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RESEARCH ARTICLE

Compounding the peasant struggles: the effects of the COVID-19 pandemic on Ghanaian farmers' adaptation to climate change

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Abstract

In recent times, the effects of climate change, the COVID-19 pandemic and other natural disasters have undermined global efforts to reduce poverty and inequality among rural farmers. While efforts at mitigating the impacts of climate change, particularly in developing countries, have not yielded significant improvements, the global health crises of the COVID-19 pandemic have, in many ways, undermined the positive adaptations to climate change. Based on data produced through mixed methods, the paper explores how COVID-19 affected farmers' ability to adapt to the changing climatic conditions in Ghana's Coastal and Guinea savannah ecological zones. The paper argues that the disruption caused by the COVID-19 pandemic has undermined farmers' access to markets, knowledge, innovations, technologies and critical inputs such as fertilisers, seeds and weedicides/herbicides/pesticides. This has decreased farm output, increased post-harvest loss and increased farmers' vulnerability to the adverse effects of climate change.

Keywords: Climate change; COVID-19; peasant farming; adaptation; Ghana

Introduction

The COVID-19 pandemic has compounded the impact of climate change in developing countries and undermined global efforts towards the realisation of various Sustianble Development Goals (SDGs), such as poverty and inequality reduction. Africa, particularly Sub-Saharan Africa (SSA), is one of the most

vulnerable regions due to several socio-economic and (infra)structural constraints that limit the ability of state and local systems to respond and adapt to these stressors in the context of the region's overreliance on climate-sensitive activities, such as rain-fed agriculture, pastoralism and fishing (Konapala *et al.* 2020; IPCC 2022). As such, farmers are also among the most vulnerable populations to climate change and COVID-19 impacts since their activities are highly dependent on climate fluctuations and the accessibility of markets.

So far, projections are that the rise in temperatures and fluctuations in rainfall will disrupt farming activities and exacerbate food insecurity, notably in Southern Africa and the Sahel regions, with relatively less impact in oil-exporting African countries (Dale *et al.* 2017; Zenda 2024). Gbetibouo *et al.* (2010), for instance, conducted a study on South Africa's agriculture sector and found a complex relationship between climate-induced risks and productivity, with provinces such as Limpopo, KwaZulu-Natal and the Eastern Cape being the most vulnerable to climatic impacts. These regions are distinguished by densely populated rural areas, a high frequency of small-scale farming and substantial reliance on rain-fed agriculture, emphasising the magnitude of vulnerability and the uneven geographies of climate change-related impacts.

The combined effect of the COVID-19 pandemic and climate change in East Africa's agriculture sector is no different from that of its Southern counterpart. Farmers in Ethiopia, Africa's second most populous country after Nigeria, experienced a significant decline in risk resilience capacity during the pandemic in the context of existing climate change issues as well as hardships exacerbated by the nation's history of political instability, warfare, ethnic strife, drought, famine and economic adversity (Kassegn and Endris 2021). In Kenya, Roussi (2020) noted a disruption in food supply due to the pandemic-related safety protocols. Whereas in West Africa, where land tenure issues and associated fragmentation of holdings make it challenging to invest in farming, farmers suffered severely from disruption caused by the series of COVID-19-related lockdowns and restrictions in addition to the effects of rising temperatures, changing precipitation patterns and more frequent and intense weather events (Amoak *et al.* 2022).

Many farmers in Ghana similarly experienced a significant decrease in crop yield during the COVID-19 period (Yaro *et al.* 2024; Aduhene and Osei-Assibey 2021; Asante and Mills 2020; Martey *et al.* 2022). The pandemic disrupted movement across the country while major Ghanaian cities such as Accra and Kumasi were on lockdown (Owusu *et al.* 2023). With about 70% of the Ghanaian population in the informal sector, the COVID-19 pandemic and the existing challenge of climate change compounded farmers' struggles (Yaro *et al.* 2024). Consequently, across Africa, farmers had to adapt strategies such as agroforestry, conservation agriculture and management of natural resources to build resilience. However, the success rate for most adaptation programs, both externally promoted and internally innovated by farmers, yielded low results due to some intersecting factors (Siakwah *et al.* 2025; Yaro *et al.* 2024; Martey *et al.* 2022).

Even though there is extensive research on climate change impact on agriculture and a growing body of work on the pandemic (Owusu *et al.* 2023; Delardas *et al.* 2022), issues concerning the twin impact of climate change and the COVID-19 pandemic on smallholder farmers' adaptation strategies in Ghana appear to be a relatively neglected niche, apart from a recent study that qualitatively focuses on female farmers' struggles and adaptation strategies in two farming communities in Ghana (See Yaro *et al.* 2024). This paper uses data produced through surveys, interviews and observation to explore the experiences of farmers during and immediately after the COVID-19 pandemic and how that influenced their adaptation strategies. The central question in the article is how the COVID-19 pandemic affected the strategy deployed by smallholder farmers in response to climate change. We argue that the disruption caused by the COVID-19 pandemic has undermined farmers' access to markets, knowledge, innovations, technologies and critical inputs such as fertilisers, seeds and weedicides/herbicides/pesticides. This has decreased farm output, increased post-harvest loss and increased farmers' vulnerability to the adverse effects of climate change.

Climate change, COVID-19 and agriculture nexus

To answer the study's central question of how the pandemic compounded and undermined farmers' climate adaptation strategies, we probe the concepts of climate change, pandemic and adaptation to frame the paper's arguments. This approach allowed us to explore how farmers' perception of hazards influences the types of adaptation they deploy. While climate change and the pandemic appear to validate the argument that human activities have reached an alarming state and pose critical threats to the physical, social and economic structures of society, the concept of adaptation focuses on human agency and the proactive measures to avert the anthropogenic traits of climate change and pandemic. As discussed in the paper, the appropriate methods of adapting to these imminent issues have been debated over the centuries. However, given the disruption caused by the COVID-19 pandemic to smallholder farmers' adaptation strategies in Ghana, we argue that the search for appropriate adaptation solutions to the twin impacts of climate change and the pandemic cannot be unidimensional. Instead, there is a need to take an integrated approach to address the effects, particularly among small-scale farmers in Ghana.

