

**CLIMATE CHANGE PERCEPTIONS, SEASONALITY IN COCOA OUTPUT AND
THEIR EFFECTS ON FOOD SECURITY AMONG COCOA FARMERS IN THE
WESTERN AND ASHANTI REGIONS OF GHANA**

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**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN
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SCHOOL OF AGRICULTURE, COLLEGE OF BASIC AND APPLIED SCIENCES
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NOVEMBER, 2024

DECLARATION

I, Mary Nana Anima Akrofi, author of this thesis titled '**CLIMATE CHANGE PERCEPTIONS, SEASONALITY IN COCOA OUTPUT AND THEIR EFFECTS ON FOOD SECURITY AMONG COCOA FARMERS IN THE WESTERN AND ASHANTI REGIONS OF GHANA**' do hereby declare that with the exception of references to past and current literature duly cited, the entire research for this thesis was carried out by me in the Department of Agricultural Economics and Agribusiness, College of Basic and Applied Sciences, University of Ghana from January 2021 to November 2024. This work has never been presented either in whole or in part for any other degree of this University or elsewhere.


.....

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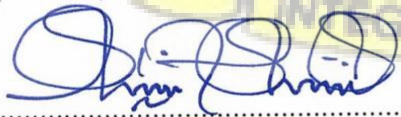
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DEDICATION

This work is dedicated to my parents for all the inspiration, motivation they gave, my beloved husband for his inspiration, unwavering support and sacrifices, my children, and all who supported me throughout the PhD journey.



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ABSTRACT

To enhance policy towards addressing the challenges that climate change poses on seasonality of cocoa outputs and farmer income. Seasonality is a particular type of temporal (time) variability in endowments and prevalent in agricultural production cycles. It is important to have knowledge of cocoa farmers perception of climate change on their cocoa yields and food security, their perceptions on potential climate-smart agricultural practices that enhances adaptation to climate change, their seasonal cocoa production and output that smoothen their income and food security in enhancing cocoa farm productivity and sustainability. However, there is a scarcity of information and empirical evidence on their linkages. This study used cross-sectional baseline and panel data across 15 communities in three cocoa districts: Ellembelle and Wassa Amenfi Central in the Western region and Afigya Kwabre North in the Ashanti region for the analyses. The study used responses from 402 cross-sectional baseline, and monthly panel data responses from 150 farmers over two (2) years. A combination of purposive and random sampling approaches was developed by the study. The panel data covered the period 2022/2023 to 2023/2024 cocoa cropping years. The study describes and analyzes farmers' perceptions of climate change variability and its effects on cocoa yields. Descriptive statistics such as frequencies, percentages, means and graphs were used to describe socioeconomic characteristics, institutional, location, climate change perceptions, Climate-Smart Agriculture (CSA) practices, among others. A regression model was used to analyze the effects of climate change variability on coca yields. The Multivariate Probit (MVP) model was used to analyze the perception of cocoa farmers CSA practices and factors influencing recommended practices for improved cocoa yields and farm income. Panel regressions using the fixed effect regression model was employed to estimate seasonality in cocoa output effects on the income of the cocoa farmers; whilst the random effect multinomial logistic regression was to estimate seasonality in cocoa output on the seasonal households (women of reproductive age 15-49yrs) food security indicators, and seasonal cocoa income effects on food security status of the cocoa farmers. The Women Dietary Diversity Score (WDDS) and the Household Food Insecurity Access Scale (HFIAS) served as proxies for individual (women) and household food security. In general, the findings of the study suggest male cocoa farmers constituted the majority for baseline and panel surveys. Perception of negative long-term changes in rainfall negatively influenced cocoa yields. Factors that influenced recommended Climate-Smart Agriculture practices for improved yields are farmer education, marital status and where the farmer resides (location). Diversifying non-cocoa farm income significantly increases the overall cocoa farm income. Women dietary diversity is better during the major cocoa season than in the minor season. Seasonality in the minor cocoa season poses a challenge to farmers, being food-secured plays a crucial role in mitigating its negative effects. Food-secured cocoa farmers tend to have higher per-capita income and off-farm income, highlighting the importance of food security in improving the livelihoods of cocoa farmers. However, household food security is impacted negatively throughout the cocoa season (major and minor season periods). The study suggests innovative irrigation schemes for cocoa production to help improve cocoa yields. Additionally, the Cocoa Health and Extension Division of COCOBOD should intensify their efforts in providing farmers with technical training on agronomic practices. Lastly, stakeholders in cocoa space strengthen agronomic practices and incentivize cocoa farmers with income generating activities to enhance cocoa productivity throughout the year to smoothen their food security needs.

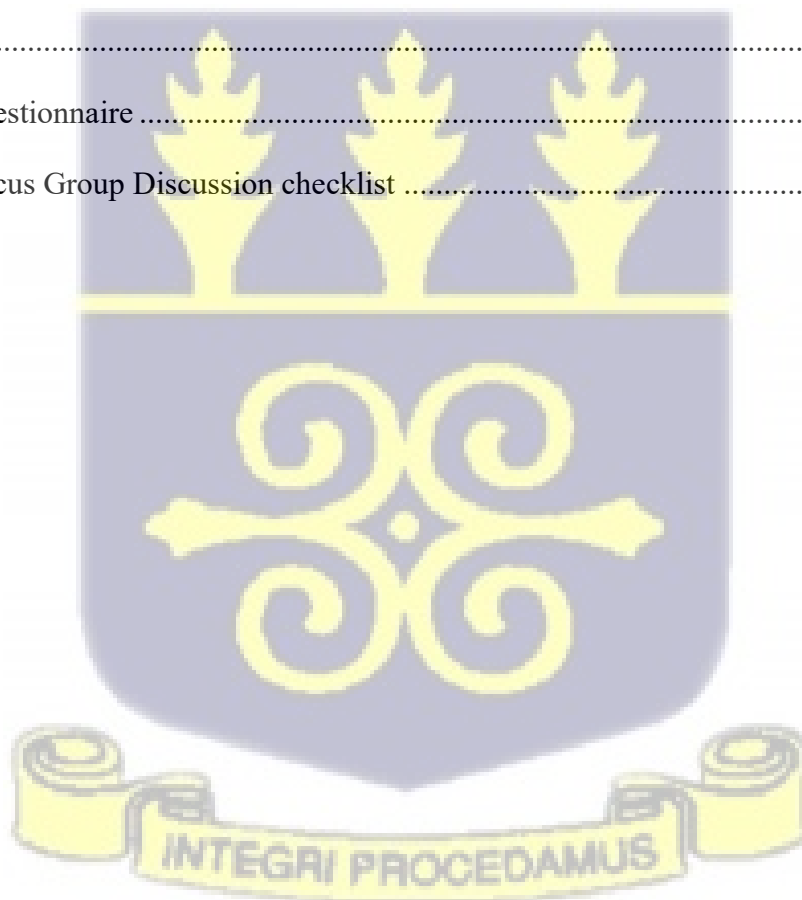
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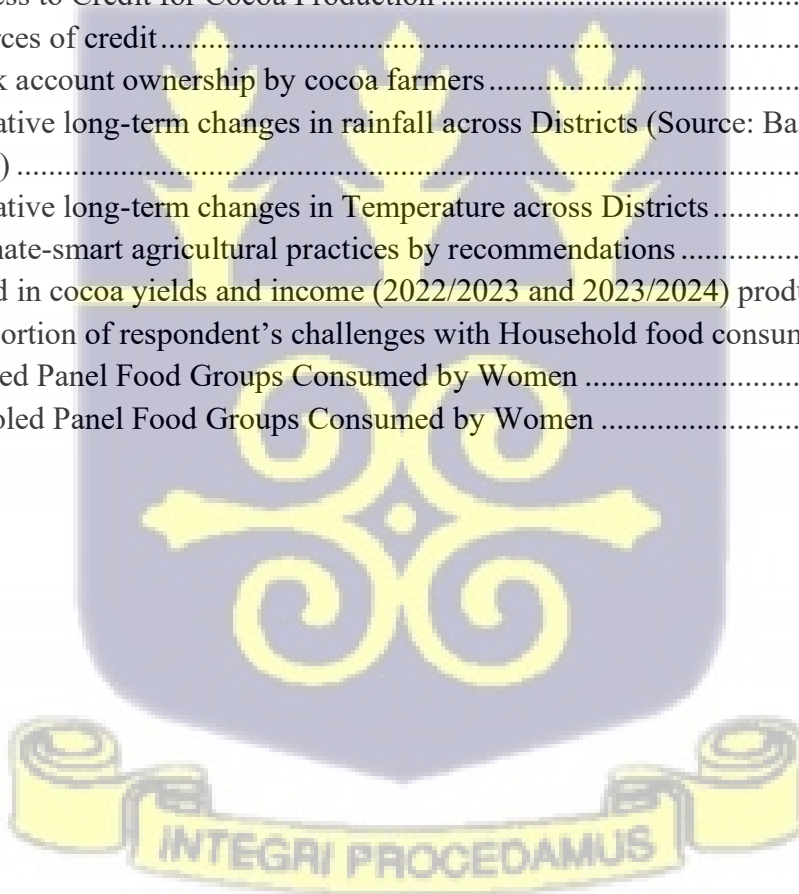
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LIST OF ABBREVIATIONS

AfDB	African Development Bank
ATA	Action Theory Approach
CMC	Cocoa Marketing Company
COCOBOD	The Ghana Cocoa Board
CODAPEC	Cocoa Disease and Pest Control Project
CSA	Climate Smart Agriculture
CSI	Coping Strategy Index
CSSVD	Cocoa Swollen Shoot Virus Disease
DfiD	Department for International Development
FAO	Food and Agriculture Organisation
FASDEP	Food and Agriculture Sector Development Policy
FBO	Farmer Based Organisation
FE	Fixed Effects
FCS	Food Consumption Score
FIES	Food insecurity Experience Scale
GAP	Good Agricultural Practice
GFSI	Global Food Security Index
GHI	Global Hunger Scale
GHS	Ghana Cedi
Ha	Hectare
HCS	Household Consumption Scale
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
HPS	Household Pulse Survey
ICCO	International Cocoa Initiative
IFAD	International Fund for Agricultural development
IFPRI	International Food Policy Research Institute
LBC	Local Buying Companies
LID	Living Income Differential
MAHFP	Months of Adequate Food Provisioning
MoFA	Ministry of Food and Agriculture
PPRC	Producer Price Reviewer Committee
RE	Random Effects
SDGs	Sustainable Development Goals
SLF	Sustainable Livelihood Framework
SRID	Statistics, Research and Information Directorate
UN	United Nations
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WDD	Women Dietary Diversity
WDI	World Development Indicators
WELI	Women's Empowerment in Livestock Index
WFP	World Food Programme
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.0 Background

West African (Ivory Coast, Ghana, Nigeria and Cameroon) cocoa production is more than six (6) million hectares of cultivated trees, which represents about 70% of the world cultivated cocoa (Adet et al., 2024; Shahbandeh, 2021; Schroth, et al., 2016, Wessel & Quist-Wessel 2015). Globally, Ghana being the second-largest producer of cocoa accounts for approximately 20% of the total global cocoa output (Suh et al., 2022; Sarpong et al., 2018; Akrofi-Atitianti et al., 2018) compared to Ivory Coast yield of 500-600kg/ha (Suh et al., 2022; Quainoo-Mensah et al., 2023; Afele et al., 2021; Ingram et al., 2014). Cocoa production in Ghana constitutes about 10% of the country's GDP, supporting 6.3 million livelihoods which constitutes about 16.5% of the population (Attipoe et al., 2021); engaging directly about 850,000 smallholder farm families and generates an annual \$2 billion foreign exchange (COCOBOD, 2024; Ghana Agriculture, 2022; Maguire-Rajpaul et al., 2020; Afriyie-Kraft et al., 2020).

In Ghana, yields are estimated to be between 0.4 to 0.55 tonne/hectare (see figure 1.1), below the achievable yield of 1.0 tonne/hectare as indicated by the Cocoa Research Institute of Ghana (CRIG) (Amponsah-Doku et al., 2022; Danso-Abbeam & Baiyegunhi, 2019) and far below the yield potential of 1.89 tonne/hectare estimated by Aneani and Ofori-Frimpong (Aneani & Ofori-Frimpong, 2013).



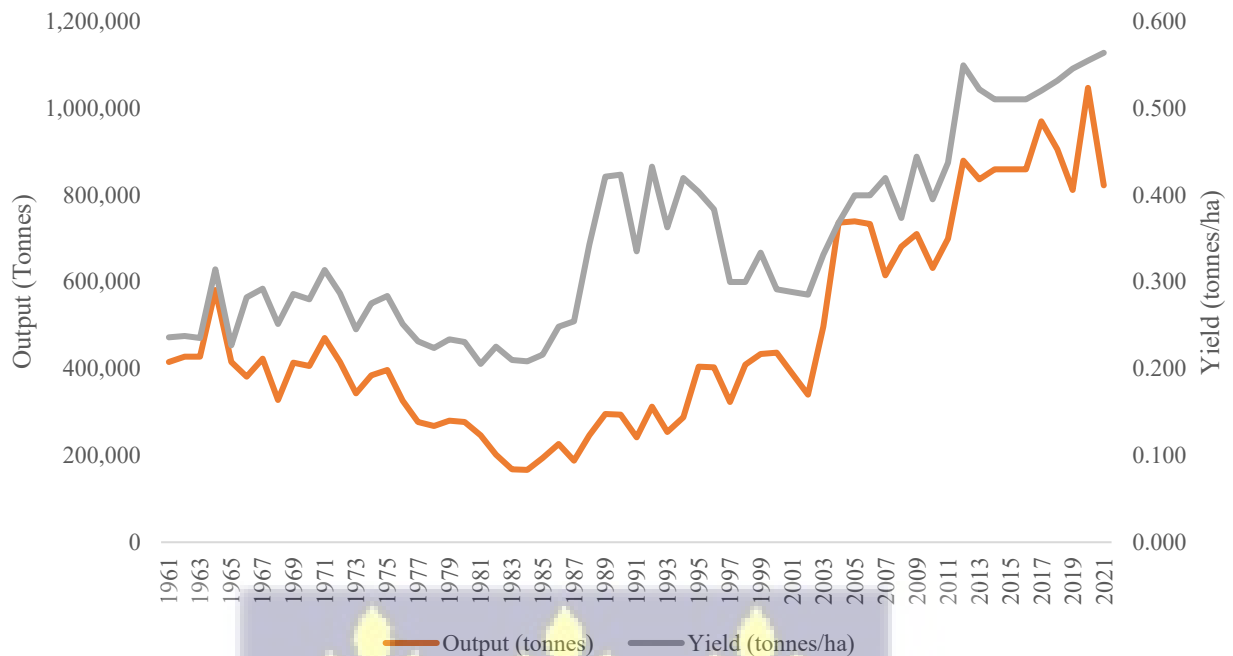
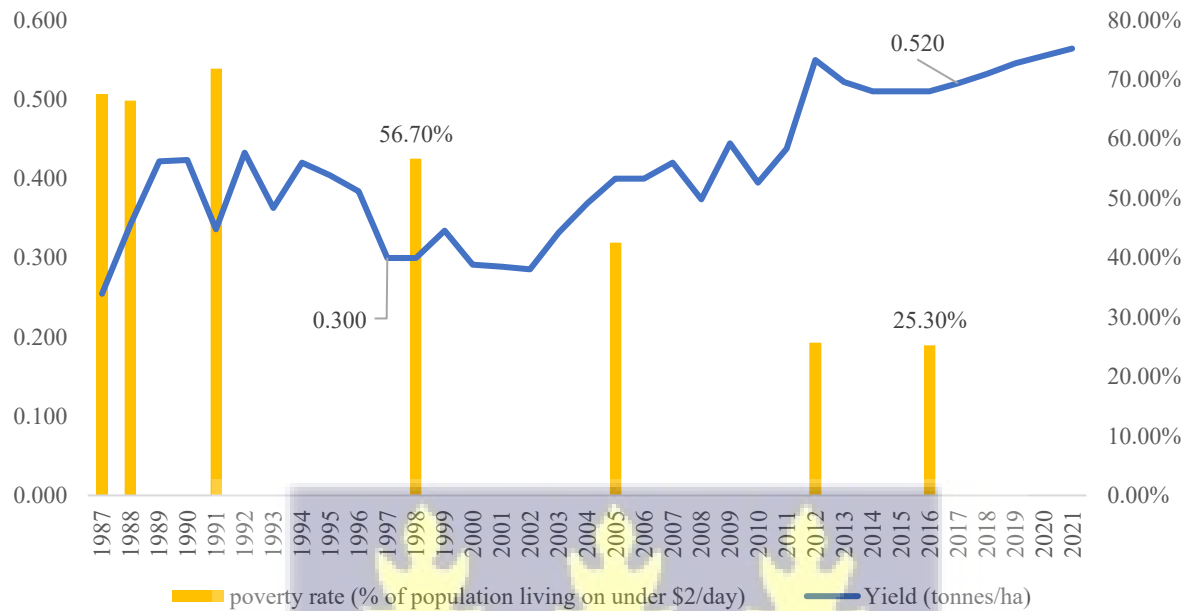


Figure 1. 1: Output and Yield of Cocoa in Ghana from 1961 to 2021

Source: Ghana COCOBOD, 2022

The government of Ghana's policy in boosting cocoa production and productivity has been towards improving crop health through programs targeted at pest and disease control, pollination and hybrid seedlings (Maciej et al., 2021). The Cocoa Pest and Disease Control (CODAPEC) mass spraying program, instituted in the 2001/2002 season and the revised Subsidized Fertilizer Program (Maciej et al., 2021), are typical policy examples. These projects have been successful to varying extents as they have been beset by both external and internal issues. The management of Ghana's Cocoa Board re-introduced a revised Subsidized Fertilizer Program (COCOBOD, 2023) after the Cocoa Pest and Disease Control (CODAPEC) mass spraying program and the revised Subsidized Fertilizer program. Despite the recorded setbacks in these programs, research suggests that since its formation and current form, COCOBOD through its productivity enhancing activities, has contributed to a reduction in poverty levels among cocoa-producing households (see figure 1.2) from 60.1% in the early 1990s to 23.9% in 2005 (Ndikumana & Adjei-Mantey, 2025;

Konkombo et al., 2023; Teye et al., 2024; ODI, 2024). This contrasts with the overall national poverty rate, which fell from 51.7% in 1991/92 to 28.5% in 2005/2006, and 11.1% in 2020.



coinciding with increased cocoa yields (FAO, 2023; World Bank, 2023).

Figure 1. 2: Poverty rate and Cocoa Yields in Ghana (1987 - 2021)

Source: Adapted from FAOSTAT; Ghana COCOBOD (2022)

Several factors have been identified to pose threats to the sustainability of cocoa production throughout the world. These include productivity-related issues such as low yields, soil fertility decline, low farmer adoption of technology, low use of fertilizer and other agrochemicals due to increasing costs, adverse effects of climate change and low adoption of proper farm management practices (Amfo & Ali, 2020a; Aneani & Ofori-Frimpong, 2013; Danso-Abbeam & Baiyegunhi, 2019; Peprah et al., 2020).

The main varieties of cocoa are Forastero, Criollo, and Trinitario. Forastero is the most widely grown variety, known for its robustness and higher yield but generally considered to have a more

bitter flavor. Criollo is a rarer and more delicate variety, prized for its fine flavor and aromatic qualities but is more susceptible to diseases and has lower yields. Trinitario is a hybrid of Forastero and Criollo, combining some of the hardness of Forastero with the flavor characteristics of Criollo. The choice of variety significantly affects both the quality and quantity of cocoa produced (Afoakwa, 2010). Together, these challenges contribute to reduced yields and economic potential (Hyde-Cooper et al., 2024; Hayford, 2023; Daymond et al., 2022; Etaware, 2022; Danso-Abbeam et al., 2020). The black pod disease which attacks the cocoa bean quality and the dry and dusty winds that blows from the Sahara during the dry season affects the flowering of the cocoa trees (Geman & Sarfo, 2020; Addae, 2022). The Western region of Ghana, currently the largest cocoa producing region, is estimated to have had a decline in production volumes from about 683,000 tons in 2021/2022 to 533,000 tons of cocoa during the 2022/2023 cropping year attributed to factors such as climate change and the Cocoa Swollen Shoot virus (CSSVD) (Afele, 2024; Anning et al., 2022; Asitoakor et al., 2022; COCOBOD, 2022).

Cocoa production in Ghana is marked by seasonality, with the main harvest season occurring from October to February, following the major rainy season, and the lighter mid-crop harvest taking place from June to August during the rainy season (COCOBOD, 2023; FAO, 2022; World Bank, 2021). Cocoa is highly sensitive to climate variations, particularly temperature, which affects evapo-transpiration (Orimogunje & Ogundeji, 2020; Oyekale, 2021), and it requires consistent water availability throughout the year (Obatolu & Esan, 1999; Oyekale, 2021). Rainfall has a greater impact on the yield of cocoa and other tree crops than any other climatic factor (Kosoe & Ahmed, 2022; Olabode, 2020; Baah, 2016). Cocoa thrives in calm conditions, as even moderate winds can severely damage yields, making cocoa output highly dependent on weather conditions (Addae, 2022; McGuire, 2022).

The impacts of seasonality and climate change on cocoa bean output have significant implications for food security among cocoa farm households in Ghana. Cocoa is not only a cash crop but also an important source of employment and income in the sector for food and nutrition for many Ghanaians, particularly in rural households, and disruptions to the sector can have far-reaching consequences for local economies and communities (COCOBOD, 2021; Fountain & Huetz-Adams, 2018; World Bank, 2019; FAO, 2020). Disruptions to cocoa production and supply chains can lead to food insecurity, particularly for vulnerable populations such as children, women, and the elderly. Furthermore, the effects of climate change, compounding seasonality on cocoa output, also have broader implications for the national economy, rural livelihoods, and poverty reduction efforts.

Achieving food security is an international agenda (SDG 1, 2 and 3: No Poverty; Zero Hunger; Good Health and Wellbeing), and for cocoa farmers, cocoa production is a major source of activity to achieve their food security. Cocoa as a perennial crop and a cash crop can generate income for cocoa farmers to meet their food security needs (Hashmiu, Agbenyega, & Dawoe, 2022). Many rural households experience recurrent seasonal food shortages when the previous season's harvest has been consumed or sold, especially if crop yields are low, with attendant high farming expenses (Abbeam & Baiyegunhi, 2019; Aneani & Ofori-Frimpong, 2013). Cocoa farm households often face food insecurity due to the seasonal nature of cocoa production, resulting in limited access to nutritious food during periods of low cocoa income (Amponsah-Doku et al., 2022; CRIG, 2018).

Ghana's cocoa holds economic, historical, cultural and political significance. Therefore, it is essential to address the challenges posed by climate change and seasonality on cocoa output and food security in Ghana. This requires a comprehensive understanding of the effects of climate change and seasonality on cocoa production, as well as the development of effective strategies for

mitigating these impacts and promoting climate-resilient cocoa production and food security in Ghana.

Seasonality (periodic fluctuations) is a common phenomenon in agricultural production and consumption (Ellis, 2000; Blackmore et al., 2021; Bonuedi et al., 2022). Climate change and extreme weather events arising from variations in rainfall patterns, due to dependence on rain-fed agriculture (Harvey et al, 2017; Magrin et al, 2014; Marego et al, 2014), among others, influence seasonality in agriculture. Thus, a primary factor influencing periodic fluctuations in agriculture production is the changes in increased unpredictability of rainfall and temperature (climate change). Seasonality in agricultural production affects food security, livelihoods, and incomes (Kansiime et al., 2023; Jones et al., 2023; Bonuedi et al., 2022) and affect households' food security (Bunn et al., 2019; Ntiamoah et al., 2023; Jones et al., 2023). A factor driving seasonality in food availability is the “on-off” nature of agricultural harvests most cases restricted to one production cycle (Ellis, 2000; Blackmore et al., 2021) in most food crops. Climate change is an element of seasonality in cocoa production and output. Seasonality in the output of perennial crops like cocoa is influenced by weather patterns (rainfall and temperature), incidence of pest and diseases, water management from agronomic practices, farm management and labour. These factors contribute to fluctuations in cocoa output throughout the year, resulting in seasonality (Asitoakor et al., 2022) in bean harvest. Seasonality in agriculture elements (outputs, income, profits, consumption) are therefore related to the calendar (within year changes) and usually based on changes in supply and demand (Ellis, 2000; Blackmore et al., 2021).

In Ghana, the lean cocoa season is characterized by shortage of cash income and food, and skips in meals/entirely (Hashmiu et al., 2022; Mariwah et al., 2019) whilst peak season provides farmers with bulk income (Kiewisch, 2015). During the bulk income periods, cocoa farmers typically

purchase food, and essential household items (Babatunde et al., 2017), sets aside funds for future investments and emergencies (Owusu et al., 2011), fulfill social obligations by paying for children's education and community contributions (Yira et al., 2016), diversification by investing in alternative income activities like livestock and food crops (Osei-Amponsah et al., 2017), paying off debts incurred during the lean season (Dzanku et al., 2015), and purchases of fertilizers, pesticides and other inputs (Padi et al., 2015; Asare et al., 2018). Seasonality affects all aspects of food and livelihood security for cocoa farm households and is a critical element in the vulnerability context of the sustainable livelihood's framework (Batame et al., 2024; Picot et al., 2024). Persistent seasonal food insecurity can lead to asset depletion, food shortages, and unsustainable debt cycles, trapping households in poverty and limiting their resilience (Laah, 2020). Seasonal food deficits endanger future household well-being (Osman, 2023; Rockler et al., 2023; Kundo et al., 2023; Scott et al., 2024; Watts et al., 2024; Lain & Brunelin, 2024). In response, households may sell productive agricultural assets to buy food, which lowers the chances of a successful harvest, as seeds, fertilizers, tools, and machinery are sold. In Ghana, most cocoa households experience food insecurity for 3 to 7 months annually due to the seasonal nature of cocoa production (Bymolt et al., 2018). Although some food crops are harvested throughout the year, food shortages persist (Acheampong et al., 2022; Ajagun et al., 2020; Hashmiu et al., 2022). While cocoa trees bear fruit year-round, harvesting is seasonal, with the main crop harvested from October to March and the less productive mid-crop harvested from May to June.

