyasimi et al., 2017; Partey et al., 2018; Zougmoré et al., 2021). Gendered social norms further constrains women's capacity to adopt CSA technologies and practices (Jellason et al., 2021). Understanding the reasons behind this low adoption is crucial in developing effective CSA interventions. CSA interventions are often designed and promoted by development agencies, selectively recognizing and involving stakeholder in participation, and having their preferences recognized, which influences the outcomes of such interventions (Mustalahti et al., 2012; Mathur et al., 2014; Sova et al., 2015; Wood et al., 2016). Wood et al. (2016) studied donor funded projects in Malawi and found that donor agencies are driving design processes and involving other stakeholders selectively. Such top-down approach restricts the opportunity for local people to participate in development projects and have their preferences recognized in the design and implementation of such development interventions (Atela et al., 2015; Andrieu et al., 2019). This results in procedural injustice emanating from power dynamics which reduces the likelihood that such development projects will be contextually appropriate and have widespread stakeholder buy-in (Sova et al., 2015; Wood et al., 2016). The local people for which these development project interventions are meant to improve their livelihood often desire to be involved in decision making process and design of project interventions (Mutune and Nunow, 2018; Makate, 2020; Ogunyiola et al., 2022). Involving local people in development interventions can help expand their intellectual capabilities and facilitate their interest and engagement in the implementation of development project, resulting in the achievement of large-scale change and project outcomes that improve the livelihoods of local people (Alkire et al., 2015; Andrieu et al., 2019). However, the achievement of these benefits remains precarious when local people are selectively recognized and their preferences are not recognized in the decision-making processes in the design, planning and implementation of development project interventions.

It is often the case that many CSA technologies and practices are promoted by the development agencies to smallholder farmers with the assumption that farmers would adopt these CSA technologies and practices for the potential benefits and that these innovations would be widely adopted, and upscaled for broader impact in the agricultural food system. But in reality, this is often not the case, and CSA technologies and practices are not widely taken up as expected (Lipper et al., 2017; Thornton et al., 2018; Westermann et al., 2018). This raise concerns on whether there is the need for the many CSA technologies and practices advanced to the smallholder farmers and whether these CSA technologies and practices align with smallholder farmers preferences.

In seeking to understand the plausible reasons for the low CSA adoption, it is important to understand the complexity of the innovation process (Glover et al., 2019). Often adoption of a technology or practice is viewed as a simple linear process, with binary outcomes of adopters and non-adopters, without clarifying what needs to be counted as instances of adoption or recognizing the dynamic process of experimentation and learning characteristic of the innovation process (Meijer et al., 2015; Whitfield, 2015; Brown et al., 2017; Weersink and Fulton, 2020; Jellason et al., 2021). Technology adoption has often been perceived as readymade technological packages capable of being transferred smoothly from one setting to be adopted and implemented in anothjeller (Glover et al., 2016; Mathews, 2017). This is based on the diffusion of innovation theory (Rogers, 2003). Such conception of adoption tends to suggest adoption as a simple linear process with binary outcomes of adopters and non-adopters (Glover et al., 2019; Hermans et al., 2021). Such a linear view does not provide much insight on what needs to be counted as instance of adoption, intensity of adoption or recognize the dynamic process of learning and experimentation during the innovation process (Andersson and D'Souza, 2014; Whitfield, 2015; Brown et al., 2017). Also, a simple focus on adoption as linear process limits space for identifying and representing local knowledges within innovation process (Hermans et al., 2021). Also, reporting metrics based on binary outcomes of adopters and non-adopters risks overlooking unintended outcomes of interventions (Smith et al., 2021). There is limitation in understanding how individuals unequally experience the innovations across time and space (Whitfield et al., 2015; Smith et al., 2021). Different individuals experience these innovations in different ways, influencing their decision-making process towards the uptake of innovations. Recent studies on adoption have indicated the need to rethink and move beyond the simple linear model of adopters and non-adopters to further understand the complexity of the innovation process (Mathews, 2017; Glover et al., 2019; Pannell and Claassen, 2020; de Oca Munguia et al., 2021; Hermans et al., 2021).

1 SDG 13 – take urgent action to combat climate change and its impacts. SDG 12—ensure sustainable consumption and production patterns.

This study seeks to provide empirical insight into how smallholder farmers innovate. We examine the messages contained in farmers narratives of their experiences with CSA interventions using participatory video (PV) methods and provide insight on what happens during the innovation process. For this study narrative is defined as 'an unfolding story with the potential to serve as a theoretical thinking tool and an empirical guide to promote practical action (Jerneck, 2014). We move away from the use of conventional research approaches involving conducting research on the smallholder farmers where information gathering, and interpretation is carried out by external agents, to using participatory approaches, specifically participatory video in creating space and means for smallholder farmers to tell their stories in their own words and effectively included in the research process and information dissemination. PV integrates indigenous knowledge, providing the opportunity for rural people to document their own knowledge and experiences and to express their wants and hopes from their own perspectives (Lunch and Lunch, 2006). PV provide smallholder farmers the opportunity to voice their concerns and explore solutions to their problems (Haynes and Tanner, 2015; Richardson-Ngwenya et al., 2019).

The paper contributes to building knowledge on innovation process moving beyond the notion of adoption viewed as a simple linear process and presents the innovation process as ongoing and dynamic. From a methodological point of view, the study contributes to the use of participatory videos to better understand farmers' experiences in the innovation process which will help inform the design of interventions and promote widespread uptake of innovations. This is particularly important because the extant literature (Zakaria et al., 2020; Djido et al., 2021; Antwi-Agyei and Amanor, 2023) remains skewed towards the use of cross-section data and econometric approaches in understanding CSA adoption. Additionally, the study adds knowledge to the few previous studies (e.g., Brown et al., 2017; Glover et al., 2019; de Oca Munguia et al., 2021; Hermans et al., 2021; Smith et al., 2021) that have addressed the knowledge gap in rethinking adoption as a process which remains critical in understanding adoption of innovation which threatens increasing productivity of smallholder farmers and reducing environmental impacts in African food systems.