Climate change and adaptation: a conceptual review

Misconceptions and presumptions about climate change as an act of God, for instance (Teye *et al.* 2015), in many ways, affect adaptation strategies. Golo and Yaro (2013) observed that locals in some Ghanaian villages ascribe supernatural or divine causes to climate change and its ensuing effects on the ecosystem. Whether scientific or not, personal perspectives are crucial in creating socio-political policies regarding climate variability and change.

Adaptation to climate change is a function of perceptions. 'Perceiving is a cognitive process by which humans learn and interpret their sensory

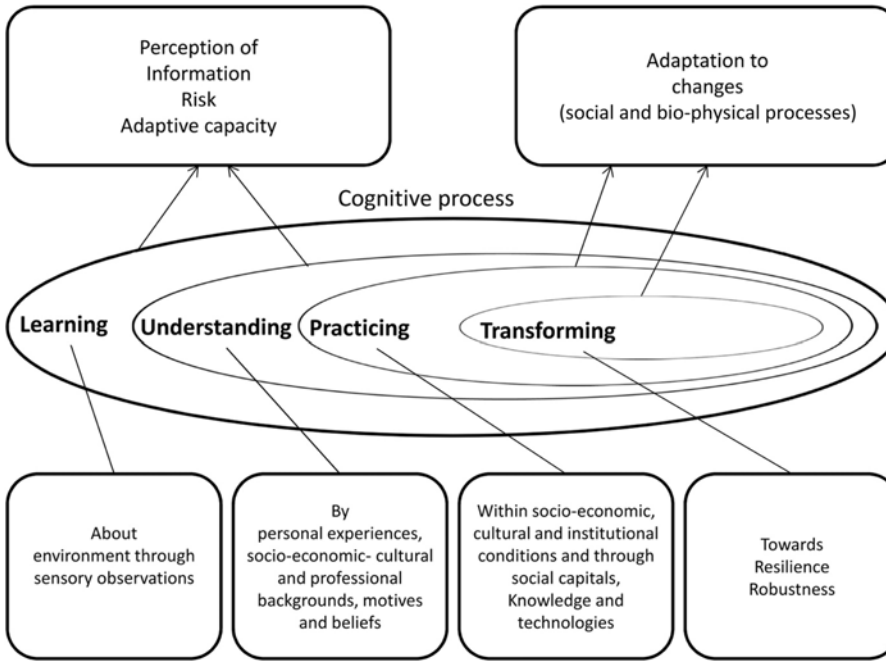

Figure 1. Conceptual framework of perceiving and adapting process.
Source: Nguyen *et al.* (2016).

impressions on the basis of their interest, historical background, knowledge, experience and attitudes to give meaning to their environment and act accordingly' (Nguyen *et al.* 2016: 206). Perceptions have a dual role in shaping our experiences, on the one hand, and enabling adaptation on the other. Perception can be direct or mediated by interactions and experiences. The kinds of adaptation to climate change are thus a function of perceptual learning – the long-term changes to a perceptual system that improve the ability to respond to change (Nguyen *et al.* 2016; Adolph and Kretch 2015; Gibson 1963). Thus, in the context of climate variability and change, people's ability to perceive the direct environmental problems and their impacts and understand them is core to the adaptation strategies they deploy.

Perception of climate change as a cognitive process is sensory and shaped by people's observation and processing of extreme weather events, the social, political and economic context within which their activities are embedded, and their knowledge and previous experiences (See Figure 1 below).

Within the context of rapid urbanisation, deforestation and increased burning of fossil fuels, more people have become aware of the effects of climate change (Bauer *et al.* 2020; Korir 2019). According to Slegers (2008), key factors that shape perception include the perceptual environment, values, beliefs, knowledge and culture. In Ghana, studies show farmers' perception of temperature increases causing water stress, lower crop yields, frequent and

severe droughts and flooding as precipitation patterns change (Alrteimei *et al.* 2022) which influences their adaptation strategy.

Adaptation to climate change is based on perception, influencing the motivation to change (Frank *et al.* 2011). In developed countries, adaptation to climate change tends to focus on developing and implementing new technologies and infrastructure to reduce the vulnerability of communities and critical systems (Obringer and Nateghi 2021). In developing countries, on the other hand, the focus is often on improving the resilience of communities, particularly those in rural areas, and building the capacity of local institutions and organisations to manage the impacts of climate change (Mehryar *et al.* 2022; Gabriel-Campos *et al.* 2021). This often involves improving the management of natural resources, such as water, soil, and forests and developing new crops and livestock breeds that are more resistant to the impacts of climate change (Wassie 2020).

More so, adaptation strategies such as education, training and awareness-raising initiatives to build the capacity of communities and organisations to manage the impacts of climate change are being championed in SSA (Obringer and Nateghi 2021). This includes providing training on sustainable agriculture and natural resource management, as well as education on climate science and the impacts of climate change. Human capital development and education focusing on sustainable agriculture and natural resource management can help farming communities adjust in specific ways by boosting yearly revenue, farm production and general well-being (Yomo *et al.* 2020; Theron *et al.* 2023).