Warmer temperatures and shifting rainfall patterns change the areas suitable for cocoa cultivation, while more frequent droughts and floods damage cocoa trees and reduce yields. Weather shocks often result in harvest failures. For example, the World Meteorological Organization reported that in 2019, below-average rainfall during both the long and short rainy seasons led to severe food

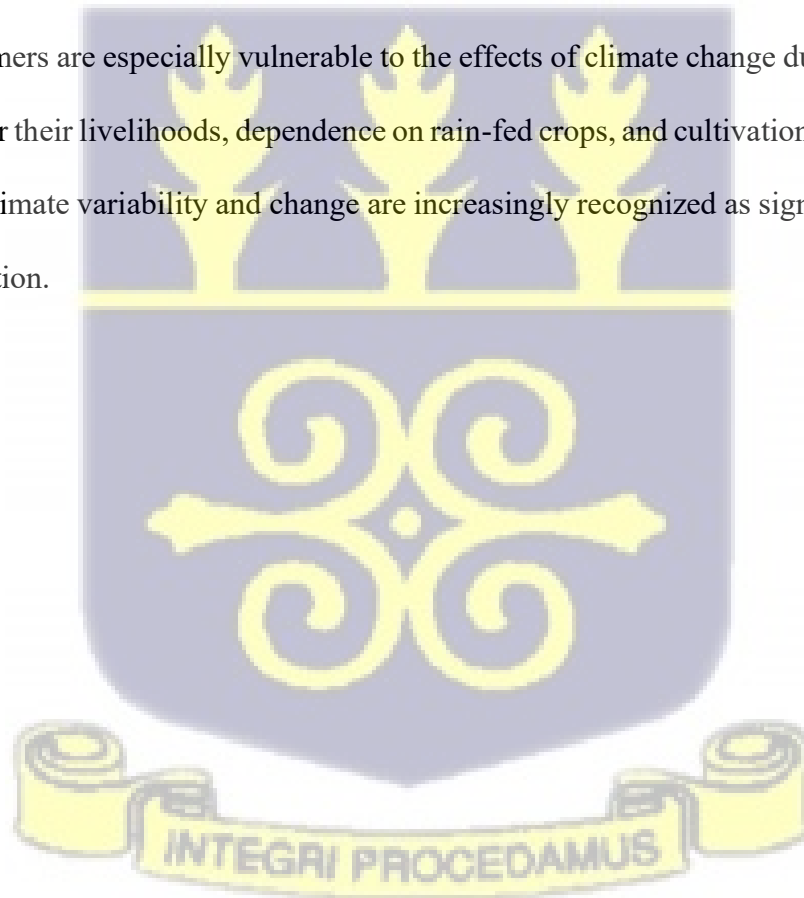
insecurity for about 12 million people in East Africa, while 14 million people in Southern Africa required flood assistance (WMO, 2019). In West Africa, heavy floods in July and August caused significant crop and livestock losses (Canton, 2021). Cocoa productivity is also affected by diseases such as Cocoa Swollen Shoot Virus Disease (CSSVD) and black pod, as well as pests like capsids (Gyamera et al., 2023; Gyamfi et al., 2020; Akrofi et al., 2015). Black pod disease alone has led to over 40% pod loss and more than a 70% reduction in output levels (Agyeman-Boaten & Fumey, 2020). Weather-related shocks, such as poor rainfall, droughts, floods, or storms, significantly impact food security in developing countries (FAO; IFAD; UNICEF; WFP; WHO, 2018). Climate change trends cause substantial annual fluctuations in cocoa yields, which, in turn, affect the incomes of cocoa farmers, worsening the effects of CSSVD and reducing the areas suitable for cocoa production (Iwmi, 2024; Asante and Amankwa-Mensah, 2022; World Bank 2023). Changes in climate impact both livelihoods and food security (Bunn et al., 2019). Since cocoa is a primary income source for smallholder farmers in Ghana, the potential effects of climate change on cocoa production disproportionately threaten the poor (Lawson et al., 2020).

Cocoa yields are influenced by several factors, with climate and soil erosion being key determinants (Sarker, 2012). Understanding the weather conditions in cocoa-producing regions is crucial to improving cocoa production. Climate-smart agriculture (CSA) presents a promising approach to enhancing sustainable productivity, boosting farming system resilience to climate impacts, and mitigating climate change through greenhouse gas reductions and carbon sequestration (FAO, 2010).

The application of CSA varies depending on scale. For smallholder farmers in developing countries, the main incentives for adopting CSA include improved food security, higher incomes, and greater resilience, with mitigation benefits often being secondary (Thornton et al., 2009; FAO,

2010; Lobell et al., 2011). Many CSA practices, such as agroforestry, reduced or zero tillage, cover cropping, and soil and water conservation, also promote carbon sequestration both in the soil and above ground (Hoerling et al., 2006; IPCC, 2007; IPCC, 2014). These practices provide long-term benefits, including more stable and increased yields, making farming systems more resilient to climate variability (Thornton et al., 2007; Jones & Thornton, 2008). Furthermore, these activities generate positive outcomes at the local level benefiting households and communities while also contributing to reduced atmospheric carbon globally.

Despite these advantages, CSA adoption remains slow, particularly in food-insecure and vulnerable regions like sub-Saharan Africa and Southeast Asia (Jones & Thornton, 2008). Smallholder farmers are especially vulnerable to the effects of climate change due to their reliance on agriculture for their livelihoods, dependence on rain-fed crops, and cultivation of marginal lands (FAO, 2013). Climate variability and change are increasingly recognized as significant challenges to cocoa production.



1.1 Conceptual framework for the study

The conceptual framework of Figure 1.3 demonstrates the linkages between and among elements of climate change, seasonality in cocoa production output, household income and farmer's food security and dietary intake of women in the farming households.

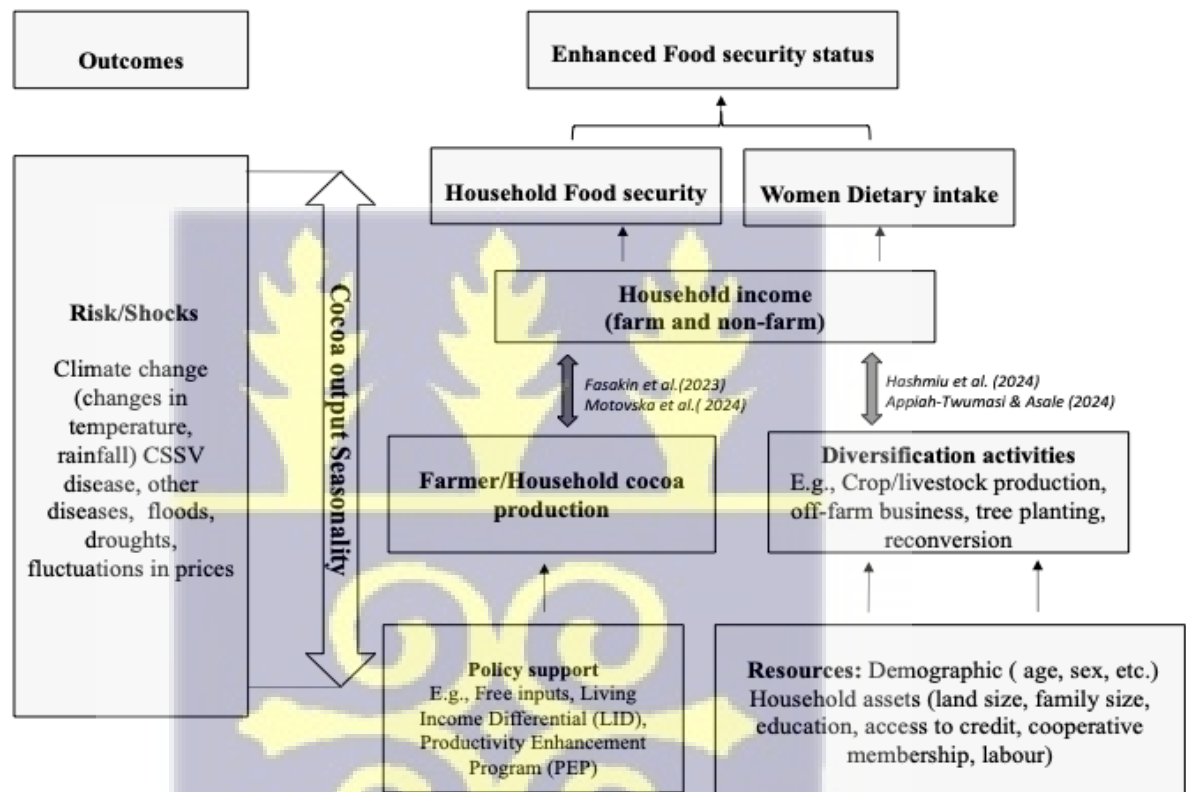


Figure 1. 3: Conceptual framework for seasonality in cocoa production and household food security in cocoa farming households, Ghana.

Source: Authors compilation, 2023.

The framework, derived from empirical studies at the household level, primarily guides the problem underpinning this study. Following from the literature reviewed (Affoh et al., 2022; WFP, 2021; Anderson et al., 2018; Gilbert et al., 2017), seasonality and climate change may have varying

effects on food security. The components and interrelationships outlined in the framework are synthesized with a focus on climate change, agricultural output seasonality, household income (farm and non-farm), and food security effects on the cocoa farmer households' wellbeing with an enhanced food security status: increased farm income, on-farm availability and diversity of food for households for consumption.

For a cocoa farmer and its households to achieve enhanced food security status through an increased farm income (cocoa and other crops) and an on-farm availability and diversity of food, cocoa farmers are expected to use their limited resources (human and economic resources) to produce cocoa with policy support. Policy support includes the free/subsidized inputs from government, the Living Income Differential on cocoa and the COCOBOD Productivity Enhancement Programmes in minimizing the damaging effects of dry weather and illegal mining activities (*galamsey*) that have destroyed water bodies in cocoa production in the study areas and, in some instances, other non-cocoa income from diversified activities. Some cocoa farmers diversify into food crops and livestock, off-farm business and other cash crop production as their livelihood strategy. Cocoa farmers' on-farm livelihood strategies are mostly undertaken under climate, pest and diseases, seasonality shocks and fluctuations in prices. In the cocoa sector, however, cocoa and other increased income sources together with policy support for the cocoa farmers could enhance farmers' households' access and availability to diverse food types amongst women, thus enhancing food security status. Assessing climate change perceptions, seasonality in cocoa output (yields) and climate change influences on household food security helps to increase cocoa farm income with diversified, available and accessible food throughout the year.

1.2 Problem Statement

Cocoa production plays an important role in Ghana's economy and the lives of millions of smallholder farmers. However, the sector faces persistent challenges such as changing weather patterns, declining soil fertility, plant diseases, and fluctuating yields across seasons (Amoah et al., 2016; Owusu et al., 2017). These problems threaten not only Ghana's position in the global cocoa market but also the livelihoods and food security of the farmers who depend on it. In the Ghana's major cocoa-growing areas particularly the Western and Ashanti regions, climate conditions have a strong influence on production, often leading to seasonal periods of hardship when household income and access to food decline (Amponsah-Doku et al., 2022; CRIG, 2018).

Over the years, Ghana's Cocoa Board (COCOBOD) has launched several initiatives to boost productivity and improve farmer welfare. These include the National Cocoa Rehabilitation Programme, Hand Pollination Programme, Cocoa Roads Project, and Farm Irrigation Programme (COCOBOD, 2018, 2021). More recently, new policies and systems such as the Cocoa Management System (CMS), the Cocoa Farmers Pension Scheme, and the Living Income Differential (LID) were introduced to make the sector more sustainable and ensure fairer prices for farmers (Boysen et al., 2021; FCC, 2019; ICCO, 2012; Fountain & Huetz-Adams, 2015; van Vliet et al., 2021; ISEAL, 2022). However, despite these efforts, many cocoa households still struggle with low and unstable incomes, weak enforcement of fair pricing policies, and rising production costs (Asoko, 2022; International Cocoa Initiative, 2020; Bymolt et al., 2020).

Food insecurity remains a serious concern in cocoa-growing communities. Seasonal changes often lead to periods of limited food availability, reduced dietary diversity, and lower nutrition, particularly among women who are central to household food decisions and farming activities

(Waswa et al., 2021; Roba et al., 2019; Gupta et al., 2021; Mittal et al., 2021; Shibata et al., 2020; Uduji et al., 2019). With cocoa prices often too low to meet household needs, many farmers face difficulties covering food and basic living expenses throughout the year (Boysen et al., 2021; Hashmiu et al., 2022). Although several studies have examined food security and cocoa production in Ghana, few have explored how seasonal changes specifically affect food access and well-being among cocoa farmers (Owiredu et al., 2022; IFAD, 2019; World Bank, 2019; WFP, 2018; FAO, 2017). Evidence from recent research shows that some farmers are diversifying their income sources or replanting new cocoa varieties to improve productivity, especially in the Western and Ashanti regions (Anang et al., 2022; Leita, 2020; Yaro et al., 2022; Gama-Rodrigues et al., 2021). However, the seasonal nature of cocoa production continues to make rural livelihoods fragile, leaving farmers vulnerable to both climate and economic shocks.

There is also limited evidence on how fluctuations in cocoa income across different seasons shape household food security. Many cocoa farmers experience months of reduced income between harvests, yet we know little about how this seasonal hardship impacts their daily food consumption and wellbeing (ICI Cocoa Initiative, 2024).

In addition, while women play a central role in food preparation, household budgeting, and farming activities, their specific experiences of food insecurity within cocoa growing communities are not well documented. For example, female-headed cocoa households in the Juaboso-Bia landscape had a substantially lower dietary diversity than male-headed households and reported more frequent unavailability of food in June and July (Batame et al., 2024). The effectiveness of recent government and industry initiatives such as the Living Income Differential (LID), the Cocoa Management System (CMS), and the Farmers' Pension Scheme also remains unclear when it comes to reducing income instability and improving household food security.

1.2.2 Research Questions of the study

To enhance policy towards addressing the challenges that climate change poses on seasonality of cocoa outputs (hence yields) and farmer income, it is important to have knowledge of cocoa farmers perception of climate change on their cocoa yields and food security, their perceptions on potential climate-smart agricultural practices that enhances cocoa farmers adaptation to climate change, their seasonal cocoa production and output and that smooths their income and food security. It is imperative to also assess seasonality in cocoa output on the one hand and how climate variability affects seasonality in farm households' food security for improving existing policies and formulating new policies, on the other. Assessing dietary diversity of women of reproductive age and households at different points in the cocoa agricultural seasonal production cycle is one way of investigating the extent of seasonality and climate change effects on cocoa farming households' food security in Ghana, given the Living Income Differential (LID) on ensuring equitable access to nutritious food to cocoa farmers all year round.

Based on the above-mentioned issues, the gaps in knowledge lends itself to empirically understand the linkages to grow the literature, thus providing policy implications towards seasonality in cocoa production and farm household food security, and promoting a sustainable climate-resilient cocoa production in Ghana and beyond. Is there seasonality in the cocoa income and food security status of cocoa farmers amidst changes in the climate? Given this, the research questions that arise in this study are:

1. What are cocoa farmers perceptions of the effects of climate change variability on cocoa seasonal outputs?
2. What are cocoa farmers recommended CSA practices and factors that influence each for improved cocoa yields?

3. How does seasonality in cocoa output affect the income of the cocoa farmers?
4. How does seasonality in cocoa output affect the seasonal households and women of reproductive age (15-49 yrs) food security indicators?
5. What are the seasonal cocoa income effects on food security status of cocoa farming households?

1.3 Objectives of the study

Following from the research questions, the overall objective of the study is to assess the effects of climate change perceptions on cocoa yields and the seasonality in cocoa output on food security status of cocoa farm households in the Western and Ashanti Cocoa Regions, Ghana. To meet this broad objective the specific objectives are:

1. to describe and analyze farmers perceptions of climate change and its effects on cocoa yields
2. to describe and analyze the cocoa farmers CSA practices and factors influencing the use of these for improved cocoa yields
3. to assess seasonality in cocoa output effects on the income of the cocoa farmers
4. to estimate seasonality in cocoa output on the seasonal households and women of reproductive age (15-49 yrs) food security indicators
5. to estimate seasonal cocoa income effects on food security status of cocoa farmers

1.4 Hypotheses tested under the study

The hypotheses tested in this study are:

Hypothesis 1: Cocoa farmers perception of climate change in rainfall and temperature is negative on cocoa yields

Hypothesis 2: Climate Smart Agricultural practices use induces cocoa yields.

Hypothesis 3: Seasonality in cocoa production induces seasonal variability in income of cocoa farm households

Hypothesis 4: Seasonality in cocoa output influences women dietary diversity of cocoa farming households

Hypothesis 5: Seasonal cocoa income provides food security for cocoa households throughout the year

1.5 Relevance of the study

This thesis contributes to the ongoing *Cocoa4future* project funded by the European Union (2021-2025) initiated by CIRAD to understand the ecological and social changes of cocoa farmers to combat farm conditions that affect cocoa farm productivity. A main aim of the CIRAD project is “putting people and the environment back at the heart of tomorrow’s cocoa farming”. Hence the project obtains insights into cocoa farm households’ social innovations around seasonal cycles in cocoa and food consumption and to develop policy tools that can work on forms of dialogues and techniques to help government of Ghana on its Living Income Differentials pursuits and decent livelihoods that enhances cocoa production.

This thesis fits the *Cocoa4Future* project on the cocoa farm households’ social innovations around seasonal cycles in cocoa and food consumption and helps provide a basis for expanding the frontier for future analysis of seasonal household food security studies in agricultural and cocoa farm households. In addition, the study provides information to policy regarding seasonality and food security status of cocoa farm households in Ghana and beyond.

Ghana currently does not have a core Living Income Differential (LID) policy document or an official strategy, leading to differing and often conflicting perspectives on achieving long-term

poverty reduction (Stanbury & Webb, 2021). The evidence of seasonality in food security and a strategic pricing mechanism which aims to raise the farmgate price for cocoa farmers would provide an insight into how the LID policy could benefit livelihoods of cocoa farming households in meeting their seasonal food security. The evidence on climate change perceptions and its implications on climate smart agriculture practices for improved yield of cocoa farming and the subsequent test of the transmission mechanism can inform policy making. For example, a positive effect of climate smart agriculture practices would inform policy makers on the critical variables to tackle in policy formulation.

In conclusion, findings from this study would provide evidence to assist the government of Ghana to ascertain asymmetry in household Food Security and Women Dietary Diversity to ensure improved livelihoods of people, reduce poverty, and enhance food security. These policies include increasing cocoa producer prices, disease and pest control programs, and the encouragement of good agricultural practices (GAPs) to enhance yield. The effective management of policies has played a key role in the cocoa industry's success, though there remains room for further progress. Enhancing our understanding of the connections between climate, food, and livelihoods is not only an academic priority but also a practical necessity. Such insights can inform policies, programs, and actions including climate change adaptation efforts aimed at sustaining or improving livelihoods and food security in sub-Saharan Africa amidst ongoing climate change, thereby enriching the existing body of literature.

1.6 Organization of the study

The study is organized into five chapters, beginning with an introduction chapter that provides a background of the study, the conceptual framework, the problem and the research questions,

objectives of the study and the hypotheses tested. Chapter two presents a review of the empirical literature on climate change effects in agriculture and in cocoa production, food crop production by cocoa farmers, seasonality in cocoa production, food security concepts and indicators. Chapter three presents the methodology of the study. The chapter addresses the theories underpinning the study; the methods of analyses of the specific objectives of seasonality and climate changes on household food security; sources of data and the study areas. Chapter four presents the results and discussions of the various objectives from the data analyses. Chapter five present the general conclusion of the entire study, comprising summary, conclusions policy implications and recommendations. Figure 1.4 provides a schematic linkage of the chapters under this study:

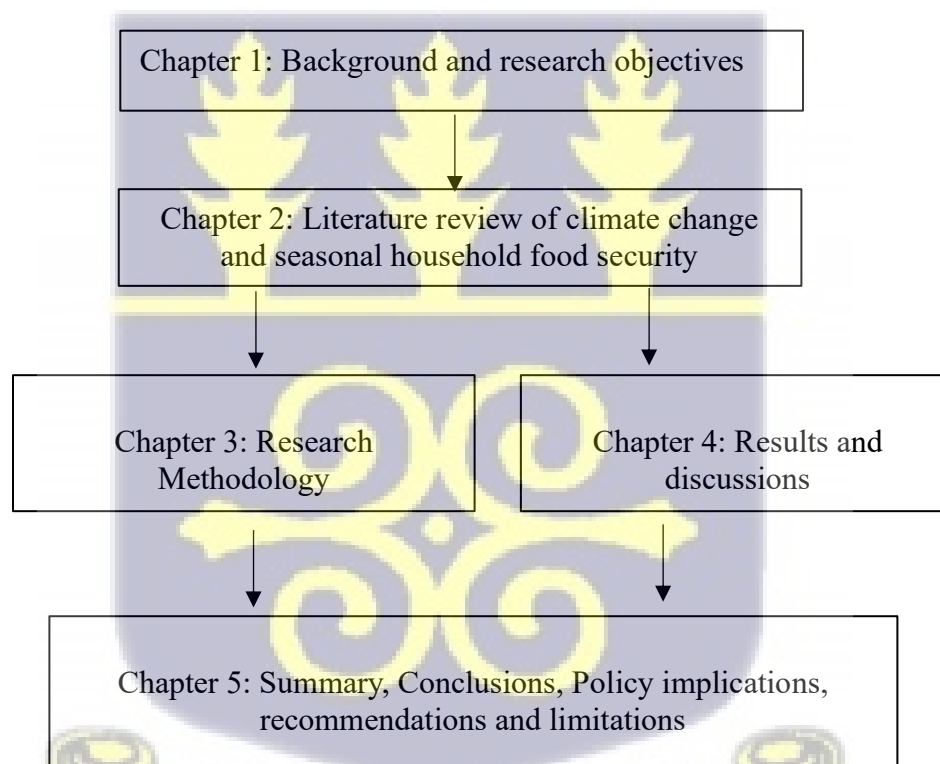
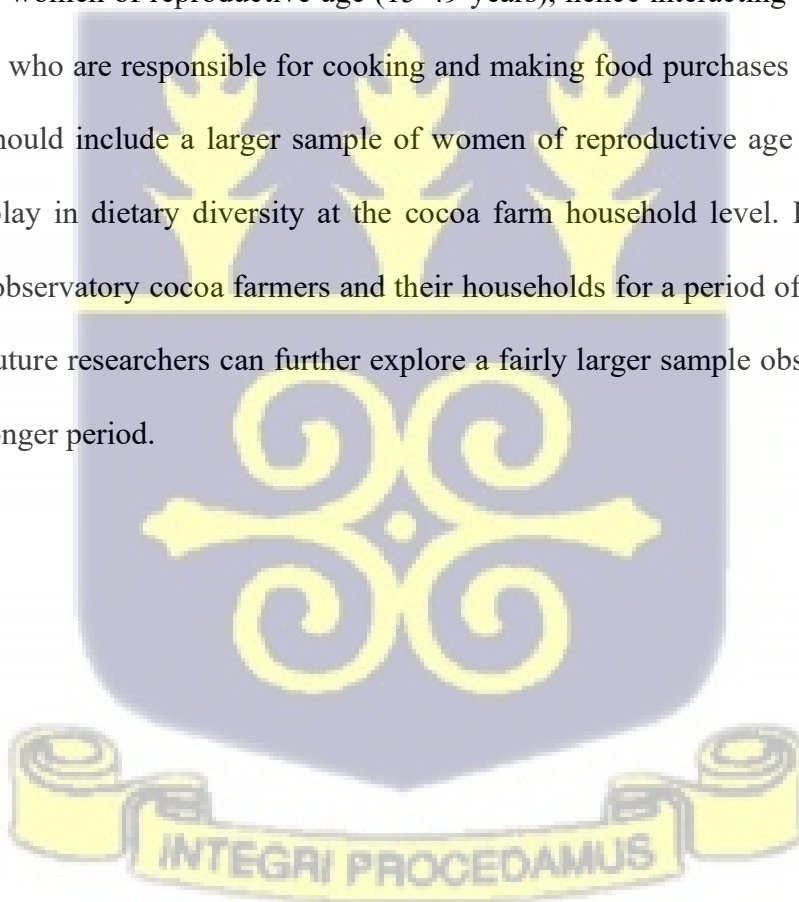


Figure 1. 4: Organization of the study
Source: Authors computation, 2024

1.7 Limitation to the study

This study has some limitations that can be addressed by future researchers. Firstly, the study focused on only two cocoa regions of Ghana due to the nature of cocoa conversion (planting) and reconversion (replanting) which is a focus for the *Cocoa4Future project* in the two regions and the associated seasonality effects of cocoa output on farm households. Future researchers should consider a larger sample size to capture a good representative of cocoa production and farm families' livelihoods at large and across the diverse cocoa agroecological zones. Secondly, this study explored farmer household to understand their household food situation, with minimal representation of women of reproductive age (15-49 years), hence interacting with other women of the household who are responsible for cooking and making food purchases for the household. Future studies should include a larger sample of women of reproductive age to understand the dynamics they play in dietary diversity at the cocoa farm household level. Finally, this study focused on 150 observatory cocoa farmers and their households for a period of two (2) years (24 monthly data); future researchers can further explore a fairly larger sample observatory of cocoa farmers over a longer period.



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature review covers climate change, climate change effects on agriculture, climate change and its impact on cocoa production, Seasonality in cocoa production and its effects, concepts of food security, measurements of food security, Cocoa seasonality in Ghana, Seasonality, Climate change and Food security, empirical studies on seasonality and food security, and living income for cocoa farmers in Ghana.

2.2 Climate Change

Climate change is a serious environmental concern primarily driven by the emission of greenhouse gases by human activities and, to a lesser extent, natural causes (Chen et al., 2021). This has led to an increase in the average global temperature (Chowdhuri & Gupta, 2023; Kamal, 2023). Evidence of climate change encompasses warming oceans, shrinking ice sheets, glacial retreat, and ocean acidification (Khazalah & Gopalan, 2019). There have been alterations in the patterns of precipitation (Ghanghas et al., 2023; Yang et al., 2020), increase in the frequency of drought and heat waves, and more intense hurricanes (Batibeniz et al., 2023; Tripathy et al., 2023). The change in climate has accelerated since the 1970s, resulting in various environmental impacts such as melting sea ice and glaciers (Rounce et al., 2023), rising sea levels (Ran et al., 2023), species extinction (Holzmann et al., 2023), and more frequent extreme weather events (Nda et al., 2018). Mitigation efforts and adaptation strategies are crucial for tackling the issues brought about by climate change (Khazalah & Gopalan, 2017; Nda et al., 2018).

According to global climate models, temperatures will continue to rise, as will the spatial and temporal dispersion of precipitation. These advances have been shown to possibly alter cocoa production at its most critical origins (Bunn et al., 2017). Every country is experiencing some degree of climate change effects, but African nations are predicted to be particularly hard hit.

Due to its heavy dependence on weather conditions such as sunshine, rising temperatures, and humidity, Africa's agricultural economy is expected to suffer the most from the impacts of climate change (Owusu, 2022). Furthermore, studies predict that temperature increases in Africa will occur at a faster rate than the global average (Wongnaa & Babu, 2020).

2.2.1 Climate changes in Ghana

Climate change poses significant challenges for Ghana, affecting various sectors of the economy and society. It seriously affects many other industries, including agriculture. Projections indicate higher temperatures, lower rainfall, and rising sea levels by 2080, leading to desertification and impacts on agriculture, fisheries, and hydropower (Asante & Amuakwa-Mensah, 2014). These changes are expected to reduce national welfare, particularly affecting poor and urban households and the northern Savannah zone (Boansi et al., 2021). Climate-related events like droughts and floods have already impacted food security and livelihoods in Northern Ghana, challenging the resilience of vulnerable communities (Atanga & Tankpa, 2021; Osman, 2013). In response, Ghana has implemented various adaptation and mitigation strategies, including building resilience in economic sectors. Amfo & Ali, (2020)'s work on cocoa farmers revealed that recent years have seen a rise in the frequency and severity of adverse effects on cocoa output. However, inadequate funding remains a critical challenge to achieving climate change policy goals (Bhandary, 2022; Moser et al., 2019). To address these issues, recommendations include developing a holistic

climate change adaptation framework and investing in agricultural research and extension (Atube et al., 2021; Yorgey et al., 2017).

2.2.2 Climate Change effects on Agriculture

Climate change has far-reaching effects on agriculture, including rising temperatures (IPCC, 2013), changing precipitation patterns (FAO, 2017), extreme weather events (Lesk et al., 2016), shifts in growing seasons (Chen et al., 2019), soil degradation (Lal, 2010), water scarcity (WWAP, 2019), biodiversity loss (IPBES, 2019), and impacts on pollinators (Garibaldi et al., 2013). While many studies indicate that reduced pollination negatively affects crop reproduction and yields (Potts et al., 2010), the magnitude of this effect varies across crops and regions, suggesting that some agricultural systems may be more resilient than others. Similarly, rising temperatures have been linked to altered growing seasons, yields, and crop quality (Lobell et al., 2011), but research also shows considerable variation: Schauburger et al. (2017) report up to a 6% reduction in maize and soybean yields per day above 30°C in the US, whereas Tito et al. (2018) emphasize that tropical and subtropical regions may be more sensitive, reflecting the context-specific nature of climate impacts.