1.1 Understanding the innovation process

The diffusion of innovation theory by Rogers (2003) has widely been used in many studies to understand the adoption of innovations (Leeuwis, 2004; Loevinsohn et al., 2012; Teferi et al., 2015; Glover et al., 2016; Wongnaa et al., 2018). Rogers (2003) defined adoption of innovation as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003). Innovations is an idea, practice or project that is perceived as new by an individual or other unit of adoption (Rogers, 2003). With Rogers concept of adoption of innovation, adoption is assessed based on a binary metrics of individual decision to use or reject an innovation as the best course of action available to an individual (Rogers, 2003). Thus, an individual makes a yes or no decision with a linear development of adopting or not adopting an innovation (Glover et al., 2016). The adoption of innovations theory has often been applied in assessing the success or failure of agricultural interventions. This remains central in evaluating the impact of agricultural interventions and resulting technological change in Africa's agriculture (Glover et al., 2016, 2019). Adoption rates of new agricultural innovations are often measured in evaluating farmers adoption or non-adoption of introduced innovations and for making decisions about new investments to upscale innovations (Schut et al., 2020; Hermans et al., 2021). However, several scholars have pointed to difficulties with regard to such a use of the concept of adoption and a focus on binary metrics of yes or no decision to replace old technologies and practices with new innovations (Leeuwis, 2004; Loevinsohn et al., 2012; Glover et al., 2016). A focus of the conventional way of thinking about adoption overlooks important processes and decision-making through which innovation happens on farms (Sumberg, 2005; Hermans et al., 2021). It overlooks unintended outcomes of interventions (Smith et al., 2021), intensity of adoption, or recognizing the dynamic process of learning and experimentation during the technology change and transfer process (Andersson and D'Souza, 2014; Whitfield et al., 2015; Brown et al., 2017; Glover et al., 2019; Smith et al., 2021). Andersson and D'Souza (2014) critiques the notion of adoption as limiting the understanding of realizing what would be considered as full or partial adoption. The binary lens limits an understanding of farmers modification and adaptations to suit their local contexts. Thus, the conventional way of thinking about innovation as outlined by Rogers (2003) fails to view predictable patterns of innovation.

Understanding adoption should move beyond evaluation of adopters and non-adopters of innovation to further understand the complex dynamic process that shapes the innovation process (Andersson and D'Souza, 2014; Glover et al., 2019; de Oca Munguia and Llewellyn, 2020; Hermans et al., 2021).

The innovation process starts with the knowledge stage where the individual learns about existence of the innovation and seeks information about the innovation (Rogers, 2003). The information the individual receives about the innovation shapes his/her attitudes towards the innovation. Since the individual is embedded within a social system, social reinforcement by other friends, or peers based on their subjective evaluation of the innovation affects the individuals' opinion and beliefs about the innovation (Sahin, 2006; Leeuwis and Aarts, 2020; Kwapong and Ankrah, 2023). The innovation process is influenced by complexity of multiple factors which influences outcomes of interventions. Studies have shown that farmers demographic characteristics and personal goals (Assan et al., 2018; Pannell and Zilberman, 2020; Tsige et al., 2020); trialability and observability of the innovation (Pannell et al., 2011; Weersink and Fulton, 2020); farmers social network and interaction (Maertens and Barrett, 2013; Weyori et al., 2018; Streletskaya et al., 2020); farmers access to information and extension services (Nyasimi et al., 2017; Say et al., 2018); relative advantage of the technology (Meijer et al., 2015; Brown et al., 2017; Rodenburg et al., 2021); sociocultural and political conditions in the external environment (Kendall et al., 2022; Shilomboleni, 2022) are crucial in shaping the innovation process. Moreover, the local context and enabling conditions is critical to shape innovation process (Zanello et al., 2016; Hermans et al., 2021).

Few studies focus on understanding the innovation process and the many instances of learning and changes that happen during the adoption process. The few studies that have focused on understanding the innovation process have described adoption as a continuous process (Glover et al., 2019; Hermans et al., 2021), often not being complete or partial or having aspect or component of the innovation

taken or experimented with (Andersson and D'Souza, 2014). Leeuwis and Aarts (2020) argued that there should be an understanding of the innovation process as a collective interactional process explained with sociological and institutional dimensions of innovation.

In understanding the experiences of participants through innovation process, it is important to use ethnographic and context specific research approaches that create the space and means for participants to tell their stories in their own voices (Whitfield et al., 2021). Involving local people and their knowledge in the research process can facilitate innovation when local people are able to suggest solutions for overcoming their vulnerabilities. The use of narratives and participatory videos can provide a way of understanding farmers' experiences of the innovation process and shed light on what farmers consider important in the innovation process to encourage uptake of innovations.

1.2 Participatory video

Participatory video (PV) is a participatory visual methodology in which a group or community creates their own films or video to voice their concerns and explore solutions (Richardson-Ngwenya et al., 2019). PV brings together community members to tell their stories in their own narratives, thus amplifying their voices and enabling self-representation (Lemaire and Savage, 2012). Thus, PV empowers and gives voice to the participants to be heard through their stories.

The PV methodology is characterized by group or community co-creating videos on a topic, drawing collective perspectives according to what they feel is important and how they want it to be represented (Mistry and Berardi, 2012; Cai et al., 2019). PV combines the need to represent multiple viewpoints while capturing the complexities of the real world (Fisher et al., 2021). Through PV, local knowledge is integrated and influences the research process (Bignante et al., 2016; Milne, 2016), thus supporting dialogue between researchers and community members. PV has been explored in representing communities' concerns or project outcomes to policy makers, academics and or donor (Cai et al., 2019; Richardson-Ngwenya et al., 2019; Snyder et al., 2019).

PV has been used in evaluating humanitarian projects, project monitoring, empowering local community members and facilitating social transformation (Cai et al., 2019; Cardinal, 2019; Synder et al., 2019; Bezzina, 2022). Cai et al. (2019) for instance used PV methodology in understanding farmers slow adoption of composing in Malawi, eliciting elicit perceptions and social and cultural factors that can impede adoption of agricultural innovations. Haynes and Tanner (2015) suggested PV process as an effective tool for empowering young people to raise important issues with decision-makers and advocate on behalf of their communities. Snyder et al. (2019) found the PV process to be inclusive of community members perspectives, and objectives in the research process.

Using PV methodology provide the opportunity for local people to communicate their idea, preferences, decisions and experiences to researchers, donors, development partners, and other stakeholders (Haynes and Tanner, 2015; Snyder et al., 2019; Takeda, 2021; Saha et al., 2023). This is important in fostering inclusion of local people voices and their preferences in the design, planning and implementation of development interventions. Thus, empowering and fostering better understanding of local people experiences with innovation processes which will help inform the design of effective interventions to promote change (Lunch and Lunch, 2006; Cai et al., 2019; Cardinal, 2019; Snyder et al., 2019). PV helps to better understand the impact of development interventions. According to Tremblay and Harris (2018), PV is a reflective process leading to personal transformation, knowledge co-creation and enabling local people and communities to participate in civic and political debates and resource governance. The PV process leads to empowerment, representation and giving voice to those who could otherwise not be heard (Colom, 2011; Richardson-Ngwenya et al., 2019; Synder et al., 2019). Furthermore, the PV process facilitates conceptualization of innovation processes, while at the same time creating spaces of inclusion in which power relations could be renegotiated (Caretta and Riaño, 2016; Richardson-Ngwenya et al., 2019).