Sustainable agriculture is one of the main adaptation strategies being implemented in Ghana to improve the resilience of communities and ecosystems. Some of these practices are agroforestry, which combines trees and crops on the same land, and conservation agriculture, which uses techniques such as crop rotation and soil management to maintain soil health and fertility, which is believed to have low adoption rates (Ehiakpor *et al.* 2021; Antwi-Agyei *et al.* 2021). Improving the management of natural resources, such as water, is another crucial adaptation strategy in Ghana. For instance, in addition to complementing organic fertilisers with zero tillage (Martey *et al.* 2022), investments in water management techniques such as rainwater collection and irrigation were used as means to ensure that people have access to water during droughts (Jeil and Abass 2021; Owusu and Asante 2020). Recent studies by Okumah *et al.* (2020) highlight that stakeholders appear willing to support water protection measures in Ghana.

Other adaptive strategies involve improving forest management, including implementing community-based forest management programs to protect these critical ecosystems and reduce greenhouse gas emissions (den Besten *et al.* 2019; Krah and Njume 2020). According to Krah and Njume (2020), this is accomplished through forming laws and taboos in Ghanaian communities and through prohibition and suppression. Moreover, community-based adaptation is a crucial strategy in Ghana, where local communities are empowered to develop and implement their adaptation strategies with support from the government and other stakeholders (Ogahara *et al.* 2022). Mainly through local authorities and farmers, sustainable practices are widely

practised and advocated to reduce greenhouse gas emissions (Okyere-Manu and Morgan 2022; Arhin *et al.* 2021).

COVID-19 and the disruption of agriculture

The onset of the *COVID-19* pandemic and the menace of climate change have become the two most pressing global challenges. The agricultural sector suffered some of the greatest disruptions due to the *COVID-19* pandemic. The pandemic caused disruptions in global supply chains and other systems (Xu *et al.* 2020; Li *et al.* 2021), making it more difficult for governments and businesses to take the necessary action to address climate change. The COVID-19 pandemic profoundly impacted agriculture and food systems, creating new challenges for farmers grappling with climate change's effects. The pandemic disrupted global supply chains through shortages and price spikes, making it more difficult for farmers to access markets, credit and other essential services (Clapp and Moseley 2020).

With the closure of borders and the disruption of global trade due to the pandemic (Owusu *et al.* 2023), new barriers to adopting adaptive measures to climate change emerged as it became more difficult for farmers to access seeds, inputs and financing that are needed to adapt (Nchanji and Lutomia 2021; Van Hoyweghen *et al.* 2021). Furthermore, the pandemic strained public health systems (Lal *et al.* 2021), making it more difficult for farmers to access health care and veterinary services to keep their crops and livestock healthy (Hashem *et al.* 2020). According to Ragasa *et al.* (2021), even though the food industry was exempt from lockdown measures, the COVID-19 policies and external shocks resulted in about a 20% loss in value added in the agri-food system.

Due to the pandemic, farmers could not receive incentives such as fertilisers and funding for education, as most of these funds were concentrated on vaccine production and preventive measures (Delardas *et al.* 2022; Dudek and Śpiewak 2022). Dudek and Śpiewak (2022) observed modifications in people's behaviour in food markets, changes in consumption patterns and how demand for food was met during the pandemic. For instance, in Nigeria, Ethiopia and Malawi, people were reported to have adopted reduced food consumption to cope with the food crisis during the pandemic (Furbush *et al.* 2021). According to Martey *et al.* (2022), some farmers recorded low sales, while others had limited access to markets and subsidised farm inputs and seedlings due to travel restrictions during the COVID-19 pandemic. Consequently, the pandemic created new challenges and disruptions for farmers already grappling with climate change's impacts. We explore these linkages in the context of Ghana and try to understand if these challenges present opportunities to enhance the food system's resilience and support farmers in adapting to changing conditions.

Study areas and methods

Ghana is primarily an agrarian economy, with about 70% of the population earning livelihoods in that sector. Consistent with the national picture, the economy of the study districts is primarily based on agriculture, with the

majority of the population engaged in subsistence farming (GSS 2021). Data were collected in farming communities within the Greater Accra, Upper East and North East Regions between September and October 2022 and February 2023. In the Upper East Region, we collected data in the Builsa South District, specifically from Weisi, Uwasi and Gbedembilisi. The study communities in the North East Region were Yagaba, Loagri No.1 and Kuba in the Mamprugu Moagduri (Yunyoo District). The study sites in the Greater Accra Region were Ada West District (Hwakpo, Addokope, and Koluedor) and the Ada East District Agmorsikope, Fantevikope and Asigbekope. These communities were selected because they are all located in the savanna ecologies where agriculture is essential. The Coastal and the Guinea savanna are vital ecologies for producing food crops in Ghana. These ecologies are also very susceptible to the effects of climate change. As ecologies that produce food crops in Ghana, disruptions from the twin challenges of climate change and the pandemic have significant implications for household self-food sufficiency and overall food security. Furthermore, climate change-induced innovations are altering the adoption of traditional agriculture practices in these locals (Siakwah *et al.* 2025), and thus, it is essential to understand how the pandemic complicated the situation.

We used a mixed-method approach, which enabled us to collect, use and triangulate qualitative and quantitative data. The mixed-method approach helped us leverage the overlapping strengths of qualitative and quantitative approaches while minimising their weaknesses. The qualitative data were produced through interviews with farmers to gain insight into their perspectives, views and perceptions of climate change, their experiences during the COVID-19 pandemic, and how that affected their adaptive capacity. The data collection methods included interviews, focus group discussions and observation. The in-depth interviews and focus group discussions explored the importance of agricultural livelihoods, perceptions and experiences of climate change, adaptation strategies and disruptions from the COVID-19 pandemic. In-depth interviews were conducted with 40 elderly farmers to understand the historical trajectory of climate change effects and the evolving adaptation strategies. Thus, by targeting elderly farmers, we mapped how agricultural activities in the communities have changed over time, the types of adaptation deployed, factors influencing these adaptation strategies and how they have evolved over the years. A structured interview guide guided the interviews. In each study community, two focus groups, one for men and women, were organised with participants between 8 and 10. All interviews were audio recorded, transcribed and analysed.