Global assessments similarly reveal divergent outcomes. Asseng et al. (2015) estimate a 6% decrease in wheat yield per degree Celsius of warming, whereas Wang et al. (2020) find that maize, rice, soybean, and wheat yields could decline by 3–13% under a 2°C warming scenario. These differences highlight ongoing debates in the literature about the reliability of model projections versus field-based experiments, and the importance of local environmental and agronomic conditions in moderating climate impacts.

Beyond yield, climate change also affects crop quality, including nutritional content. Elevated CO₂ and higher temperatures have been shown to reduce protein, iron, and zinc in staple grains (Al-Hadeethi et al., 2019; Zhu et al., 2018). Yet, some studies suggest that nutrient declines are uneven across regions and cultivars, raising questions about whether all populations will be equally affected. Similarly, while temperature changes can accelerate fruit and vegetable maturation, affecting size, taste, and shelf life (Ali et al., 2022; Choi & Park, 2023), the direction and severity of these effects are not universally consistent, pointing to the need for localized assessments.

In Ghana, climate change has disrupted traditional farming calendars, shortening or altering crop growth periods (Cook & Vizzy, 2012; Fosu-Mensah et al., 2019). Erratic rainfall has delayed planting, caused mismatches between sowing and optimal growth periods (Boansi et al., 2021; Owusu & Waylen, 2013), and in some cases prevented crops from reaching maturity (Alou et al., 2018; Obour et al., 2022). While droughts in northern Ghana have consistently been linked to poor germination, stunted growth, and lower yields (Yahaya et al., 2019; Nyamekye et al., 2018), some studies suggest that certain adaptive practices—like early-maturing varieties or supplemental irrigation—can partially offset these losses, illustrating how local adaptation mediates climate impacts.

Flooding, another extreme event, can cause waterlogging and nutrient leaching, yet the severity of damage is often context-specific and dependent on soil type, drainage, and crop species (Atanga & Tankpa, 2021). Similarly, the rise of pests and diseases such as fall armyworm and cocoa black pod is generally associated with changing climate conditions (Danso et al., 2019; Ramasamy et al., 2022; Asitoakor et al., 2022), but evidence also suggests that management practices, crop variety, and ecosystem interactions can modulate these effects, indicating that climate is not the sole driver.

Soil fertility is another area where findings are mixed. Heavy rainfall and higher temperatures can cause erosion and organic matter loss, reducing soil fertility (Tesfahunegn et al., 2021; Hu et al., 2023). At the same time, some studies note that targeted soil management and sustainable fertilization can mitigate these losses, suggesting that the impact of climate change on soil and productivity is not uniform. The increased reliance on chemical fertilizers to compensate for declining fertility (Adomako & Ampadu, 2015; Musa et al., 2022) also introduces trade-offs between short-term yield gains and long-term environmental sustainability, a topic of ongoing debate.

Overall, while the literature overwhelmingly points to negative impacts of climate change on agricultural quantity and quality, the magnitude and nature of these effects are highly context-dependent, influenced by crop type, local climate variability, management practices, and adaptive strategies. Recognizing these nuances is critical to developing policies and interventions that are responsive to both regional and crop-specific vulnerabilities.

2.2.3 Climate change and its impact on cocoa production

Cocoa production is a key agricultural activity in Ghana, but it is increasingly vulnerable to changing climatic conditions (Anning et al., 2022; Jamal et al., 2021), making it a high-risk venture (Bunn et al., 2019; Gateau-Rey et al., 2018). Afriyie-Kraft et al. (2020) report that approximately 90% of cocoa farms in Ghana are already experiencing adverse climate effects, yet about 25% of farmers employ no adaptation strategies. This highlights a significant gap between exposure and resilience-building, though some studies suggest that the adoption of climate-smart practices is increasing, indicating variability in adaptive capacity across regions and farmer demographics.

Cocoa is highly sensitive to climate throughout all stages of production, with precipitation being particularly critical for yield outcomes (Kosoe & Ahmed, 2022; Osei, 2017). While most literature emphasizes drought and water stress as the primary constraints, some studies suggest that excessive rainfall can be equally harmful, causing waterlogging, nutrient leaching, and increased disease incidence (Okoffo et al., 2016). This indicates that cocoa's climatic vulnerability is complex and context-specific.

As climate change progresses, suitable cocoa-growing areas in Ghana are expected to shrink and shift southward (Anning et al., 2022; Denkyirah et al., 2017; Okoffo et al., 2016), potentially threatening livelihoods since cocoa contributes 70–100% of income for many farm households (Van Vliet et al., 2021; Afriyie-Kraft et al., 2020). While rising temperatures and drought generally reduce yields, the exact magnitude of losses varies across studies. For instance, Raey (2019) predicts substantial pod damage under high temperatures, yet some evidence suggests that local microclimates and shade management can buffer these effects, illustrating the uneven distribution of climate risks.

Climate change also worsens pest and disease pressures. Phytophthora black pod and cocoa swollen shoot viral disease (CSSVD) are particularly destructive, affecting pods and stems (Anning et al., 2022). Rising temperatures and high relative humidity accelerate pest development, increasing susceptibility to diseases (Kosoe & Ahmed, 2022; Raza et al., 2019; Denkyirah et al., 2016). However, while many studies emphasize climate as the primary driver of these problems, others highlight the compounding effects of poor agronomic practices, low-yielding varieties, and deteriorating soil quality (Boadi et al., 2022; Yamoah et al., 2020). This suggests that cocoa productivity is shaped by an interplay of environmental and management factors, rather than climate alone.

Floods, prolonged dry spells, inconsistent rainfall, and shifting seasonal patterns further threaten both cocoa yields and household food security (Gateau-Rey et al., 2018; Okoffo et al., 2016). Nevertheless, some research argues that targeted interventions, such as improved drainage, irrigation, or agroforestry, can mitigate these hazards, indicating potential for resilience even in highly vulnerable regions.

Recognizing these challenges, the Ghana National Climate Change Policy emphasizes the need for effective adaptation strategies in the cocoa sector (Yiridomoh et al., 2022). Climate-smart agriculture (CSA) practices including cocoa shade control, soil conservation, and the introduction of improved crop varieties are recommended to enhance productivity and resilience. Yet, literature shows mixed results regarding their adoption and effectiveness; while some studies report substantial yield and income benefits, others note constraints such as high costs, limited knowledge, and socio-economic barriers that can impede widespread implementation.

In summary, while the evidence overwhelmingly points to negative impacts of climate change on cocoa production, the literature also reveals significant variability and nuance: the severity of yield losses and disease pressures depends not only on climatic conditions but also on local management practices, adaptive strategies, and socio-economic factors. Addressing these multiple layers of vulnerability is essential for sustaining cocoa production and farmer livelihoods in Ghana.

2.3 Cocoa Production

According to Abdulai et al, (2020), the demand for global cocoa demand is expected to rise significantly, while output is expected to remain unstable due to low productivity per unit area and climate variability. The world's cocoa production area has increase from 4.7 to 11.7 billion ha

between the years 1980 and 2017, although yields have hardly improved from 350kg/ha to 443kg/ha per year (Brobbe et al., 2020). This stresses that global production growth solely relies on land expansion, which has resulted in severe tropical rainforest loss (Kouassi et al., 2021; Gockowski et al., 2013a).

Indonesia, that is Central Sumatra and Sulawesi, and Latin America (Ecuador) are cocoa producing countries (Neilson et al., 2020; Franzen & Borgegerhoff Muddler, 2007). Despite Ecuador's size, it supplies the international markets with high-quality cocoa beans due to the availability of well-established transformation and commercialization (Castaneda-Ccori et al, 2020). About 290.000 metric tonnes of cocoa were produced in Indonesia which makes Indonesia, the fifth producer in the world (Praseptianga et al., 2020). In West Africa, cocoa is one of the relevant perennial tree crops and for global chocolate business (Busquet et al., 2021; Yahaya et al., 2015). Cocoa crop has contributed immensely towards strengthening of the West and Central Africa economies (Donkor et al., 2023; Kehinde & Ogundeji, 2022) and sustains over two million smallholder farmers (Kongor et al., 2018).

2.3.1 Cocoa Production in Ghana

Cocoa cultivation (*Theobroma cacao*) has been a part of Ghana's agricultural landscape for over two centuries, primarily concentrated in the country's forested regions, where favorable climatic conditions support its growth (Boateng, Codjoe, & Ofori, 2014). Ghana emerged as the world's leading cocoa exporter in the 20th century (Grossman-Greene & Bayer, 2009), and cocoa remains one of the country's most significant agricultural export commodities (Kuusaana, Adu-Gyamfi, & Darkwa, 2021; Barrientos & Asenso-Okyere, 2012). The crop is predominantly grown by small-scale farmers and harvested in two seasons annually: the main crop season from September to March and the mid-crop season from May to August. Farmers sell their cocoa beans to the Ghana

Cocoa Board (COCOBOD) through licensed buying companies (LBCs) at prices set by the Government of Ghana (GoG) (Abbadi et al., 2019). Cocoa production in Ghana has experienced substantial growth over the years, maintaining the country's prominent position in global production. However, the sector faced notable contractions in the 1980s due to a combination of falling global prices, drought, and political instability (Essegbey & Ofori-Gyamfi, 2012). The recovery and growth in production since the mid-1980s have been attributed to several factors, including enhanced extension services, increased fertilizer use, and the introduction of disease-resistant or improved cocoa varieties (Vigneri, 2008). Kolavalli and Vigneri (2011) further credit the expansion of cocoa output to rising global prices, a series of interventions by COCOBOD to improve farm practices, and significant policy reforms aimed at strengthening the sector. As shown in Figure 2.1, Ghana's cocoa production reached 1.0 million MT by the 2010/11 production year from a low of about 0.18 million MT in the 1984/85 season. Despite this expansion, cocoa yields in West African nations, including Ghana, remain relatively low due to factors such as limited use of inputs, inadequate maintenance, challenges in pest and disease management, minimal fertilizer application, and the aging of cocoa farms (Wessel and Quist-Wessel, 2015).

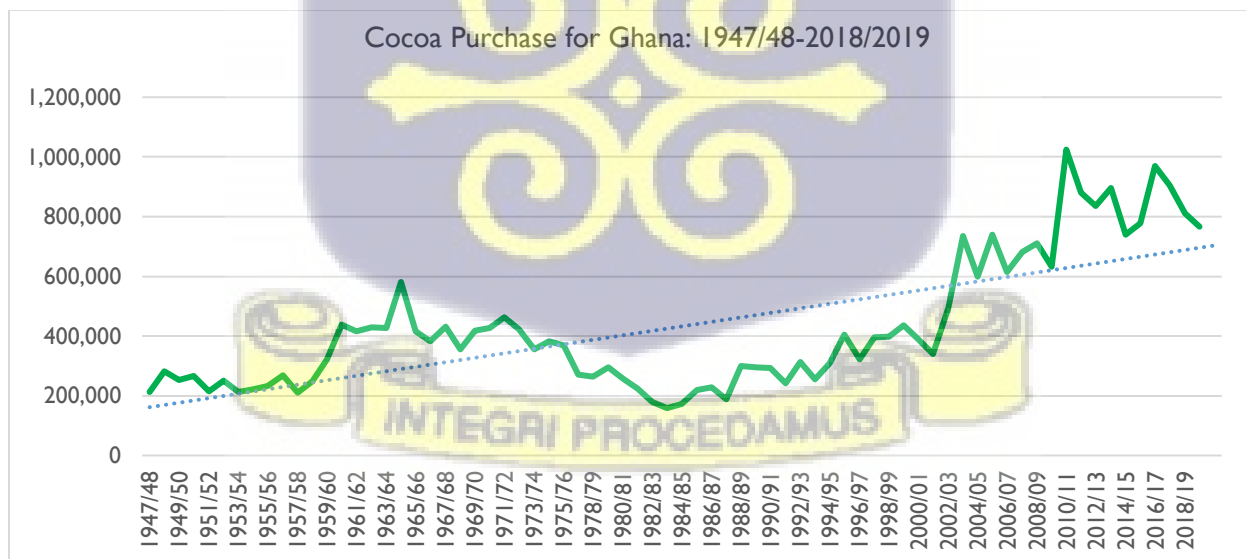


Figure 2. 1: Purchases of Ghana Cocoa beans, 1947/48 to 2019/2020

2.4 Food Crop Cultivation by Cocoa Farmers

This section reviews the drivers to food crop cultivation among cocoa farmers, types of food crops cultivated, benefits of diversification and some challenges and barriers cocoa farmers face in growing food crops. Cocoa farmers have traditionally grown food crops alongside their cocoa production (Cardinael et al., 2020). Food crop cultivation among cash crop farmers, over the years, have been increasing (Kemboi et al., 2020), and have attracted a lot of attention due its potential of benefiting both farmers and the environment (Brannan et al., 2023). Food crop cultivation provides a source of revenue for farmers (Devi & Sharma, 2022), which can alleviate risk (BIRTHAL & Hazrana, 2019), relieve poverty (Singh et al., 2020), and supply these farmers with food for their own consumption (Bellon et al., 2020). Environmentally, it functions as a pest and weed controller without compromising yields (Tamburini et al., 2020), increases biodiversity (Beillouin et al., 2020), improves soil fertility (Ali et al., 2012; Kumar et al., 2021), and is one of the primary strategies used by farmers to mitigate long-term changes in climatic conditions worldwide (Lancaster & Torres, 2019). Food crop cultivation among cocoa farmers are driven by several factors: socioeconomic factors; farm level factors; institutional and policy driven factors; economic and financial factors; and risks and shocks.

2.4.1 Socioeconomic factors

The traits of farmers and their households comprise the socioeconomic elements. In food crop production in Kenya (Kemboi et al., 2020) and Nigeria (Odjuvwuederhie et al., 2021) the age of the farmer was positively correlated with production. It was clarified that elderly farmers are typically better at managing diversified crops and may be aware of its advantages. Nyiatagher et al., (2019) contrasted by reporting a negative relationship between age of farmers and their crop

diversification practices. This was explained by saying that older farmers would be less adept with information technology, which would limit their access to current knowledge and information needed to engage in crop diversification. As a result, the age of cocoa farmers has an uncertain effect on the production of food crops.

Another aspect of the socioeconomic factors is the educational level of the farmer. Vekariya et al., (2022) and Kemboi et al., (2020) found that higher educated farmers typically cultivate more food crops. Farmers with higher levels of education are better able to obtain knowledge and are aware of the various production possibilities available to them as well as any potential advantages (Rehman et al., 2013). However, George & Sharma, (2020) did not agree to this by estimating a negative relationship between educational level and the practice of crop diversification in Kerala, India. George & Sharma, (2020) reported that, as farmers in Kerala, India, attain a higher level of education, they practice crop specialization.

Household size is another socioeconomic factor that is reported to have an influence on the decision of the farmer to practice crop diversification. Ochoa et al., (2019) found that the probability of the farmer to grow more food crops increases with increasing size of the household in southern Ecuador. The paper explained that larger families have more people depending on the farm; hence they require more food production which necessitates crop diversification.

2.4.2 Economic and financial factors

Economic and financial factors, such as sources of income, market access, credit availability, and crop prices, play a crucial role in determining whether farmers choose to grow food crops alongside cocoa or specialize in one. The ability to access credit and other financial resources greatly influences farmers' decisions to diversify their cropping systems. Capital is essential for farmers to enhance their agricultural practices, and a lack of adequate financial resources to implement and

sustain diversified cropping systems has been identified as a potential constraint for farmers (Tacconi et al., 2022). McCord et al., (2015) affirmed that wealthier farmers and those with the ability to access credit grow a variety of crops. Vekariya et al., (2022) also found this claim to be true in the Gujarat state in India where farmers with higher income levels tend to grow more crop types. This implies that cocoa farmers with higher levels of income may be able to grow more food crops as compared to cocoa farmers with lower levels of income.

Markets have a complex and conflicting influence on farmers' decisions and possibility to diversify. Market access, road distance to market and road access were the major indicators of markets that were reported to affect farmers decision to grow more crop types by literature. Farmers react differently to markets depending on their characteristics and orientation (whether they are subsistence or market-orientated farmers). For instance, Kumar et al., (2018) found a significant positive relationship between marketed oriented farmers' access to markets and the adoption of crop diversification practices in Uttar Pradesh. Gebresilasse, (2023) also affirmed that road access means farmers are well connected to extension services, farm inputs, and new varieties. This increases the probability of these farmers that produce food crops to sell to grow more food crops. Therefore, inability of a cocoa farmer to access proper road systems limits his ability to produce more food crops. On the other hand, subsistence farmers with poor road networks to markets grow more food crops to mitigate farm risks and to produce enough food for their families (Tacconi et al., 2022).

2.4.3 Farm level factors

Farm-level factors encompass the physical resources and structures that farmers utilize in their production, including farm size, land access, and land tenure security. Among these, the size of land under cultivation significantly influences food crop production by cocoa farmers. Research

has highlighted a positive relationship between farm size and crop diversification, suggesting that larger farms can expand production and mitigate risks by cultivating a wider variety of crops (Baul et al., 2013). Conversely, limited space on smaller farms often restricts diversification, particularly in regions where average farm sizes are small (McNally, 2001). However, other studies reveal a negative relationship between crop diversification and farm size, arguing that smaller farms may have a greater incentive to diversify as a strategy to minimize risks and stabilize incomes (Aheibam & Singh, 2017). This variability is further explored by Kankwamba et al. (2018), who identified a non-linear relationship between farm size and crop diversification. Their findings suggest that diversification initially increases with farm size but eventually decreases as larger farms benefit from economies of scale, making specialization more cost-effective due to factors like labor and input costs. Beyond farm size, land access, and tenure security also play crucial roles in shaping farmers' decisions about crop diversification. Nkomoki et al. (2018) noted that farmers lacking secure land tenure, such as legal titles, are more likely to focus on annual crops and simplified cultivation systems that provide short-term returns. In contrast, farmers with secure land tenure are more inclined to engage in diversified and long-term agricultural practices.

2.4.5 Policy and Institutional factors

Policies and institutions play a pivotal role in shaping farmers' decisions, influencing agricultural practices through mechanisms such as taxes, subsidies, and extension services. Several studies highlight the positive impact of extension services on farmers' decision-making. For example, Odjuvwuederhie et al. (2021) found a strong positive link between access to extension services and the decision to diversify crops. Similarly, Abhijeet et al. (2023) emphasize that extension services do more than provide technical knowledge—they raise awareness about sustainable

agricultural practices, such as integrating food crop production with cash crops, thereby promoting both livelihood security and climate resilience. Extension services also act as a critical channel for accessing improved planting materials (Gebresilasse, 2023) and for keeping farmers informed about market opportunities, emerging technologies, and climate and risk management strategies (Rai et al., 2023).

However, the literature also points to mixed and sometimes conflicting outcomes of policy interventions on farmers' practices. While agricultural development programs like rural subsidies are generally intended to support farmers, their actual effects can vary depending on their design and implementation. For instance, Ciaian et al. (2018) argue that policies targeting specific crops can unintentionally constrain crop diversification. By incentivizing the production of certain high-priority crops, these policies increase the opportunity cost of growing alternative crops, potentially limiting farmers' ability to diversify their production for food security or risk mitigation. In contrast, other studies suggest that subsidies and support programs that provide inputs like seeds and fertilizers can enhance crop diversity, enabling farmers to experiment with multiple crops and adopt more sustainable practices (Iles & Marsh, 2012).

This apparent contradiction highlights a critical tension in agricultural policy design: the same instruments subsidies, extension services, or development programs can either promote or inhibit diversification depending on the objectives, targeting, and context of the intervention. For example, blanket input subsidies for staple crops may inadvertently discourage investment in alternative crops, whereas well-targeted, flexible programs can foster diversification and resilience. Furthermore, while access to extension services generally improves adoption of sustainable practices, there are debates regarding equity and reach. Smallholder or remote farmers

may have limited access, reducing the overall impact of such services and potentially widening gaps between well-supported and under-supported communities.

Additionally, some literature raises questions about the long-term effectiveness of extension services. While immediate technical knowledge and inputs can improve adoption, sustained behavior change often requires complementary measures such as market support, credit access, and institutional capacity building (Rai et al., 2023; Abhijeet et al., 2023). Without these supports, adoption of recommended practices may be partial or short-lived, limiting the resilience benefits for farmers.

The literature underscores that policies and institutions are powerful tools for shaping agricultural decision-making, but their effects are neither uniform nor straightforward. Extension services, subsidies, and development programs can encourage crop diversification and sustainable practices, yet they can also inadvertently constrain farmer choice or exacerbate inequalities. Understanding these nuances is critical for designing interventions that genuinely enhance both productivity and resilience in cocoa-growing and mixed farming systems.

2.5. Seasonality and Cocoa Yield variability in Ghana

Ghana is the second-biggest supplier of cocoa in the world after Cote d'Ivoire (German et al., 2020). These two countries collectively produced about 64% of the world's cocoa bean output (Asante et al., 2022). Though there are economic benefits of the cocoa industry to the Ghanaian economy, it is hampered by its innate seasonality, characterized by uneven production patterns and price volatility. However, in Ghana, the producer price for cocoa is set by the Ghana Cocoa Board (COCOBOD) each year. As a result, farmers are protected from world market price fluctuations (Asibey et al., 2019; Asante et al., 2017). Most cocoa farmers in Ghana are small-scale farmers

who harvest the crop all year round. From September to March, the major crop is harvested, while the minor crop is harvested from May to August. Cocoa income does not come throughout the year due to the seasonal harvesting periods which create fluctuations in household income and food security among cocoa farmers (Batame et al., 2024; Hashmiu, Agbenyega, & Dawoe, 2022; Anang, Kuwornu, & Donkor, 2022). Many cocoa farmers face significant financial difficulties during the off-season. In the postharvest months, some are forced to sell their produce at low prices and later buy it back at higher prices during the lean season (Burke et al., 2019).

Over the past 50 years (1970–2020), cocoa production in Ghana has been volatile, often attributed to low farmer productivity, which is sometimes linked to unfavorable weather conditions (Oyekale, 2021). The decline in cocoa productivity is primarily due to poor agronomic practices, insufficient farm maintenance by aging farmers, declining soil fertility, widespread pest and insect infestations, and vulnerability to adverse weather conditions (Benneh & Anaman, 2022).

2.6 Concepts of Food Security

The world population hit 8 billion people, meanwhile the issue of availability, accessibility, and affordability of food is becoming even more challenging. Agriculture, as the second largest contributor to climate change with about 19-29% of emissions of greenhouse gas (World Bank, 2021), the world is faced with the dilemma of feeding the ever-increasing population whiles adapting and mitigating climate change and variability, especially in Africa which is at the receiving end of climate crises. The demand for food is rising as a result of changing diets and a growing worldwide population. A measure of food security is the availability of food and the ability of individuals to access it (Gürsoy, 2022). Food security as defined by FAO is anchored on four (4) main pillars including the availability of food (includes quantity, quality, and diversity),

accessibility (includes infrastructure and physical access), stability (includes incidences of disturbances), and utilization (ability to consume or unutilized). However, Clapp et al. (2022) has expanded the FAO (2006) pillars to six-dimensional food security to include agency and sustainability. Figure 2.2 gives a brief description of the dimensions of food security.

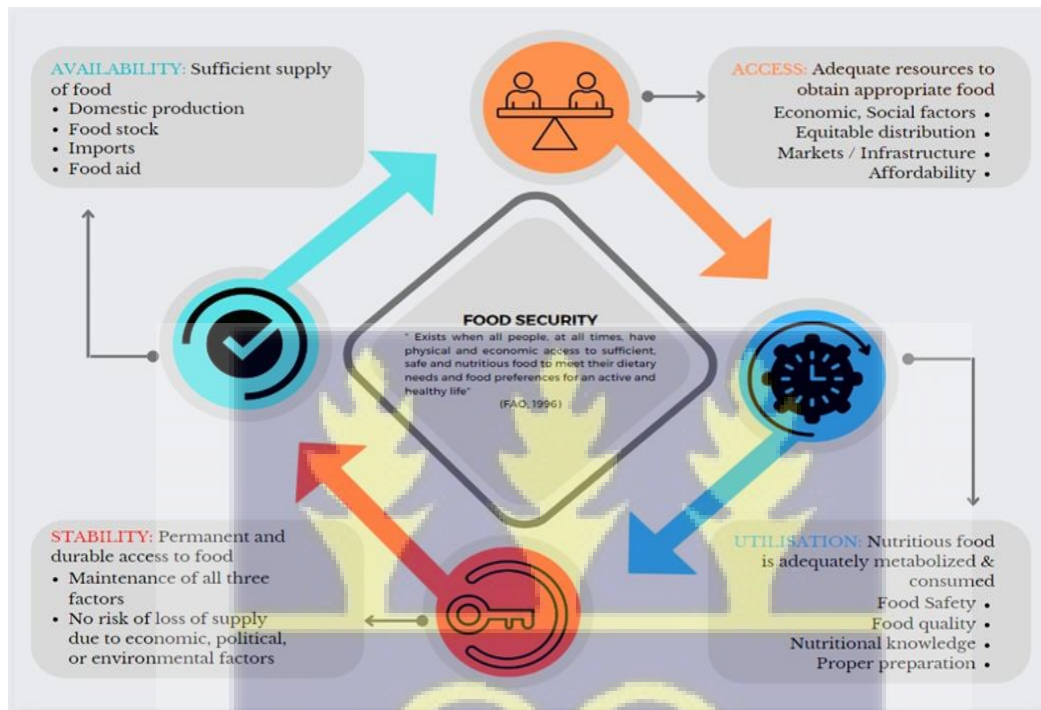


Figure 2.2: Food security and Factors

Affecting the Accessibility, Availability, Stability, and Utilization

Source: Adapted from Kakani (2022)

As crop yields level off globally, ocean health deteriorates, and natural resources like soils, water, and biodiversity are severely depleted, crop production is finding it difficult to keep up (World Bank, 2021), and the vulnerability of agriculture to climate change makes the challenge of food security even more intensified.

Availability of food refers to the accessibility of adequate supplies of food of the right quality, whether they are imported or produced domestically (including food aid). Food is essential for human survival and a tool for exercising authority (Gürsoy, 2022). In 2021, acute food insecurity

affected over 193 million people at worst levels (IPC/CH Phase 3-5) throughout 53 countries or territories.

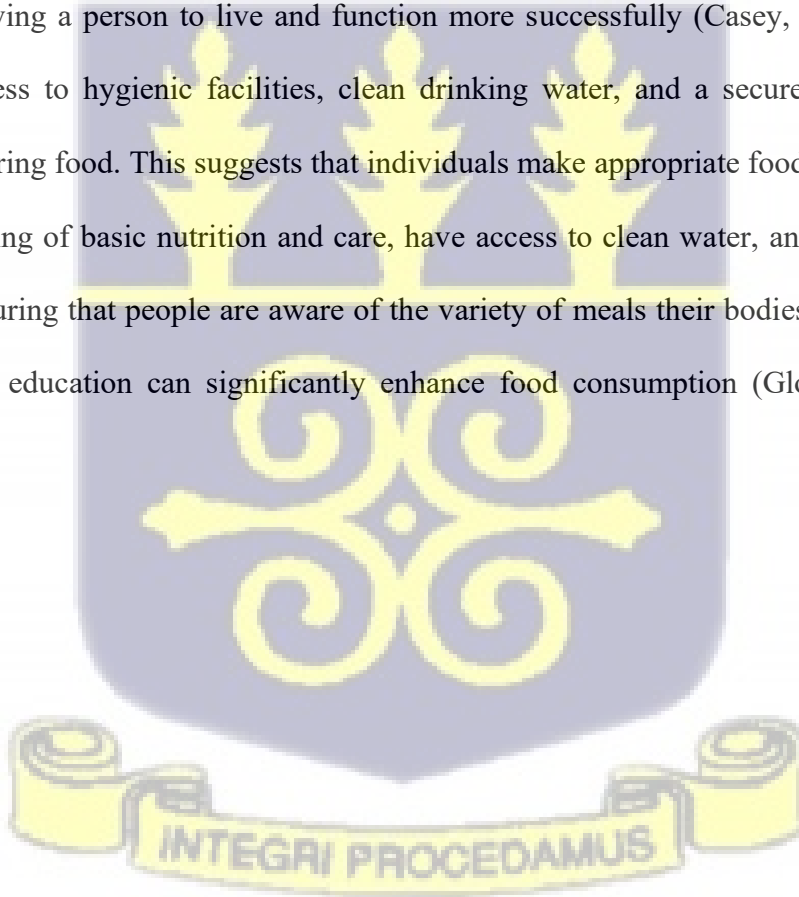
Compared to the already historic figures of 2020, this means an increase of over 40 million people. Over half a million individuals (570 000) reside in Ethiopia, Southern Madagascar, South Sudan, and Yemen, and are considered to be in the most severe stage of acute food insecurity (IPC/CH Phase 5), which calls for immediate intervention to prevent widespread livelihood collapse, famine, and death (WFP, 2022). The sharp increase is primarily caused by escalating violence, existing economic shocks connected to COVID-19, harsh weather, or a combination of these elements. Additionally, the use of updated population estimates, as in Afghanistan, as well as expanded population coverage in nations like the Democratic Republic of the Congo caused the rise in acute food insecurity (WFP, 2022).