Although PV as a methodology has proven useful as an appropriate tool for empowering, participation, knowledge co-creation, giving voice and inclusion of local people in power relations, there are some limitations. The PV process has an inevitable performative aspect, in that participants carefully curate and construct the stories that they choose to tell for specific purposes and specific audiences (Lunch and Lunch, 2006; Tremblay and Harris, 2018). As with other participatory approaches, there is potential for certain voices to be privileged over others (Cooke and Kothari, 2001; Mosse, 2007). Such participatory approaches often mask local and researcher-participant power dynamics and processes that lead to the privileging or exclusion of certain voices and knowledges (Cooke and Kothari, 2001). This means that participatory video research needs to go hand in hand with critical reflection on the relational dynamics within communities, as well as between communities and external organizations, both of which a participatory video process can bring to light. This can help to improve the authentic co-design and co-development of agricultural support initiatives.

This paper uses participatory video in understanding farmers narratives on their experiences with CSA innovations and what they consider important in the innovation process. We use participatory videos to understand the complexities and dynamics involved in the uptake of CSA interventions by farmers using two case study communities in the Upper West region of Ghana. The use of participatory video provides the opportunity for farmers to describe their encounters with the CSA technologies and practices and suggest what they consider important in addressing climate change in their communities as well as measures to encourage uptake of the innovations.

1.3 Conceptual framing

In this paper we follow the conceptual framing of Hermans et al. (2021) in understanding complex innovation dynamics. Hermans et al. (2021) proposes four lenses in understanding the innovation process, thus, by understanding the social dynamics and information transfer, contextual costs and benefits, experiences and risk aversion, and practice adaptation of farmers.

1.3.1 Social dynamics and information transfer

Hermans et al. (2021) suggest that farm-level knowledge and decision-making are socially constructed. The social dynamics shape farmers' perceptions and experiences of innovation, including

decisions about whether and at what points to engage with or disengage from a process of trialling innovations (Hermans et al., 2021). Farmers involvement and interaction within the social system provide access to information, enhances social capital, build trust, and can influence decision making in relation to innovations (Weyori et al., 2018; Leeuwis and Aarts, 2020). Farmers awareness of innovation is largely determined by their social networks, which can be both informal (friends, community members) and formal (extension agents and non-state actors). The closeness to a trusted source of information affects the belief in the validity of the information (Fisher et al., 2018; Holden et al., 2018). Also, the information farmers receive and knowledge about innovation form the basis of perception and attitude the farmer develops towards the new practice.

1.3.2 Contextual costs and benefits

Herman et al. (2020) demonstrate that there are complex set of contextual costs and benefits that shape decision-making about innovations, and that these are themselves socially constructed. In making decision about a new practice, farmers consider the relative advantage of the new practice over the current practice. Where relative advantage is the extent to which an innovation is better than the current system, which depends on the nature of the technology and how it will impact farm profits (Rogers, 2003). An assessment of relative advantage includes a consideration of the characteristic of the technology and the context in which they operate, as well as the compatibility of innovation within the existing context in which they operate (Andersson and D'Souza, 2014; Bouwman et al., 2021). In addition, farmers consider the economic benefit (balance between the cost and benefits of the innovation), social and ecological aspects of changing to something new (Hermans et al., 2021; Lalani et al., 2021).

1.3.3 Experience and risk aversion

Farmer take a risk-averse approach in making decision to change to new a practice. A farmer presumably compares all potential profits from alternative practices in making decision about a new practice. They consider the risk of crop loss, decline in yield, and income loss related to the new practice. Their past experience of technologies and interventions can contribute to an aversion to risk (Whitfield, 2015; Hermans et al., 2021). Farmers who have not used a practice typically start with a trial that may involve only a small part of the farm over a limited period of time (Pannell and Claassen, 2020). Trialability and observability of innovation provide information on the suitability of the innovation and provides opportunity for learning about the potential impact of the innovation (Weersink and Fulton, 2020). The information from the trial reduces the uncertainty surrounding the net benefits, which is particularly important for risk-averse individuals. Trail and evaluation can reduce the risk of failure and develop new skills. The results and experience from the trial and evaluation of the new practice, will inform their decision on the next step of actions whether to further explore the innovation, take on aspects of the innovation or discontinue use of the innovation.

1.3.4 Practice adaptation

In agricultural innovation, we rarely see a linear perfect and whole-scale replacement of old practices by new ones (Glover et al., 2016). There can be adaptation, re-invention, or modification of practices to suit the farmers local context (De Oca Munguia and Llewellyn, 2020; Hermans et al., 2021). There is hybridization of old and new practices. Modifications will probably be necessary and the ability to make these adjustments depends on the human capital of the farmer along with the trialability of the innovation and experience of the farmer (Weersink and Fulton, 2020). These changes in practices happens across space and time, which reflects the socially constructed knowledge, local costs and benefits, and risk aversion and experimentation of different farmers (Hermans et al., 2021).

We apply these conceptual framing in understanding the complexities of how smallholders innovate.

2 Method

2.1 Study design

Participatory methods allow people to speak for themselves, rather than having researchers or development agents speak for them, thereby improving their capacity to influence decisions shaping their lives (Cai et al., 2019). We used participatory video methodology for this study. Other qualitative participatory methods were also used as part of the participatory video process to gather information. These included a combination of key informant interviews, narrative interviews, field observations and innovation history. The study was conducted in two communities in the Upper West region of Ghana. The field work was done between August and December 2022.

2.2 Study site

The study was conducted in the Upper West Region of Ghana. The region was purposively selected because of the region's high climate change vulnerability. It has a unimodal rainfall pattern lasting about 4–6 months and receives an average of 1,000 mm of rainfall *per annum*. Agriculture provides income and employment for over 80% of the population in Upper West Region. The Lawra district was selected for the case study based on the presence of development organizations in the community promoting CSA to smallholder farmers in the communities over the past ten years to help mitigate the effect of climate change. Three CSA interventions were selected for the study. These were the CGIAR Climate Change, Agriculture and Food Security (CCFAS) project, the FAO conservation agriculture project and the German Development Cooperation (GIZ) Resilience Against Climate Change (REACH) project. These projects had implemented interventions in the communities selected as case studies for this study.

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) in Lawra Municipal (Bompari Community) started in 2014 with about 30 beneficiaries. The beneficiaries were provided trainings in over ten CSA technologies. Selected farmers with support of the Agricultural Extension Agents and CCAFS project staff set up small demonstration plots on the technologies on a few selected farmers' fields. Each year, at least one new technology was demonstrated on the selected farmer's field. The project supplied inputs to the farmers and provided technical assistance together with the Ministry of Food and Agriculture (MoFA) Agricultural Extension Agents (AEAs). Farmers were taught Good Agronomic Practices (GAPs). Farmers mostly reported that the CCAFS project introduced the following innovations; Maize-cowpea

TABLE 1 Respondents profile.