For the quantitative data, a total of 545 respondents were surveyed. A multi-stage sampling was employed to select study areas up to the community level. We used a purposive sampling approach to select the respondents involved in farming. The sample size for each district assembly was 142 in Builsa South, 130 in Mamprugu Moagduri, 136 in Ada East and 137 in Ada West. All respondents recruited for the study consented. We checked the data for completeness and cleaned it for analysis using Stata version 17. Descriptive statistics were employed to analyse and present the data. Cross-tabulations using the Chi-square independent tests were adopted to establish the relationship between

socio-demographic background characteristics and climate change adaptation strategy. The multinomial logistic regression was used to explore determinants of climate change adaptation strategies.

Peasant farming and pandemic-induced disruption of climate adaptation strategies in Ghana

Socio-demographic data such as age, education, income, livelihood strategies and social capital helped map how farmers respond to climate vulnerabilities and changes in rural communities. Table 1 shows the socio-demographic and background characteristics of farmers in these localities.

From Table 1 above, the mean age of the respondents is 42.8 years (range 17–80 years), while the average income was $51.92.[1] More than half (52.5%) of the respondents were between 36 and 60. The average household size was 4.8 people, and about 49% of the respondents had a household size of five (5) or more. A high proportion (42.6%) of the respondents had completed primary school, and less than a tenth (4.2%) had tertiary education. Most (78.5%) of the respondents from the Mamprugu Moagduri district had no formal education. The sample was predominantly married individuals (76.3%), with slightly more than a tenth (12.5%) of previously (divorced and widowed) married persons. A majority (64.6%) of the respondents belonged to the Christian religion, while a few (2.2%) of them did not belong to any religion.

Livelihood activities in Ghana's coastal and Guinea savanna ecologies

The principal livelihood activities of the localities include farming and non-farming activities (services and trading). From Table 2, a majority (63.9%) of the respondents had rented some hectares of land for agricultural livelihood activities, with 86.6% from the Builsa South and 93.1% from Mamprugu Moagduri. Of the sample, a high proportion (68.7%) of the respondents indicated that both men and women engaged in crop farming, while almost a tenth (9.5%) suggested that women performed crop farming. Similarly, most (72.7%) of the respondents indicated that animal husbandry, farm labourer (55.0%), trading (60.3%) and civil service (84.1%) were activities performed by both genders. In contrast, most (84.7%) respondents indicated that men performed fisheries activities. There were similarities across the districts regarding the specific genders that performed agricultural activities such as crop farming, animal husbandry, fisheries and farm labour. A similar trend was observed regarding the gender that performed or was involved in non-agricultural activities, including trading and civil service.

The pattern observed in Table 2 is consistent with the national picture, where the agriculture sector is the mainstay of the population within the country (Dapilah 2023). The evidence shows that a significant proportion of rural livelihood is agriculture-dependent (see Table 2). In Ada West and East Districts, participants reported that staples such as maize and cassava were cultivated (for household consumption) alongside tomatoes, pepper, watermelon and sorghum leaves (Kokoba) for the urban market. In Builsa South and

Table 1. Socio-demographic characteristics of respondents

Variable	District				
	Builsa South	Mamprugu Moagduri	Ada East	Ada West	All
	N=142 (%)	*N*=130 (%)	*N*=136 (%)	*N*=137 (%)	*N*=545 (%)
Age-group	Mean age = 42.7				
15–35	50.0	40.0	25.7	26.3	35.6
36–60	39.4	53.8	57.4	59.9	52.5
61–80	10.6	6.2	16.9	13.9	11.9
Income level	Average = GHC 649				
< Ghc100	8.5	32.3	0.7	1.5	10.5
Ghc100-300	66.2	50.0	27.9	30.7	43.9
Ghc301-499	7.0	3.1	11.0	12.4	8.4
Ghc500 and above	18.3	14.6	60.3	55.5	37.2
Household size	Average = 4.8				
1-4	41.5	12.3	66.2	83.2	51.2
5+	58.5	87.7	33.8	16.8	48.8
Education_level					
No education	30.3	78.5	16.9	32.8	39.1
Primary	49.3	11.5	66.2	41.6	42.6
Secondary	17.6	6.2	11.0	21.2	14.1
Tertiary	2.8	3.8	5.9	4.4	4.2
Marital status					
Never married	14.1	2.3	9.6	18.2	11.2
Married	68.3	96.2	76.5	65.7	76.3
Divorced	4.2	0.0	7.4	10.2	5.5
Widowed	13.4	1.5	6.6	5.8	7.0
Religion					
Christian	61.3	0.8	96.3	97.1	64.6
Muslim	8.5	98.5	0.7	0.7	26.1
Africa Traditional Religion	26.8	0.8	0.0	0.0	7.2
No Religion	3.5	0.0	2.9	2.2	2.2

Source: Fieldwork 2022.

