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RESEARCH ARTICLE

Cocoa vs. food crops: smallholders' seasonal food access and extension support for climate adaptation in Ghana

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ABSTRACT

The food security implications of the production of cocoa compared to food crops and the phenomenon of the lean season amongst smallholder farmers have been well-researched. Yet, the literature has yet to consider how climate variability affects these dynamics. This study addresses this gap by comparing the contributions of cocoa and food crops to food stability and access during extreme and erratic weather events. It then compares government extension support for households' climate adaptation of these crops. Our data draw on the case of smallholder cocoa farmers in Ghana's Central Region and comprise a survey of 250 households, 16 focus group discussions, and 81 semi-structured interviews with smallholders, market sellers, and government officials. We find that food crops are essential for households' food access during the cocoa lean season and when cocoa yields are reduced by climate change-related extreme or erratic weather events. However, food crop yields are themselves negatively affected by climate variability impacts. Furthermore, many farmers lack climate adaptation strategies or support for food crops as government extension services focus instead on export-driven cocoa. We argue that to promote households' food stability, more smallholder extension support for food crop production and climate adaptation is urgently needed.

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Food security; climate adaptation; extension; lean season; food crops; cocoa; smallholders

1. Introduction

Many smallholder farmers cultivate both food crops and cash crops (Rapsomanikis, 2015), often in rainfed systems that are highly sensitive to climate change (Wudil et al., 2022). The food security implications of producing cash crops compared to food crops[1] have been extensively debated and researched (Anderman et al., 2014; Hashmiu et al., 2022a; Jarzebski et al., 2020; Maxwell & Fernando, 1989; Wiggins et al., 2015). Likewise, the phenomenon of the lean season has been well documented (Chambers et al., 1981; Kansanga et al., 2022; Sahn, 1989; Sibhatu & Qaim, 2017; Vaitla et al., 2009). However, there is a gap in the literature related to the effects of climate variability on smallholder farmers' food stability and access over time. This study addresses this gap by examining how food crops contribute to households' food access during the lean season, specifically in the context of climate change. It examines how climate variability shapes food access during the lean season and, in light of this, adds analysis of the extent to which extension services support smallholder farmers to adapt their cocoa to climate change compared to their food crops. Using cocoa smallholder households in the Central Region of Ghana as a case study, in this paper, we pose three questions. First, how do food crops contribute to households' food access during the cocoa lean season? Second, how do cocoa and food crops contribute to households' food access during extreme and erratic weather events? Third, how do government extension services and climate adaptation support vary between cocoa and food crops?

Food security has been widely conceptualized in four dimensions: availability, access, utilization and stability (FAO, 2006). In this study, we investigate households' food stability, which concerns the presence of continuous access to food and can vary due to seasonal variations in income or food supply, climate variability, and price fluctuations (Schmidhuber & Tubiello, 2007; Ziervogel & Ericksen, 2010). Figure 1 illustrates the components of food stability that form this research. We conceptualize food stability as composed of food access over time (FAO, 2006; Manikas et al., 2023), and focus in particular on the temporal aspects of the cocoa lean season and the harvest seasons of food crops.

In the cocoa belt of Ghana, the majority of farming households engage in cocoa production, which serves as their primary source of income, and also cultivate a range of food crops (Hirons, Robinson, et al., 2018). These food crops play various roles, including directly providing food for consumption, marketing for cash, and providing favourable shade

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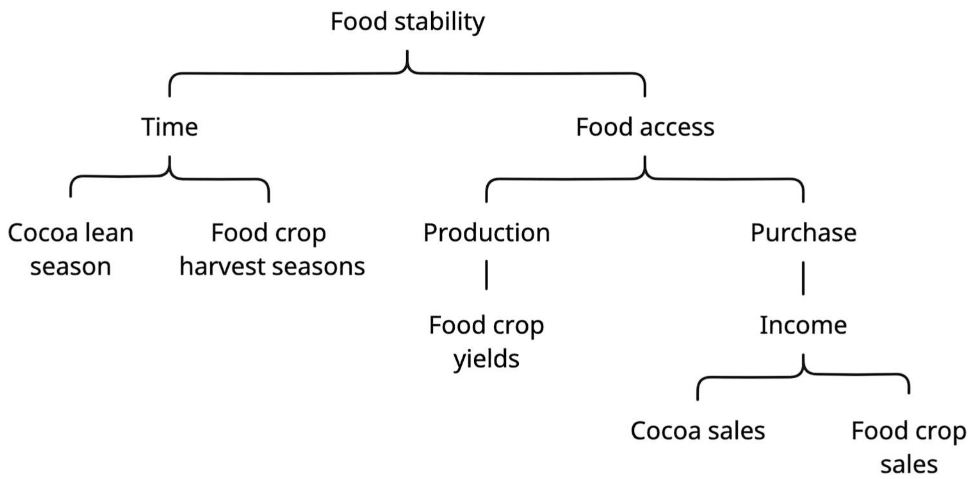

Figure 1. The components of food stability examined in this paper. Source: authors' own.

conditions for growing young cocoa (Osei-Bonsu et al., 1998). Households may access food through direct production or market purchases, which are largely determined by incomes from cocoa and food crop sales. Many farming households in the region also have off-farm income sources, but these are beyond the scope of this study, as it compares the roles of on-farm cocoa and food crops specifically. When considering the temporal aspects of food stability, this research also focuses on smallholders' crops and considers the seasonality of cocoa and food crop harvests. Relevant fluctuations in the prices that farmers receive for the sales of their food crops are considered, which are influenced by seasons and climate variability (Anderman et al., 2014; Dzanku et al., 2021; FAO, 2008; Gregory et al., 2005; Kotir, 2011). However, we do not examine price variations of purchased foodstuffs that are not subject to these local-level seasonal and climatic dynamics, such as imported canned goods.

The management of the sale of smallholder farmers' cocoa and food crops differs greatly in Ghana. Cocoa export and international sales are controlled by COCOBOD and the Ghanaian government benefits greatly from cocoa exports. Cocoa is the largest contributor to agricultural GDP and is of great strategic importance for foreign exchange generation (Dompreh et al., 2021; ISSER, 2018). Farmers are paid an immediate fixed payment for each standard 64 kg bag of cocoa beans – 800 Ghana cedis (approximately 70 USD) for the 2022/2023 cocoa season. Food crops, on the other hand, are traded at local markets close to farmers' villages, rather than exported. Here, prices can be low and are determined through negotiation and in response to relative abundance. Food crop markets are, therefore, uncertain and volatile compared to assured ready cocoa markets (Hashmiu et al., 2022b).