Community: Bompari				Community: Tolibri			
Farmer ID	Gender	Age (years)	Farm size (acre)	Farmer ID	Gender	Age (years)	Farm size (acre)
F1	Female	65	3	F16	Female	45	1
F2	Male	60	5	F17	Female	39	3
F3	Male	28	6	F18	Female	30	2
F4	Female	60	5	F19	Female	27	3
F5	Male	45	5	F20	Male	56	7
F6	Male	35	3	F21	Female	55	6
F7	Female	58	9	F22	Female	49	5
F8	Male	53	5	F23	Male	57	7
F9	Female	40	3	F24	Male	54	6
F10	Male	43	3	F25	Male	35	3
F11	Female	46	4	F26	Male	42	3
F12	Male	56	5	F27	Male	45	6
F13	Female	52	4	F28	Male	35	3.5
F14	Male	32	6	F29	Male	39	2
F15	Male	65	5	F30	Female	42	2

rotation, Minimum tillage/conservation agriculture, Earth bunding, Tie ridges, Ridge contouring, Composting, Combine minerals, Agroforestry (Jatropha), Farmer managed natural regeneration, Zai-pit, and Cover cropping. The innovations were introduced to the farmers through trainings, demonstrations, field days, peer to peer farmer education. The demonstrations and field days were repeated annually during the farming season with each beneficiary/contact farmer showcasing a different technology on his field and educating neighboring farmers.

The FAO Conservation Agriculture project in Lawra (Tolibri community) started in 2020. Farmers were taught to spray weedicides on the field, allow the grass to decompose and plant the seeds directly in the field, with minimum disturbance to the soil. There should be no burning of crop residue. Farmers were also taught crop rotation (cereal-legume), for example, rotation of maize and groundnut or cowpea on the same field. Farmers were taught to plant in lines, planting two seeds of maize per hill. Also, good agronomic practices for planting of maize, application of weedicides for weeds control, application of chemicals to control Fall Armyworm and postharvest handling of produce, including storage of harvested produce in hematic bags to prevent gain destruction by pest and insects. One demonstration plot was established in the community.

Resilience Against Climate Change (REACH) project by the German Development Cooperation (GIZ) started in 2021 in Lawra (Tolibri community). Under the GIZ REACH project, they trained farmers on minimum tillage, using ripper for land preparation, crop rotation, and good agronomic practices. Trainings were conducted by the Agricultural Extension Agents and GiZ project officers. One demonstration plot was established and demonstrations done together with the farmers. The farmers trained belonged to a farmer group. Farmers were taught to use ripper to plough the field. The ripper was used to loosen the soil and to create the rows where the seeds will be planted. Using the ripper, there is minimum disturbance to the soil, compared to ploughing of the entire field. It is less costly compared to the cost of ploughing the entire field. The ripper loosens the loose where the planting will be done and created the rows for planting. The weeds are sprayed with weedicide and left on the field in-between the rows and it conserves some moisture and decompose to add biomass and nutrient in the soil. Farmers were advised to plough around the field as fire belt to prevent bush burning. After the demonstration, farmers were given maize and cowpea seeds to plant on one acre of land. Two communities (Tolibri and Bompari) in the Lawra Municipal Assembly where these development organizations had implemented CSA interventions were selected as case study communities for this study.

2.3 Data collection

2.3.1 Individual interviews

We first interviewed four (4) project officers and two (2) agricultural extension agents who were directly involved in the implementation of the CSA interventions in the Lawra Municipal. They then supported with selection of participants from a list of farmers who had participated in the CSA interventions in the selected communities. Purposive sampling was used in identifying 30 farmers ($N = 30$, Males =17, Females =13) from the two selected communities (Table 1). We considered in the sampling, farmers who were members of the community, had participated in the trainings and demonstration events organized by the CSA projects, and had at least 10 years farming experience and able to talk about their experience with CSA. To obtain a diversity of perspectives from farmers with diverse characteristics, the selection criteria also included farmers age, gender, level of education, membership of farmer group, land ownership and accessibility to agricultural extension services, which are some key factors that influence the innovation process.

Interviews were conducted with the selected farmers familiar with CSA to give an oral history account of their experience with

CSA. Farmers narratives on timelines and changes in CSA practices, and drivers of their decision, and what led to change over time were documented and analyzed. Narrative interviews were used in documenting farmers lived experiences with CA practices introduced by development organizations. Narrative interview is a form of qualitative research method that uses narrations to elicit information on personal experiences from the informant with a detailed focus on events and actions, making reference to place and time (Muylaert et al., 2014). Farmers experiences narration were guided by the following themes; (1) Farmers' characteristics and personal goals, (2) Farmer knowledge, attitude and practices, (3) Trialability of technology, (4) Farmer's social network and interaction, (5) Farmer's access to information and extension services, and (6) Sociocultural conditions in the external environment.

2.3.2 Participatory videos

We further selected 10 farmers form the farmers interviewed in each community to participate in the participatory video activities. Selection of the participants considered diversity in the narratives of the farmers experiences, as well as other farmer characteristics such as age, gender, and years of experience in farming.

PV combines the need to represent multiple viewpoints while capturing the complexities of the real world (Fisher et al., 2021). It allows farmers to define what they feel is important in telling their story and how they want it to be represented. Farmers were taken through a series of steps in producing the video. The first step was to allow the farmers to share in a group their experiences with CSA interventions with others in a group. In this way, we listened to every voice, in addition to information from the individual interviews and our experiences, we reflected on the emerging themes. This also served as a step to team building and finding consensus on how the farmers would tell and capture their stories.

Next, the farmers were engaged in a community mapping exercise to discuss where their resources were located, identify places of interest, resources they considered important in their community, they farming practices before CSA interventions and how their farming had changed over time. Mapping out their community provided further insight for the farmers as they discussed the stories to be captured in the video and where the scenes would be captured. Innovation history permits farmers to reflect on their actions, how these are linked to the actions of others and how better results might be achieved in the future (Ankrah and Freeman, 2022). Farmers were then trained on basics of using a camera to build their confidence in-front and behind camera. The farmers then decided on the scenes to be taken, allocated roles for each and what will be said, sketched out storyboard scenes. This storyboard guided the filming. Farmers then filmed in their stories of their experiences with CSA in their communities. Each community produced one video (see appendices for links to videos). Videos produced were edited together with the farmers. All the farmers gave group consent for the videos to be widely disseminated.

2.3.3 Screening of videos and discussions

After the video production, video screenings were organized in the two communities. In each community, over 60 farmers attended the screenings. We also invited other stakeholders, including the agricultural extensions from the MoFA, the village chief, local assembly officials, and project officials. Both videos were screened in each community. Video screening was done at the community meeting grounds. Farmer who was involved in the PV process narrated the PV process to the gathering before the screening, thus providing a background to the rational of the study and an overview of the process of making the video. Screening of videos was followed by a group discussion on the content of the video.

2.4 Data analysis

The recorded narratives from the interviews and focus groups were transcribed. Content analysis was done where information with similar themes were grouped into clusters and patterns identified (Castleberry and Nolen, 2018). The coding strategy included a first order coding based on the identified themes from the literature review. New and emerging themes were identified and added as they emerge from the coding process. The Nvivo 12 software was used for analyzing the data.

3 Findings

In presenting the results, we follow the framework proposed by Hermans et al. (2021) in understanding the complex innovation dynamics and on-farm decision making focusing on these themes; social dynamics and information transfer, contextual costs and benefits, experiences and risk aversion, and practice adaption of farmers. We further add on to this framework another important theme on farmers motivation to take on CSA technologies and practices.