Table 2. Livelihood activities in the study communities

Variable	District				
	Builsa South	Mamprugu Moagduri	Ada East	Ada West	All
	N=142 (%)	*N*=130 (%)	*N*=136 (%)	*N*=137 (%)	*N*=545 (%)
Rent or sharecropping					
Rented or shared crop	86.6	93.1	30.9	45.3	63.9
Had not rented or shared crop	13.4	6.9	69.1	54.7	36.1
Crop farming					
Men	9.9	11.0	22.1	41.6	21.8
Women	1.4	7.0	14.7	14.6	9.5
Both	88.7	82.0	63.2	43.8	68.7
Animal husbandry					
Men	27.7	48.5	2.9	22.2	23.6
Women	2.3	0.0	6.8	5.6	3.8
Both	70.0	51.5	90.3	72.2	72.7
Fisheries					
Men	76.3	100.0	75.0	86.8	84.7
Both	23.7	0.0	25.0	13.2	15.3
Farm labourer					
Men	14.9	4.8	18.2%	92.7	33.0
Women	21.3	19.0	4.5%	1.8	12.0
Both	63.8	76.2	77.3	5.5	55.0
Civil servant					
Men	57.1	22.2	100.0	1.9	11.6
Women	28.6	0.0	0.0	1.9	4.3
Both	14.3	77.8	0.0	96.2	84.1
Off-farm natural resource					
Men	3.4	36.4	–	25.5	18.5
Women	62.9	0.0	–	3.9	29.7
Both	33.7	63.6	–	70.6	51.8
Off-farm trading					
Men	32.6	9.7	75.0	25.3	23.0
Women	32.6	17.7	25.0	8.4	16.7
Both	34.9	72.6	0.0	66.3	60.3

Source: Fieldwork 2022.

Table 3. Animal husbandry and fisheries

	Livestock		Fishing	
District	Yes	No	Yes	No
All	338 (62.4)	204 (37.6)	53 (9.8)	489 (90.2)
Builsa South	129 (92.8)	10 (7.2)	34 (24.5)	105 (75.5)
Mamprugu Moagduri	91 (70)	39 (30)	15 (11.5)	115 (88.5)
Ada East	73 (53.7)	63 (46.3)	2 (1.5)	134 (98.5)
Ada West	45 (32.8)	92 (67.2)	2 (1.5)	135 (98.5)

Source: Fieldwork 2022.

Mamprugu Moagduri Districts, rice, sorghum and millet are the main crops grown. It was observed that millet was the staple crop for meeting local dietary needs, while farmers produced rice and sorghum for commercial purposes.

As a male farmer in Gbedembilisi noted, 'Maize, Rice, Cowpea, and sometimes Groundnuts are produced. However, cowpeas and rice are the most cultivated crops. We grow them for their commercial value. They are among the most in-demand commodities in the market'. There is a transition from crop production primarily for household dietary needs to output for the external market. This transition is both a response to the climate and a means of livelihood diversification strategy (Amoak *et al.* 2022). Conceptually, perceptions have a dual effect of shaping experiences and enabling adaptation (Nguyen *et al.* 2016; Adolph and Kretch 2015; Gibson 1963) as indicated in respondents' views.

Animal husbandry and fisheries are also essential livelihood activities in the study communities. Animals such as goats, sheep, fowl, cattle and guinea fowl are vital to agriculture in the savanna ecological zone. Table 3 displays the distribution of respondents by livestock and fishing activities across the study districts. Almost two-thirds (62.5%) of respondents in all study regions keep livestock, while a tenth fish. It emerged from the qualitative in-depth interviews that animal rearing was an essential livelihood adaptation strategy to climate change, as was reported in an earlier study (Yiridomoh et al. 2021).

Climate change experiences, farmers' agency in adaptation strategies and capacities

Figure 2 shows farmers' agency in the multiple adaptations to climate change. A high proportion (43.5%) of the respondents cultivate high-yielding varieties of crops as an adaptation strategy against the impact of climate change, while one-fourth (25.3%) of them practice climate-resilient and high-yielding strategies. The approach adopted against the climate change impact significantly varies across the study districts. In the Builsa South district, more than half (51.3%) of the respondents used a combination of climate-resilient and high-yielding crop varieties to adapt to climate change impacts, while less than a tenth (8.3%) of them employed climate-resilient strategies.

Bivariate analysis presented in Table 4 shows an association between respondent age and climate change adaptation strategy. However, we observed

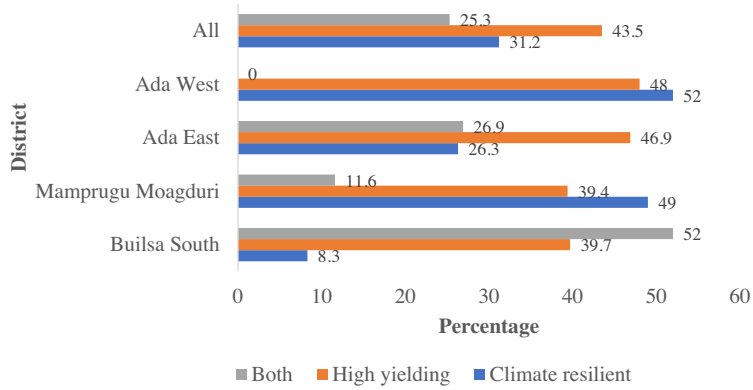

Figure 2. Distribution of respondents by climate change adaptation strategies.
Source: Fieldwork 2022.

that climate-resilient adaptation increases with age while adapting a high-yielding crop and a combined strategy declines as with increase in age. Ada West was associated with the highest proportion of respondents who adopted a climate-resilient strategy (52.0%) and zero preference for the combined strategy. There is no significant association between marital status and climate change adaptation strategy. Married individuals constituted a higher proportion of those who adopted high-yielding crops (53.3%), and widowed persons constituted a higher proportion of those who adopted a climate-resilient strategy (34.3%; $p < 0.001$).

Religious affiliation is significantly associated with climate change adaptation strategy ($p < 0.001$). Christians constitute a higher proportion of those who adopted high-yielding crops (55.0%) and Muslims constitute a higher proportion of those who adopted a resilient strategy (46.7%). A higher proportion of people with no religion practised the combined strategy (40.0%) and high-yielding crops (40.0%). Indeed, as Frank *et al.* (2011) and Slegers (2008) noted, perceptual environment, values, beliefs, knowledge and culture shape people's adaptation to climate. Indeed, this paper shows that perceptions are embedded in religious and cultural beliefs, which can influence adaptation.