Another key dimension of food security is accessibility. Accessibility refers to the individuals' ability to access sufficient financial resources (entitlements) to buy the right foods for a balanced diet (FAO, IFAD, UNICEF, WFP, & WHO, 2021). A food is deemed accessible if it is reachable, prepared for consumption, or situated in an area that is simple to access. Economic access to food and a healthy diet is measured by affordability, which is a significant factor in food security and nutrition. The term "affordability" describes people's capacity to purchase food in their immediate environment (World Bank, 2021). Around 2.37 billion people worldwide did not have access to sufficient food in 2020, making the gender gap in moderate or severe food insecurity even larger in the year of the COVID-19 pandemic. The prevalence of moderate or severe food insecurity was 10% higher among women than men in 2020. Of the 768 million people who were undernourished, 418 million lived in Asia, 282 million in Africa, and 60 million in Latin America and the Caribbean (FAO, IFAD, UNICEF, WFP, & WHO, 2021). These estimations could be higher due to data gaps which remains a challenge on reporting the full range of people or countries that are food insecure

(WFP, 2022). It is obvious that the world's obligation to end hunger, food insecurity, and all types of malnutrition by 2030 is just practically impossible with the remaining fewer years to 2030, the world is not on track to end world hunger and malnutrition, we are moving in the wrong direction to curtailing global hunger (FAO, IFAD, UNICEF, WFP, & WHO, 2021).

Food access is commonly measured by the Household Food Insecurity Access Scale (HFIAS), The Food Consumption Score (FCS), The Household Dietary Diversity Score (HDDS) and the Household Hunger Scale (HHS)

Utilization of food, another key concept of food security, is defined as a safe and nutritious food that satisfies nutritional demands, a requirement for the body to properly assimilate the nutrients from food, allowing a person to live and function more successfully (Casey, 2022). Utilization necessitates access to hygienic facilities, clean drinking water, and a secure environment for handling and storing food. This suggests that individuals make appropriate food choices based on their understanding of basic nutrition and care, have access to clean water, and maintain proper hygiene. By ensuring that people are aware of the variety of meals their bodies need for optimal health, nutrition education can significantly enhance food consumption (Global Issues: Food Security, 2022).



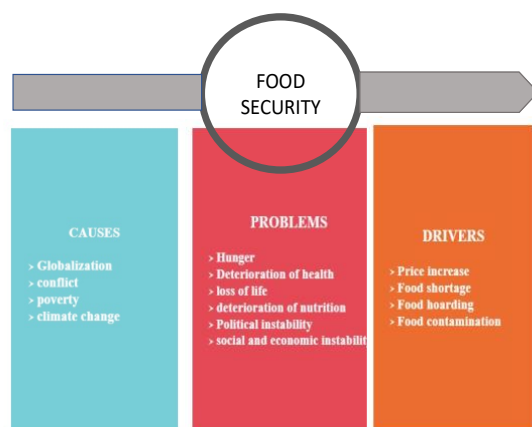


Figure 2. 3: Drivers, Causes and Problems of Food Security

Source: The World Bank (2021)

The stability component of food security refers to the consistent availability, accessibility, and utilization of food over time. This concept addresses both access and production stability. Factors such as extreme weather events, health crises, economic shocks, and the seasonality of markets and agricultural production can threaten stability. Key elements that support stability include agricultural infrastructure and technology, which can stabilize production, as well as public and private food stocks, financial services, and safety nets (World Bank, 2021). A population, household, or individual is considered to have food stability when they consistently have access to food and are not at risk of losing it due to cyclical events, such as the dry season (Doršner, 2021).

The World Bank identifies price fluctuations, food shortages, hoarding, and contamination—driven by globalization, conflict, climate change, and poverty—as the main factors affecting food security (World Bank, 2021). Figure 2.2 illustrates the primary drivers, causes, and issues associated with food security. Despite long-term efforts by development agencies and governments to promote cash crop production as a strategy for improving food security, literature

remains inconclusive about cocoa as a contributor to food security. Jarzebski et al. (2020) argue that the lack of clear understanding stems from the vast diversity of cash crops, differences in their production methods, and varying impact mechanisms.

Another element of food security is the concept of agency, which can be measured at various levels, including individual, household, local community, national, and global. A few key evaluation tools have captured agency in relation to food security, such as the WEN grid and the WENI, which explicitly include agency, along with knowledge and resources, as critical components of empowerment related to food and nutrition (Lentz et al., 2021; Narayanan et al., 2021). Indicators specific to this agency-based framework include, but are not limited to, women's decision-making abilities regarding expenditures, employment status, and perceptions of domestic violence. Other metrics, such as the Women's Empowerment in Agriculture Index and the Women's Empowerment in Livestock Index, assess women's agency in farming and livestock management by measuring their involvement, compared to men, in a range of decision-making contexts (IFPRI, 2012; Alkire et al., 2013; Malapit et al., 2019; O'Hara and Clement, 2018; Bonis-Profumo et al., 2021; Galiè et al., 2019). These empowerment measures offer valuable insights into the link between women's agency and nutritional outcomes. However, recent research highlights variability in their relationship with nutritional indicators, underscoring the need to consider the dynamic interactions between various factors influencing food security (Quisumbing et al., 2021).

Tools like the Household Food Insecurity Access Scale (HFIAS) and the Food Insecurity Experience Scale (FIES) incorporate agency from the household and individual perspectives, respectively. Both have been widely applied in research as general measures of household food

insecurity. Several questions from these surveys provide insights into household agency, such as the power individuals feel they have over their food supply and choices. Examples include questions about concerns over future food availability, perceptions of food quality, and whether there is enough food (Coates et al., 2007; FAO, 2017). The FIES, for example, can be calibrated to create an internationally comparable indicator and has been adopted as the measure for SDG 2.1.2, which focuses on the severity of food insecurity (Cafiero et al., 2018). A potential approach could involve using a subset of questions from these surveys to develop a new index, such as a household or community food agency index (Table 2.1).

Other measures of agency at the individual, household, and community levels may include those that empower consumers in their food choices, such as clearer labeling and information about the social, economic, and environmental conditions of food production. These indices could also capture participation in decision-making and governance within local food systems, such as municipal food security councils in some countries (Chappell, 2018). At the national level, a combination of institutions, including government entities, private sector actors, and social movements, shapes the national food system. Government policies, in particular, influence how much control a population has over its food system and its autonomy in relation to the global food system. Various indicators can offer insights into a country's and its people's power, both individually and collectively, to influence food systems. These include national commitments to uphold the right to food and other human rights, levels of national food self-sufficiency, the number and types of food producers, domestic market concentration, participation in associations, cooperatives, and unions, opportunities for engaging in food system governance, rates of farmer suicide, and national rates of hunger, malnutrition, and obesity.

Table 2. 1: Comparison on questionnaire use and construction of dietary diversity at the household or individual level

	Household level questionnaire	Individual level questionnaire
What the score measures	Household economic access to food (dietary energy)	Quality of individual's diet; for women probability of micronutrient adequacy of the diet
Respondent	Person responsible for the preparation for the household the previous day	Women aged 15-49 years or individuals in other age/sex groups
Target of interest	The household (all persons living under the same roof who share meals)	The respondent
Inclusion and exclusion of foods	Includes foods Prepared in the home or outside the home; or purchased outside and consumed at home	Does not include foods All foods eaten by the individual of interest, consumed inside or outside the home, irrespective of where they were prepared
Number of food groups in the score	12 groups included in the HDDS	9 groups included in the WDDS

Source: Authors literature review, 2022

Reason for inclusion of food is because there is some evidence that women's dietary diversity also reflects household economic access to food. Those foods that are not included is because the respondent may not know which other household members purchased and ate outside the home.

Using one 24-hour recall period does not provide an indication of an individual's habitual diet, but it does provide an assessment of the diet at the population level and can be useful to monitor progress or target interventions (Savy et al., 2005). There are various other valid timeframes for recall, such as the previous 3 or 7 days, and in the case of some foods, the previous month. The recall period of 24 hours was chosen by FAO as it is less subject to recall error, less cumbersome for the respondent and also conforms to the recall time period used in many dietary diversity studies (Kennedy et al., 2007; Ruel et al., 2004; Steyn et al., 2006; Savy et al., 2005; Arimond et al., 2010). Moreover, analysis of dietary diversity data based on a 24-hour recall period is easier than with longer recall periods.

2.6.1 Measurements of Food Security

Despite long-term efforts by development agencies and governments to promote cash crop production as a strategy to enhance food security, the literature remains unconvinced regarding cocoa's role in food security. According to Jarzebski et al. (2020) and Ahsan et al. (2020), the lack of clarity on the food security impacts of cash crops stems from their vast diversity, including differences in production methods, regions, and impact mechanisms.

Food security also includes the concept of agency, which can be measured at various levels such as individual, household, community, national, and global. Key evaluation tools that incorporate elements of agency related to food security include the Women's Empowerment in Nutrition (WEN) grid and the Women's Empowerment in Nutrition Index (WENI), which recognize agency alongside knowledge and resources as vital dimensions of empowerment concerning food and nutrition (Lentz et al., 2021; Narayanan et al., 2021). Agency indicators at the individual and household level include, but are not limited to, women's decision-making power over expenditures, employment status, and perceptions of domestic violence. Other measures, such as the Women's Empowerment in Agriculture Index (WEAI) and the Women's Empowerment in Livestock Index (WELI), evaluate women's agency in farming and animal husbandry by assessing their involvement relative to men in various decision-making contexts (IFPRI, 2012; Alkire et al., 2013; Malapit et al., 2019; O'Hara and Clement, 2018; Bonis-Profumo et al., 2021; Galiè et al., 2019). These empowerment measures offer valuable insights into the link between women's agency and nutritional outcomes. However, recent studies indicate some variability in their correlation with nutritional indicators, highlighting the need to consider the dynamic interactions of factors influencing food security (Quisumbing et al., 2021).

The Household Food Insecurity Access Scale (HFIAS) and the Food Insecurity Experience Scale (FIES) focus on agency from the household and individual perspectives, respectively, and have been increasingly used as general measures of household food insecurity. Some questions within these surveys provide insights into how much power households feel they have over their food supply and choices. These questions include concerns about the future availability of food, perceptions of insufficient food quality, and feelings of inadequacy regarding food (Coates et al., 2007; FAO, 2017). The FIES, for instance, can calibrate responses into an internationally comparable.

Table 2. 2: Indicators used for measuring food security and their purpose

Scale	Food security dimension	Metric/Indicator	Purpose/Advantages	Disadvantages	References
National/ Household/ Individual	Availability	FAO method (food balance sheet)	-provide comparisons across nations -annual data update -low cost	-Difficult to identify vulnerable household -does not account for dietary quality -high level of measurement -Low standardization	Kuwornu, Osei, E, Osei- Asare & Porgo. (2018); Jones, Ngure, Pelto & Young. (2013)
		Global Hunger Index (GHI)	-Global application -provide comparisons across countries -Annual data update	Complicated interpretation of GHI. Cannot stand food shock. Double counting.	Coates et al. (2013)
National/ Household/ Individual	Utilization/ consumption	Anthropometry (ranks countries on a 100-point scale using 3 equally weighted indicators: undernourishment; child underweight; and child mortality.	Identifies vulnerable groups at both local and national levels. Compare differences in hunger across countries. Highly standardized. Widely applied in national surveys.	Hard to interpret the relationship between food insecurity and obesity. Indirect proxy for food insecurity (measuring malnutrition).	Jones et. al. (2013)

National/ Household/ Individual	Access	Household Income and Expenditure Surveys (HIES)	Food quality. Useful in evaluating poverty reduction programs.	Measures food availability and not consumption (does not capture home food consumed outside the home). Expensive. Data is not collected annually. Data collection methods are not standardized.	Ogundari. (2017); Babatunde et. al. (2013)
National/ Household/ Individual	Access	Dietary Diversity Food Consumption Score (FCS). Household Dietary Diversity Score (HDDS)	Captures both dietary quantity and quality. Measures food consumption, not only availability. Highly correlates with other food security measures (per capita consumption, expenditure).	Does not capture factors affecting changes in food consumption. Time-consuming when used for national surveys. Expensive. Difficult to justify cut-offs. Difficult to assess portion sizes. Memory recalls bias.	Ogundari. (2017); WFP. (2009, 2010); Coates et al. (2007); Swindale & Bilinsky. (2006)
National/ Household/ Individual	Access	Livelihood strategies Coping Strategies Index (CSI). Reduced Coping Strategies Index (rCSI).	For evaluating the impact of household food access and targeting programs. Estimating short and long-term changes in food security. Monitors the impact of food aid.	Does not give a direct indication of the food gap. Difficult to differentiate pre-crisis and induced coping strategies (i.e., difficult to distinguish transitory and chronic food insecurity). Highly subjective and require high expertise on the part of the researcher.	Maxwell, Cadwell & Langworthy. (2008); Babatunde. (2008); Maxwell. (1996)
Direct or Fundamental	Household Access	Experientially based measures Household Food Security Survey Module (HFSSM). Latin American and Caribbean Food Security Scale (HFIAS). Household Hunger Scale (HHS). Food Insecurity Experience Scale (FIES)	Direct measure of food insecurity. Captures the physical and psycho-emotional aspects of food security. Valid across different socio-cultural contexts.	Hard to standardize cutoffs across different nations. Does not account for food safety dimensions. Different reference times and frequency responses in a different context.	Cafiero, Viviani, & Nord. (2018); Nkegbe, Abu & Issahaku. (2017); Cordero-Ahiman, Santellano-Estrada & Garrido, (2017); Sharaunga, Mudhara & Bogale, (2016); Headey (2013, 2011); Deitchler, Ballard, Swindale, & Coates, (2010); Swindale & Bilinsky. (2006).

Source: Authors literature compilation, 2022

Table 2.2 presents the national, household, and individual food security scales, displaying various measures for both direct and indirect indicators of food access, which are often used interchangeably without clear understanding of the specific food security dimensions they address. This approach carries the risk of underestimating the number of food-insecure individuals, especially when single measures are used that do not fully align with a comprehensive definition of food security (Coates, 2013). The selection of a particular indicator depends on the questions to be answered and the available resources. However, these methods can complement one another, as no single method can capture all the dimensions of the multi-faceted phenomenon of food security (FAO, 2003).

2.7. Seasonality, Climate Change and food security

In Ghana, cocoa production is heavily influenced by the seasons. Cocoa trees follow seasonal phenological patterns, with flowering happening primarily during the wet season (Adjaloo et al., 2012). New pod production peaks during the main rainy season, and is evenly divided during the minor to dry seasons (Kitson Baffour Asamoah et al., 2017). Cocoa requires good environmental conditions throughout the cultivation process (Kosoe & Ahmed, 2022). Precipitation has the greatest impact on cocoa yield than any other climate variable, rendering the crop susceptible to soil water scarcity (ibid, 2022). Furthermore, the physiological performance of cocoa stems is influenced by seasonal shade structures, which alter photosynthetic rates and biomass production (Acheampong et al, 2013). Shade trees on cocoa fields influence yields distinctly depending on the season, with varied effects on cocoa output during the light and main crop seasons (Asare et al., 2017; Ackah & Dompey., 2021). Rural communities in Sub-Saharan Africa are particularly susceptible to the effects of climate change, including frequent droughts, intensified floods and storms, and unpredictable rainfall, all of which threaten food security and disrupt the sustainability

of smallholder crop-livestock systems (Abebe et al., 2022; 2023; Adesete et al., 2023; Baptista et al., 2022; Bedasa and Deksis, 2024). The region's vulnerability to climate variability is exacerbated by its reliance on rain-fed, low-input, and small-scale farming systems (Omotoso et al., 2023; Njoya et al., 2022).

Several studies have shown that seasonality in cocoa production in Ghana is intrinsically linked to climate change and food security (Yiridomoh et al., 2022). Climate change impacts cocoa pod development increases insect pests, and promotes infections, leading to lower crop yields and reduced farm profitability (Agbongiarhuoyi et al., 2013), which in turn negatively affects the food security of cocoa farmers. Smallholder cocoa farmers in Ghana have already noticed climatic changes affecting their plantations, resulting in increased dieback, illnesses, and lower yields, spurring adaption strategies such as early planting, intercropping, and mulching (Russell, 2022). These farmers have been implementing various adaptation strategies such as crop diversification, improved farming techniques, and the application of organic manure to mitigate the effects of climate change on food crop production and sustain household food security. Amfo & Ali (2020) reported that most cocoa farmers in the Tepa and Bekwai cocoa regions in Ashanti region of Ghana, practice crop and livestock diversification, among others, as a way of increasing farm income, sustain household food security and mitigating impacts of climate change.

Climate change poses a serious threat to global food security (Bryson et al., 2020). The recent rise in hunger and the setbacks in addressing the various types of malnutrition can be attributed to climate variability (UNICEF, 2021). According to FAO (2008), all aspects of food security, including availability, accessibility, and stability of the food system, are impacted by climate change, which influences markets, human health, and assets used for generating a living. There is growing evidence that frequent and severe climate change is occurring and it does so in a variety

of ways, including melting glaciers, greater climate variability, and an increase in the frequency of extreme weather events (Nkonya et al., 2022; Holleman et al., 2020).

In sub-Saharan Africa, the productivity of the agricultural and livestock sectors is heavily limited by unpredictable rainfall patterns and droughts, which in turn affect food supply chains (Affoh et al., 2022). The form of increased frequency and greater intensity of weather shocks limits on-farm production, resulting in lower agricultural yields and farmer production capacity, and subsequently lower income for farming communities (Dincher, 2022; Bryson et al., 2021; Qaim, 2020). The seasonal impacts may also affect urban areas, as reduced food supplies from rural regions lead to rising food prices and detrimental changes in dietary and nutritional habits (Anderson et al., 2018; Gilbert et al., 2017). Climate change intensifies the prevalence of pests and diseases (Cilas and Bastide, 2020; World Bank, 2018). Furthermore, it negatively influences the dietary diversity of farming communities and reduces the nutrient quality of foods grown on farms (WFP, 2021).

2.8 Empirical Studies on Seasonality and Food Security

The multidimensional phenomenon that covers food security are climate change, civil unrest, disaster and social norms along with food production, access and utilization. A number of studies have assessed the effects of seasonality and food security globally. For example, Bonuedi et al. (2022) reported that seasonal variations in agriculture in many agrarian economies are a major contributor to food security and undernutrition. Purchased foods contribute much more to dietary diversity than subsistence production throughout all seasons (Sibhatu and Qaim, 2017). In Kenya, smallholder households saw a notable rise in food insecurity during the COVID-19 pandemic (Huss et al., 2021).

A study by Brander et al. (2020) revealed a positive impact of enhanced on-farm storage on alleviating food insecurity during lean seasons among smallholder farmers in Tanzania. Stevens

et al. (2017) studied the effect of seasonality on household food security in Bangladesh and discovered that food insecurity and child growth are more pronounced during the rainy season than in the dry season. In Ghana, the [fish] closed season significantly reduced the dietary diversity of women of reproductive age (Balana, et al., 2019). Seasonal and casual workers are more prone to food insecurity than permanent workers because they typically work only during specific agricultural seasons and often earn wages below the legally mandated minimum for their sector. The influence of seasonality was demonstrated to impact both the availability and accessibility of food, heightening the vulnerability to food insecurity while also contributing to diminished dietary quality and malnutrition (Tay, et al., 2023).

Aweke et al. (2022) found significant differences in dietary diversity and food security between the two farming seasons. Households that produced a greater variety of food groups, cultivated larger plots of land, had higher household incomes, kept more livestock, owned cell phones, had access to cooperatives, enjoyed improved drinking water, and received education were more likely to be food secure throughout the seasons. However, households that kept livestock in their homes and those with access to credit were found to have a negative association with seasonal food insecurity.

Table 2. 3: Summary of empirical studies on food security and the validation

Variable	Sign Effect	Country	Authors	Validation
Household size	+	Nigeria	Ogundari (2017) Ogunniyi (2018)	This is when most household members are employed and have additional income for purchasing food for the household. Meanwhile, households less vulnerable to shocks results from breadwinner losing job or death (Lipton, 1983).
		Ethiopia Ethiopia Zambia Indonesia	Sisay (2024) Gelata et al., (2024) Kaminski et al., (2024) Akbar et al. (2023)	
	-	Nigeria	Asogwa & Umeh (2012) Lawal et al., (2009) Reinke et al., 2018 Mukaila (2024)	Large household size with limited productive agricultural land and other livelihood earnings means food supply may not match demand and that may lead to less calorie intake. Households with larger sizes require more mouths to feed, thus placing much pressure on family resources leading to food insecurity.
		Ethiopia	Tega & Bojago (2023)	
Household Income (On-farm)	+	Nigeria	Asogwa & Umeh (2012) Mukaila et al., (2024)	The variable is expected to increase food production and access to greater food quality and quantity

		Ethiopia	Tega & Bojago (2023)	
Off-farm income	+	Ghana	Kuwornu et al., (2018) Addai et al., (2023)	Off-farm work is a coping strategy for households that generates additional income for food consumption. Hence, households engaged in off-farm activities are more resilient to hunger.
		Nigeria	Asogwa & Umeh (2012); Babatunde & Qaim. (2010)	
		Benin	Amoussouga (2023)	
		Asia	Bai et al. (2024)	
Farm size	+	Nigeria	Asogwa & Umeh (2012)	Farmers who produce on a large scale tend to be more efficient with their resources than those who produce on a small scale. Small-scale farms are unable to practice mechanized farming with modern inputs due to limited resources at hand, resulting in low productivity and income which will affect household food security. Farmers with large farms possess the ability to collateral to participate in social groups.
		Ghana	Appiah-Twumasi & Asale (2024)	
		Ethiopia	Tega & Bojago (2023)	
		Nigeria	Kehinde et al., (2021)	
Age	+	Pakistan	Abdullah et al., 2017 Hameed et al. (2023)	The older the household head, the more experience they are, the higher risk-averse they are with a more likely to diversify.
		Ethiopia	Abate et al., (2019)	
		Senegal	Vanden Broeck et al. (2018)	
		Malawi	Manikas (2023) Beyene (2023)	
	-	Nigeria	Asogwa & Umeh (2012)	Other studies' results are contrary to a positive direction. As household heads get older, they become less productive and thus rely on gifts and remittances from friends and others. The younger household member becomes energetic and able to engage in both on-and-off farm activities to generate income to increase their food security status.
		Indonesia	Akbar (2023)	
		Global	Haini (2023)	
		Ethiopia	Fikire et al., (2022)	
		SSA	Dzanku (2019)	
Sex (male-headed household)	+	Nigeria	Kehinde et al., (2021)	Male-headed households are more food secure because they can source on-farm laborers better than female-headed households and have a higher dependency ratio. Male-headed households increased the decision to participate in social which is attributed to the fact that they are more willing to take risks than female-headed households, therefore more likely to diversify and improve food security.
		Nepal	Broussard (2019)	
		Tanzania	Reincke et al., (2018)	
Education	+	Nigeria	Asogwa & Umeh (2012); Nkegbe et al., (2017); Tefera & Tefera. (2014) Balana et al., (2022) Nkomoki & Banout (2018) Acheampong et al., (2022)	Education influences household income, resource management, and the adoption of technologies that improve food productivity. Farmers with formal education tend to have better dietary outcomes compared to those without. Over the long term, educated household heads are more likely to access food security information and have stronger opportunities for livelihood and income diversification. Either male or female-headed households become less vulnerable to food insecurity with increased educational attainment.
	-	Nigeria	Olagunju et al., (2019) Ogunniyi et al., (2021)	
Remittance	+	Nigeria	Asogwa & Umeh (2012) Haini (2023)	
Member of assoc.	+	Nigeria	Asogwa & Umeh (2012)	
Extension Services	+	Nigeria	Asogwa & Umeh (2012) Onyeneke (2021)	Contact with extension agents enhances the chances to better inputs, good agric. practices that increase

		Benin	Adjimoti & Kwadzo (2018)	productivity and incentives to improving farming for food and income.
		Malawi	Ragasa et al., (2019)	
Farm experience	+	Nigeria	Oluyole et al., (2009)	An experienced farmer is more comfortable to task risks with technology adoption. Competent and is more efficient in taking decisions.
Access to credit	+	Nigeria	Babatunde, (2007) Mukaila (2024)	Obtaining credit increases crop productivity which improves food consumption, hence food security
		Uganda	Twongyirwe et al., (2019)	Credit builds productive capacity through the purchase of inputs and enables households invest resources in agribusiness and non-farm activities to improve food security status.
		Benin	Adjimoti & Kwadzo (2018)	
	-	Nigeria	Ogunniyi et al., (2021)	
Dependency ratio	-	Nigeria	Agwu et al., (2014)	An increase in unemployed household members, children inclusive will exert pressure on the limited resources of the household. Which will increase food insecurity.
Ownership of livestock	+	Senegal	Van den Broeck e al., 2018	Ownership of livestock acts as a hedge and an indicator of wealth which the household can fall on to mitigate the household during crop failures and other disasters.
		Ghana	Danso-Abbeam (2021)	

Source: Authors literature compilation, 2023

2.9 Living income

The concept of a living income, as defined by the Living Income Community of Practice (2020), refers to the net annual income required for a household in a specific location to afford a decent standard of living for all its members. This idea goes beyond the notion of merely reducing poverty, which concentrates on basic survival and subsistence. Instead, it advocates for an income level that enables households to participate in social and cultural activities in addition to meeting their basic requirements (Smith & Sarpong, 2018). A decent standard of living encompasses basic needs such as food, water, housing, education, healthcare, transportation, and clothing, as well as a financial safety net for unforeseen events like medical emergencies. The living income theory expands beyond economic survival, emphasizing quality of life, active participation in social and organizational activities, and the growth of individual capabilities (Carr et al., 2016). Fair pricing is a tool used by the living income framework, which is based on moral values and the Universal Declaration of Human Rights, to fight poverty (Bronkhorst, 2020).

Studies on living income has revealed several critical factors that influence household earnings. Education, for instance, plays a significant role; in Guatemala, an additional year of education is associated with a 7.4% increase in income (Quijivix, 2020). Other determinants of living income include age, geographical location, and political affiliation (Gallet, 2004). In rural Vietnam, strategies for income diversification have been shown to positively impact household living income, with socio-economic parameters playing a key role (Diep & Vien, 2017). Gallet (2004) further identifies minimum wage rates, fair-market rent, per capita income, and proximity to cities offering livable wages as important variables.

The estimation of living income involves a variety of methodologies designed to determine the income necessary for a decent standard of living. The Living Income Methodology, which is adapted from the Living Wage Methodology, estimates living income for rural households through fieldwork, with results expressed per adult equivalent per day (Van De Ven et al., 2021). This approach has been applied in countries like Tanzania, Uganda, and Ethiopia, revealing that the extreme poverty line is insufficient for meeting basic needs (Mellisse et al., 2024; Van De Ven et al., 2021). Waarts et al., (2019) indicates that for many cocoa and tea farmers, household income would need to double to achieve a living income.