3.1 Social dynamics and information transfer

The agricultural extension agents played a crucial role in conveying the objectives of the development agencies and translating to the farmers. The Agricultural extension are trusted agents in the local communities and the farmers have confidence in the information received from these agents. They used trainings through farmer field schools, demonstration events, individual and group meetings to create awareness on the innovation and demonstrate to the farmers these innovations. Awareness on the innovation is a key step in the innovation process. Having information on the innovation influenced farmers decision and perception of the innovation.

In both videos, during the dialogues after first learning about the new farming practice, the question always came up "who taught you this method of farming?," or the actor narrating on the CSA innovation was quick to add the source of the information or how they became aware of the CSA innovation which was the agricultural extension agent. The farmers in Tolibri video acted out a skit where the group went for a field day at a farmer's farm to meet with the agricultural extension agent who educated them on modern farming practices, minimum tillage, and conservation agriculture to improve their soil fertility and minimize their cost on buying fertilizers. Also, in the Bompari video, the farmers played a skit where a husband and wife were working on their farm and another female farmer asked them about their new farming practice of making ridges and planting

in lines. They responded informing the female farmer of the method of making ridges and the benefits of conserving moisture and improving soil fertility. They mentioned "the agric. Officer taught us new methods of farming." In several of the scenes of the videos of both communities, this statement was made which shows the importance of the agricultural extension agent as an important information source on climate smart agricultural practices.

In the narratives by the farmers, all farmers indicated that they got to know of the innovations from the agricultural extension agent when they attended the farmer meetings and participated in the demonstration field events. Farmers narrations included;

> "the agricultural extension agent informed me of the training. We all gathered at the Chiefs palace for the training. I participated and learnt of the new improved practices." (F7/ Female farmer, Bompari community).
>
> "We were introduced to CCFAS project by the agricultural extension agents. He came to our community with the officers. They trained us on different technologies." (F4/ Female farmer, Bompari community).
>
> "The Agricultural Extension Agent invited me for the farmer meeting, and I took part in the farmer demonstration activities on the field days." (F25/ Male farmer, Tolibri community).

The agricultural extension agents acted as a broker or intermediaries who develop ties to the development agencies promoting the innovation to the community members. The agricultural extension agents organized demonstration events on farmers' fields where farmers were trained on the new innovations.

Farmers social groups provided the avenue to learn about innovations when they attended farmer meetings, farmer demonstration events, and also participated in collective farming activities such as weeding, planting, and harvesting. Farmers comments included;

> "I am a member of a farmer-based organization, we get money/ loan to buy farm inputs from our farmer group. We help each other with our farming activities (F27/Male farmer, Tolibri community).
>
> "We learn about modern farm practices from our farmer groups (F11/Female farmer, Bompari community)".
>
> "I participated in the demonstration farm. I joined my farmer group whenever they went for the training (F29/Male farmer, Tolibri community)."

The video produced by the Bompari community farmers had a skit where farmers were having a group meeting and making payments to their savings groups. At this meeting, two women shared with the group what they had learnt from the farmer training and questions were asked by the group members. Farmers social groups provided the avenue to learn about innovations when they went to the fields for collective farming activities. Agricultural extension workers and development workers often met the farmers as a group for field days and demonstration events. Farmer groups also provided social support and network for the farmers. They supported each other with farming activities. The farmer groups provided social and financial support for their members. Through the farmer groups, the farmers could make savings and take loans to buy agro-inputs such as fertilizers. When farmers were asked of their opinion on what will work to encourage uptake of the CSA technologies and practices, almost all the farmers interviewed ($n = 25$) indicated that education and training of farmers on improved technologies will help to promote the uptake of the innovations. Also, peer to peer farmer education on the improved practices and showcasing of the innovations through demonstrations will help promote the innovations. Farmer trust the information they receive from their farmer groups and fellow farmers. Farmer learn about innovations, receive help and support to address the challenges pertaining to the uptake of innovation, gain access to resources, and trainings through their social groups. Farmers learn from the experiences of other fellow farmers which help inform their decisions in relation to their uptake of innovations.

We also found in both community videos, when women played a key role in a skit enquiring about new farming practice, they were quick to say that 'I will go and inform my husband' so that we can come and learn more about the innovation and try on our farm. Here are some of the statements from the farmers videos. For example, in the Bompari video, a female farmer enquired from male farmer and his wife who were digging a whole and burying crop residue to make compost. The male farmer informed her on the benefit of making compost and applying to the field to improve soil fertility, avoiding buying and application of inorganic fertilizers and helping to increase yield. Her response was.

> "Then I have to go home and inform my husband about what you just told me so that we can also try it and stop spending money on fertilizers".

In another Scence at Bompari, a female farmer after learning about making ridges and planting in lines, thanks the fellow male farmer and his wife for educating her and concludes saying.

> "I have to inform my husband about what you just told me so that we can also learn from you and have a better harvest this year and years to come."

Likewise, in the Tolibri farmer videos, in a skit where two women attended a farmer group meeting to inform the group about the new farming practices they had learnt from their participation in farmer field school, one of the women in her narration indicated that.

> "I took this new farming method very seriously and most people were insulting me by saying that I am a woman, but I attended the farmer meetings like my life depended on it."

She further narrated that she had informed her husband of what she had learnt, and initially he did not want to practice it but when he had tried the new practice of making ridges, he had good yields. In her narration she stated,

> "I told my husband and he did not want to practice it, but later he saw that it was true."

In another scene acted by farmers, a female farmer observes a male farmers practising minimum tillage on his farm by applying weedicide to kill weeds on his farm and he explained to the women he will directly sow the seeds without tilling the land to minimize disturbance to the soil. The female farmer after the dialogue concludes by saying.

> "…then I will inform my husband so we can come and learn from you later to help ourselves, family members and friends, so we can all benefit from it."

In another scene when a female farmer was invited by a male farmer to come and learn more about new farming practice during the farmer group meeting day, female farmer is happy and interested in attending the meeting but was quick to ask.

> "Please can I come along to the farmer meeting with my husband?"

Women often highlighted the theme of 'informing husbands' about the new CSA technologies and practices they had learnt from other farmers. These comments highlights gender dynamics in uptake of new innovations and learning about innovations. The cultural and social norms Northern Ghana limits women ownership and control of land and decision-making concerning farming activities. These communities are patrilineal societies, and women are dependent upon their husbands for key decision making relating to farming activities. Women do not directly own land, and land is inherited through the husband's lineage. Women would need the husband's concern if these new farming practices would be implemented on their farms. The women once they were informed and aware of the innovations, had the task of informing their husbands, and getting them to see the rational of implementing the new practice.