Many studies have questioned whether households in Ghana earn sufficient money from cocoa to purchase food from markets or if it is necessary to grow food crops to improve self-sufficiency (Anderman et al., 2014; Asubonteng et al., 2018). Studies vary in their conclusions, but some suggest that cultivating more cocoa reduces food access, as cocoa income is insufficient to match market food prices, markets are unreliable, and profits are seasonal (Ajagun et al., 2021; Anderman et al., 2014). Indeed, many households are vulnerable to recurrent seasonal food shortages, or the 'lean season', which occur among cocoa farmers after the previous season's cocoa harvest has been sold, as farmers are unable to bridge the income gap between harvests (Chambers et al., 1981; Dzanku et al., 2021; Hashmiu et al., 2022a; Kiewisch, 2015; Sahn, 1989). Our study builds on this research by considering the effects of climate variability on the lean season and the relative importance of food crops. In our study area, the lean season tends to fall between March and July for most households, during which approximately 70% of cocoa farming households report food shortages (Hashmiu et al., 2022a), particularly of high-quality foods, including vegetables (Anderman et al., 2014). This can lead to farmers resorting to buying food on credit, eating lower quality or variety of food, reducing portion sizes or skipping meals (Amfo et al., 2021; Kiewisch, 2015). This study builds on this research on cocoa production and seasonal food shortages by specifically analysing the role of households' food crops for their food access during the cocoa lean season.

This study introduces considerations of the effects of climate change to research on seasonal food shortages and debates on cocoa and food crop production. Smallholder households' seasonal food shortages tend to be intensified or lengthened if yields from cash crops are low or fail (Alpízar et al., 2020; Brown et al., 2009; Kansanga et al., 2022; Sahn, 1989; Sibhatu & Qaim, 2017; Vaitla et al., 2009), which is becoming more likely as the climate changes (Chemura et al., 2020). In Ghana, climate change is predicted to reduce cocoa yields in particular, rendering some areas unsuitable for cocoa production and necessitating adaption strategies (Läderach et al., 2013; Schroth et al., 2016). Increasing temperatures, longer dry periods, and unpredictable and variable rainfall also threaten a number of food crops in the area, including maize, cassava, plantain, and vegetables (Chemura et al., 2020; Hirons, Boyd, et al., 2018; Owusu-Sekyere et al., 2011; Schlenker & Lobell, 2010). This study compares the impacts of extreme and erratic weather events on households' cocoa and food crop production and the roles the two types of crops play in households' food stability in the context of climate change.

Finally, this study compares the provision of government extension services to support the production and climate adaptation of households' cocoa and food crops. Like many smallholders worldwide, Ghanaian smallholder cocoa farmers have little capital for climate adaptation and are vulnerable to extreme weather events as they rely on rainfed agriculture with small land holdings and basic farming technologies (Asante et al., 2017; Morton, 2007). Studies in Ghana have consistently found that the ability of Ghanaian farmers to adapt their cocoa and food crop production to the impacts of climate change is partly shaped by access to agricultural extension services (Antwi-Agyei et al., 2021; Asare-Nuamah et al., 2019; Denkyirah et al., 2017). Climate adaptation measures provided in communities by extension officers include offering education to improve climate change awareness, providing technical advice, demonstrating innovations, and promoting strategies such as planting shade trees, crop diversification, use of chemical inputs and improved varieties, and soil conservation (Anang et al., 2020; Antwi-Agyei et al., 2021; Antwi-Agyei & Stringer, 2021; Asare-Nuamah et al., 2019; Denkyirah et al., 2017; Emmanuel et al., 2016). Farmers in Ghana receive agricultural extension for their cocoa from the Ghana Cocoa Board (COCOBOD) as well as from licensed cocoa-buying companies (LBCs) (Attipoe et al., 2021). On the other hand, extension for food crops falls under the broad institution of the Ministry of Food and Agriculture (MoFA), which has historically focused on export crops rather than locally-traded food crops (Wolter, 2009). Both COCOBOD and MoFA deliver agricultural extension through decentralized services administered by district offices, with local extension agents assigned to visit designated geographical areas (Anang et al., 2020). This study investigates and compares the provision of agricultural extension services from MoFA and COCOBOD. Building on this, the paper then compares farmers' ability to adapt their cocoa and food crop production to the effects of climate change.

While our study focuses on the contributions of cocoa compared to food crops and extension provision in Ghana, its findings are relevant to climate-vulnerable smallholders across a variety of contexts who grow food crops alongside export-driven cash crops, such as coffee, rubber and tea (Wiggins et al., 2015). Our findings may have relevance for policymakers and practitioners who seek to understand the relative prioritization of cash and food crops for smallholder food access, how the climate crisis affects this balance, and how they may support smallholders to adapt.

The rest of this paper is presented as follows. Section 2 outlines the case study, methods, and data utilized in this study. Section 3 presents our results. In Section 4, we discuss our findings, before providing conclusions and implications of our study in Section 5.

2. Methods

This study is based on fieldwork conducted in seven forest-fringe villages surrounding Kakum National Park in Assin South District, Central Region, Ghana (Figure 2), which has been a hotspot of cocoa production for around 50 years (Hirons, McDermott, et al., 2018; NCRC, 2020). Study villages were selected to capture variations in microclimate, community size, and land tenure systems, including land owned by traditional authorities and privately owned land (Hirons, Robinson, et al., 2018).

We conducted field visits between June 2021 and March 2023, in which we carried out 16 focus group discussions ranging from four to 15 participants, surveys with 250 cocoa-farming households, and 81 semi-structured interviews with smallholder farmers, market sellers, and government officials. Due to COVID-19 travel restrictions, some research team members collected part of the field data in-person while others worked remotely. Data collection and analysis were an iterative process according to Miles and Huberman (1994) and Patton (2002). Following initial focus group discussions (which were gender-segregated) and