In the UK, the estimation of the living income involves technical decisions and judgments rooted in societal values. This process requires rigorous analysis, stakeholder consultation, and a robust governance structure to ensure that the living wage remains relevant and accurate (D'Arcy & Finch, 2019). These methodologies serve as benchmarks for evaluating development opportunities and tracking progress toward poverty elimination. While the World Bank's International Poverty Line of \$1.90 per day is recognized as insufficient for meeting basic needs, National Poverty Lines, when adjusted to align with the Anker methodology, may offer a more appropriate measure for approximating a decent standard of living (Minos, 2018; van de Ven et al., 2020).

In Ghana, many workers earn below the minimum wage (Gyadu-Asiedu et al., 2023). The pursuit of a living income is therefore important for ensuring social justice and economic inclusivity (Gneiting & Sonenshine, 2018). Moreover, the concept of living income plays an important role in achieving several of the Sustainable Development Goals (SDGs), particularly, ending poverty (SDG 1), ensuring decent work and economic growth (SDG 8), and reducing inequalities (SDG 10) (Carr, 2021; Lusseau & Mancini, 2019; Soto, 2024). Living income helps to create more inclusive economies where all individuals have the opportunity to thrive.

In the rural and agricultural communities in Ghana, achieving a living income is challenging due to low productivity, volatile commodity prices, and limited access to markets (Boeckx et al., 2020; Rapsomanikis & Sarris, 2008). Even in urban areas, where wage levels are generally higher, the cost of living can outpace earnings, particularly for those employed in the informal sector (Cuesta et al., 2021; Perlman, 2019), which constitutes a significant part of the workforce. The informal sector is characterized by low wages, job insecurity, and a lack of social protections, such as healthcare and pensions (Anku-Tsedu, 2020; Donne et al., 2019; Oteng et al., 2022), making it difficult for workers to meet their basic needs. The national minimum wage often falls short of providing a living income, especially in urban centers (Cuesta et al., 2021) where housing, food, and other essentials are significantly more expensive. Furthermore, the cost of living in Ghana has been rising steadily due to inflation (Seidu & Vasilev, 2024) worsening the difficulties faced by low-income households. Inflation reduces purchasing power, meaning that even those whose incomes have nominally increased may still struggle to afford basic goods and services. This situation is further complicated by persistent poverty and income inequality, particularly between urban and rural areas. Rural communities often suffer from a lack of infrastructure (Addo et al., 2023; Somanje et al., 2020), and limited access to quality education and healthcare (Adu et al.,

2021; Amoah-Nuamah et al., 2023), and fewer other economic opportunities which contribute to their lower income levels compared to the urban communities.

2.9.1 Living income for Cocoa farmers in Ghana

Cocoa farmers in Ghana face various challenges that hinder their productivity and livelihoods. These challenges include inadequate adherence to weedicides and personal protective equipment usage, leading to health issues (Santo et al., 2023), motivations for illegal mining activities like galamsey, causing labor shortages, water pollution, and land competition (Osman et al., 2022), reliance on aging cocoa trees, weed invasion, and pest management difficulties (Ankuvi et al., 2023) and insufficient attention to food crop production, resulting in food insufficiency among farming households (Acheampong, 2023). Addressing these challenges requires promoting proper agricultural practices, discouraging illegal mining activities, enhancing cocoa tree management and improving food crop production. The government of Ghana has implemented various interventions to enhance the livelihoods of cocoa farmers in the country. These interventions include promoting technical efficiency through supply-side support like hand pollination, hybrid seedlings, and extension services (Jebuni and Sandza, 2023).

The Living Income Differential (LID) is a strategic pricing initiative aimed at increasing the farmgate price for cocoa farmers in the world's two largest cocoa producers. Together, Ghana and Côte d'Ivoire, which account for over two-thirds of global cocoa production, introduced the LID to require any buyer in the international cocoa market to pay an additional US\$400 per ton on the export price, starting with the 2020/21 crop. This \$400/ton differential is intended to be passed directly to cocoa farmers (Boysen et al., 2021; 2023). Both countries have highly regulated cocoa sectors, overseen by COCOBOD in Ghana and the Conseil du Café-Cacao (CCC) in Côte d'Ivoire. These institutions regulate domestic pricing, quality control, cocoa trading, and tax revenue, thus

playing a significant role in shaping the welfare of smallholder farmers (Abbey et al., 2016). In Ghana, cocoa prices are determined by the Producer Price Review Committee (PPRC), which sets the prices at the beginning of the season through its subsidiary, the Cocoa Marketing Company (CMC). The CMC exports sell forward, or hedges about 70 percent of the anticipated harvest. The PPRC is chaired by the Minister for Food and Agriculture, and its members include representatives from farmers, transporters, Licensed Buying Companies (LBCs), the Ministry of Finance and Economic Planning, and COCOBOD. Although the PPRC includes farmer representatives, evaluations suggest that farmers have limited influence on price-setting decisions, with the process largely driven by political elites (Asche, 2018; Chinsinga & Naess, 2022). The farmgate price for cocoa farmers is derived from the expected export price, which is based on 70 percent of the costs associated with shipping cocoa from the port of departure, as determined by the buyer. All cocoa is purchased through semi-privatized Local Buying Companies (LBCs), which can offer higher prices through sustainability premiums to compete for market share. However, the LID is separate from these premiums, as well as the 'origin differential,' where exporting countries demand higher prices based on national quality standards (Boakye, 2021; Boysen et al., 2021). Despite these efforts to stabilize domestic prices and influence global cocoa prices, exporting countries remain "global price takers" with limited power to set prices on the international market (Trster et al., 2019).

2.10 Theoretical Review

This study draws on three interrelated theories: the Action Theory of Adaptation, the Livelihood Theory, and the Seasonality Theory to explain how cocoa farming households respond to climate change and seasonal variations, and how these responses affect household income, food security,

and the dietary intake of women. Together, these theories provide a holistic understanding of the behavioral, structural, and temporal factors that shape the lived experiences of farmers in cocoa-growing regions.

Action Theory of Adaptation

The Action Theory of Adaptation focuses on how people actively respond to changes and stress in their environment. Rather than seeing communities as passive victims of climate change, this theory views adaptation as a deliberate and goal-oriented process where individuals assess risks, draw on available resources, and choose strategies that help sustain their livelihoods (Grothmann & Patt, 2005; Moran, 2010).

In the context of cocoa production, farmers constantly make choices about how to deal with unpredictable weather, pest outbreaks, and changing rainfall patterns. Their actions may include replanting with drought-resistant cocoa varieties, adopting shade management practices, or diversifying their income through food crops or non-farm work (Below et al., 2012; Antwi-Agyei et al., 2014). Research in Ghana shows that access to credit, information, and extension services enables better adaptation, while limited resources often constrain smallholder and female farmers (ILRG, 2021; Batame, 2024).

This theory helps to explain why adaptation decisions differ across households and why some farmers cope more effectively with climate stress than others. It also highlights the social and gender dimensions of adaptation, recognizing that women's adaptive strategies often focus on household food management and nutritional resilience rather than farm-level investments (Gupta, 2025).

Livelihood Theory

The Livelihood Theory, rooted in the Sustainable Livelihoods Framework (Chambers & Conway, 1992; Scoones, 1998; DFID, 1999), takes a broader view of how people combine resources such as land, labour, capital, and social networks to make a living. It emphasizes that livelihoods are shaped not just by what people have, but also by the institutions, policies, and environmental conditions that influence how those assets are used.

For cocoa-farming households, this theory provides a useful way to understand the complex links between income, food security, and vulnerability. Cocoa is a valuable cash crop, but heavy dependence on it can expose farmers to significant risk when climate change or market shocks affect production (Hashmiu, Agbenyega, & Dawoe, 2022; CABI Agriculture & Bioscience, 2024). Studies show that households that combine cocoa farming with food crop production, animal rearing, or petty trading tend to have more stable incomes and better food security (Abdulai, Agbenyega, & Dawoe, 2022; Batame, 2024).

Livelihood Theory also brings attention to gender inequalities that shape access to livelihood assets. Women in cocoa-farming households often have limited control over land, credit, and income from cocoa sales, which affects their ability to secure nutritious food for their families (ILRG, 2021; Gupta, 2025). Thus, the theory emphasizes not only the resources people use but also the social and institutional barriers that determine who benefits most from them.

Seasonality Theory

The Seasonality Theory, first proposed by Chambers (1989), explains how agricultural households experience recurring periods of plenty and scarcity based on seasonal production cycles. It argues

that rural poverty and hunger are not just outcomes of low productivity but also of predictable seasonal fluctuations in income, labor demand, and food availability (Devereux, 2019).

In cocoa-growing areas, seasonality plays a major role in shaping farmers' livelihoods. Income rises during the harvest season when cocoa is sold but drops sharply before the next harvest. During these “lean” months, households often struggle to buy food or maintain diverse diets (Picot, Appiah, & Owusu, 2024; Hashmiu et al., 2022). Climate change has made these seasonal swings even more unpredictable by altering rainfall patterns and harvest timing (Climate Central, 2025; WUR, 2025).

Women are particularly affected because they are usually responsible for household food preparation and management. When cocoa income falls, they often resort to coping strategies such as skipping meals, relying on cheaper carbohydrate-based foods, or reducing portion sizes (Batame, 2024; Gupta, 2025). Seasonality Theory, therefore, helps explain how time, income flow, and climate variability combine to shape food and nutrition outcomes in farming households.

Integrating these three theories provide a powerful lens for understanding how climate and livelihood dynamics intersect in cocoa growing communities. The Action Theory of Adaptation captures the decision-making and behavioral side of how farmers respond to climate risks. The Livelihood Theory emphasizes the structural and resource-based factors such as access to assets, gender roles, and diversification—that shape their adaptive capacity. The Seasonality Theory introduces a time-based perspective, showing how these responses and constraints play out across the agricultural calendar.

Together, they form the foundation of this study's conceptual framework. Climate change affects cocoa production and its seasonal patterns, which in turn influence household income. Income

fluctuations shape food access and consumption, especially for women who manage family nutrition. The extent to which households can adapt to these challenges depends on their assets, resources, and agency. This integrated perspective allows for a more nuanced understanding of how environmental, economic, and social factors jointly determine food security and dietary outcomes in cocoa-farming households.



CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the theoretical and empirical frameworks as well as the analytical tools used to address the objectives of the study. The sampling procedure and sampling frame, methods of data collection and estimation procedures for the parameters in the study are also presented.

3.2 Data for the study

The study used the mixed methods approach (qualitative and quantitative) to conduct the research among cocoa farm households in the Western and Ashanti cocoa regions in Ghana. This integrated approach provided a better understanding of the research problem that involves collecting, analyzing and integrating the quantitative (survey data that was collected from the smallholder cocoa farmers and existing data) and the qualitative (data from focus group discussions and personal interviews) information that were generated. The mixed method approach provided triangulation in the type of information provided by each method, including its strengths and weaknesses.

Descriptive statistics and regression-based analyses was undertaken to (a) analyze farmer's perception of climate change on food security, (b) describe how farmers respond to seasonal food security in the light of climate change, (c) describe how seasonality in cocoa production affect food security status of the farm households, (d) analyze the seasonal food security status and women of reproductive age (15-49 years), and the relationship between seasonal income from cocoa output and Women Dietary Diversity (WDD) scores of cocoa farm households. The analyses also include the linkages between sustainable farming practices and food security among the

smallholder cocoa farmers and assessing the characteristics of family farms (demographics, income and food security for improved livelihoods).

This study used two types of quantitative data (a) a large and unbalanced panel/longitudinal data, and (b) a baseline data from the *Cocoa4Future* project in Ghana, and qualitative data from Focus Group discussions (FGDs) and key informants (KI). Data were collected by field technicians and graduate students under the project from the University of Ghana. The project set up a 3-location observatory with two-men trained technicians imbedded in each of the locations to supplement the data collected by the graduate students. Of the panel data, the study used a two-year cocoa cycle (2022/2023 and 2023/2024 cocoa years) monthly data for the analysis. The panel data was collected monthly from August 2022 to July 2024 using a standardized questionnaire pre-coded in Insynt and Kobo Collect. This dataset is a rich panel consisting of a wide range of information. The baseline quantitative data was collected in July 2022 using a pre-coded set of questionnaires developed by the *Cocoa4future* project. The qualitative data covers focus Group Discussions and Key informant interviews around climate changes and issues of institutional arrangements governing ownership and use of land in the districts and implications for cocoa production and seasonal household food security. The comparative baseline and the panel data analyses and the qualitative data provide a time variant comparison of cocoa farm households characteristics. Data collected included farmer demographic characteristics, farm characteristics, climate change perceptions, food security status, dietary diversity, cocoa yields, farm practices including agroforestry practices. FGDs were conducted in the selected communities with the smallholder farmers on general agricultural practices and food security sustainability in farming issues.

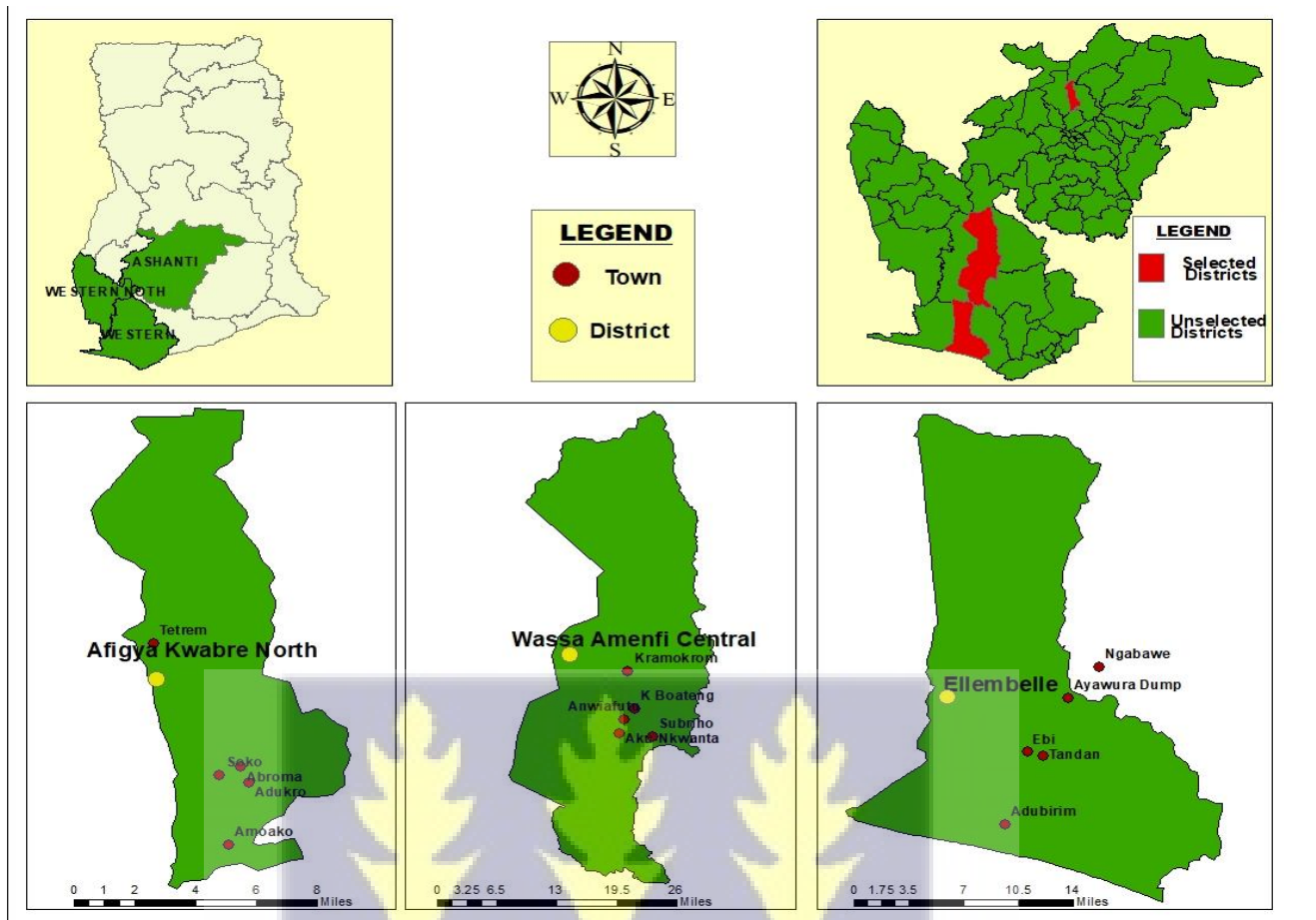
3.3 Study area

The data were collected from cocoa farmers in selected districts in the Western and Ashanti cocoa regions. Cocoa is a major tree crop in the Western and Ashanti regions of Ghana. The districts were pre-selected within the framework of the *Cocoa4Future* project, funded by the European DeSIRA Initiative and by the French Development Agency (CIRAD) in the Ellembele, Wassa Amenfi Central (Western Region) and Afigya Kwabre North district (Ashanti Region). See figure 3.1. The total volume of cocoa produced in the 2023/2024 cropping calendar from the two regions are 96,810MT and 103,976MT (COCOBOD, 2024; Adombila, 2024). The selection of the Wassa Amenfi Central district, to the project, is to help understand the importance of income diversification to cocoa productivity. In the Western cocoa region, several cocoa farming communities suffer intense competition from rubber cultivation (Gama-Rodrigues et al., 2021). In the Ellembele district, several farm communities are observed diversifying away from coconut farming to cocoa production (Amfo & Ali, 2020). Rubber cultivation and coconut farming in the Wassa Amenfi Central and Ellembele districts therefore serve as a means by which cocoa farmers diversify their incomes for improved livelihoods.

Wassa-Amenfi Central is one of the fourteen districts that make up Ghana's Western Region. In 1988, it was a part of the larger Wassa Amenfi District and separated in 2012. Wassa Amenfi Central district is located at 5°37'60"N 2°15'4.32"W. In 2021, the district's population was estimated to be around 119,117 people. Agriculture is the main economic activity in the district. The district is located within the tropical rainforest zone, resulting in two major rainy seasons. Major cash crops grown are cocoa, oil palm, and rubber and food crops include cassava, plantain, maize, rice, garden eggs, and tomatoes (see figure 3.1). The district has been hit by heavy galamsey operation, leading some youth and farmers to indulge in the activities for ready cash.

Ellembelle on the other hand is part of the fourteen districts in Ghana's Western Region (GSS, 2014b). It was initially a part of the then-larger Nzema East District. Nkroful is the capital of the district assembly, which is located in the southwest portion of Western Region. The Ellembelle district is located at 4°57'50"N 2°19'20"W. According to 2021 PHC data, the Ellembelle District has a total population of 120,893 people, accounting for 5.9 percent of the Western Region's total population. Males account for 60,586 (or 48.4%) of the population, while females account for 60,307 (or 51.6%) (Ghana Statistical Service, 2014b). The occupation with the biggest percentage of employed people (35.2%) is skilled agriculture and allied economic activities, with male workers accounting for much more (39.1%) than female workers (31.7%). Geographically, the district is bordered by the Gulf of Guinea to the South, the northern part of the Axim municipality and the Wassa Amenfi West district to the north, the Jomoro district to the west, and the river Ankobra to the east. The district falls within the wet semi-equatorial climate zone of the West African Sub-region, with consistent rainfall occurring throughout the year, reaching its peak during May and June. The primary livelihood of the inhabitants revolves around farming, particularly fishing, and cocoa cultivation. Cocoa stands out as the most prominent among the tree crops, mainly due to the decline of the coconut crop as a result of the deadly Lethal Yellowing Disease (Cape Saint Paul's Wilt Disease). Other economically significant tree crops include oil palm, rubber, and citrus. Major food crops cultivated are cassava, plantain, rice, vegetables such as garden eggs, pepper, and tomato (Yankey, Aidoo & Sossah, 2024)





Source: GIS remote sensing 2022

Figure 3. 1: Map of the Study Area

Afigya Kwabre North District was a defunct Ghanaian district in the Ashanti Region (GSS, 2014a). On November 1, 2007, it was formed by combining the western portions of Afigya-Sekyere District (now known as Sekyere South District) and the western portions of Kwabre District (now known as Kwabre East Municipal District) (effectively 29 February 2008). However, on March 15, 2018, it was divided into two new districts: Afigya Kwabre South District and Afigya Kwabre North District with Kodie and Boamang as the capitals respectively. Agriculture is the primary source of income for 36.9% of the district's households (Ghana Statistical Service, 2014a). Geographically, it lies between Longitude 1°40'W and 1°25'W and Latitude 6°50'N and 7°10'N.

According to the 2021 Population and Housing Census, Afigya Kwabre North has a total population of 73,330 with 36,608 males and 36,722 females. The Afigya-Kwabre North District is located within the semi-deciduous forest zone and agriculture plays a significant role in the socio-development of the district. The major rainy season occurs from March to mid-July, with the peak in May and June, followed by a dry spell from mid-July to mid-August. The minor rainy season extends from mid-August to the end of October, with its peak in September. The district's climatic conditions are conducive for cultivating cash and food crops such as cocoa, maize, plantains, bananas, and rubber, as well as for livestock farming and fisheries.

3.4 Sampling Technique and sample size computation

Multistage sampling procedure was used for this study. Cocoa producing households were chosen across the two purposefully selected cocoa regions. The first stage of sampling involved a CIRAD *Cocoa4future* project set-up of three (3) observatories in the Western and Ashanti regions of Ghana, the two main cocoa producing regions in Ghana in consultation with COCOBOD staff and stakeholders in the cocoa sector. The second stage purposively selected Ellembelle, Manso Amenfi Central, Afigya Kwabre North cocoa districts from the Western and Ashanti regions of Ghana. Manso Amenfi Central District was selected because of competition between rubber and cocoa; Ellembelle District was selected because of replanting moribund coconut farms into cocoa; Afigya Kwabre North District (AR) because cocoa farmers cutting down their old varieties of cocoa and planting new improved varieties. The third stage involved random selection of 5 communities in each of the three (3) sampled districts. Communities selected in the Manso Amenfi Cocoa District in the Western region were Kramokrom, Aku Nkwanta, Anwiafutu, K. Boateng and Subriho/Gyabra Nkwanta. These communities were chosen because they are faced with strong competition for rubber plantation (conversion of cocoa lands into rubber cultivation). In the

Ellemebelle Cocoa District in the Western region, selected communities were Adubrim, Ayawura Dump, Ngabawe, Tandan and Ebi. These selected communities provide a good reflection of communities migrating from the loss of coconut to embracing cocoa (reconversion). The Afigya Kwabre North Cocoa district in the Ashanti region have Tetrem, Amoako, Adukro, Soko and Abroma as the selected communities. These communities provide a good reflection of cutting old cocoa variety such as Tetteh Quarshie and Amazonia to adopting new cocoa hybrid variety (replanting). The final stage involved a random selection of farmers from cocoa households in each of the fifteen (15) communities.

Two stages of the sampling of farmers in cocoa households were undertaken. Firstly, a list of cocoa farmers in each of the fifteen (15) communities was obtained from Ghana's COCOBOD for the baseline study in July 2022. A total of 450 farm households was randomly sampled across the two regions. The sample size was based on the Cochran (1963) formula stated as:

$$n_o = \frac{[t^2 (p * q)]}{d^2}$$

Where;

n_o = computed minimum sample size

$t = 1.96$ (95% confidence interval)

p = maximum variability = 0.5; $q = 1 - p = 1 - 0.5 = 0.5$

$q = 1 - p = 1 - 0.5$

$d = 5\%$

$$\text{This implies that } n_o = \frac{[1.96^2 (0.5 * (1 - 0.5))]}{(0.05)^2}$$

$$n = 385$$

t^2 represents the t-distribution value for normal deviation set at a 95% confidence level.

p represents the cocoa farm household population proportion with all the characteristics required but unknown hence the maximum 50%; the assumption is that the cocoa household characteristics are similar. d^2 represents the error margin. The study oversampled 450 respondents to allow for

data completeness in case of data omissions. However, due to attrition, 402 respondents were interviewed during the baseline survey.

At the community level, a random sampling technique using Excel was used to select respondents from a list of cocoa farmers provided by COCOBOD extension officers located in the districts. The transient walk approach was also used when some selected respondents were not available for the interview. Table 3.1 and 3.2 shows the sample distribution per district and communities respectively.

Table 3. 1: Sampled districts, Communities and Sampled Size for baseline survey

Region	Sampled districts	Sampled Communities	Estimated Sampled size	Actual Sampled size
Ashanti	Afigya-Kwabre	Tetrem	30	25
		Amoako	30	32
		Adukro	30	29
		Soko	30	25
		Abroma	30	33
Western	Manso Amenfi	Kramokrom	30	23
		Aku Nkwanta	30	29
		Anwiafutu	30	25
		K. Boateng	30	35
		Chichiso no. 2	30	31
	Ellembelle	Adubrim	30	21
		Ayawura Dump	30	22
		Ngabawe	30	19
		Tandan	30	27
		Ebi	30	26
Total			450	402

Source: Field survey, 2022

In each of the 5 randomly selected communities, 30 respondents from cocoa producing households were randomly selected for a total of 450 respondents comprising of male, female and youth for a baseline interview based on a well-structured questionnaire to ensure that results obtained are representative of the districts. The baseline data was collected at the inception of the research (July 2022) to understand cocoa farming in the lean season. The survey questionnaire was based on that developed by CIRAD Cocoa4future project with additional data from the field (Qualitative FGDs) to address the thesis research objectives.

Secondly, after the baseline data collection, within the randomly sampled 30 farm households in each community at baseline, ten (10) households were purposively selected to follow up on a monthly panel data collection based on the following criteria: cocoa farmers who are residents in the selected communities and are likely to stay in the community for the next 3 years, a farm-household with at least a woman aged between 15 and 49 years (for their dietary intake and food security measures); farmers who are recommended by the field extension officers to follow good agronomic practices and agroforestry, and farmers with already yields from their cocoa establishments. A total of 150 cocoa farm household observations per month for at least two (2) seasonal cocoa periods (2022/2023 to 2023/2024) resulting in 3600 observations. See table 3.2 for the distribution in the sampled farm households for the monthly data collection. This sample size aligns with prior agricultural studies in Ghana and Sub-Saharan Africa that used panels of 130 to 150 farmers over 2 years (Asante et al., 2021; Anang et al., 2022). According to Baltagi (2021), such medium-sized panels with $T > 10$ are statistically adequate for reliable fixed or random effects estimation. The sample was therefore considered sufficient to capture both inter-farmer heterogeneity and intra-annual variations in cocoa yield and income.

Table 3. 2: Sampled districts, Communities and Sampled Size for observatory

Region	Sampled districts	Sampled Communities	Sampled size
Ashanti	Afigya-Kwabre	Tetrem	10
		Amoako	10
		Adukro	10
		Soko	10
		Abroma	10
Western	Manso Amenfi	Kramokrom	10
		Aku Nkwanta	10
		Anwiafutu	10
		K. Boateng	10
		Subriho/Gyabra Nkwanta	10
	Ellembelle	Adubrim	10
		Ayawura Dump	10
		Ngabawe	10
		Tandan	10
		Ebi	10
		Total	150

Source: Authors compilation, 2023

To complement the baseline cross-sectional and panel data, two rounds of Focus Group Discussions (FGDs) and key informant interviews were conducted in each district. These FGDs took place in December 2023 and April 2023. Key informants included Chief cocoa farmers, purchasing clerks, and Youth leaders in the communities, all of whom have extensive knowledge of cocoa production. Each FGD consisted of at least five and no more than ten farm members. The reason for the qualitative interviews were to provide additional insights into institutional arrangements governing ownership and use of land in the districts, and implications for seasonal household food security. This was to provide the opportunity to seek contextual explanations for key findings from the survey. The qualitative interviews focus was on land for cocoa production, farmers perceptions of climate change, cocoa production output and its effects on household dietary diversity and seasonal food security, and food consumption patterns at the household and individual levels.