3.2 Contextual costs and benefits

Even though farmers were taught many CSA technologies and practices (more than 12) they selected a few innovations and applied on their farms. The development projects by the CGIAR CCAFS, FAO and GIZ all together introduced over 12 CSA technologies and practices to farmers in both case study communities. Out of these, farmers mostly reported on having practiced these CSA technologies and practices – making ridges, composting, crop rotation, tree planting, and minimum tillage. Farmers however had knowledge on all the innovations after participating in the field demonstrations and field days or having the demonstrations established on their farms.

In the videos, farmers talked about only a few of the innovations.

In the Tolibri video, farmers acted skits on the practice of minimum tillage and making ridges. Whereas in the skit by farmers in the Bompari video, the farmers acted skits about composting, making ridges, and tree planting. Farmers had been introduced to over 12 CSA technologies and practices, however in their skit they chose and agreed to perform and talk only these new practices they had learnt. From field observations, these were the main practices observed on farmers' fields. In using narrations and participatory videos, farmers were able to voice out the CSA technologies and practices that was of importance to them and they could talk about how they had implemented it and the benefits.

This shows that even though a lot of CSA technologies and practices are often advanced to farmers, they are all not likely to be used by the farmers. Farmers choose a few of the innovations after careful evaluation, particularly predicated on economic gains, food security, and environmental benefits. In the videos produced by the farmers in the two communities only about three out of the many CSA technologies and practices was preferred by the farmers and predominantly practiced by the farmers on their fields. This highlights the need to consider and understand farmers preferences in advancing CSA technologies and practices. The assumption that CSA technologies and practices due its potential benefits should be widely adopted by farmers is misplaced. This results in the disconnect between what innovations farmers prefer and their rational for going for these innovations and what development agencies advance to these farmers. Farmers preferences in choices of innovation should be integrated into the design process of advancing CSA innovation to encourage uptake.

3.3 Practice adaptation of farmers

Farmer preferred and used innovations that were less labor intensive, less costly and aligned to their current farm practice and local context. From the farmers narratives, the farmers did not like innovations that required much time and effort. For example, all farmers interviewed in Bompari community even though alluded to the fact that the Zai pit method has the advantage of improving soil fertility, moisture retention and improving yields, did not like to take on the technology since it required a lot of labor and time. For the Zai pit method, the farmer has to dig small planting pits of about 20-30 cm, 10-20 cm deep, where seeds would be planted, fill the pits with manure, before sowing the seeds. This technology has the advantage of improving soil fertility and conserving moisture for plant use (Danso-Abbeam et al., 2019). Farmers indicated that they would not have the labour and time to go through all the process required for the Zai pit technology. According to the farmers, the Zai pit due to its labor-intensive nature can only be applied on a small scale. Farmers statements included;

> "I am not likely to take on the Zai pit method because it requires too much work. You have to dig holes at the recommended planting distance, apply compost in all the holes before you put in the seeds and cover with soil. This is too much work! (F20/ Male farmer, Tolibri community).
>
> "Even though the Zai pit is good, I am not likely to use the Zai pit because it is labor intensive. It will require too much time and labor to dig the holes and apply compost before planting the seeds." (F2/ Male farmer, Bompari community).
>
> "The Zai pit method is labor intensive and very tedious. I do not have the required strength and labor to do this practice" (F8/ Female farmer, Bompari Community).

From the farmer interviews, many farmers indicated that cost of input was a barrier to implementing some of the innovation such as application of fertilizers for soil fertility enhancement, and use of improved seeds to increase their yields. Farmers comments included;

> "I cannot apply fertilizer and weedicides because it is costly" (F30/ Female farmer, Tolibri community).

> "Because of the high cost of inputs, we are not able to farm large acreages. We know the quantity of fertilizer to apply but we are not able to apply the recommended quantities on our fields" (F24/ Male farmer, Tolibri community).

> "Maize requires use of fertilizer and I do not have money to buy fertilizer. So, I will continue to plant my groundnut which does not require fertilizer" (F16/ Female farmer, Tolibri community).

Also, the unavailability of tractor service and ripper for land preparation is a constraint to the use of the ripper for ploughing by farmers in Tolibri community. The FAO project introduced the farmers to the use of ripper, however there are no ripper and tractor services in the community. The tractors have to be hired from the district capital and the tractor services charge a fee for the service and only likely to come to the community if a group of farmers request for the service. Even though the FAO project had introduced farmers to the use of ripper for land preparation, none of the farmers interviewed had used the ripper for their land preparation.

> "I am not thinking of using the ripper because it is not available in our community, and I will also have to pay a fee to have the tractor to plough my field. I do not have the money to pay for it." (F8/ Male farmer, Tolibri Commmunity).

In the group video by Tolibri farmers, they did indicate in a skit where they talked about their main challenges with farming and uptake of the innovations. They stated the cost of fertilizers and agro-inputs and the unavailability of tractor services as major challenges in their farming activities. This is consistent with the individual narratives by the individual farmers and the group videos. CSA technologies and practices that require the use of inputs like fertilizers, improved seeds, tractor services or adding on additional cost to the farmer were not favorable for the farmers even though they were knowledgeable of the potential benefits. Where farmers decided to apply fertilizer, they could did not apply following the recommended rates. Also, some farmers chose to plant less of the crops like maize which required fertilizer input and planted more of groundnut which did not require fertilizer input. Farmers adapted the new practices to fit their local context.

3.4 Experiences and risk aversion

It noteworthy that before the farmers committed their entire farm to any of the new CSA technologies and practices, they first 'experimented' on small plots, about one third of their land. Once they proved that the innovation was beneficial, they would scale it up gradually to the whole farm. Most of the farmers interviewed ($n = 21$) indicated that they tried the innovation on about 0.5–2 acres of their farmland. Based on their satisfaction with the innovation, they either continued with the innovation, expanded their farm acreage or discontinued using the innovation. Examples of farmers comments included;

> "I tried the practice on about 2 acres of my land. I tried composting, constructing ridges, and planting in lines on my farm. I saw the benefits and so now I have ridges on all my fields. I no longer farm on mounds" (F5/Male farmer, Bompari community).

> "I tried the Zai pit method on about 0.5 acres of my land. It was too labor demanding. I did not do it the next planting season" (F23/Male farmer, Bompari community).

This shows that farmers in the process of deciding on the innovation will consider trial on a small portion of their land. Their evaluation of the trial experimentation of the innovation on their farm will inform their decision on the next step of actions whether to further explore the innovation, take on aspects of the innovation or discontinue use of the innovation.

In the farmers videos, farmers were more confident informing other farmers about their experiences with new practices that they had successfully tried on their fields and seen the results. In one of the skit in the Bompari video, a male farmers working on his farm is visited by a female farmer who engages him in a dialogue on how good his crops are looking in a season when her crops are not growing well on her farm. He explains,

It is because of the new farming methods that I learnt. I made ridges and planted in lines. They told us to experiment applying the inorganic fertilizer on one piece of land and applying the compost we prepared ourselves on another land and compare the performance of the crops. I can tell you for a fact that, there is vast difference between the crops response to inorganic fertilizer and the compost. I planted maize and sorghum and applied compost to the soil. That is why the crops are looking good.