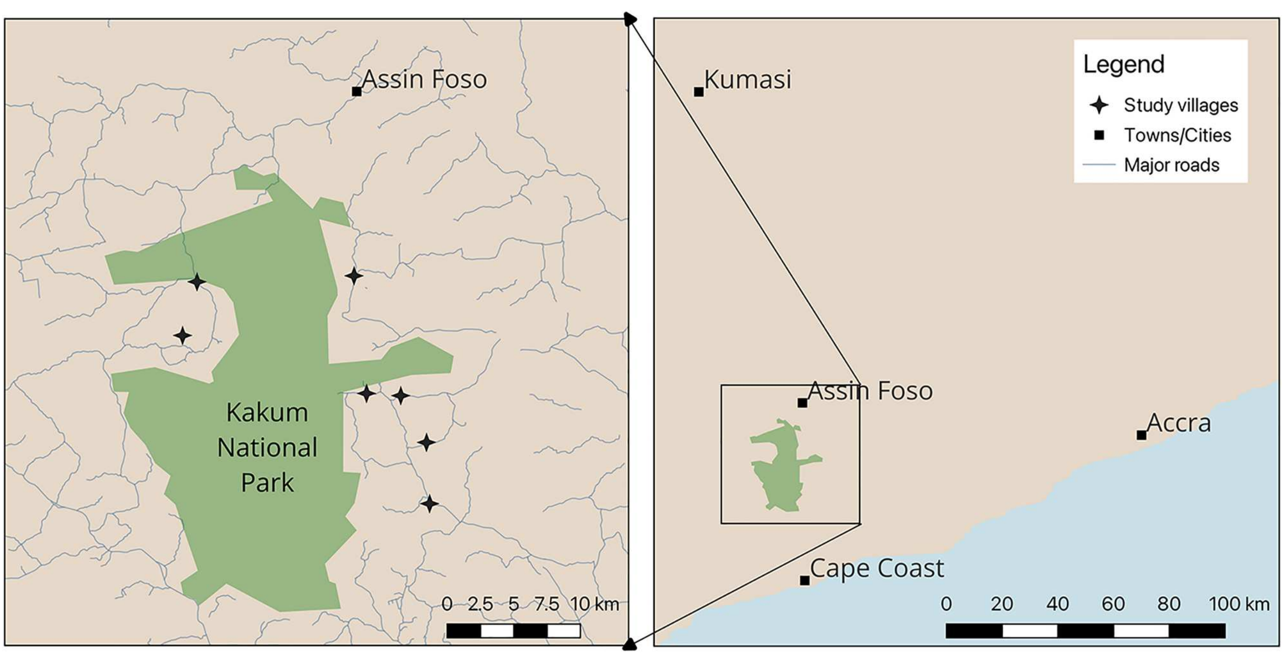

Figure 2. Map showing study villages in southern Ghana and nearby towns and major cities (Picot et al., Under review).

survey data collection and analysis, we conducted further semi-structured interviews and two more focus groups (mixed-gender). Data collection also followed a mixed methods triangulation design (Creswell, 1999) in which we collected and analysed separate quantitative and qualitative data on the same topics, comparing these results during interpretation to inform further data collection, according to Creswell and Plano Clark (2011). Ethical review and approval were obtained for this research by the University of Oxford's Central University Research Ethics Committee (reference SOGE 1A021 – 02).

We initially conducted two focus group discussions in each study village, as this had been determined through pilots to be sufficient to reach theoretical saturation (Hennink & Kaiser, 2022; Patton, 2002). Findings from these discussions informed the subsequent smallholder household survey in which we used a random spatial sampling approach, surveying every fifth household until we had the required sample size for that village, proportional to the relative village population (Nyantakyi-Frimpong & Bezner-Kerr, 2015). Accordingly, 273 households were surveyed, representing approximately 5% of the households living in the seven selected villages. The sample size was determined according to Adam (2020). Of the 273 households we surveyed, 250 (91.6%) grow cocoa, demonstrating the high incidence of cocoa production by smallholders in the area. We specifically analyse only these 250 households in this paper, as we focus on comparing the contributions of cocoa and food crops for cocoa-farming households. To capture stability of food supply, we used a survey indicator that measures the household's own assessment of the number of months in the past year that they were able to provide sufficient quantity and variety of food for themselves, either through production or purchasing (Hirons, Robinson, et al., 2018c; Alpízar et al., 2020; Dzanku et al., 2021). For analyses related to how food security correlated to other variables, we created a binary variable for whether the household self-reported having had sufficient quality and variety of food in the last year (Hirons, Robinson, et al., 2018). Annual household incomes were self-reported by respondents with arithmetic support from researchers. We analysed the survey data using descriptive statistics in SPSS Version 29.0.1.0.

Following the survey, a total of 81 semi-structured interviews were conducted: 56 with smallholder farmers, 15 with market sellers, 7 with district-level agricultural officials from MoFA and COCOBOD, and 3 with staff from licensed cocoa-buying district offices. Our preliminary smallholder survey analysis informed both the contents of the interviews and our selection of farmer participants, mostly a sub-set of survey participants with a wide demographic range (e.g. age, land size, gender) and varied responses on key issues. We also included some community leaders and others sampled through snowballing. Additional interview participants were included until we reached theoretical saturation in the responses given (Patton, 2002). Conversations were audio-recorded with permission from participants and transcribed using the assistance of Sonix AI. We used standard coding and memoing techniques to analyse the interview data (Miles & Huberman, 1994).

3. Results

The results section starts with an overview of the households surveyed. The rest of the results are presented in three main sections which correspond to the paper's three research questions. First, we examine the contributions of food crops to household food access during the cocoa lean season. Second, we compare the contributions of food crops and cocoa to households' food access in the context of climate variability. Third, we compare the extent to which government extension services support farmers to produce cocoa and food crops and adopt climate adaptation strategies.

3.1. Overview of study households

Table 1 provides a summary of descriptive statistics for 250 cocoa-farming households in the study region. Households had, on average, farmed cocoa for 17 years, indicating a wealth of experience in cocoa production and marketing. However, nearly a third of household heads had received no formal education, highlighting the need for other forms of education, such as agricultural extension services. The majority of household heads in our cocoa household survey

Table 1. Summary of descriptive statistics for cocoa-farming households in the study region.

Variable	Mean	Median	Min.	Max.	Std dev.
Age of household head	50.46	50.00	21	89	13.56
% female-headed households	31.0%				
Ethnicity of household head	35.8% Fante; 32.9% Assin; 7.3% Krobo; 6.5% Northern; 5.3% Asante				
Education of household head	46.4% Junior High School; 30.2% no formal education; 13.7% Primary School; 8.5% Senior High School				
Primary occupation of household head	86.3% cocoa farming; 5.6% food crop farming; 2.8% artisan; 2.4% petty trading				
Time household head has lived in village (years)	29.61	30.00	1	63	14.99
Age of person responsible for food crops	47.80	47.00	21	87	13.20
% female household member grows food crops	40.3%				
Household size (number of adults)	3.10	3.00	1	14	1.78
Household size (number of children)	3.30	3.00	0	18	2.71
Household cocoa production experience (years)	17.07	15.00	1	70	12.45
Annual income from cocoa (GH₵)	3335.8	2000.0	0	30000	4201.9
Annual income from food crops (GH₵)	784.6	50.0	0	11000	1521.0
Total annual income, including off-farm sources (GH₵)	4753.8	3000.0	20	50000	5899.7
Farm size total (ha)	3.77	3.24	0.40	17.81	2.70
Land used for cocoa only (ha)	2.01	1.62	0.00	12.14	2.13
Intercropped land (ha)	1.01	0.81	0.00	10.93	1.28
Land used for food crops only (ha)	0.46	0.00	0.00	6.07	0.76

farmed cocoa as their primary occupation, although a small minority focussed on producing food crops instead. Households in the area may split their land into areas used only for cocoa, only for food crops, or intercropping food crops among cocoa trees. Significantly more land is used for cocoa than for any other crop.