3.5 Ethical considerations

Ethical Clearance for the study under the CIRAD COCOA4FUTURE was obtained from the University of Ghana's Ethical Committee for Basic and Applied Sciences (ECBAS). Informed written consent was obtained from each of the participants before proceeding with the data collection. Respondents were also informed about the voluntary participation, their right to refusal at any point, and the confidentiality of their identity.

3.5 Theoretical framework

Three interrelated theories underpin this study. These are the action theory of adaptation, the theory of livelihood, and the seasonality theory. These theories project the notion that food security

influences farmers' adaptive capacity to climate change, which impacts cocoa production. Farmers' adaptive measures subsequently impact their livelihood resources, leading to seasonal fluctuations in cocoa production, which in turn affects both food security and income levels. Climate change alters seasonal trends (as outlined in Seasonality theory), and these seasonal trends have a direct effect on cocoa yield. The quantity of cocoa produced influences food security, while adaptation strategies (as per Action Theory Adaptation) contribute to enhancing resilience in livelihoods. Furthermore, the assets associated with these livelihoods (according to the Theory of Livelihood) play a significant role in shaping adaptive capacity.

3.6.1 Action theory of Adaptation (ATA)

Several theories seek to explain food security in the context of seasonal climatic variations, their impacts, and adaptation strategies in developing countries. Among these are the modernization theory (Rostow, 1960; Schultz, 1964) and structuralism (Frank, 1966; Wallerstein, 1974), which focus on achieving sustained food production and poverty reduction through agricultural modernization and industrialization. However, the limitations of these theories make them inadequate in addressing the complexities of food security in developing countries. The modernization theory, for example, places too much emphasis on economic growth while neglecting social and environmental costs (Schultz, 1964) and offering little focus on sustainability (Leys, 1996), making it less effective in explaining how to maintain food production in response to seasonal climatic fluctuations. The Action Theory of Adaptation (ATA), proposed by Donkoh et al. (2015), was used to understand how Ghanaian farmers respond to climate variability. The authors concluded that extension services could leverage this knowledge to develop targeted adaptation strategies that improve food security and sustainability. In this framework, terms of the Action Theory of Adaptation can be mapped to the clarifying questions posed by Smit et al. (2000).

For example, "Adaptation to what?" identifies the impact or stimulus that affects a given exposure unit (IPCC, 2014). "Who or what adapts?" refers to the entity implementing adaptation, such as farmers or communities, and their relationship to the exposure unit (IPCC, 2018). For instance, farmers may adapt agricultural practices to protect crops from drought. Lastly, "How does adaptation occur?" requires an explanation of how strategies, measures, and actions are linked to the purpose of adaptation and whether processes or actions are involved (UNFCCC, 2015). An example is the implementation of conservation agriculture to reduce soil erosion and increase yields, demonstrating how adaptation occurs. This theory was used to understand the perceptions of farmers climatic changes and testing hypothesis 1 and 2.

3.6.2 Theory of Livelihood

This framework suggests that farmers rely on five types of capital: human, physical, financial, social, and natural when forming their strategies to adapt and respond to challenges in their environment. It is recognized that the vulnerability context affects the availability of these livelihood assets, which include physical farm infrastructure (such as roads, technology, and irrigation), human capital (such as gender, education, and the number of active household members over 18), social capital (such as connections to leaders or value chain actors), natural capital (such as water availability), and financial capital. The financial category encompasses household savings, off-farm income (including remittances), and the ability to access additional funding sources. These assets are exposed to external factors, including unpredictable economic trends such as fluctuations in cocoa prices and production, policy changes, and competition (Morse et al., 2009; Sneddon, 2000), as well as environmental shocks like climate change, pest outbreaks, and diseases (Busquet et al., 2021; Teye & Nikoi, 2021; Walters, 2021), and market stresses (Morse et al., 2009).

Transforming structures refer to land ownership systems, government and private sector actions, and processes such as laws, regulations, policies, culture, and institutions that govern access to natural resources and provide incentives for better resource management (UNDP, 2017). These transforming structures and processes shape the governance context of the cocoa sector, including policy implementation, monitoring, and coordination between public and private entities to make collective decisions, set goals, and take actions to achieve those goals.

The influence of transforming structures and processes encourages the adoption of strategies that lead to improved outcomes. The sustainable livelihood approach posits that a cocoa farmer's livelihood is considered sustainable if it can withstand shocks and continue to function even in challenging circumstances (Lan et al., 2021). Various frameworks have been developed to measure sustainable livelihoods, based on the concept of sustainable livelihoods and Sen's theory of feasible capacity (Bebbington, 1999).

3.6.3 Seasonality Theory

Seasonality theory, also known as the seasonality model, explains the periodic patterns and cycles that occur in various phenomena, including natural environments (for example the weather, climate, and daylight), economic and financial markets such as stock prices, commodity prices (Norman, 2023). The theory posits that these cycles are driven by various factors, including environmental cycles (Kwiecien et al., 2022) (e.g., temperature, precipitation, daylight), agricultural cycles based on seedling and harvesting periods, influencing supply-side factors and pricing (Petre et al., 2022). Understanding seasonality theory helps to predict and prepare for periodic patterns and cycles (Levin et al., 2020), identify opportunities and challenges associated with different seasons (Love et al., 2023), develop strategies to mitigate the impact of seasonal

fluctuations (Poole, 2020), and finally improve forecasting and decision-making in agriculture and food security (Levin et al., 2020).

Recognizing and analyzing seasonal patterns allows better navigation of the cycles that shape our economies. Even when seasonality is recognized as influencing poverty and well-being, it is too rarely factored into the design of policy responses (Ahmadzai et al., 2021). Seasonality in agricultural production implies that demands for working capital peak pre-harvest, when food prices in local markets also spike, whereas income from farming peaks post-harvest (Gilbert et al, 2017). This imbalance between agricultural costs and income creates a seasonal poverty trap, especially for poor rural households with limited access to financial services. Seasonality and poverty in themselves inhibit the emergence and development of fully functioning financial markets (savings, borrowing and insurance services) (Gbatu, 2022). Farm household models are very useful for understanding resource allocation decisions by poor rural people, but these models typically fail to consider seasonal capital constraints (Radosavljevic et al., 2020).

3.7 Method of Data Analysis

In this section, the specific methods of analyzing the objectives of this study are outlined, including the sources and type of data and the hypotheses tested. The specific theories that underpin each objective are also provided. In general, the STATA software was used to analyze the solicited data for the specific objectives. In general, also for each of the specific objectives, the data required and the variable descriptions for analyses are presented in table 3.3. Subsequently, the specific methods of data analyses for each objective are presented.

Table 3. 3: Description, measurement and a priori expectations of variables

Variable (dependent/independent)	Measurement	A priori/ Hypothesis
<i>Socioeconomic characteristics</i>		
Sex	Dummy: 1 = if male; 0 female	+/-
Age	Number of years	+/-
Household size	Number of people in household	+/-
Marital status	Dummy: 1 = if married; 0 otherwise	+
No formal Education	Dummy: 1 = if no formal education; 0 otherwise	-
Primary education	Dummy: 1 = if primary; 0 otherwise	+/-
Junior High school (JHS)	Dummy: 1 = if junior education; 0 otherwise	+
Senior High School (SHS)	Dummy: 1 = if senior high education; 0 otherwise	+
Tertiary	Dummy: 1 = if tertiary education; 0 otherwise	+/-
Credit access in past year	Ghana cedi (GHS)	+/-
Experience	Dummy: 1 = if yes; 0 otherwise	+/-
Training in past 5 years	Dummy: 1 = if yes; 0 otherwise	+
Certification participation	Dummy: 1 = if yes; 0 otherwise	+
Indigene status	Dummy: 1 = if Native; 0 Migrant	+/-
<i>Farm characteristics</i>		
Yield (both dependent/independent)	Kg/Ha	
Cocoa Income revenue (dependent/independent)	Ghana cedi (GHS)/64kg bag	+/-
<i>Community characteristics</i>		
Agric extension contact	Dummy: 1 = if yes; 0 otherwise	+
Cooperatives (FBO)	Dummy: 1 = if yes; 0 otherwise	+
Perceived temperature Increasing (both dependent/independent)	Dummy: 1 = if yes; 0 otherwise	+/-
Perceived rainfall decreasing (both dependent/independent)	Dummy: 1 = if yes; 0 otherwise	+/-
Perceived CSA practices (both dependent/independent)	Dummy: 1 = if yes to practice; 0 otherwise	+/-
<i>Location characteristics</i>		
District/Ellembelle	Dummy: 1 = if Ellembelle; 0 otherwise	
District/Manso Amenfi	Dummy: 1 = if Manso Amenfi; 0 otherwise	
District/Afigya Kwabre	Dummy: 1 = if Afigya Kwabre; 0 otherwise	
<i>Seasonality</i>		
	Dummy: 1 = any 11 months on the calendar, 0 for the one (1) other month	+ (major season) - (minor/lean season)

Source: Author's compilation, 2022

3.6.1 Description of Variables used for analysis

From table 3.3, data were collected on farmer socioeconomics characteristics, farm characteristics and community characteristics from the various locations (districts).

Gender is dummy and represents the sex of the farmer. It is measured as a dichotomous variable where males are assigned 1 and females, 0. The expectation for gender is positive for males on cocoa production than females. This is because male farmers usually command more resources than their female counterparts (Kehinde et al., 2021; Broussard, Reincke et al., 2018).

Age describes the age category of the cocoa farmer. Farmers aged from 15 years to 49 years are categorized as young farmers of reproductive age whiles aged 50 years to 60 years and above 60

years are categorized as adult farmers. The young farmers of reproductive age are assigned a value of 1 and adult farmers a value of 0. Also, adult farmers have more experience and knowledge of traditional practices, thus they are more likely to have better yields than young farmers (Agyeman et al., 2019; Asante et al., 2019). Adult farmers have reduced physical abilities to maintain cocoa farms, limited access to loans and technology, and less knowledge of modern technology, as a result, they are more likely to have lower yields than young farmers (Asante et al., 2020; Kouamé et al., 2020; Kouamé et al., 2018). Thus, the age of the adult farmer should negatively influence cocoa yields. However, the priori expectation is that the age of the farmer could positively or negatively influence cocoa output. It is also expected that farmers of reproductive age are energetic and will engage more in production and diversifying activities, hence contributing greatly to total household income. This is because the aging population predominantly cultivates cocoa and the younger generation exhibits less in cocoa cultivation, the former is more likely to have higher yields (Daymond et al., 2022).

Education describes the level of education attained by the cocoa farmer. It is expected that as the education level of the respondents increases, there is the tendency to increase their output and income generating activities. Education has long-run effects as farmers are likely to be exposed to food security information, have strong livelihood and income diversification choices (Acheampong et al., 2022)

Marital status variable presents the marital status of the farmer, and it is measured categorically as civil and traditional marriage, single, divorced, cohabiting and widowed cocoa farmers. Being married either by tradition or civil has a postulated positive probability a-priori expectation on increasing cocoa production because farmers will likely have higher yields as compared to farmers who are single, divorced or widowed. Married or cohabitating farmers often have greater access to family labor, which can assist with farm work, potentially leading to increased yields. Moreover,

married individuals may enjoy more stable and consistent access to land, credit, and other resources, positively impacting cocoa yields. In contrast, single, divorced, or widowed farmers may encounter challenges related to labor shortages, time management, and financial constraints, which could adversely affect their cocoa yields.

Household size is a continuous variable and represents the total number of members within the household of the cocoa farmer. The larger the household size the higher the tendency to engage in farm and other income diversifying activities to increase the household income to enable diversified food consumption, thus improving their food security status. Thus, household size has a positive probability a-priori expectation on livelihood diversification of youth from cocoa farm households. Household members who are employed and have additional income for purchasing food for the household (Akbar et al., 2023; Gelata et al., 2024).

Location variable represents the cocoa-growing region the farm is located in. The Ellembelle cocoa district is designated the value of 1, 0 otherwise, the Wassa Amenfi Central cocoa district was assigned 1, 0 otherwise and the Afigya Kwabre North cocoa district was assigned 1, 0 otherwise. The study assumes that with the Western Cocoa Region as the leading cocoa producer, cocoa output would be greater than in the Ashanti Cocoa Region due to more favorable climatic conditions, better soil quality, and land for cocoa cultivation. The Western Region is lies in the equatorial climatic zone and is the wettest part of Ghana, with a bimodal (double-maximum) rainfall pattern averaging around 1,600 mm annually and peaks in May–July and September–October (Ghana Stats, 2024; Twenefuor et al., 2018). The Ashanti Region lies in the semi-deciduous forest zone, with a moderate rainfall compared to the western region and it experiences a double-maxima rainfall regime with mean annual rainfall between approximately 1,100 mm and 1,800 mm, and major rainfall peaks in May/June and October (MOFA, n.d.).

Training variable is a dummy where 1 is assigned to whether cocoa farmers have received training over the past 5 years from COCOBOD or other public and private organizations, and 0 for otherwise. It is expected to have a positive influence as training would enhance farmers' knowledge of cocoa production, leading to higher cocoa output (Owusu-Ansah & Mensah, 2018; Asare & David, 2017).

Membership in community group (FBO) is a dummy with a value of 1 for respondents who are members of any farmer group, otherwise 0. The coefficient FBO is expected to have a positive probability a-priori expectation on production output as being a member of a group exposes cocoa farmers to information and training opportunities (Danso-Abbeam et al., 2020). FBO membership motivates the farmers to diversify their income activities.

Access to Credit is a dummy for cocoa farmers, with 1 for those who have had access to any form of financial resource support (through loans, grants, or other means) for their livelihood activities, 0 otherwise. It is expected that households with credit access will have a more likelihood of engaging in income generating activities thereby increasing their contribution to cocoa households' total income (Akudugu et al., 2016; Kumi & Obeng, 2017).

Farm age variable represents the age of the farm in years. It is measured as the years of the average cocoa farm. The study expects that older cocoa farms will have a lower yield than young cocoa farms because it is assumed the older the trees, the less fruiting for pod formation, slower growth rates, and increased vulnerability to diseases (Donkor et al., 2023; Aikpokpodion, 2010). The declining yields of older cocoa farms leads to higher maintenance cost (Aneani & Ofori-Frimpong, 2013).

Experience variable presents the number of years a farmer has spent cultivating cocoa in the study area. It is expected that farmers with more years of experience would have more expertise in producing that could improve their cocoa output (Amoah & Partey, 2018). Farmers that are

experienced are more likely to adopt sustainable cocoa production practices, leading to improved yields and environmental outcomes (Rosenstock et al., 2019)

Certification variable measures the certification programs that cocoa farmers have participated in. These programs offer sustainability benefits by setting farm management protocols that producers and producer groups must adhere to. Full compliance with these protocols is anticipated to improve farmers' welfare by boosting yields, increasing incomes, and enhancing environmental services (Iddrisu, Aidoo & Wongnaa, 2020).

Climate Perception variable measures cocoa farmers' perceptions of climate change. The study expects that as farmers' awareness of climate change increases, their likelihood of them recommending/adopting climate smart practices on their farms, hence experiencing higher cocoa yields (Asare & David, 2017).

Season(ality) variable describes the months or periods between harvests. Season here is categorized into main and minor season. However, since farmers could harvest and sell their cocoa during any period in the month, the seasons are dummied for each of the 12 months with a value of 1 for 11 months and 0 for only 1 month. The monthly (seasonal) probability a-priori expectation on production output is positive for the major season months and negative for the minor/lean season months.

3.7.2 Describing and analyzing farmers' perceptions of climate change variability and its effects on cocoa yields

A framework to understand the relation between farmer perceptions of climate change and cocoa production output (yield) is outlined here. The objective describes how farmers perceive climate change, and how the change variability affects production activities and output. A cross-sectional data from the *baseline survey* was used to analyze this objective. Descriptive statistics such the

mean proportion in tables and pictorials such as graphs were used to describe the portions and frequencies of farmers perceived changes in rainfall and temperature, observed changes in increased or decreased rainfall and temperature variability, late rain, increase or decrease in average rain or temperature, maximum or minimum rainfall or temperature, high and low intensity, and droughts and flood.

The Multiple Linear regression was then used to analyze farmer perception of climate change variability effects on cocoa yields. The model is defined mathematically as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon_i \text{-----}(1)$$

Where;

Y_i is Productivity (yield) (cocoa output/ha)

X are all the independent variables that explains the dependent variable. Age, Sex, Education, Marital Status, Household Size, Extension, FBO Membership, Certification, Bank Access, Credit, Experience, Training, Age of Farm, Climate change Information, CSSVD, Perceived Changes in Temperature, Perceived Changes in Rainfall, Location, among others

β_0 is the intercept, $\beta_1, \beta_2 \dots \beta_n$ are vector of regression coefficient, and ε is the error term.

Empirically the estimated model is simply presented as:

$$Y_i = \beta_0 + \beta_1 \text{Cocoa Inc} + \beta_2 \text{Age} + \beta_3 \text{Sex} + \beta_4 \text{FBO} + \beta_5 \text{EDU} + \beta_6 \text{Credit} + \beta_7 \text{FarmSize} + \beta_8 \text{Crop div} + \beta_9 \text{Ext.cont} + \sum \beta_i \text{Farmer Perceived Climate Changes} + \beta_{11} \text{District Location} + \beta_{12} \text{CSSVD} + \beta_{13} \text{Credit access} + \beta_{14} \text{Training} + \beta_{14} \text{Experience} + \beta_{15} \text{Variety} + \beta_{16} \text{Plant shade trees} + \varepsilon_i$$

Using the Multiple Linear Regression (MLR) model to examine the factors influencing cocoa production output (yield) among farmers is appropriate because cocoa yield is a continuous

variable, typically measured in kilograms or tons per hectare. The MLR model allows the study to capture how several socioeconomic, environmental, and farm management factors combine to influence yield levels. It helps explain not only whether a factor has an effect, but also the size and direction of that effect while keeping other variables constant (Gujarati & Porter, 2009; Wooldridge, 2010).

Cocoa production depends on multiple interrelated factors such as farm size, fertilizer application, rainfall, access to extension services, labor availability, and farmer experience. The MLR model is well suited to capture these relationships in a single framework, providing a clearer understanding of which variables have the greatest impact on productivity. For instance, it can help determine how an increase in fertilizer use or improved access to credit translates into higher yields, controlling for other factors.

Other statistical models were considered but found less suitable for this type of data. Logistic regression is used for categorical outcomes (for example, high versus low yield), which would oversimplify continuous yield data. Ordinal or multinomial models are meant for ranked or nominal outcomes rather than measured quantities. Similarly, Poisson and Tobit models are designed for count or censored data, not continuous variables like cocoa yield. Because of this, the multiple linear regression model provides a more flexible and realistic way to assess yield determinants (Greene, 2018; Stock & Watson, 2019).

In addition, multiple linear regression is widely used in agricultural and economic studies because it is straightforward to interpret, statistically robust, and allows for diagnostic testing. Tests for linearity, independence, multicollinearity, and homoscedasticity can be performed to ensure the

validity and reliability of results. Overall, this method provides the best balance between analytical power and interpretability for understanding the key drivers of cocoa yield.

3.7.2.1 Statement of Hypothesis

The key hypotheses tested here is as follows, where H_0 is the null hypothesis of no effect of the perceived climatic variables in the cocoa yield.

H_0 : Cocoa farmers perception of negative climate change variability in rainfall and temperature do not influence cocoa yields.

3.7.2.2 Validation of Hypothesis

The z-test is used to validate the null hypotheses:

$$Z\text{-cal} = \frac{\beta_i}{SE(\beta_i)}$$

where Z-cal represents the calculated value, β_i is the estimated parameter for the i th explanatory variable and $SE(\beta_i)$ represents the standard error of the i th parameter. If Z-calculated is greater than the critical value of Z from the z-distribution at a determined significant level, the null hypothesis (H_0) is rejected in favour of the alternative.

3.7.3 Describing and analyzing the cocoa farmers CSA practices and factors that influencing adopted for improved cocoa yields

The *baseline data* was used to analyze this objective. Descriptive statistics such as means in proportions and graphs are used to describe the perceived climate smart agriculture practices farmers recommend to use for improved yields. Following Tabe-Ojong et al., (2024), the Multivariate probit regression model was used to analyze factors influencing recommended practices for improved yield and farm income. The mathematical equation takes the form:

$$(Y_1, Y_2, \dots, Y_m) = (\Phi(Z_1), \Phi(Z_2), \dots, \Phi(Z_m))$$

where $\Phi(\cdot)$ is the cumulative distribution function (CDF) of the standard normal distribution, and

Z_i is a linear combination of the independent variables:

$$Z_i = \beta_{0i} + \beta_{1i}X_1 + \beta_{2i}X_2 + \dots + \beta_{ni}X_n$$

We let $\mathbf{Y}_i = (y_1, y_2, \dots, y_{ip})'$ be a vector that denotes the binary responses of the i^{th} individual ($i = 1, 2, \dots, N$). Let $\mathbf{z}_i$ denote a p -variate latent variable that is normally distributed with a mean vector $\beta\mathbf{x}_i$ and variance-covariance matrix Σ , where $\mathbf{x}_i = (1, x_{i1}, \dots, x_{i, q-1})'$ is a q -vector of covariates and $\beta = (\beta_0, \beta_1, \dots, \beta_n)$ is a $p \times q$ matrix of regression coefficients of $\mathbf{Z}$ on $\mathbf{X}$. The observed binary vector $\mathbf{Y}_i$ is associated with the underlying $\mathbf{z}_i$ in the following way:

Augmenting the observed binary data $\mathbf{y} = [\mathbf{Y}_1, \mathbf{Y}_2, \dots, \mathbf{Y}_n]$ with the latent variables $\mathbf{z} = [\mathbf{z}_1, \mathbf{z}_2, \dots, \mathbf{z}_n]$, the complete-data likelihood function can be written as:

$$Y_i = \Phi(\beta_0 + \beta_1 \text{Cocoa Inc} + \beta_2 \text{Age} + \beta_3 \text{Sex} + \beta_4 \text{FBO} + \beta_5 \text{EDU} + \beta_6 \text{Credi t} + \beta_7 \text{FarmSize} + \beta_8 \text{Crop div} + \beta_9 \text{Ext.cont} + \beta_{10} \text{access to climate Info} + \beta_{11} \text{District location} + \beta_{12} \text{CSSVD} + \beta_{13} \text{Credit access} + \beta_{14} \text{Training} + \beta_{14} \text{Experience} + \varepsilon_i)$$

Y_i = CSA practices: avoid deforestation, avoid bush burning, plant more trees, less use of agro-chemicals, desist galamsey, plant soil cover crops, practice diversification

β vector of regression coefficients

ε = error term

3.7.3.1 Statement of Hypothesis

The hypotheses tested are as follows, where H_0 is the null hypothesis of no effect whilst H_A is the alternate hypothesis of the expected effect of the independent variable in the model.

H_0 : Cocoa farmer perception on recommended CSA practice adoption is not affected by increased cocoa output/income

H_A : Cocoa farmer perception on recommended CSA practice adoption is positively affected by cocoa output/income.

The hypothesis is repeated for the independent variables; Age, Sex, Education, Marital Status, Household Size, Extension, FBO Membership, Certification, Bank Access, Credit, Experience, Training, Farm Size, Age of Farm, access to climate change Information, CSSVD, Location.

3.7.3.2 Validation of Hypothesis

The z-test is used to validate the null hypotheses:

$$Z\text{-cal} = \frac{\beta_i}{SE(\beta_i)}$$

where Z-cal represents the calculated value, β_i is the estimated parameter for the i th explanatory variable and $SE(\beta_i)$ represents the standard error of the i th parameter. If Z-calculated is greater than the critical value of Z from the z-distribution at a determined significant level, the null hypothesis (H_0) is rejected in favour of the alternative.

3.7.4 Assessing seasonality in cocoa output effects on the income of cocoa farmers

The *panel data* was used to analyze this objective. Descriptive statistics such as means in proportions and graphs are used to describe the perceived seasonality changes on cocoa output and

cocoa income over the months. Graphs are used to plot cocoa output and prices over the seasonal period and described.

In analyzing the seasonality in cocoa output effects on the income of cocoa farming households, the Fixed Effects (FE) model was used. The study followed the equation:

$$Y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it} \dots \dots \dots (1)$$

Y_{it} : dependent variable (farmers' cocoa income)

α_i : unit-specific intercept

β : slope coefficient (e.g., effect of cocoa output on income)

X_{it} : independent variable (cocoa output, age of cocoa farm, Age of farmer, Sex, Education, Marital Status, Household Size, Extension, FBO Membership, Certification, Bank Access, Credit, Experience, Training)

ε_{it} : error term

3.7.4.1 Statement of Hypothesis

The hypotheses tested are as follows, where H_0 is the null hypothesis of no effect whilst H_A is the alternate hypothesis of the expected effect of the independent variable in the model.

H_0 : Seasonality in cocoa output induces no variability in cocoa income among cocoa farm households

H_A : Seasonality in cocoa output does induce variability in income among cocoa farm households

The hypothesis is repeated for the independent variables; Age, Sex, Education, Marital Status, Household Size, Extension, FBO Membership, Certification, Bank Access, monthly dummies, Credit, Experience, Training.

3.7.4.2 Validation of Hypothesis

The z-test is used to validate the null hypotheses:

$$Z\text{-cal} = \frac{\beta_i}{SE(\beta_i)}$$

where Z-cal represents the calculated value, β_i is the estimated parameter for the *ith* explanatory variable and SE (β_i) represents the standard error of the *ith* parameter. If Z-calculated is greater than the critical value of Z from the z-distribution at a determined significant level, the null hypothesis (H_0) is rejected in favour of the alternative.

3.7.5 Estimating seasonality in cocoa output seasonal intra-household's food security indicators (WDD/HFIAS)

Panel data was used to analyze this objective. Seasonal cocoa output was estimated and described using descriptive statistics such as frequencies and means. Descriptive statistics such as means, frequencies and percentages for WDD and HFIAS scores were estimated by seasons. The seasonality effects of cocoa output on food security (WDD and HFIAS) scores were estimated using the fixed effects panel regression analysis. This was estimated at the intra-household level (men and women). The following data were computed: (a) Total Household Food security (HFIAS) scores; (b) Men Household Food security (HFIAS) scores; (c) Women Household Food security (HFIAS) scores; and (d) Women Dietary Diversity (WDD) score.

Analyzing differences in seasonal HFIAS patterns between men and women

HFIAS module consists of nine "occurrence" and nine "frequency-of-occurrence" questions, that was answered according to the household food security experience in the previous 30 days. The respondent is first asked if a given condition was experienced (yes or no) and, if it was, with what frequency (rarely, sometimes, or often). The resulting responses can be transformed into either a

continuous or categorical indicator of food security. When calculating the HFIAS as a continuous indicator, each of the nine questions is scored 0-3, with 3 being the highest frequency of occurrence, and the scores are added together. The total HFIAS can range from 0 to 27, (never=0, rarely=1, sometimes=2, often =3) indicating the degree of insecure food access. As a categorical variable, households are categorized as food secure, mildly food insecure, moderately food insecure, or severely food insecure. In this study, the food insecurity indicators are measured as categorical and are recast into a “positive scale” so that it can be referred as Food security (FS) indicators rather than food insecurity measure. The estimated HFIAS for the study was categorized into four (4) as: 0. Food Secured (0 – 5 scores); 1. mildly food insecure (6-11 scores); and 2. moderately food insecure (6-11 scores); and 3. Severely food insecure (greater than or equal to 18 scores). Differences in the seasonal HFIAS scores were described and analysed by gender and location using descriptive statistics and graphs.