Farmers like to experiment first with new farming technologies and practices they learn and based on their experience, make a decision on how to scaling the innovation of adapting aspects of the innovation. Farmers share with other farmers their experience of the new practice or technology. Where they are happy with the result of the trail of the new practice they encourage other farmers to take on the farming practice and also highlight on the possible challenges with the application of the new practice or innovation.

3.5 Farmers' motivation for uptake of CSA technologies and practices

Farmers' motivation to take on CSA technologies and practices was mostly driven by their desire to increase their yields, increase soil fertility, and conserve water for plant use. For most of the farmers interviewed ($n = 25$), the main reasons why they were motivated to take on the new innovations introduced to them was to increase their yields. Farmers associated benefits of high yields to having enough to feed their household throughout the year and selling surplus for income. Farmers were concerned about protecting the soil, increasing the moisture content in the soil to make it available for plant use, and improving soil fertility, all aimed at increasing their yields. In a statement below, farmers indicated:

> "We do not get enough rains, so the little rains we get, we have to conserve it for the plants to be able to make use of it, to get higher yields" (F5/ Male farmer, Bompari community).

Farmers considered that increase in their yield would result in an increase in farmers income from the sale of surplus of their harvested produce. The farmers statements included:

> "I took on the innovations to be able to increase my yields. We need food all the time and we must improve our farming practices to be able to increase our yields. (F1/Female farmer, Bompari community)

> "I want to have high yields. So, I am ready to use the new innovations. Also, it will protect the soil from erosion and conserve moisture in the soil for plant use to increase yields. And when there is drought, the plants will still have some moisture." (F23/ Male farmer, Tolibri community)

In both videos produced by the farmers (see appendice for links to videos), farmers indicated that their use of the CSA technologies and practices such as planting on ridges, composting, and tree planting was to help to improve the soil fertility, increase moisture in the soil and crop yields which enabled them to increase their incomes and ability to provide food for their family and pay their children school fees. For instance, in a skit on planting on ridges by farmers in Bompari community, a famer and his wife who were telling another female farmer about how they benefited from making ridges for planting stated that;

> "We make ridges so that when it rains, the debris remain on the land and are not washed away but provide nutrient for the plants to increase yields … We always have good harvest and able to provide for the upkeep of my family and even sell some of our produce for income."

In another skit, a female farmer in Tolibri community after learning about making ridges from a fellow farmer stated "… so there is opportunity like this and we have been suffering without even getting enough for feeding our family." In a similar skit in Bompari community farmers video, a male farmer after hearing about the benefits of planting on ridges stated, "I struggle to pay my children's school fees and to get food for the family, … I will tell my brothers about this innovation, and we will apply it on our farms."

These narrations and messages from the farmers, shows that farmers motivation to engage with the CSA innovation were mostly related to economic and environmental conservation motives. i.e., their desire to increase their incomes, yields and for other environmental benefits of increasing soil moisture and fertility. This finding is consistent with other studies (e.g., Partey et al., 2018; Mizik, 2021; Zougmoré et al., 2021) that have found farmers personal goal and motives to achieve food security while also mitigating and adapting to climate-related risks to drive their desire to practice CSA technologies and practices.

4 Discussions

Farmers were concerned about the food security, economic gains, and the adverse environmental effect of climate change on their farming activities and livelihoods and therefore motivated to take on innovations that help in adopting to the changing environmental conditions and building their resilience to these climate changes. Studies have shown that farmers motivation to adopt innovations are related or linked to farmers personal goals and values which may be economical, social, or environmental (Halbrendt et al., 2014; Thierfelder et al., 2015; Lalani et al., 2021). Farmers in both videos had included skits that talked about abandoning old practices of planting on mounds and taking on new practices such as planting on ridges, applying compost for the benefit of increasing yields, and having enough food to feed the family and selling surplus for income. In Northern Ghana, there is one major season. Farmers will have to depend on their stored food or buy food during the dry season. Having enough food to feed the family during this season is important for the family food security. In addition, farmers considered the environmental benefit of conserving moisture for plant use, and improving soil fertility. This shows that for farmers, in deciding to adopt innovations, do consider the economic, social and environmental benefit associated with the innovation which should be linked to their personal goals and values. This finding is consistent with other studies (Carr and Thompson, 2014; Assan et al., 2018; Tsige et al., 2020) who found that farmer characteristics and personal goals are important factors in farmers decision process regarding innovation uptake. This is an initial step in the innovation process to drive farmers motivation in further exploring or experimenting the innovation.

The findings of the study have shown agricultural extension agents playing a key role in the innovation process creating awareness and providing information and training on the CSA technologies and practices. Agricultural extension agents serve as an important information source for farmers on new innovations and practices (Kristin and Franzel, 2018). Several studies have showed that smallholder farmers access to extension services improve their decision and raises productivity, potentially contributing to agricultural development and higher incomes (Anderson and Feder, 2007; Birner et al., 2009). The agricultural extension agents serve as intermediaries between the farmers and the development agencies promoting the CSA technologies and practices. They play a crucial role in conveying the objectives of the development agencies and translating to the farmers. Agricultural extension employs various means in providing agricultural information to smallholder farmers including use of farmer field schools, field days, demonstration events, workshops, employing various delivery mechanisms including individual, group, and more use of information communication technology (Norton and Alwang, 2020). These platforms and training sessions provide the avenue for farmers to learn about new innovations. Farmers trust the agricultural agents and their messages as such are useful conduit in transferring CSA technologies and practices to farmers as well as providing feedback to the development agencies. From farmers participatory videos, it was evident that agricultural extension agents are important part in the innovation process in creating awareness on the CSA innovation and training farmers on these innovative practices to address climate change in their communities. This shows the need to focus on using pluralistic extension approaches and building the capacities of agricultural extension agents to effectively communicate and transfer information to farmers on innovations.

It was interesting to note that even though farmers were taught many CSA technologies and practices (more than 12) they had selected a few innovations and applied on their farms. Development projects often advance many innovations and technologies to farmers

with many not being taken up by the farmers. There is a clear mismatch between what innovations farmers see relevant and of importance in addressing their challenges and what is advanced to them by development projects. With methodologies such as participatory videos, what matters to farmers in terms of innovation can be well understood including the nuances of the innovation process. Such innovations should be adaptable to the farmers local context and should be easily implementable. It is not a matter of the number of innovations advanced to farmers, but rather what farmers want and likely take up. The assumption that CSA technologies and practices due its potential benefits should be widely adopted by farmers is misplaced. This results in the disconnect between what innovations farmers prefer and their rational for going for these innovations and what development agencies advance to these farmers. Farmers preferences in choices of innovation should be integrated into the design process of advancing CSA innovation to encourage uptake. In these case studies, just about four out of over twelve CSA technologies and practices were found relevant to the farmers in helping cope with the impact of climate change, and improving their productivity. Development organizations could use their resources more efficiently if they advanced innovations that farmers perceived beneficial and likely to fit to their local farming practice, rather than their pushing their objectives of advancing many CSA technologies and practices which farmers are not likely to adopt well. This creates the notion of low adoption of innovations. Innovations advanced to farmers should meet their preferences and needs and be adaptable to their local context. Using PV method provides a better understanding of smallholder farmers experiences in the innovation process and can help inform the design and implementation of innovative interventions in addressing challenges posed by the adverse effect of climate change. Such innovations should be less labour intensive, less costly, fit to the current farming practice and local context and the inputs, resourcses or services needed for the practice of the innovation should be available and accessible by the farmer.