3.2. Contributions of food crops to food access during the lean season

3.2.1. Accessing food through cocoa and food crops

Farming households may access food through growing crops or purchasing foodstuffs with income generated through cocoa, food crops or off-farm livelihoods. Interviewees and focus group participants described purchasing food from markets to supplement their own production, make up for losses, and provide foodstuffs that they do not themselves cultivate. These include meat and fish, spices, beans, rice, palm oil, maize dough, yams, and other vegetables not grown by the household.

Cocoa contributes to food access by providing seasonal income, with the major harvesting period in the study area typically falling between October and February (Figure 4). Cocoa is seen by farmers as the most profitable crop, with smallholders reporting mean cocoa incomes of approximately four times the amount generated from all other food crops over the course of a year (Table 1).

> The income from cocoa is very important compared to food crops … The money from food crops helps us in our day-to-day activities, but cocoa gives you money to buy new clothes for your children and things like that. With cocoa money, you can even save some for the future. [female farmer, in her 70s]

According to one district official, however, MoFA's estimates of relative food crop income are much higher as their data indicate that farmers in the area actually make more money from food crops than cocoa [key informant, MoFA district office]. Farmers in our study generally had better recall of the income from bags of cocoa than food crops, as prices for the former are fixed, whereas prices for the latter vary and sales are spread through the year.

We found that most cocoa-farming smallholder households in the study region cultivate a variety of food crops. Unlike cocoa, food crops are flexible in that they can be consumed or sold (Figure 3), depending on household needs and market factors. Farmers require food production as '*you can't eat cocoa*' [48-year-old male farmer] and our interviews found that even COCOBOD officials advise farmers to use a small portion of land for subsistence crops. Our survey showed that 43.6% of households grow food crops for household consumption only, 2.2% cultivate for the sole purpose of selling and 54.2% grow food crops to both consume and sell them. In interviews, some households described only selling what was left over after their own consumption or when harvests were about to go bad. Households surveyed ranked the profitability of food crops in the following order (from highest to lowest): cassava, plantain, maize, tomatoes, pepper, oil palm, okra, cocoyam, and garden eggs (aubergines).

3.2.2. Seasonal food access

Seasonal food shortages in the study region are common. We found that 16.8% of households reported having insufficient food quantity or variety in the last year, lasting an average of 4.0 months (SD = 2.64) and only 61.6% of surveyed households reported '*always*' having enough food to

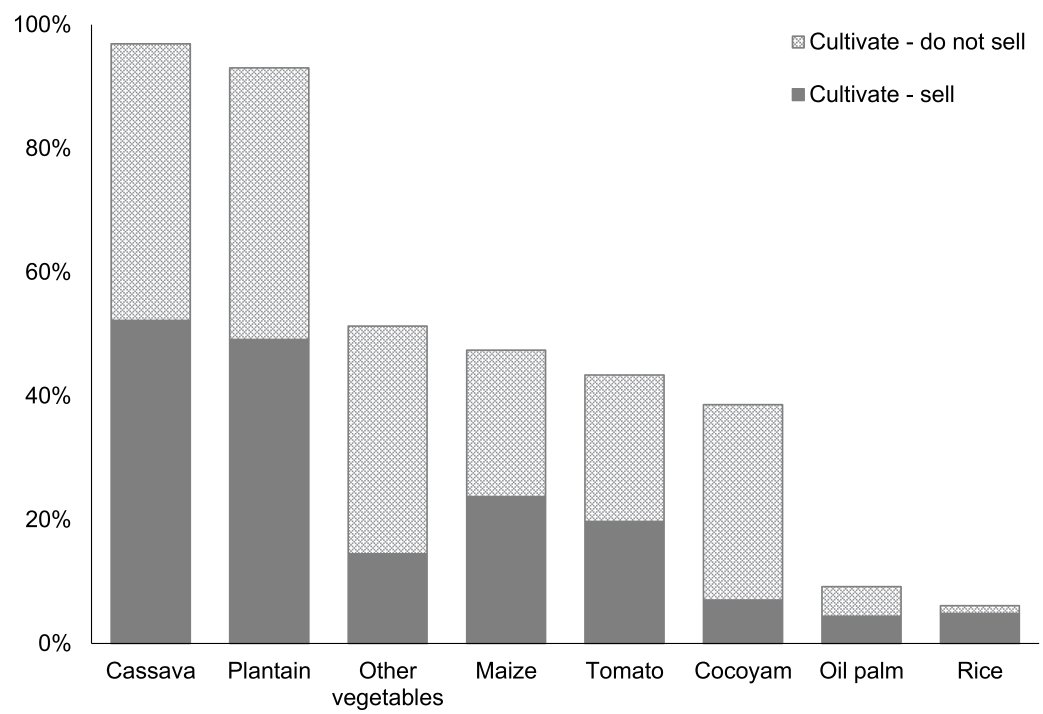

Figure 3. The proportion of cocoa farming households surveyed that cultivate and sell different food crops. Total bar height represents the total proportion of households that grow the crop. Other vegetables include pepper, garden egg (aubergine), okra, and other crops.

eat. Our qualitative data provided further evidence of food instability amongst smallholder cocoa farming households in the region and the timing of periods of food shortages. In interviews, smallholders described particularly struggling in the lean season, between cocoa harvests, as seasonal cocoa incomes are not sufficient to meet food needs throughout the whole year:

> Cocoa brings in a lot of income, but cocoa marketing season is actually quite short; it's a maximum of three months. Once cocoa has been sold, you're back to starting all over again. So that money actually may not last throughout the whole year as you'll have expenditures within those three months. So what will give you a little income here and there is food crops. We eat most of the food crops, so we are not getting huge income from it. [male smallholder farmer, aged 75]

> Normally some hardships crop up … That's when cocoa is out of season and you've used all your cocoa money. So for about five months you face some hardship, but it's not severe. If you have other food crops such as rice or maize, that will help you keep up the household. [female farmer, aged 32]

3.2.3. Roles of food crops in food access during the lean season

Our qualitative interviews showed that, during the cocoa lean season, the production and sale of food crops are essential for food access, either through direct production or income for purchase. As smallholders described:

> You can't rely solely on the cocoa all the time. You have to do something extra. So the okra and the pepper make up for when the cocoa has not been harvested yet and there's no cocoa money around. [female farmer, aged 65]

> Cocoa and food crops are of equal importance to me because I need both of them for income and food crops for survival. [female smallholder farmer, aged 53]

COCOBOD also acknowledges that farmers must have alternative livelihoods for the lean season:

> You can't get cocoa throughout the whole year. So during the lean season when there is no cocoa, farmers depend on food crops to survive. Some plant a little cassava, vegetables … [key informant, COCOBOD district office]