In Nguyen *et al.* (2016) model of perception and adaptation to climate change, education is considered critical. Results from this study show that secondary educational attainment is associated with the highest proportion of respondents who preferred to adopt high-yielding crops (58.6%) as a strategy against the impact of climate change. As the level of education increases, the preference for a combined climate change adaptation strategy decreases, while that for climate-resilient and high-yielding crops also increases.

There is a significant association between income level and climate change adaptation strategy. Individuals whose income level was less than US$8.33 constituted a higher proportion of respondents who adopted a climate-resilient strategy (64.7%), and those whose income level was US$41.66 and above constituted a higher proportion of the respondents who adopted a yielding crop (55.2%). There is a significant association between land ownership and climate

Table 4. The association between the study variables and climate change adaptation strategy

	Climate adaptation strategy			
Variable	Climate resilient	High yielding	Both	*P* value
Age-group				0.460
15-35	24.6	51.5	24.0	
36-60	29.0	50.0	21.0	
61-80	35.0	50.0	15.0	
District				<0.001
Builsa South	8.3	39.7	52.0	
Mamprugu Moagduri	49.0	39.4	11.6	
Ada East	26.3	46.9	26.9	
Ada West	52.0	48.0	0.0	
Marital status				0.292
Never married	29.5	47.5	23.0	
Married	27.0	53.3	19.7	
Divorced	32.1	46.4	21.4	
Widowed	34.3	31.4	34.3	
Religion				<0.001
Christian	23.3	55.0	21.8	
Muslim	46.7	41.3	12.0	
Africa traditional religion	27.8	36.1	36.1	
No Religion	20.0	40.0	40.0	
Educational level				0.017
No education	37.7	42.6	19.8	
Primary	22.4	53.3	24.3	
Secondary	21.4	58.6	20.0	
Tertiary	34.8	56.5	8.7	
Income level				<0.001
< Ghc100	64.7	26.5	8.8	
Ghc100-300	24.1	50.3	25.6	
Ghc301-499	23.8	50.0	26.2	
Ghc500 and above	26.8	55.2	18.0	
Perception of COVID-19 impact on agriculture				0.387
Yes	40.0	37.8	22.2	

(*Continued*)

Table 4. (*Continued*)

	Climate adaptation strategy			
Variable	Climate resilient	High yielding	Both	*P* value
No	63.6	18.2	18.2	
Household size				0.095
1-4	26.1	54.6	19.3	
5+	31.2	44.4	24.3	
Rent or sharecropping				0.002
Rented or shared crop	30.7	44.3	25.1	
Had not rented or sharecrop	24.2	60.4	15.4	
Land_Ownership				<0.001
No ownership	11.1	77.8	11.1	
<50 hectares	30.5	49.3	20.2	
50 and above	12.5	43.8	43.8	

Source: Fieldwork 2022.

change adaptation strategy. Comparably, adapting high-yielding crops was higher among respondents who did not own land (77.8%), while adopting a combined strategy against climate change impact was higher among respondents with 50 or more hectares of land (43.8%). Renting land or sharecropping was associated with a climate change adaptation strategy. Finally, respondents' perceptions of COVID-19's impact on agriculture and household size are not significantly related to climate change adaptation strategy.

In the Coastal and Guinea savannah agro-ecological zones, local perceptions and experiences of climate change are very high because smallholder farmers practice rain-fed agriculture. These were highlighted during focus group discussions with community members regarding climate change experience and the strategies adopted against its impact. A female participant in the FGD at Ada remarked, 'For about ten years, the rainfall pattern has changed. Sometimes, when it starts raining, and we plant our crops, the rains stop, and the crops dry'.

The men's focus group discussion highlighted a similar pattern.

> When we were growing up, there used to be a stream here, and it rained to the extent that these streams became full, and we could even fish in them. But now it is no more. So that is a challenge for us. Secondly, the crops grow well because it rains. But now it does not rain much or regularly. So, you could grow your crops, and it might not rain enough for your crop to grow well and harvest more yields [Men FGD, Ada].

Similarly, in Weisi during the FGD for men, a participant also noted that 'This year in particular, the rains were late and some of the crops were withering and by the time it had started raining some were tussling so when the harvest was due the grains were diseased because they are premature with less density.'

Based on farmers' perceptions and experiences, the most apparent indicator of climate change for farmers is the change in rainfall pattern, intensity and duration (Martey *et al.* 2022; Dapilah 2023). Many respondents indicated that they cultivate different varieties of crops as a strategy against the impact of climate change. The experience of climate change is characterised by 'the delayed onset of rain', which affects the types of crops planted. 'We resort to growing different varieties of the crops available; with maise, for instance, we grow two kinds. In droughts, we rely on the early, yellow corn, and late maturing varieties' [Men FGD, Builsa South].

As Frank *et al.* (2011), Yomo *et al.* (2020), and Yaro (2013) argue, the type of adaptation deployed by farmers is based on how they perceive climate change. Respondents' perspectives reflect climate variability and change, to which planting different varieties of crops is seen as insurance. Thus, as shown above, the cognitive process of learning, understanding and practising (Nguyen *et al.* 2016; Adolph and Kretch 2015; Gibson 1963) is key to farmers' adaptation to climate change.

In addition to rainfall, participants also shared experiences of increased temperature. Farmers' view of changes in temperature over the years is based on their observation of changes in the environment, heat intensity and how that affects crop production (Kemausuor *et al.* 2011). Here, the participant indicated an increase in temperature and loss of vegetation as a cause and effect of climate change. 'The temperature changes are also a challenge. It has become hotter at some times of the year. We used to have a lot of forests. But as the population grows, the trees are being cleared for farmland. So that leads to climate change' [Men FGD, Ada].