This study reveals the important role of farmers social group in providing a platform for creating awareness and learning about new innovations. Farmers should be encouraged to join social and farmer groups where they can receive information about the CSA innovation that are beneficial for their farming operations. Other studies (Nyasimi et al., 2017; Obi and Maya, 2021) have made similar recommendations encouraging farmers participation in farmer groups to learn about innovations. In addition, peer to peer farmer education where farmers learn from others through social interaction is important in learning about innovations and influencing acceptance of CSA technologies and practices. Farmers are efficient in communicating and disseminating information to other farmers (Kiptot and Franzel, 2014; Kwapong et al., 2020). Farmer trust the information they receive from their farmer groups and fellow agents. Development agencies leverage on the trust relations and farmers social groups as trustworthy actors in advancing their objective of promoting CSA technologies and practices.

The emerging narratives from the farmers videos reflected gender dynamics in adoption of CSA. Women even though had information on the CSA technologies and practices, had to inform their husbands and seek their consent and involvement to implement the CSA technologies and practices. In Northern Ghana, women traditionally do not own land and farm together on their husband's land. Major decisions concerning the farming operation is often done by the male, as such the women inform their husbands and share their farming knowledge with their husbands to be involved in the farm decision making. This finding is consistent with other studies that have shown gendered social norms and roles to constraints women's capacity to adopt CSA technologies and practices (Partey et al., 2018; Adzawla et al., 2019; Ogisi and Begho, 2023). Women farmers are less likely to adopt climate adaptation strategies due to limited control over land and financial resources (Jost et al., 2016; Mishra and Pede, 2017; McKinley et al., 2021). Also, even though women are more vulnerable to the effects of climate change, women are often excluded in climate related adaptation decision-making, which limits incorporating their knowledge in farming and household farming adaptation strategies (Huyer and Partey, 2020). On the other hand, women can be agents of change when they have access to productive resources such as land, agricultural extension services and information, which positively impacts food production and security in a changing climate (Meinzen-Dick et al., 2019; Ankrah et al., 2020). This is reflected in the findings of this study, where women made conscious effort to be heard and to share their knowledge with their husbands and other farmers to be involved in the decision making concerning the CSA technologies and practices. This shows the need to recognize the role women play in the adoption process of CSA innovation. Hence, focusing agricultural extension information, resources, and CSA technologies and practices on women is an important strategy for promoting the uptake of CSA technologies and practices. Understanding the gendered dimensions of innovation adoption is critical for achieving more equitable and sustainable agricultural food system.

5 Conclusion

Climate-smart agriculture (CSA) has gained traction as one of the effective strategies in tackling the climate crisis. Many CSA technologies and practices have been promoted by development agencies to smallholder farmers based on the assumption that farmers would adopt these innovations for their potential benefits. However, the adoption of CSA technologies and practices in Ghana and much of Africa remains low. This study used participatory videos in providing understanding what smallholders farmers consider important and how they make decisions towards adoption of CSA technologies and practices.

Participatory videos provide the opportunity for community members to tell their stories in their own narratives, thus amplifying their voices and enabling self-representation.

The findings from show that farmer's motivation to adopt CSA technologies and practices is driven by their concerns for food security, economic gains, and the environmental impact of climate change on their farming activities and livelihood. This suggest that farmers take into account the potential benefits associated with the CSA technologies and practices when deciding to adopt them.

Agricultural extension agents play a crucial role in creating awareness, providing information, and training farmers on CSA technologies and practices. They serve as intermediaries between farmers and development agencies in creating awareness on the CSA innovation and training farmers on these innovative practices to address climate change in their communities. This shows the

need to focus on using pluralistic extension approaches and building the capacities of agricultural extension agents to effectively communicate and transfer information to farmers on CSA technologies and practices. Farmers social groups served as a platform for awareness creation and learning about CSA innovations.

Even though farmers were taught many CSA technologies and practices (more than 12) they had selected a few innovations and applied on their farms. Examples of CSA technologies and practices that were of significant importance to farmers and used by the farmers included, making ridges, composting, crop rotation, tree planting, and minimum tillage. Before the farmers committed their entire farm to any of the new CSA technologies and practices, they first experimented on small plots (about one third of their land). Once they proved that the innovation was beneficial, they would consider upscaling. This reveals the mismatch between the innovations advanced by the development projects and what farmers perceive as relevant and important in addressing their farming challenges. Therefore, by focusing on the innovations that farmers perceive as beneficial and adaptable to their local contexts, development organizations can use their resources more efficiently and promote higher adoption of innovations.

Additionally, farmers videos reflected differential gendered adoption of CSA technologies and practices. Gender dynamics play a role in the adoption process, with cultural and social norms constraining women's capacity to adopt CSA technologies and practices especially in patrilineal societies. To address this, it is crucial to recognize the role women play in the adoption process and focus agricultural extension efforts on providing women with access to productive resources, information, and technologies related to CSA. It is noteworthy that, when women have the necessary support, they can become agents of change, positively impacting food production and security in the face of climate change.

These findings have important implications for policy and design of development program interventions that seek to increase adoption rates of CSA innovation among smallholder farmers in Africa. There is the need to integrate farmers voices using innovative methodologies such as participatory videos to better understand farmers' experiences in the innovation process which will help inform the design of effective interventions and promote adoption of innovations aimed at enhancing the productivity of smallholder farmers and reducing environmental impacts in African food systems. By focusing on the innovations that farmers perceive as beneficial and adaptable to their local contexts, development organizations can use their resources more efficiently and promote higher adoption of CSA technologies and practices.

Study limitations

The results presented are based on the case experiences of the selected farmers in the two communities which limits the generalization of the findings. Participatory video methodology also has inevitable performative aspect which raises concerns on the authenticity of the information provided by the farmers. We used triangulation of information combining multiple sources including one-on-one interviews with selected farmers, focus group discussions and direct observation of farmers practices to increase the credibility and reliability of the results.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Ghana, College of Basic and Applied Sciences, Ethics Committee (28th July, 2022) (Ref no ECBAS 046/21-22). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

NK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. SW: Conceptualization, Formal analysis, Methodology, Supervision, Validation, Writing – review & editing. JA: Conceptualization, Formal analysis, Methodology, Supervision, Validation, Writing – review & editing. DA: Formal analysis, Investigation, Methodology, Validation, Writing – review & editing. FS: Conceptualization, Funding acquisition, Methodology, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1282993/full#supplementary-material

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