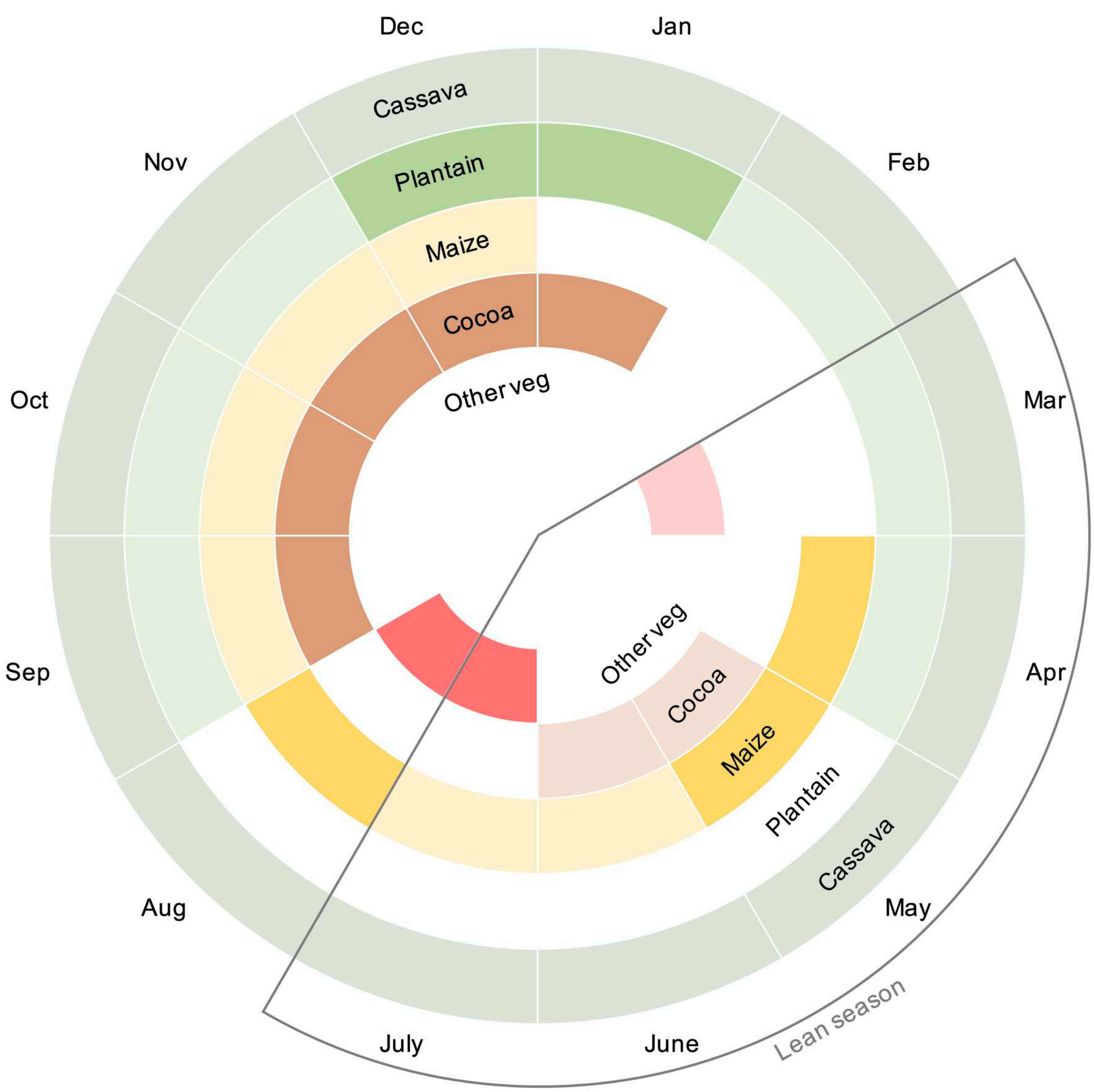

Figure 4. Annual lean season and harvesting seasons for cocoa, cassava, maize, plantain and other vegetables (tomato, pepper and okra), based on qualitative data. Dark shading denotes major harvesting seasons and light shading denotes minor seasons. Source: authors' own illustration based on field data.

Figure 4 shows the seasonality of different crops and represents how the timing of the harvesting seasons of some key crops, specifically maize, tomatoes, pepper, and okra, may help plug gaps caused by the lean season outside of cocoa. In focus group discussions, household accounts reflected this vital role of food crops. Alongside household consumption, market value, and versatility, farmers commonly cited the timing of the harvest as a reason for determining importance. For example, according to focus group discussions, maize tends to be the first crop ready in the harvest season, in April and May, so it provides food and money to households first. It also has a second major season later in the year, typically in August, and can be stored for several months in between harvests. Barring extreme weather conditions, cassava can also be stored by keeping it in the ground for one to two years and only harvested when needed; it is thus available year-round. Tomatoes, peppers and garden eggs mature quickly and therefore can generate money from sales fast. Unlike cocoa, food crop pricing responds relatively directly to supply, such that farmers reported in interviews and focus group discussions that their profits are higher if they are able to produce them at times when local abundance is relatively low. For some crops, farmers are able to adjust the timing of harvesting and timing of crops to accommodate this. For example, tomatoes, okra and peppers can be grown in marshy areas during the dry season.

On the other hand, responsive food crop pricing also means that, during times of high abundance, harvests can be hard to sell or fetch low prices that do not cover transportation costs. In our survey, 15.5% of households reported having food crop harvests go to waste because of a lack of market demand. We also note that food production and income from food crops can be insufficient to ensure food access during the lean season, with some households struggling to meet their needs:

> No, we can't always eat what we want. There are times there is no money even to buy meat to supplement the food we're eating. [male smallholder farmer, aged 75]

3.3. Contributions of cocoa and food crops during extreme weather events

3.3.1. Reported climate impacts on cocoa and food crops

The changing climate is having significant effects on the quality and yields of crops. Farmers in the region consistently reported that temperatures, sunshine and rainfall are becoming more '*irregular and unpredictable*' and '*extreme*', with a common message from farmers being that, now, '*God is the main farmer and will take care of the farm*' [male focus group discussion participant]. Rather than formerly regular patterns of wet and dry seasons, '*seasons are swapping*', and delays in rainfall extend the lean season, with negative consequences for food access. Poor weather, including heavy and erratic rainfall, high temperatures, and drought, is the most common reason for food crop wastage, with 62.6% of households reporting crops being ruined, resulting in a marked decline in food stability.

> When the weather is good and everything is favourable to the crops, we get 1000 to 2000 cedis from our pepper and tomato sales. But when the weather is bad, we get 300 to 200 cedis per year. And for cocoa, we normally get 5000 profit after expenses, but when the weather is bad, it's 1000 to 2000. [female farmer, age unknown]

According to our survey, cocoa was highly affected by recent climate variability impacts. As of November 2021, 74.4% of cocoa-growing households said they had experienced lower cocoa yields due to unusual weather in the previous two years. This is higher compared to some food crops: 68.9% for cassava, 59.4% for tomato, and 38.7% for plantain for households who grew those crops respectively; but is similar to that of maize, where 75.8% of cultivating households experienced lower yields. These numbers provide some evidence that cocoa may be even more susceptible than other crops to the types of climatic changes occurring in southern Ghana.