Analyzing differences in seasonal WDD patterns of Women (15-49 years)

Women's Dietary Diversity Score (WDDS) is a metric used to assess the variety of foods consumed by women. The dietary diversity score is categorized into Food diverse (9 or more food groups consumed), mostly food diverse (6 - 8 food groups consumed), moderate food diverse (4-5 food groups consumed), and Not food diverse (0 – 3 food groups consumed). The dietary diversity score of the women (15-49 years) of reproductive age was calculated based on data collected from single 24-hour dietary recalls conducted at the individual level during the two seasons of the study. The selected women were asked by the trained field technicians to recall all the food items and drinks they had consumed the previous day from the time they woke up until they went to bed. A detailed description of all ingredients used in mixed dishes was recorded. No differentiation was made between weekdays and the weekend, but feast days were intentionally not included. The data from

the 24-hour dietary recall was used to calculate the women's dietary diversity score (WDDS) based on the 10 food group score recommended by FAO and FHI 360 (2016), i.e., (i) grains, white tubers and plantain; (ii) pulses; (iii) nuts and seeds; (iv) dairy; (v) meat, poultry and fish; (vi) eggs; (vii) dark green leafy vegetables (DGLV); (viii) vitamin A-rich fruits and vegetables, (ix) other vegetables and (x) other fruits. A score of 1 was awarded when a food item was consumed from a particular food group, and 0 if none were consumed. Any woman who consumed foods from five or more out of the ten food groups during the previous day was considered to have achieved minimum dietary diversity for women (MDD-W), which is an indicator for assessing micronutrient adequacy among women of reproductive age.

The estimated WDD for the study was categorized into three (3) groups as: 1. Not food diverse (0 – 3 food groups consumed); 2. Mostly food diverse (4 - 5 food groups consumed); and 3. Diverse (more than 6 food groups consumed). After computing the above, changes in Women Dietary Diversity score (WDD) were described using graphs.

Estimating seasonality in cocoa output on the seasonal women of reproductive age (15-49 years (WDD) food security indicators (WDD/HFIAS)

Following Aweke et al. (2022) and Adekoya et al. (2023), the Random Effects GLS regression was used to analyze seasonality (monthly/cocoa cycle) on households' food security indicators. This model helps us understand the variations over the seasonal periods and across individual farmer households in terms of food security status and factors influencing it. The dependent variable is Household food insecurity access scale (HFIAS) and Women Dietary Diversity (WDD) which are categorical. Following the nature of the dependent variable, a multinomial panel data model was used for examining factors influencing seasonal food security. This model helps in understand the variations over time and across individual households in terms of food security

(HFIAS/WDD) and factors influencing it. These models also have an additional advantage in that it captures the effects that cannot be detected in cross-sectional data (Wooldridge, 2002). Various tests are used for selecting panel data models which best fit the data set. Moreover, Breusch and Pagan Lagrangian multiplier test (LM test) was used for choosing panel data model between Pooled OLS and Random Effects Model. The model which fits well with the data set was selected based on the results of Hausman test and LM test. The multinomial Fixed effect model specification of the FS status is categorical, following the HFIAS score as:

$$Y_{it} = \alpha_i + \beta_i X_{it} + u_{it}$$

Where;

Y_{it} = proxy score for food security HFIAS and WDD for household i at time t

α_i = unobserved household specific effects which are assumed to be fixed over time and vary across household i

β_i = vector of coefficients.

X_{it} = vector of explanatory variables for household i at time t .

The explanatory variables are socio-economic, farm characteristics, seasonal dummies and institutional factors affecting food security. These factors include Age, Sex, Education, Family Size, Migrant, Extension contact, FBO membership, Credit access, Season, Farm Size, Experience, Labour, Training, Certification, Land Ownership, Livestock ownership, monthly (seasonality) dummies, Age of plot, off-farm income.

3.7.5.1 Statement of Hypothesis

The hypotheses tested are as follows, where H_0 is the null hypothesis of no effect whilst H_A is the alternate hypothesis of the expected effect of the independent variable in the model.

Ho: There are no significant differences between overall household level food security status and women dietary diversity score of cocoa farming household across the seasons (months)

H_A: There are significant differences between overall household level food security status and women dietary diversity score of cocoa farming households across the seasons (months)

The hypothesis is repeated for the independent variables; Age, Sex, Education Household Size, Household assets, Extension, FBO Membership, Certification, Bank Access, Credit, Experience, Training, Farm Size, Age of Farm, Climate change Information, CSSVD,

3.7.5.2 Validation of Hypothesis

The z-test is used to validate the null hypotheses:

$$Z\text{-cal} = \frac{\beta_i}{SE(\beta_i)}$$

where Z-cal represents the calculated value, β_i is the estimated parameter for the *ith* explanatory variable and SE (β_i) represents the standard error of the *ith* parameter. If Z-calculated is greater than the critical value of Z from the z-distribution at a determined significant level, the null hypothesis (Ho) is rejected in favour of the alternative.

3.7.6 Estimating seasonal cocoa income effects on food security (availability, accessibility) status of cocoa farmers

Again, following from Aweke et al. (2022) and Adekoya et al. (2023) as outlined in section 3.6.4, the Random Effects GLS regression model was used to estimate seasonal cocoa income effects on food security status of cocoa farmers.

$$Y_{it} = \alpha_i + \beta_1 X_{it} + u_{it}$$

Y = HFIAS for household *i* at time *t*

B = vector of coefficients

X = Age, Sex, Education Household Size, Household assets, Extension, FBO Membership, Certification, Bank Access, Credit, Experience, Training, Farm Size, Age of Farm, Climate change Information, CSSVD, monthly dummies (seasonality)

U_{it} = Error term

The data used in this study follow the same cocoa farmers across different seasons, which means the information collected has a panel (or longitudinal) structure. With this kind of data, households tend to have certain characteristics that remain the same over time, such as their distance to the nearest market, the size of their farmland, or the level of education of the household head. The Random Effects model is well suited for this type of data because it recognises that each household has its own unique features that might influence food security outcomes (Wooldridge, 2021). Instead of ignoring these household-specific traits, the model treats them as part of the error structure, allowing us to analyse the data more accurately.

A major reason for selecting the RE model over the Fixed Effects (FE) model is that FE automatically removes all time-invariant variables from the estimation. In this study, however, several of these variables are crucial in explaining why some households may be more food secure than others. The RE model keeps these variables in the analysis, enabling a fuller understanding of both seasonal income changes and long-standing household characteristics (Greene, 2020).

The decision to use the Random Effects approach was also supported by the Hausman test, which checks whether the household-specific effects are correlated with the explanatory variables. The test showed that this correlation was not significant, confirming that the RE model provides consistent and reliable estimates in this context (Baltagi, 2021).

Another strength of the RE model is that it helps us understand not only how changes within a household from one season to another influence food security, but also how differences between households contribute to these outcomes. This is important because cocoa income varies strongly across seasons, but food security is also shaped by differences in farm size, market access, and other factors that vary across households. Recent studies in Africa have used Random Effects models for similar reasons when exploring agricultural livelihoods and food security (Adjari et al., 2022; Dube & Phiri, 2021).

There is also a growing trend in recent food security research to apply RE or mixed-effects models. For example, Tessema et al. (2024) used a random-effects ordered logit model to study resilience to food insecurity in Ethiopia, while Nkegbe and Abu (2020) applied a random-effects probit model to examine dietary diversity in Ghana. These studies highlight that the RE approach is widely accepted and suitable for research involving repeated observations of rural households.

The Random Effects model fits the panel nature of the data, it allows important household characteristics to be included, providing statistically efficient estimates, and has strong support from recent agricultural and food-security literature. It therefore offers a well-founded and practical approach for examining how seasonal cocoa income shapes food security among cocoa-farming households.

3.7.6.1 Statement of Hypothesis

The hypotheses tested are as follows, where H_0 is the null hypothesis of no effect whilst H_a is the alternate hypothesis of the expected effect of the independent variable in the model.

H_0 : Seasonal cocoa income does not provide food security for cocoa households throughout the year.

Ha: Seasonal cocoa income does provide food security for cocoa households throughout the year.

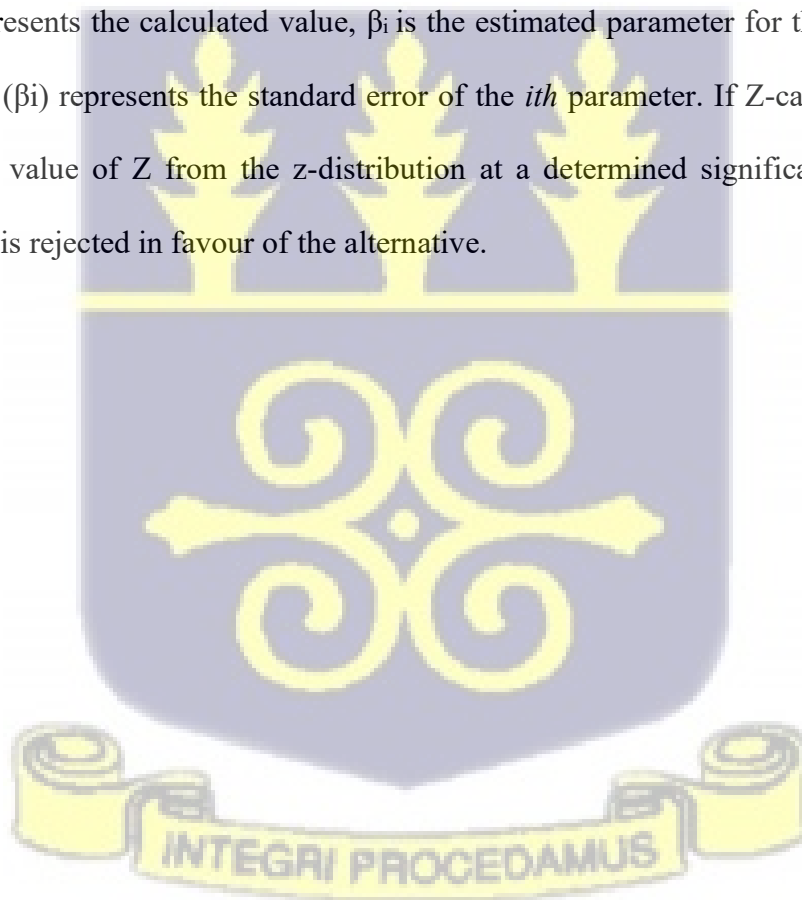
The hypothesis is repeated for the independent variables; Age, Sex, Education, Training, Family Size, Extension, FBO, Credit, Cocoa Monthly Income, Labour, Inputs, Livestock, Land Ownership, Remittances, Climate changes, health care services, pest and diseases

3.7.6.2 Validation of Hypothesis

The z-test is used to validate the null hypotheses:

$$Z\text{-cal} = \frac{\beta_i}{SE(\beta_i)}$$

where Z-cal represents the calculated value, β_i is the estimated parameter for the *ith* explanatory variable and SE (β_i) represents the standard error of the *ith* parameter. If Z-calculated is greater than the critical value of Z from the z-distribution at a determined significant level, the null hypothesis (H_0) is rejected in favour of the alternative.



CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the findings and the discussions from the study objectives. The first section presents descriptive statistics of the socioeconomic variables of the cocoa farmers and farm characteristics. The other sections are followed with findings from the specific objectives: (a) describing and analysing farmers' perceptions of climate change variability and its effects on cocoa yields; (b) describing and analysing the perception of cocoa farmers' CSA practices and factors influencing recommended practices for improved cocoa yields and farm income; (c) estimating, describing, and analysing seasonality in cocoa output effects on the income of the cocoa farmers followed by results from estimating the seasonality in cocoa output on the seasonal intra-households (adult men and women of reproductive age 15-49 yrs) food security indicators (WDD); and lastly, (d) Lastly, results from estimating seasonal cocoa income effects on the food security (availability, and accessibility) status of cocoa farmers.

4.2 Descriptive statistics

The descriptive statistics of sampled variables for both the baseline and panel data are presented in tables and graphs.

4.2.1 Socioeconomic characteristics of farmer Respondents (Baseline Study)

The socio-economic variables of age, gender, education, and marital status of the farmers in the study areas are described. This is followed by the description of the farm characteristics, institutional, and location variables. A total of 402 cocoa farmers participated in the baseline cross-sectional survey. Most respondents, about 72.39%, were males (table 4.1). Female respondents

were about 27.61%, reflecting male dominance in cocoa production. This finding is consistent with the study of Jamal et al. (2021), which confirms male dominance in Ghana's cocoa sector.

Table 4. 1: Socioeconomics characteristics of the cocoa farmers in Ellembelle, Wassa Amenfi Central, and Afigya Kwabre North (Baseline cross-sectional survey, 2022)

Variable	Measurements	Pooled (n=402; %)	Ellembelle (n=114; %)	Wassa Amenfi Central (n=144; %)	Afigya Kwabre North (n=144; %)
Gender	Male	291 (72.39)	94 (82.46)	101 (70.14)	96 (66.67)
	Female	111 (27.61)	20 (17.54)	43 (29.86)	48 (33.33)
Age category	15-49 Years	201(50)	67 (58.77)	69 (47.92)	65 (45.14)
	50-60 Years	99 (24.63)	34 (29.82)	41 (28.47)	24 (16.67)
	>60Years	102 (25.37).	23 (20.18)	34 (23.61)	45 (31.25)
Marital status	Single	10 (2.49)	10 (8.77)	0 (0)	0 (0)
	Married (Civil)	28 (6.97)	28 (24.56)	0 (0)	0 (0)
	Married (Traditional)	292 (72.64)	76 (66.67)	132 (91.67)	84 (58.33)
	Divorced	45 (11.19)	0 (0)	1 (0.69)	44 (30.56)
	Widowed	20 (4.98)	0 (0)	9 (6.25)	11 (7.64)
	Cohabitation	7 (1.74)	0 (0)	2 (1.39)	5 (3.47)
Education level	No education	94 (23.38)	29 (25.44)	42 (29.17)	23 (15.97)
	Primary/Basic	88 (21.89)	27 (23.68)	33 (22.92)	28 (19.44)
	Junior High School	161 (40.05)	37 (32.46)	52 (36.11)	72 (50)
	Secondary	43 (10.70)	15 (13.16)	13 (9.03)	15 (10.42)
	Tertiary	15 (3.73)	5 (4.39)	4 (2.78)	6 (4.17)
	Quranic	1 (0.25)	1 (0.88)	0 (0)	0 (0)
Migration status	Native	224 (55.72)	70 (61.40)	34 (23.61)	120 (83.33)
	Migrant	178 (44.28)	44 (38.60)	110 (76.39)	24 (16.67)
Credit access	Yes	152 (37.81)	40 (35.09)	57 (39.58)	55 (38.19)
	No	250 (62.19)	74 (64.91)	87 (60.42)	89 (61.81)
Extension contacts	Yes	302 (75.12)	78 (68.42)	115 (79.86)	109 (75.69)
	No	100 (24.88)	36 (31.58)	29 (20.14)	35 (24.31)
FBO	Yes	301 (74.88)	67 (58.77)	117 (81.25)	117 (81.25)
	No	101 (25.12)	47 (41.23)	27 (18.75)	27 (18.75)
Climate change perception	Yes	362 (90.05)	98 (85.96)	132 (91.67)	132 (91.67)
	No	40 (9.95)	16 (14.04)	12 (8.33)	12 (8.33)

Source: Field Survey, 2022

In table 4.1, amongst the three districts (Ellembelle, Wassa Amenfi Central, and Afigya Kwabre North districts), Ellembelle had a higher proportion of male farmers. Half of the respondents were of reproductive age between 15 to 49 years. Consequently, Afigya Kwabre North and Wassa Amenfi Central have a higher proportion of adult cocoa farmers compared to Ellembelle. Traditional marriage constitutes about 72.64% of respondents sampled, whereas 6.97% were

married under ordinance (civil), 2.49% were single, 4.98% were widowed, 11.19% were divorced, and 1.74% were cohabiting. The results show that the majority of the cocoa farmers in the study are married. Additionally, the study found that a higher proportion of cocoa farmers in Wassa Amenfi Central (about 91.67%) were traditionally married compared to those in Ellembelle (about 66.67%) and Afigya Kwabre North (58.33%). This suggests a promising potential for generating more family labour to support cocoa production activities. Table 4.1 also shows that the largest proportion of respondents, approximately 40.05%, had completed formal Junior High School. About 23.38% of the farmers had no formal education, 21.89% had completed primary education. These results indicate a relatively high level of basic literacy (62%) among cocoa farmers, which is a positive contribution to human capital. In Afigya Kwabre North, the percentage of Junior High School graduates was about 50%, higher than in Wassa Amenfi Central (36.11%) and Ellembelle (32.46%). Of the 402 respondents, 56% were natives and 44% were migrants. This finding is in harmony with Kissi & Herzig (2024) study, which found a decline in migrant labour within Ghana's cocoa sector due to socioeconomic changes and institutional factors, despite the continued importance of hired labour and sharecropping arrangements. Wassa Amenfi Central had more migrant farmers, about 76%, compared to 24% of natives. Furthermore, the majority of the farmers constituting 62% of the total population did not have access to credit whereas the remaining 38% of the sampled farmers had access to credit. Other studies have found the similar results (Anane et al., 2021; Attipoe et al., 2020; Kpabitey et al., 2024). The majority of the farmers, 75%, were in Farmers Based Organizations (FBO). Finally, most of the respondents (90.05%), constituting 362 of the total sample size perceived climate change whereas about 9.95% do not.

Table 4. 2: Socioeconomics characteristics of the cocoa farmers in Ellembelle, Wassa Amenfi Central, and Afigya Kwabre North (Panel Survey, 2024)

Variable	Measurements	Pooled (n=150; %)	Ellembelle (n=50; %)	Wassa Amenfi Central (n=50; %)	Afigya Kwabre North (n=50; %)
Gender	Male	116 (77.33)	42 (85.71)	34 (66.67)	40 (80)
	Female	34 (22.67)	8 (14.29)	17 (33.33)	10 (20)
Age category	15-49 Years	15 (16.67)	19 (76)	26 (52)	6 (12)
	50-60 Years	37 (25)	6 (24)	8 (16)	44 (88)
	>60 Years	32 (21)	9 (18)	16 (32)	0 (0)
Marital status	Single	3 (2)	3 (6)	0 (0)	4 (8)
	Married (Civil)	14 (9.33)	7 (14)	3 (6)	35 (70)
	Married (Traditional)	108 (72)	34 (68)	39 (78)	5 (10)
	Divorced	14 (9.33)	4 (8)	5 (10)	4 (8)
	Widowed	7 (4.67)	1 (2)	2 (4)	2 (4)
	Cohabitation	4 (2.67)	1 (2)	1 (2)	4 (8)
Education level	No education	26 (17.33)	8 (16.33)	14 (27.45)	9 (18)
	Primary/ Basic	30 (20.33)	12 (24.49)	9 (17.65)	31 (62)
	Junior High School	68 (45.33)	18 (36.73)	19 (37.25)	3 (6)
	Secondary	18 (12)	8 (16.33)	7 (13.73)	3 (6)
	Tertiary	7 (4.67)	3 (6.12)	1 (1.96)	0 (0)
	Quranic	1 (0.67)	0 (0)	1 (1.96)	44 (88)
Migration status	Native	88 (58.67)	31 (63.27)	13 (25.49)	6 (12)
	Migrant	62 (41.33)	18 (36.73)	38 (74.51)	18 (36)
Credit access	Yes	60 (40)	19 (38.78)	23 (45.10)	19 (38.78)
	No	90 (60)	30 (61.22)	28 (54.90)	30 (61.22)
Extension contacts	Yes	115 (76.67)	28 (57.14)	45 (88.24)	28 (57.14)
	No	35 (23.33)	21 (42.86)	6 (11.76)	21 (42.86)
	Yes	116 (77.33)	28 (57.14)	45 (88.24)	28 (57.14)
FBO	No	34 (22.67)	22 (42.66)	5 (11.76)	22 (42.66)

Source: Field Survey, 2022

The panel survey involved 150 farmer respondents, drawn randomly from the baseline survey respondents to constitute the panel. The characteristics of the panel farmer respondents are therefore very different from the baseline survey. In table 4.2, about 116 respondents were males, representing 77.33% of the total sample size, while 34 were females, representing 22.67%. At the district level, Ellembelle had more male cocoa farmers compared to Afigya Kwabre North and Wassa Amenfi Central. Farmers in Wassa Amenfi central district (45%) seem to have access to credit compared to counterparts in the Ellembelle and Afigya Kwabre North. This finding corroborates with Donkor et. al (2024); WCF (2020); Bymolt et. al (2018) which highlighted that farmers access to credit for inputs and hiring of labour to increase yield is tough. Low access to

credit by farmers is caused by risks, low financial literacy, lack of hard collateral, and high moral hazard (Afele et al., 2021). Most farmers (77%) had access to extension contacts. About 77% cocoa farmers are member of farmer-based organizations (FBO). Wassa Amenfi central districts tend to have majority (88%) of the farmers in the district being members of an FBO. This could justify the reason for the having access to credit and extension contacts. The FBO's act as intermediaries for securing loans for farmers.

4.2.2 Summary Farm Characteristics in Ellembelle, Wassa Amenfi central, and Afigya Kwabre North (Baseline cross-sectional data)

The farm characteristics of the baseline cross-sectional and panel surveys, including mean, standard deviation, minimum, and maximum values, are shown in Tables 4.3 and 4.4. The mean and standard deviation and the indication of its statistical significance using mean statistical significance at a 5% level as an indication that the difference in means between the two regions is not attributed to chance. In tables 4.3 and 4.4, the corresponding socio-economic and farm characteristics for the baseline and the panel data are presented, noting that the 150-panel respondents were selected from the 402 farmers used for the baseline cross-sectional survey.

From the baseline data, table 4.3 shows the average age of cocoa farmers as 50.56 years, indicating that older farmers are primarily engaged in cocoa production. This finding underscores the continued dominance of older farmers in the cocoa sector. It aligns with the findings by Salvi et al. (2024), which explicitly stated that younger farmers are not interested in cocoa production. Among the selected cocoa districts, farmers in Afigya Kwabre have an average age of about 53.17 years, making them older than those in Wassa Amenfi Central (about 50.26 years) and Ellembelle (about 47.64 years). The average age of cocoa farms was 16.26 years, with Ellembelle having the

youngest cocoa farms and Afigya Kwabre North having the oldest cocoa farms. The average farm size was 2.1 hectares, with Ellembelle having the largest mean farm size, followed by Wassa Amenfi Central and Afigya Kwabre North. From Table 4.3, the mean cocoa yields for the major and minor seasons were 286.17 Kg/Ha and 103 Kg/Ha, respectively for a total mean yield of about 390kg in the year. Ellembelle had the highest average yields, with approximately 333.20 Kg/Ha in the major season and 103 Kg/Ha in the minor season (436kg/Ha), compared to Afigya Kwabre North and Wassa Amenfi Central. The average years of cocoa farming experience was 17.5 years, with Afigya Kwabre North cocoa farmers having the highest average cocoa farming experience of about 20.85 years, followed by Wassa Amenfi Central at about 16.88 years, and Ellembelle at about 14.05 years. The mean farm distance was 3.17 Km. Ellembelle had the shortest mean farm distance at 1.86 Km, while Afigya Kwabre North had the longest average farm distance at 3.11 Km. The mean household size of the cocoa farmer was 5.31 persons with Afigya Kwabre North having the highest mean household size followed by Wassa Amenfi Central and Ellembelle. This figure is higher compared with the national average household size of 3.6 persons as reported by the Ghana Statistical Service (GSS) (2021) in the 2021 Population and Housing Census (PHC).

The average cocoa income for the sampled farmers was GHS 11,383.47 (USD 1540.59) per year. Farmers in the Wassa Amenfi cocoa district had the highest average income of GHS 13,500.80 (USD 1827.15) per year, followed by Ellembelle with approximately GHS 13,437.66 (USD 1818.60), and Afigya Kwabre North with about GHS 7,660.39 (USD 1036.73). The pooled average costs per hectare were as follows: GHS 1,123.94 for fertilizer, GHS 348.80 for pesticides, GHS 155.82 for fungicides, GHS 436.62 for herbicides, and GHS 854.86 for labour. At the district cocoa level, Ellembelle incurred the highest average costs per hectare for all these categories: fertilizers, pesticides, fungicides, herbicides, and labour compared to Wassa Amenfi Central and

Afigya Kwabre North. The higher average labour costs per hectare in Ellemabelle (about GHS 651.20) and Wassa Amenfi Central (about GHS 518.97), relative to Afigya Kwabre North (about GHS 345.19), is largely attributed to the prevalent illegal mining activities in the cocoa districts which increase competition for available cocoa labour. In table 4.3 there are statistically significant differences between the means of the three districts for several variables: age of cocoa farmers, age of cocoa farms, minor season yields, farmer experience, farm size, household size, cost of fertilizer per hectare, cost of pesticides per hectare, and cost of fungicides per hectare, all at the 1% level. Major cocoa season yields were significant at the 5% level, and the cost of herbicides per hectare was significant at the 10% level. From the panel data, table 4.4 summarizes the farm characteristics of the cocoa farmers. Although the mean age of cocoa farmers was 48.72 years, compared to the baseline (50.56 years), this finding is contrary to the results of Osman et al. (2022) and Afele et al. (2021), who reported that the average age of cocoa farmers was above 50 years.

The mean age of cocoa farms was 17.18 years, with the older cocoa farmers in Afigya Kwabre North and younger cocoa farmers in Ellemabelle. The average major and minor cocoa yields were 289.34 Kg/Ha and 95.05 Kg/Ha, respectively (384.39kg/Ha in the year). Disaggregated by districts, Ellemabelle has the highest average major and minor cocoa season yields, followed by Wassa Amenfi Central and Afigya Kwabre North. The mean years of farmers having cocoa farming experience was 17.78 years but farmers in Afigya Kwabre North had the highest mean cocoa farming experience of about 21.80 years and Ellemabelle cocoa farmers had the least average cocoa farming experience of approximately 15.14 years. This result implies that the sampled cocoa farmers have engaged in cocoa production for many years, translating to a high level of acquaintance with cocoa production about agronomic practices, variety choice, budgeting, and marketing. The average cocoa farm size is 2.98 Ha, with Ellemabelle having the largest farm size

of about 3.20 Ha and the smallest farm size in Afigya Kwabre North was about 2.0 Ha. This result corroborates the findings of Fairtrade (2020) and Huetz-Adams et al. (2016) who reported that in Ghana the average cocoa farm size is 2 to 3 Ha, implying that cocoa production is small-scale.