The Intergovernmental Panel on Climate Change (IPCC) estimates that, by the mid-21st century, global crop yields could decline by up to 2% per decade due to climate change (Maliva and Maliva 2021). In Ghana, we found that farmers are experiencing declining yields and have stopped cultivating crops due to climate change. A male farmer in Ada said, 'We have stopped producing the groundnut because of a change in the weather and with more rodents destroying it'.

The incidence of pests and diseases also indicates climate change (Yaro 2013; Amadou *et al.* 2015), and this local knowledge drives the transition to more resistant crop varieties. In the coastal savanna, sorghum leaves, called kokoba (see Figure 3), are an example of drought-resistant crops farmers cultivate in response to climate change.

> Now, everyone produces kokoba leaves. When you harvest dry leaves, you can store them if the selling price is low. And sell it when the price appreciates. For example, it is selling at [US$0.8] now; you can store it and

Figure 3. Sorghum (kokoba) leaves.
Source: Fieldwork 2022.

> sell it at [US$1.2] or [US$1.6] during Christmas and after Christmas [Male Farmer, Ada East].

While sorghum is a staple in the Guinean savanna, in the Coastal Savanna, it is produced for its leaves. The leaves are used to prepare waakye (rice and beans), one of Ghana's ubiquitous foods. Waakye is consumed in every part of Ghana; thus, the sorghum leaves that give waakye its distinctive red colour are always in demand. The sorghum leaves are also used to produce local drinks and medicine.

Apart from being what farmers described as an 'all-weather crop' – thus, viable whether it rains or not, the sorghum leaf has a long shelf life. Therefore, farmers can store it until the prices go high. Storage of the leaves is also a simple process of parking the dried leaves in sacks and keeping them in a dry area. Unlike maize and other cereals that require chemical treatment to prevent pests such as weevil infestation, sorghum leaves do not require such treatment. It is a low-maintenance crop that farmers store for an extended period. In all study communities in the Coastal Savanna, all farmers, both men and women, produce the sorghum leaves in addition to whatever crops they grow. While the sorghum leaf is not a staple crop in the communities, it provides income security for farmers.

The transition from staples such as groundnut, maize and cassava to commercial crops such as tomatoes, watermelon, okro and pepper is a crucial adaptation strategy by farmers.

> Previously, we were not farming on a large scale; we did not apply fertiliser or use tractors. It was purely manpower. We cultivated groundnut, beans, maize and cassava during those days. But now, with the changes in the season, it is up to you to know which crops to grow when the rain starts. Growing sorghum leaves, okro, tomatoes, and pepper is good. If you grow these crops as the rain starts, yields will be higher. But if you do not do that and wait for some time, the rains might stop, and you may not achieve anything [Male Farmer, Builsa South].

The production of vegetables in the coastal savannah also responds to market demands. The proximity of Ada to major markets in Accra, Tema and Kumasi is also driving this transition. Freshly produced vegetables are easily transported to urban markets with high demand. Effectively, the transition of crops is not purely in response to climate change but also market-driven (Vernooy 2022).

In both savanna ecologies, irrigation is an essential adaptation strategy to climate change. The use of irrigation allows for year-round crop production. With support from the World Bank, a solar-powered irrigation scheme has been developed in Ada. They pump water from the Volta River into a pond, then circulate it to farmers using gravity at a fee. In addition to centralised irrigation schemes, farmers increasingly rely on boreholes to irrigate their farms. A participant observed, 'Due to the change in the rainfall pattern, we have put a strategy in place. In February, whether it has rained or not, we hire a tractor to

plough the land and fetch water from boreholes to grow watermelons in anticipation of the first rain. The first rain makes the watermelon germinate. We grow watermelon to make money faster and venture into growing other crops for the year'. In the Guinean savanna ecology, farmers use bonds and irrigation, which allow them to produce rice without overreliance on rain. Others also cultivate in riverbeds where they can easily access water to irrigate their crops. Even with the fees, farmers grow commercial crops, apply external inputs and have a guaranteed water supply, thereby dealing with the challenges of rain-fed agriculture. What is apparent from these strategies is that they are context-specific and localised, and thus, policies must aim at leveraging existing local adaptation strategies.

In all study areas, fertiliser use has become a central aspect of adaptation to climate change (Tsiboe *et al.* 2021), as noted by a participant that, 'When our parents were farming, they were not using fertiliser. But now, we use fertiliser, and the land is used to that. So, if you plant crops without fertiliser, the crops will not grow well'. Farmers rely on fertiliser to increase output. In Gbedembilisi, a farmer recounted, 'In the past, the soil was more fertile. But now, we must select and cultivate suitable crops even in extreme weather. And using agrochemicals and dry season farming is new to us, but they are very beneficial and increase crop yield'. Fertiliser use has become ubiquitous among farmers to increase production (Henderson *et al.* 2018). Farmers combine organic fertilisers from animal droppings, which are applied to the land when preparing them, and inorganic fertilisers, which are applied to crops. The conditions necessary for adaptation are the availability of transport networks essential for the bulk supply of fertilisers and other vital inputs to rural communities. The availability of input suppliers in or near the communities also affects the accessibility and overall costs related to inputs. For instance, farmers in the Ada area can invest in irrigation for vegetable production because of their proximity to Accra, Tema and Kumasi, three of Ghana's most prominent urban markets. Farmers in the Guinean savanna are further away from these major markets; hence, the emphasis on rice, which has a longer shelf life and is, therefore, easy to transport to urban markets in southern Ghana. In all instances, the unrestricted movement of people has facilitated the transportation of inputs to and outputs from farms as well as critical skills and technology. It is therefore imperative to shed light on how the pandemic has disrupted access not just to agricultural activities but also to farmers' adaptation to climate change.