In qualitative interviews, farmers also described the effects of different extreme and erratic weather patterns on their cocoa. Excess rains caused farmers' fruits to develop black pod disease and drop before maturity, whilst high sunshine and lack of rains caused leaf discolouration and also reduced yields. Our interviews also showed the ways in which food crops were affected by climatic variability. For cassava, farmers described that excess rains '*spoil tubers in the ground*', meaning they could no longer be stored, or '*destroy*' the crop, resulting in less to sell. Farmers also described high temperatures reducing tuber quality, as well as difficulties in pulling cassava out of dry, hardened soils. Excess heat and drought stunted farmers' plantain growth such that the plantains became '*very small and you can't sell them for high prices*', whilst strong winds uprooted stalks and caused bunches to fall. Maize was also reported to be adversely affected by a range of extreme weathers, particularly flooding and drought. Moreover, excess sunshine and drought conditions were described to have particularly negative effects on tomato and pepper cultivation. Nearly a third (31.3%) of households reported changing their diets by less quantity or variety of food, or switching to different foods from normal in response to weather disruptions in the past two years.

3.3.2. Role of food crops during extreme and erratic weather events

According to our findings, some food crops seem to be more tolerant to climate variability than cocoa, or are sensitive to different climatic effects than cocoa. They can therefore fill gaps when cocoa yields are hampered by extreme or erratic weather, as well as during the lean season.

Our interviews showed that MoFA district officers in the area advise farmers to use half their land for non-cocoa crops, so that they are still able to have access to food through production, even if their cocoa does not yield well. Many farmers also described how they sell more food crops when they have a low cocoa yield. In our survey, we found that 66.9% of households sell more cassava and 69.8% sell more plantain to cope when they have less money than usual. In addition, 19.2% sell more maize, 14.5% sell more tomatoes, and 20.9% sell more vegetables, such as garden eggs and cocoyam. Furthermore, farmers adjust the planting of certain crops to compensate for cocoa losses. Tomatoes, pepper and okra may be replanted, as they are less seasonal than cocoa and may grow in other seasons '*as long as you giving them the right requirements that they need*':

> We subsidise [low cocoa yields] with the income that we get from tomatoes, pepper and all that. So it means that we would have to do more of the tomatoes and the pepper to support their income from the cocoa. [male smallholder farmer, aged 75]

Furthermore, a COCOBOD official explained that the annual lifespan of some food crops, such as tomatoes, means they are planted in response to changing seasons and therefore may be more climate tolerant than perennial cocoa. Plantain and cassava are particularly useful when cocoa fails, as plantain production peaks in December to January, coinciding with the cocoa season (see Figure 4), and cassava can be harvested '*as the need arises*'. One farmer also described times when cocoa has been badly affected by the weather but there has been '*little to no effect on the cassava and plantain*', as, according to a MoFA official, these crops are more '*adaptive*' during dry periods.

Even if they have food crops to help with cocoa failures, households may still endure hardship and a prolonged lean season. Compared to cocoa, incomes from food crops are low and cannot make up fully for what is lost from cocoa. Furthermore, the ability to supplement low cocoa yields with food crops depends on how the food crops themselves have been affected by the weather. Although some species are more climate tolerant than cocoa, the evidence described above shows how extreme weather still affects them, and farmers are doing little to adapt their food crop production to climatic changes. Therefore, farmers have to buy more food crops to supplement their harvests when yields are reduced by poor weather:

> Generally now, the food crops do not do well on the farm, so we buy almost everything … but it's very expensive. [female smallholder farmer, aged 43]

3.4. Extension and climate adaptation support for cocoa versus food crops

3.4.1. Provision of extension services for cocoa and food crops

Our study found differences between smallholders' receipt of agricultural extension services for cocoa and food crops, which shaped farmers' abilities to adapt the production of these two groups of crops to the effects of climatic variability. In our study, we found that smallholders' receipt of extension services for cocoa and food crops varies greatly, with more extension provided for cocoa than food crops from different sources (Figure 5). In this paper, we focus on government extension as provided by MoFA and COCOBOD district offices.

Overall, 57.6% of surveyed households reported receiving visits from COCOBOD agricultural extension officers, compared to 13.0% for MoFA officers. This is reflective of decision-making at the national level, resulting in significantly more understaffing of MoFA extension officers, such that MoFA officers must cover twice the number of communities as COCOBOD extension providers, according to a MoFA district official. We found that extension receipt from MoFA differs significantly between villages in our study (Fisher's Exact Test, $p = .003$), whereas extension from COCOBOD did not (Fisher's Exact Test, $p = .074$) (see Table 2).

A senior MoFA district officer explained that district radio extension service extends to all communities that can access

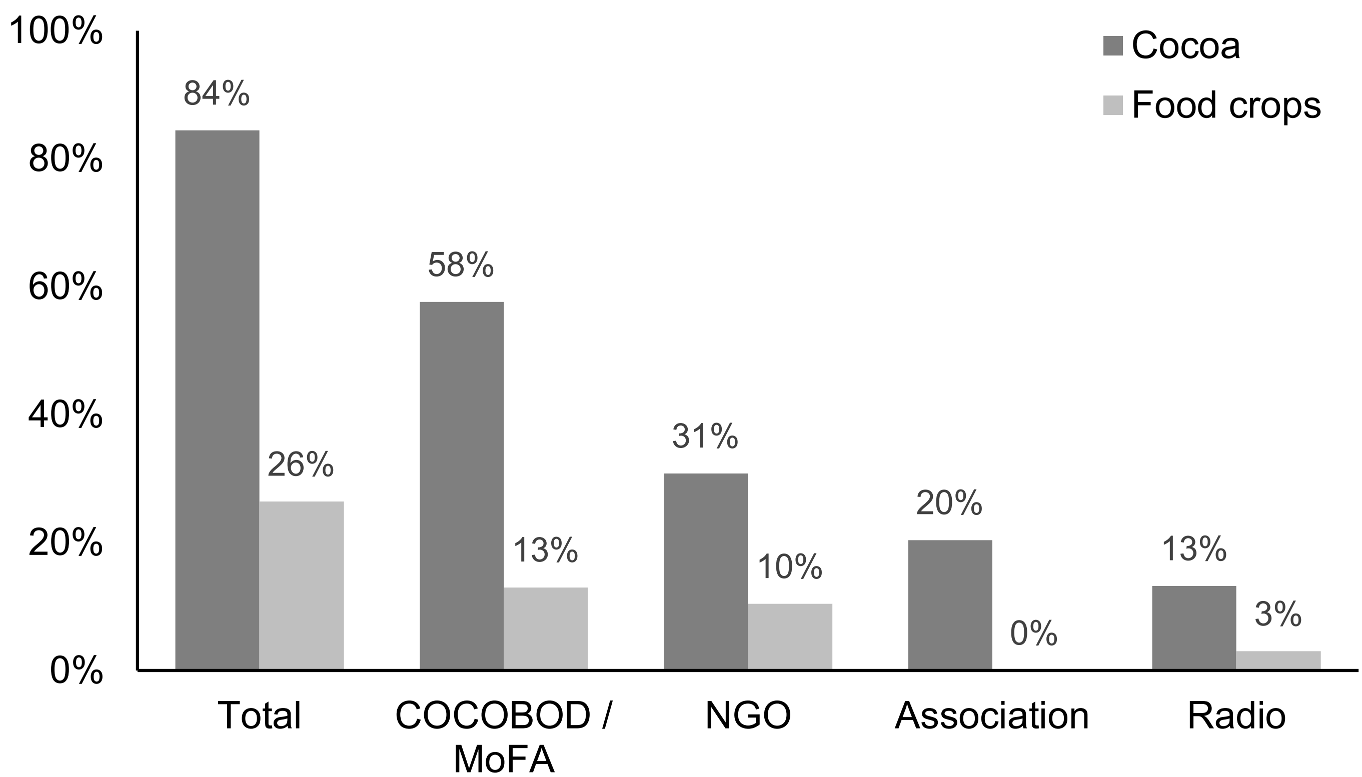

Figure 5. The proportion of cocoa farming households that receive agricultural extension from different sources for their food crops and cocoa. The COCOBOD / MoFA category indicates visits from COCOBOD extension officers on cocoa and from MoFA officers related to food crops.

Table 2. The number of households in different villages who receive extension visits from MoFA and COCOBOD.

	MoFA			COCOBOD		
	Receive	Do not receive	Total	Receive	Do not receive	Total
Village 1	8 (3.6)	20 (24.4)	28	28 (21.9)	10 (16.1)	38
Village 2	5 (5.5)	37 (36.5)	42	30 (26.5)	16 (19.5)	46
Village 3	2 (2.5)	17 (16.5)	19	12 (11.5)	8 (8.5)	20
Village 4	1 (2.7)	20 (18.3)	21	15 (12.7)	7 (9.3)	22
Village 5	1 (6.1)	46 (40.9)	47	24 (27.6)	24 (20.4)	48
Village 6	3 (4.8)	34 (32.2)	37	18 (21.9)	20 (16.1)	38
Village 7	10 (4.8)	27 (32.2)	37	17 (21.9)	21 (16.1)	38
Total	30	201	231	144	106	250

Note: Values given as: observed (expected).

radio and aims to '*close the gap*' for communities '*disadvantaged*' by not receiving extension officer visits. However, only 3.0% of farmers surveyed in our study reported listening to MoFA radio extension, despite 75.1% of households reporting owning a radio.

3.4.2. Support for climate adaptation for cocoa versus food crops

As well as differences in extension visits offered by MoFA and COCOBOD, we found differences in the extent to which the two government agencies provide resources to help households cope with the effects of climate change on their crops. Our qualitative data showed that government support for climate adaptation is greater for cocoa than for food crops. COCOBOD district officers explained that the government agency provides free shade tree seedlings and hybrid cocoa seedlings with improved tolerance to poor weather and disease, as well as frequent extension visits with information and inputs. Pilot testing is also underway to evaluate irrigation mechanisms that will soon be rolled out to more communities. Farmers also described receiving climate-related support from LBCs, with buyers conducting community visits. On the other hand, MoFA officers said that they are doing little, beyond raising awareness, to help farmers improve the climate impacts on their food crops, despite climate change being a priority.

> We are not doing so much as far as climate change is concerned. But I can say that we are sensitising the farmers on the effects of climate change on food production, especially the major food crops grown in the municipality, maize, cassava, plantain … Just a matter of sensitisation, just to create the awareness that climate change is catching up with us. [Municipal Director of Agriculture, district MoFA office]

MoFA advice to farmers includes using organic fertilizers and in-a-row sowing patterns to improve yields, planting forest trees to stabilize the micro-climate, practising mulching to improve soil moisture, and constructing drainage gutters to cope with excess rains. However, unlike for cocoa, farmers are not provided with materials to achieve these recommended measures, so their implementation can only be done by the few households who have sufficient resources. For example, MoFA's advice to farmers to plant maize in upland areas, not low-lying land, depends on households having access to such lands. Furthermore, given MoFA's significant understaffing, relatively few households benefit from such education and extension office visits. In some communities, MoFA is giving public demonstrations to teach new systems for planting involving demonstrations of planting in raised pipes, land preparation techniques, and using types of drought-resistant seeds, but as these are only available in some communities that have received extension officer visits, many have yet to access these technologies.

As a result, we found that few households said they are able to adopt climate adaptation measures for food crops:

> I'm not able to do anything to protect against the weather, so I'm just praying and hoping for the rains to come in. [male rice farmer, aged 25]

A small number of households we surveyed described using raised beds or gullies to drain off excess rain, for example, for pepper and tomatoes. Vegetables like these and garden eggs can also be manually irrigated, but only if farmers have the strength and a nearby water source to carry from, or if they can afford to construct a borehole. However, interviewees stated that plantain, maize and cassava require too much water to manually irrigate. One MoFA official noted that farmers are '*not really*' adapting to the climatic changes that are already occurring in the area, and many smallholders reported lacking the capacity to adopt any measures at all:

> Even for myself, even water to drink, I struggle with it. So there's no way I can irrigate the farm. [male farmer, aged 62]

4. Discussion

This study introduces considerations of climate variability and adaptation into debates on the cocoa lean season and the food stability implications of the production of cash crops compared to food crops (Anderman et al., 2014; Chambers et al., 1981; Hashmiu et al., 2022a; Jarzebski et al., 2020; Kansanga et al., 2022; Sahn, 1989; Sibhatu & Qaim, 2017; Vaitla et al., 2009; Wiggins et al., 2015). Specifically, this research analyses the role of food crops as cocoa and the related lean season is affected by extreme and erratic weather events, and compares the extent to which cocoa and food crop adaptation are supported by government extension services. In the following, we present our key findings and discuss them in the context of related literature.

The study focuses on food stability and finds that food crops play a key role in facilitating households' access to food during the cocoa lean season, through both direct crop production and providing income for the purchase of foodstuffs. In support of other studies that demonstrate cocoa smallholders' vulnerability to food instability (Anderman et al., 2014; Dzanku et al., 2021; Kiewisch, 2015), we find that 16.8% of households reported having insufficient food quantity or variety in the preceding 12 months, lasting for an average of four months. Our qualitative data suggest that, for many households, the cocoa lean season is a period of particular hardship, as the income generated during harvesting season does not last through the year. In this time between cocoa harvests, we find that food crops provide households with staples for meals and essential incomes. Food crops can, therefore, help feed the household through direct consumption and income provision, and many households sell more food crops when they have less money than usual, particularly cassava and plantain. In interviews and focus group discussions, farmers described how the seasonality of different crops is an important factor in crops' value. The flexibility of food crops is a key asset, as a diversity of non-cocoa crops allows for harvesting throughout the lean season and a choice as to whether yields are consumed or sold. However, food crop incomes may be too low and unreliable to ensure food access during the lean season. Our findings on the prevalence of insufficient food access in the cocoa lean season support studies from different regions in Ghana which find similar food shortages between cocoa harvests (Ajagun et al., 2021; Anderman et al., 2014; Dzanku et al., 2021; Kiewisch, 2015). Building on this research, this study contributes a novel research focus by specifically considering the role of food crops in food access during the cocoa lean season.