The experiences of COVID-19 and its effects on farmers' adaptation to climate change

Table 5 shows respondents' perception of COVID-19's impact on agriculture, food supply chain and production across the various districts. The result indicates that the majority (81.4%) of respondents in all study regions noted that the COVID-19 pandemic impacted agricultural activities. In the Guinean Savannah, a Wiesi farmer lamented, 'Movement restrictions slowed down work and reduced productivity as I worked alone and could not cultivate more land

Table 5. Perception of COVID-19's impact on agricultural and food production

Variable	District				All
	Builsa South	Mamprugu Moagduri	Ada East	Ada West	
	N=142 (%)	*N*=130 (%)	*N*=136 (%)	*N*=137 (%)	*N*=545 (%)
Impact of COVID-19 on agriculture					
Yes	67.6	90.8	98.5	70.1	81.5
No	32.4	9.2	1.5	29.9	18.5
Impact of COVID-19 on food production					
Production has increased	0.0	3.1	2.2	0.0	1.3
Production has decreased	64.1	91.5	95.6	99.3	87.3
No changes	22.5	5.4	2.2	0.0	7.7
Don't know	13.4	0.0	0.0	0.7	3.7

Source: Fieldwork 2022.

because we could not get help'. Many people from these rural areas typically migrate to Accra and Kumasi during the dry season and return in the rainy season to work on farms. With restrictions on movement imposed in these cities, many migrants struggled to return. Like many regions in the world (Siche 2020), agriculture in Ghana was adversely affected by the pandemic.

About 87.3% reported a decrease in food production due to COVID-19. Across the study districts, respondents had comparable and similar perceptions regarding the negative impact of COVID-19 on agriculture and food production. This is unsurprising as farmers in all the study areas were faced with new rules of engagement during the pandemic through preventive measures put in place.

The evidence presented here suggests that agricultural and, particularly, food production was negatively affected by the COVID-19 pandemic. This is because the disruptions in global supply chains, agriculture and movement restrictions were among the significant ways the pandemic affected societies (Martey *et al.* 2021). In Ghana, measures taken by the state and global actions affected farming activities (Andrieu *et al.* 2021). Access to inputs, mobility, health and work, and increasing expenditure affected farmers' output.

In addition, market access was restricted at the pandemic's peak, with devastating consequences for farmers. Some participants said, 'We made some losses because the buyers could not come to buy our crops'. Another participant noted that 'for me, during that time [peak of the pandemic], buyers were not coming to buy products on the farm due to lockdown. When I sent it to the market, there was no one to buy it. So, I made losses'. While these communities did not experience any lockdown, the closure of major markets and lockdowns in Accra and Kumasi negatively affected rural farmers. In the Guinean Savanna, farmers rely on female aggregators to take their farm produce to major markets, a process disrupted by the pandemic. Farmers who managed to access

the market experienced low sales. Farmers producing perishable goods such as tomatoes, peppers and watermelons with short shelf life suffered losses, and many were plunged into debt (Schmidhuber 2020).

The supply of inputs like fertilisers was also negatively affected by lockdowns and restrictions on movement due to the COVID-19 pandemic. A farmer noted that the pandemic 'was a challenge because the fertiliser price was high. And most of us could not afford it. And the Agric Extension officers did not help us get access to fertilisers. They tell us to buy it from the market. So that was a serious challenge to us'. For many farmers, this increased their production cost, and those who could not afford higher fertiliser prices suffered reduced yields. The reference to extension officers also relates to the government of Ghana's fertiliser subsidy initiative for farmers under the Planting for Food and Jobs initiative. Under this program, farmers received subsidies, thus making fertiliser affordable (Pauw 2022). However, as the government of Ghana struggled with managing the pandemic and the overall state revenue reduced, the subsidised fertilisers became scarce, adversely affecting agricultural output.

Conclusion

The paper set out to explore how the COVID-19 pandemic affected farmers' adaptation strategies to mitigate the impact of climate change. A mixed-method approach was deployed to achieve this goal with data from surveys and interviews. The paper outlines farmers' knowledge and perceptions of climate change, both intrinsic and external adaptation strategies they deploy and how the pandemic affected these strategies. Findings from this study indicate that smallholder farmers in Ghana faced numerous challenges in adapting to climate change, which was exacerbated by the onset of the global COVID-19 pandemic. It is argued that smallholder farmers face multiple challenges due to climate variability and change. Farmers adapted strategies such as changes in crop types, irrigation, incorporating livestock and using inputs such as early maturing varieties, pesticides, weedicides/herbicides and fertilisers against climate change.

The above adaptation strategies were compromised during the COVID-19 pandemic due to the draconian measures adopted by the government and the global community. The restrictions imposed during the pandemic adversely affected farmers' access to markets, leading to increased post-harvest losses, debt accumulation, food production, and an adaptive capacity crisis. There is a need to pay critical focus and attention to the agriculture sector, particularly smallholder farmers, during health emergencies to reduce the impact of climate change that farmers are already facing.

Efforts and interventions to address climate change impact should consider the socio-demographic background characteristics and land ownership for their effectiveness. The consciousness of farmers and levels of skills needed to adapt to climate change are already very high; what policymakers and development partners need to do now is to support through adaptive capacity building in the

areas that increase physical, financial, human, social and economic capital required by farmers to get them back on track. This paper raises conceptual issues related to the nexus between land tenure, farming systems, climate change adaptation and pandemics that require further scholarly attention. In the context of climate change and the increased potential for future pandemics, it is imperative to understand how knowledge systems, local technologies in agriculture and dependence on external inputs affect farmers (see Narh 2022) and further complicate the challenges of local farmers – the peasant struggle.

Note

1 The currency exchange rate used in this study is $1 equivalent to GHC12.5

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