Next, this study compares the contributions of cocoa and food crops in the context of the climate crisis, an urgent issue for smallholder farmers worldwide that threatens livelihoods and food stability (Cohn et al., 2017; Vermeulen et al., 2012). It finds that food crops are again vital in facilitating households' food access when cocoa yields are hampered by the effects of climate variability. Cocoa yields were reported to be particularly negatively affected by extreme or variable weather. Excess temperature and sun, or rain, both reduced smallholders' incomes from cocoa, as expected from other studies. On the other hand, cassava, tomato and plantain seemed more tolerant, although still vulnerable to certain weather conditions, echoing results from other studies on the relative climate tolerance of food crops cultivated in West Africa (Chemura et al., 2020; Owusu-Sekyere et al., 2011; Schlenker & Lobell, 2010). We find that food crops, including plantain, cassava, tomato, pepper and okra, appear to compensate for losses when the main cocoa cash crop is hampered by climate variability effects. The flexibility of food crops was a key characteristic of their utility in two main ways. First, crop seasonality was found to be important and farmers may adjust the timing of the planting and harvest of certain crops to plug cocoa income gaps and in response to changing weather patterns. Second, households had the option to consume or sell yield, or with certain crops such as cassava, to process them into foodstuffs to use at a later date. Our findings concur with studies showing the importance of diversifying crops as a climate adaptation strategy to insure households against the variability of climatic conditions and protect against crop failure (Amfo & Ali, 2020; Mohammed et al., 2021). Our results also align with research by Antwi-Agyei et al. (2014) and Kansanga et al. (2022) which found that food crops' short time to maturity and flexible planting timing are helpful climate adaptation features amongst smallholder cocoa farmers in Ghana.

Having established the importance of food crops for smallholder cocoa farmers' food access during the cocoa lean season and periods of climatic variability or extreme weather, this study directly compares the provision of extension and adaptation support for cocoa and food crops. Our findings highlight comparative gaps in extension for food crops and farmers' ability to adapt to the effects of climate change. It is well-established that extension services in Ghana increase farmers' adoption of climate adaptation strategies, boost productivity, and raise farm incomes (Anang et al., 2020; Antwi-Agyei et al., 2021; Asare-Nuamah et al., 2019; Danso-Abbeam et al., 2018; Denkyirah et al., 2017; Emmanuel et al., 2016; Yeleliere et al., 2023). Furthermore, a lack of extension has been identified by farmers as a key barrier to crop production and also hinders climate change adaptation support (Antwi-Agyei & Stringer, 2021; Attipoe et al., 2021). Yet, our research finds a disparity in government extension provision between the two types of crops. Despite food crops' importance, we find low rates of extension receipt from MoFA, including radio extension, and great variation in extension officer visits between villages. Moreover, our results indicate that households receive more agricultural extension visits for cocoa than for food crops, reflecting the relatively high ratio of MoFA extension officers to farmers. Our results suggest lower rates of MoFA radio listenership than found in the Upper West Region of Ghana (Anaglo et al., 2014) but mirror other studies' findings of MoFA challenges, including staff shortages, lack of adequate transport, poor road networks and limited logistical support (Anang et al., 2020; Antwi et al., 2022; Antwi-Agyei & Stringer, 2021; Asare-Nuamah et al., 2019).

While our study provides useful insights into the importance of food crops for seasonal food access and highlights a lack of climate adaptation support, some limitations and avenues for further research should be considered. First, this study relies on self-reporting for its quantitative food security measures, which are subjective and risk participants overreporting the severity of the issue (Maxwell et al., 2008). Additional survey indicators recording during which specific months households had insufficient food would have strengthened the qualitative analysis of the typical timing of household food shortages and their relation to the cocoa lean season (Anderman et al., 2014; Bilinsky & Swindale, 2007). Although, our findings are corroborated by other studies which found similar lengths of periods of insufficient food (approximately four months per year) amongst cocoa farming households in Ghana (Dzanku et al., 2021). Second, crop yield data would facilitate a deeper analysis of how food crop production relates to household food access and extension receipt, beyond a binary variable of whether or not a household grows a given crop. Our quantitative analyses also relied on self-reported impacts of climatic events on crop yields, which may be less accurate than crop yield measurements. Finally, this study focused on government extension as provided by MoFA and COCOBOD through extension officer visits and radio services. Further research could unpack support from other sources, such as NGOs, farmer associations and LBCs.

5. Conclusions

This study reveals the vital but overlooked role that food crops play in the stability of Ghanaian smallholder cocoa farming households' food access during the cocoa lean season and in the context of climate variability. It argues that, given their importance, extension services and climate adaptation support for food crops must be improved.

We find that cocoa incomes are often insufficient to facilitate food purchasing throughout the year, such that many farmers struggle with recurring food shortages during the lean season between cocoa harvests, which are worsening as erratic events become more frequent and extreme. Our results suggest that food crops play an essential role in bolstering food access during these months through income generation and direct food production for consumption. Food crops' flexibility, variety and relative climate tolerance mean they play an essential role, particularly when the cocoa crop fails under extreme or erratic weather conditions. In particular, different options for the timing of planting and harvesting, and choices about consuming or selling, give food crops certain advantages over cocoa. However, food crops may themselves be susceptible to the impacts of climate variability and farmers lack feasible strategies to adapt their production. We find that government extension support to smallholders, including for coping with the effects of climate change, remains focussed on export-driven cocoa, to the detriment of food crop cultivation and climate adaptation.

Recent MoFA agricultural initiatives, such as Planting for Export and Rural Development and the creation of the Tree Crop Development Authority (TCDA), continue to focus on cash and export crops rather than locally consumed and traded food crops. We suggest that MoFA extension services prioritize supporting smallholders with locally consumed and traded food crops and address gaps in households that may not receive extension visits. In the face of intensifying extreme weather events, farmers across Ghana and other smallholder contexts will increasingly need resources, tools, and technologies to adapt their food crops and promote food stability as lean seasons become longer and more severe. We propose that the benefits of food crop production may become increasingly important as climate change impacts worsen, impacting cash crop incomes and food prices. Support for food crops should, therefore, be prioritized given their essential role in food access in the context of climate change and the lean season.

Note

1. We define 'food crops' as staples which are used principally for subsistence, but are often also sold in market (Barbier, 1989).

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