Table 4. 3: Summary statistics and farm characteristics in Ellembelle, Wassa Amenfi Central, and Afigya Kwabre North (Baseline cross-sectional survey, 2022)

Variable	Measurements	Pooled (n=402)	Ellembelle (n=114)				Wassa Amenfi Central (n=144)				Afigya Kwabre North (n=144)				p-value (tests of pooled vs locational)
		Mean	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	
Age of cocoa farmer	Years	50.56	47.64	13.30	25	80	50.26	13.61	23	86	53.17	14.42	24	93	0.01***
Age of cocoa farm	Years	16.26	13.07	6.75	3	37	15.74	9.33	2	40	19.29	8.79	3	31	0.00***
Major season yield	Kg/Ha	286.17	333.20	369.32	7.91	1976.80	290.18	311.57	13.18	3044.3	242.79	205.82	1.71	1581.44	0.03**
Minor season yield	Kg/Ha	103	139.71	190.46	3.80	1186.08	93.24	82.45	0.42	474.43	80.32	71.70	4.22	593.04	0.00***
Farmer experience	Years	17.5	14.05	8.23	2	45	16.88	11.60	2	57	20.85	12.53	1	66	0.00***
Farm size	Ha	2.1	3.05	3.16	0.20	20.23	3.05	3.16	0.20	20.23	2.10	2.06	0.40	16.19	0.01***
Farm distance	Km	3.17	3.11	3.58	0	24	1.86	3.36	0	36	3.40	2.25	0	16.09	0.67
Household size	Number	5.31	4.78	2.04	1	10	5.29	2.31	1	11	5.74	2.62	1	16	0.01***
Cocoa Income	GHS	11383.5	13437.7	16038.4	620	74400	13500.80	19014.8	119.80	167400	7660.39	7186.47	49.60	34720	0.00**
Cost of fertilizer/Ha	GHS per Ha	1123.94	1811.44	2764.42	38.61	15814.4	854.86	1036.54	15.56	4283.1	361.85	652.59	7.80	2965.20	0.00***
Cost of pesticides/Ha	GHS per Ha	348.80	541.22	1127.44	13.59	7116.48	326.62	494.22	7.78	3706.5	186.41	253.79	8.64	1532.02	0.00***
Cost of fungicide/ha	GHS per Ha	155.82	248.04	454.53	4.94	2635.73	139.64	194.35	1.06	1037.8	54.42	61.79	0.95	296.52	0.00***
Cost of herbicides/ha	GHS per Ha	436.62	710.94	2954.80	9.27	23721.6	308.58	503.53	8.72	3261.7	218.22	333.03	15.72	1383.76	0.06*
Cost of labour/ha	GHS per Ha	854.86	651.20	1007.41	14.83	5189.10	518.97	942.70	5.93	7412.7	345.19	396.77	2.12	1877.96	0.12

*** p<0.01, ** p<0.05, * p<0.10

Source: Field Survey, 2022

Average GHS/\$ = 7.39 as at the time of the study

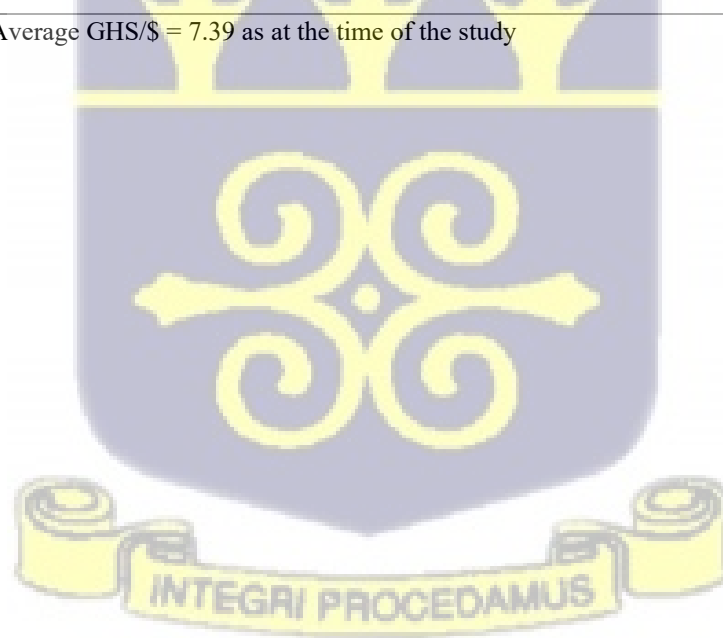


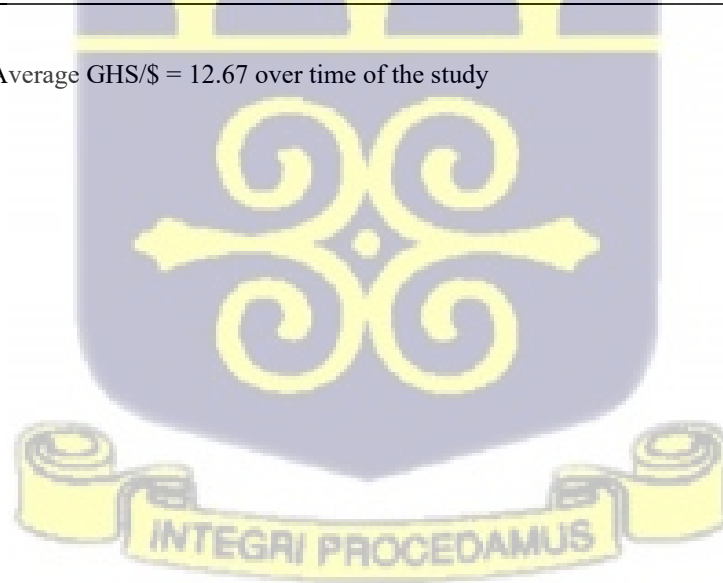
Table 4. 4: Summary and farm characteristics in Ellembelle, Wassa Amenfi Central, and Afigya Kwabre North (Panel survey, 2022-2024)

Measurements		Pooled (n=150)	Ellembelle (n=50)				Wassa Amenfi Central (n=50)				Afigya Kwabre North (n=50)				p-value (test of pooled vs locational)
		Mean	Mean	SD	Min	Mean	SD	Min	Max	Mean	SD	Min	Max		
Age of cocoa farmer	Years	48.72	48.22	12.92	25	47.06	12.63	23	80	50.88	14.07	27	80	0.34	
Age of cocoa farm	Years	16.29	12.70	5.31	3.0	14.52	8.73	3.0	31	21.66	8.61	4.0	31	0.00***	
Major season yield	Kg/Ha	289.34	300.15	369.96	26.36	331.03	452.79	13.18	3044.27	283.83	253.58	1.71	1581.4	0.64	
Minor season yield	Kg/Ha	95.05	131.75	205.01	10.54	88.15	84.74	0.42	395.36	95.50	99.74	10.5	593.04	0.20	
Farmer experience	Years	17.78	15.14	9.17	2.0	16.40	11.60	2.0	45	21.80	10.91	1.0	48	0.00***	
Farm size	Ha	2.98	3.72	3.77	0.61	3.04	3.16	0.20	20.23	2.00	1.64	0.40	10.12	0.00***	
Farm distance	Km	3.19	3.93	5.12	0	1.26	0.97	0	5.00	3.62	3.01	0	16.09	0.02**	
Household size	No. of people	5.64	4.92	2.18	1.0	5.90	2.30	2.0	11	6.10	2.85	1.0	16	0.04**	
Cocoa Income	GHS	13416.0	14756.24	16257.0	744	15594.58	24878.39	119.80	167400	9923.8	7655.3	682	34720	0.24	
Cost of fertiliser/Ha	GHS per Ha	2658.21	4907.50	8258.87	190	1191.56	771.31	80	2250	869.29	578.29	350	2000	0.04**	
Cost of pesticides/ Ha	GHS per Ha	742.96	1003.97	1802.36	55	1003.97	1802.36	50	1200	304.52	287.42	35	1560	0.09*	
Cost of fungicide/ Ha	GHS per Ha	337.10	523.28	851.93	20	257.65	292.13	10	1260	119	127.84	10	600	0.00***	
Cost of herbicides/Ha	GHS per Ha	810.97	1563.46	4699.16	80	397.78	450.46	50	2160	335.78	511.73	50	1680	0.16	
Cost of labour/Ha	GHS per Ha	740.23	1076	1338.20	50	704.86	679.96	50	2550	465.39	492	30	2280	0.06	

*** p<0.01, ** p<0.05, * p<0.1

Source: Field Survey, 2024

Average GHS/\$ = 12.67 over time of the study



The average distance cocoa farmers travelled to their farms was 3.19 Km (see table 4.4), with Ellembelle having the greatest average distance (3.9km) and Wassa Amenfi Central having the shortest average distance (1.26km). The average household size of cocoa farmers was five (5) persons. This finding agrees with the studies of Hutz-Adams et al. (2017) who reported an average household size of about six individuals for cocoa-producing households in Ghana. Often, household members serve as a source of family labour in cocoa production (Adu et al. 2020).

The mean cocoa income per year was GHS 13,415.95 (USD 1059) with Wassa Amenfi having the highest mean income at about GHS 15,594.58 (USD 1230), followed by Ellembelle at GHS 14,756 (USD 1165). The pooled average costs per hectare were as follows: GHS 2658 (USD 210) for fertilizer, GHS 742 (USD 59) for pesticides, GHS 337 (USD 27) for fungicides, GHS 810 (USD 64) for herbicides, and GHS 740 (USD 58) for labour. At the district cocoa level, Ellembelle incurs the highest average costs per hectare for fertilizers, and herbicides compared to Wassa Amenfi Central and Afigya Kwabre North. However, Afigya Kwabre North has the highest average labour costs per hectare, about GHS 740 (USD 58).

Table 4.4 shows statistically significant differences across the three cocoa districts in several metrics: age of cocoa farms, farm size, farmer experience, and the cost of fungicides per Ha at the 1% level, household size, farm distance, and cost of fertilizer per Ha at the 5% level, and cost of pesticide per Ha at the 10% level.



4.2.3 Cocoa varieties cultivated in the study area

Tables 4.5 and 4.6 show the types of cocoa varieties cultivated in the baseline and panel survey. Most farmers cultivated the hybrid cocoa variety, constituting about 51% of the sampled respondents (table 4.5). The hybrid cocoa variety was mostly cultivated in Ellembelle (65%), noting that this district are replanting their moribund coconut farms with cocoa, and Wassa Amenfi Central (about 53%) cocoa districts. About 13% of the farmers cultivated hybrid and Amazonia cocoa varieties with Wassa Amenfi Central (about 19%) cultivating more of these two varieties, followed by Afigya Kwabre North (13%) and Ellembelle (6%) cocoa districts. The Criollo cocoa variety was the least cultivated in the study, comprising about 1% of the sampled farmers.

Table 4. 5: Types of cocoa varieties cultivated in Ellembelle, Wassa Amenfi Central, and Afigya Kwabre North (Baseline cross-sectional survey, 2022-2024)

Variety	Pooled (n=402; %)	Ellembelle (n=114; %)	Wassa Amenfi Central (n=144; %)	Afigya Kwabre North (n=144; %)
Tetteh Quarshie	37 (9.20)	5 (4.39)	9 (6.25)	23 (15.97)
Hybrid	204 (50.75)	74 (64.91)	77 (53.47)	53 (36.81)
Criollo	2 (0.50)	0 (0)	1 (0.69)	1 (0.69)
Amazonia	55 (13.68)	18 (15.79)	15 (10.42)	22 (15.28)
Don't Know	10 (2.49)	1 (0.69)	7 (6.14)	2 (1.39)
Other	1 (0.25)	0 (0)	0 (0)	1 (0.69)
Tetteh Quarshie and Hybrid	27 (6.72)	3 (2.63)	11 (7.64)	13 (9.03)
Tetteh Quarshie and Amazonia	10 (2.49)	0 (0)	0 (0)	10 (6.94)
Tetteh Quarshie and Don't Know	1 (0.25)	0 (0)	1 (0.69)	0 (0)
Hybrid and Amazonia	54 (13.43)	7 (6.14)	28 (19.44)	19 (13.19)
Hybrid and Don't Know	1 (0.25)	0 (0)	1 (0.69)	0 (0)

Source: Field Survey, 2022

The majority of the panel survey farmers (table 4.6), approximately 48%, cultivated the hybrid cocoa variety, with Ellembelle district having the highest number of hybrid cocoa cultivators, followed by Wassa Amenfi Central and Afigya Kwabre North districts respectively (see table 4.6). This findings reflects the wider shift in Ghana's cocoa sector toward hybrid varieties, which are favored for their higher yields, shorter maturation period, and better resistance to pests and diseases (Acheampong et al., 2023; Ofori, Padi, & Owusu-Ansah, 2024). A study by have (Hawkins et al.,

2024) shown that these improved hybrids are not only more productive but also perform well under sustainable, moderate-shade agroforestry systems that enhance both income and environmental outcomes. About 9% of the farmers planted the Tetteh Quarshie cocoa variety while about 13.43% of the farmers grow both hybrid and Amazonia cocoa varieties, with Wassa Amenfi Central Afigya Kwabre North cultivating more of these two varieties compared to land Ellembelle. The Criollo cocoa variety was the least cultivated, representing only about 1% of the sampled farmers.

Table 4. 6: Types of cocoa varieties cultivated in the Ellembelle Wassa Amenfi Central and Afigya Kwabre North (Panel survey, 2022-2024)

Variety	Pooled (n=150; %)	Ellembelle (n=50; %)	Wassa Amenfi Central (n=50; %)	Afigya Kwabre North (n=50; %)
Tetteh Quarshie	11 (7.33)	3 (6)	3 (6)	5 (10)
Hybrid	72 (48)	29 (58)	25 (50)	18 (36)
Criollo	1 (0.67)	0 (0)	1 (2)	0 (0)
Amazonia	16 (10.67)	5 (10)	3 (6)	8 (16)
Don't Know	5 (3.33)	1 (2)	3 (6)	1 (2)
Other	0 (0)	0 (0)	0 (0)	0 (0)
Tetteh Quarshie and Hybrid	14 (9.33)	2 (4)	6 (12)	6 (12)
Tetteh Quarshie and Amazonia	5 (16.67)	0 (0)	0 (0)	5 (10)
Tetteh Quarshie and Don't Know	0 (0)	0 (0)	0 (0)	0 (0)
Hybrid and Amazonia	25 (16.67)	10 (20)	8 (16)	7 (14)
Hybrid and Don't Know	1 (0.67)	0 (0)	1 (0)	0 (0)

Source: Field survey, 2022; 2023

4.2.4 Access to Credit for Cocoa Production and Credit sources

The results showed that 40% cocoa farmers in Manso Amenfi central and 38% of cocoa farmers in the Afigya Kwabre North, respectively received some form of loan/credit for their cocoa production (fig 4.1), more than farmers in Ellembelle (22%), either from a bank or from individual money lenders.

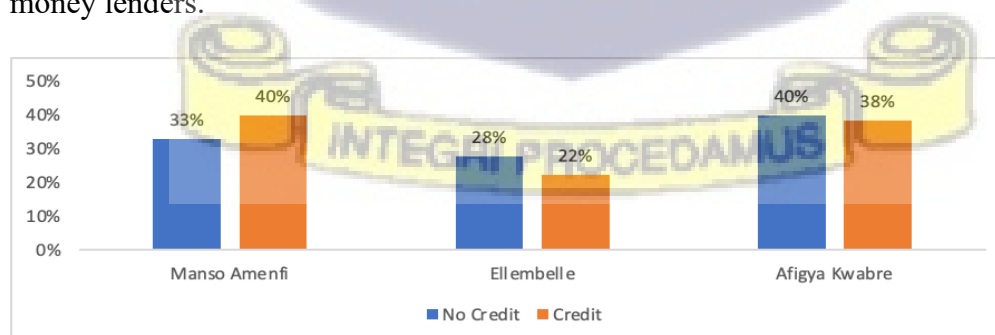


Figure 4. 1: Access to Credit for Cocoa Production

The higher levels of credit access in Manso Amenfi Central and Afigya Kwabre North may be linked to stronger farmer-based cooperatives and more active financial institutions in these areas, which make it easier for farmers to obtain credit for inputs and farm maintenance (Adu-Gyamfi, 2024; Owusu & Donkor, 2023). These findings are consistent with broader research showing that access to finance remains one of the most significant challenges facing Ghana's cocoa farmers. While some regions benefit from the presence of rural banks and credit cooperatives, others—particularly remote districts like Ellembelle struggle with limited access to financial services (Quaye, Aidoo, & Frempong, 2023; Donkor, Sarpong, & Kuwornu, 2022). Farmers in such areas often rely on informal lending or personal savings, which restricts their ability to invest in farm expansion or to adopt improved technologies such as hybrid seedlings and fertilizers (Acheampong et al., 2023).

At Manso Amenfi Central, one farmer in a FGD asserted that she used her one-acre cocoa farm as collateral to take a loan of GHS 5,000 from a money lender in her community. Under the arrangement, the creditor will harvest cocoa from his farm for a period of 3 years before the land reverts back to the original owner. At the time of the FGD, the new owner had harvested the land for 2 years and they had one more year to go under the arrangement (FGD, Manso Amenfi Central, 2022).

There are two rural banks in Manso Amenfi central (that is Amenfi-man Rural Bank and ROAA Cooperative Credit Union Ltd) that gives loans to cocoa farmers in groups of 10 cocoa farmers and it is highly patronized by cocoa farmers in the district. Additionally, the rural banks loan money to farmer groups other than to individuals because it is much easier to recover loans from groups than from other individuals.

Figure 4.2 shows the sources of credit for cocoa farmers in the study areas. The credit sources include banks, microfinance, cooperative societies, family and friends, input dealers, money

lenders in the communities, and purchasing clerks. Cocoa farmers did not obtain credit from exporters in all the three (3) districts. The Manso Amenfi and Ellembelle districts did not obtain credit from traders. All cocoa farmers in the Afigya Kwabre district indicated that they obtained credit from traders for their cocoa production. The study results further show that in Afigya Kwabre district, the most important source of credit for cocoa farmers is traders where 100% of the farmers there claimed to have received some form of credit. Such arrangements are common in regions where formal financial institutions are limited, with traders providing short-term loans or advance payments in exchange for guaranteed cocoa supply (Owusu & Donkor, 2023; Quaye, Aidoo, & Frempong, 2023). The least important source of credit for cocoa farmers in Afigya Kwabre is the microfinance which recorded only 9% of the farmers receiving credit assistance from them.

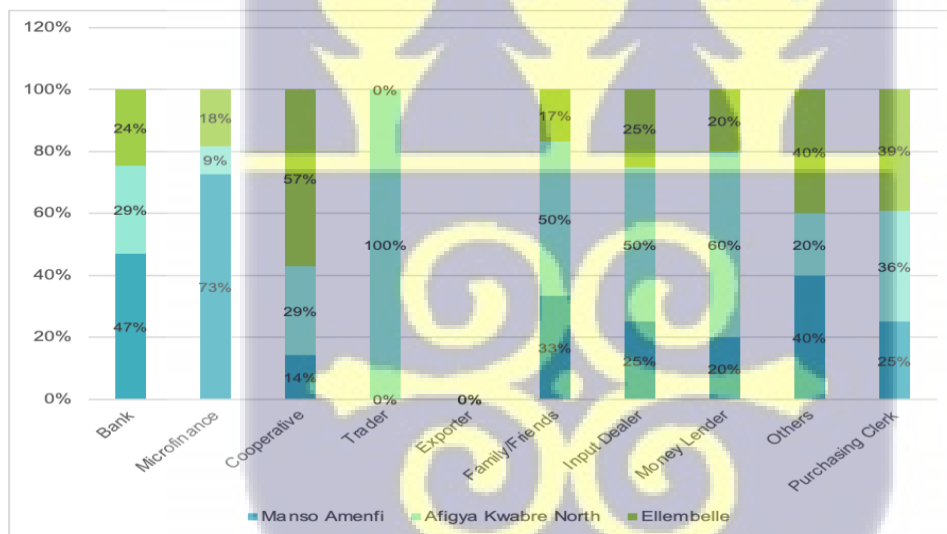


Figure 4. 2: Sources of credit

Source: Author's Construct from baseline data, July 2022

With regards to Manso Amenfi district, the most important source of credit to cocoa farmers is the microfinance where 73% of the farmers indicated they have received some form of credit from, followed by the banks representing 47%. This connection to formal finance in Manso Amenfi

Central aligns with findings showing higher financial inclusion and access to rural banking services in the district (Acheampong et al., 2023). However, the least important source of credit for cocoa farmers in the district is traders where no farmer (0%) indicated that they have received credit from.

Ellembelle district showed that the most important source of credit for cocoa farmers is the cooperative societies representing (57%) which is closely followed by purchasing clerks. Purchasing clerks are very popular sources of credit for cocoa farmers once you show proof that you have cocoa beans which will be ready for sale at a later date. But where the cocoa farmer has no cocoa for sale, purchasing clerks will not be willing to give credit to cocoa farmers. The least important source of credit for cocoa farmers in the Ellembelle district is traders just like in the Manso Amenfi district where no farmer indicated they had ever taken loan/credit facility from a trader. Accessing credit from money lenders (60%), input dealers (50%), and family and friends (50%) made a strong showing in Afigya Kwabre as a key source of credit for cocoa farmers.

Bank account ownership of cocoa farmers (fig. 4.3) with the lending bank or institution is in many instances a prerequisite to obtain credit facilities from them. Having a bank account is also a sign of prudent financial management by farmers, from the part of the lending institution. There are more cocoa farmers in Manso Amenfi representing 43% who own bank accounts as compared to farmers in Ellembelle (24%) and Afigya Kwabre (33%). This result could explain why cocoa farmers in Manso Amenfi have access to a credit facility than the other districts (see figures. 4.1 and 4.2). Another reason for this could be the fact that illegal mining (*galamsey*) activities are high in the Manso Amenfi district.

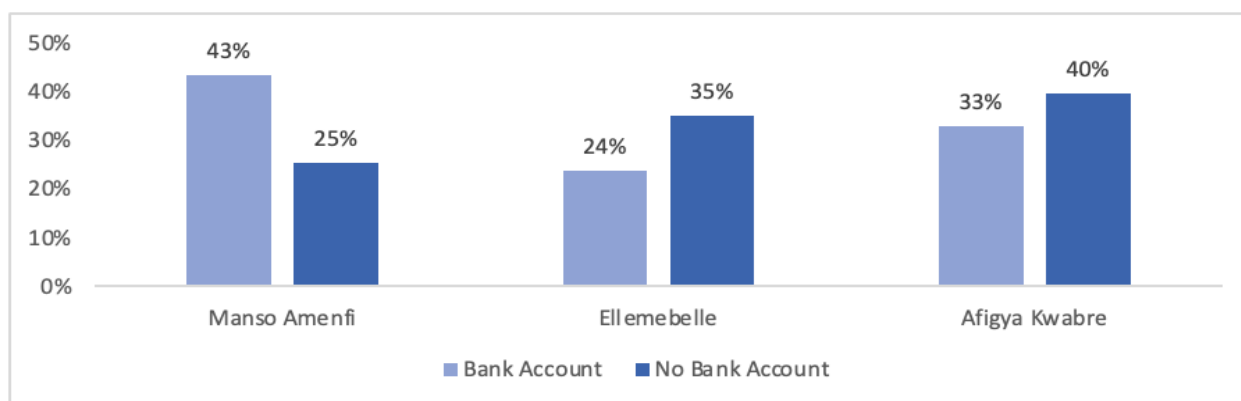


Figure 4. 3: Bank account ownership by cocoa farmers

4.2.4 Farm diversification: food crop production and livestock activities

The main food crops cultivated and harvested by cocoa farmers in all the study areas are cereals (maize), tubers (cassava, cocoyam, plantain, yam), and vegetables (tomatoes, okra, leafy vegetables). This aligns with a study on vegetable diversification in cocoa based farming systems in Ghana by Djokoto et al. (2017) the main food crops grown by cocoa farmers in the Ashanti and Western Regions included tomato and okra, and also cultivate other crops on cocoa plots at the early stages of the cocoa plants. Other crops grown in the communities are rice. From Table 4.7, most of the farmers (47.33%) cultivated crops other than cereals, tubers, vegetables, and non-food crops. Cereals were the least-grown crops among the three districts, followed by vegetables and non-food crops.

Table 4. 7: Type of crops grown in the districts

Crop	Pooled (n=150, %)	Ellemabelle (n=50, %)	Manso Amenfi Central (n=50, %)	Afigya Kwabre North (n=50, %)
Cereal	6 (4)	1 (2)	5 (10)	0 (0)
Tuber	61 (40.67)	14 (28)	23 (46)	24 (48)
Vegetable	10 (6.67)	4 (8)	5 (10)	1 (2)
No food crops	57 (38)	27 (54)	16 (32)	14 (28)
Other Crops	71 (47.33)	14 (28)	26 (52)	31 (62)

Source: Field survey, 2022; 2023

Cocoa farmers in the study districts, therefore, do not only produce cocoa but cultivate food crops as a diversified activity for income generation. Roots and tubers are the main crop

produced (*see Table 4.7*). Other crops such as tree crops of rubber, coconut and oil palm are prominent diversified crops.

Table 4. 8: Types of livestock reared by farmer households across the districts

Livestock	Pooled (n=150, %)	Ellembelle (n=50, %)	Manso Amenfi central (50, %)	Afigya Kwabre North (50, %)
Poultry	34 (22.67)	7 (14)	17 (34)	10 (20)
Cattle	3 (2)	1 (2)	2 (4)	0 (0)
Sheep	12 (8)	1 (2)	9 (18)	2 (4)
Goat	22 (14.67)	4 (8)	10 (20)	8 (16)
Pigs	1 (0.67)	0 (0)	0 (0)	1 (2)
Other Livestock	4 (2.67)	1 (2)	3 (6)	0 (0)
No Livestock	97 (64.67)	39 (78)	26 (52)	32 (64)

Source: Field survey, 2022; 2023

Farmer households across the district's rear poultry, cattle, sheep, goats, pigs, and other livestock (table 4.8). However, most farmers (64.67 %) across the three districts do not rear any livestock. Among the animals bred by the farmer households across the three districts, poultry was dominant (22.67 %). This shows poultry as the most commonly raised livestock, and consistent what Smith and Jones (2020) found in their study in similar rural communities, poultry tends to be farmers' first choice. This was followed by goats (14.67 %), sheep (8%), other livestock (2.67%), cattle (2%), and pigs (0.67%), which was the least. It is also interesting that few of farmers don't raise any livestock at all, which confirms Brown et al. (2018) findings that many smallholders face challenges like limited resources that keep them from rearing animals. Also, these results differ from Taylor's (2019) study, where cattles were more popular, suggesting that livestock preferences can vary quite depending on the region. The very low number of pig farmers here contrasts with Nguyen & Patel's (2021) observations, who showed that pigs were more common in areas closer to towns.

4.3 Cocoa Farmers' perception of Climate Change Variability and its effects on cocoa yields

4.3.1 Description of Farmer's Perceptions of Changes in Rainfall and Temperature over the Last 20 year

This section describes the distribution in the perceptions of changes among cocoa farmers about changes in rainfall and temperature patterns, seen in the last 20 years in their communities (table 4.9).

Table 4. 9:Description of Farmer's Perceptions of Changes in Rainfall and Temperature over the last 20 years across districts

Farmer perceptions	Yes Pooled	Yes Ellembelle	Yes Wassa Amenfi Central	Yes Afigya Kwabre North
Changes in weather will induce an increase in temperature and a decrease in rainfall	284 (70.65)	73 (64.04)	101 (70.14)	110 (76.39)
Changes in weather will increase the variability of precipitation	320 (79.60)	93 (81.58)	111 (77.08)	116 (80.56)
Change in weather will reduce the availability of water	256 (63.68)	55 (48.25)	100 (69.44)	101 (70.14)
Change in weather will increase land erosion	351 (87.31)	126 (87.50)	104 (91.23)	121 (84.03)
Change in weather will increase likelihood of drought and flood	311 (77.36)	111 (77.08)	93 (81.58)	107 (74.31)
Change in weather will affect agriculture production	311 (77.36)	111 (77.08)	93 (81.58)	107 (74.31)

Source: Field Data Survey, 2022

In table 4.9, about 71% of the farmers perceived that weather changes would induce an increase in temperature and a decrease in rainfall. A significant majority, 80% of farmers, perceived that weather changes will increase the variability of precipitation. Additionally, about 87% of the farmers perceived changes in weather would increase land erosion. Finally, about 77% of the farmers perceived changes in weather will increase the likelihood of drought, flood, and flood affecting agriculture production.

Most respondents in all the districts had heard about climate change, and perceived changes in temperature and rainfall will have either positive or negative effects on cocoa production.

“Climate change is occurring in the form of changes in rainfall and temperature. Participants in the Ashanti region (Afigya Kwabre district) mentioned that their cocoa did not grow well, as expected due to poor rainfall patterns. Communities in the district experienced more sunshine now which was not so in the past years. The Western region (Ellembelle and Wassa Amenfi central districts) communities suffered a high variability in rainfall, the FGDs participants and some key informant discussions in all the communities indicated unexpected rains caused the constant purchase of chemicals to spray the cocoa. Previously, it rains heavily in the expected months but now you cannot predict. It rains heavily all the time. The heavy rains and strong winds destroy our farms, hence causing the rotting of cocoa pods and other food crops. The women also get stuck at home and cannot go to the farm” (Focus Group Discussion; Key Informant, December 2022).

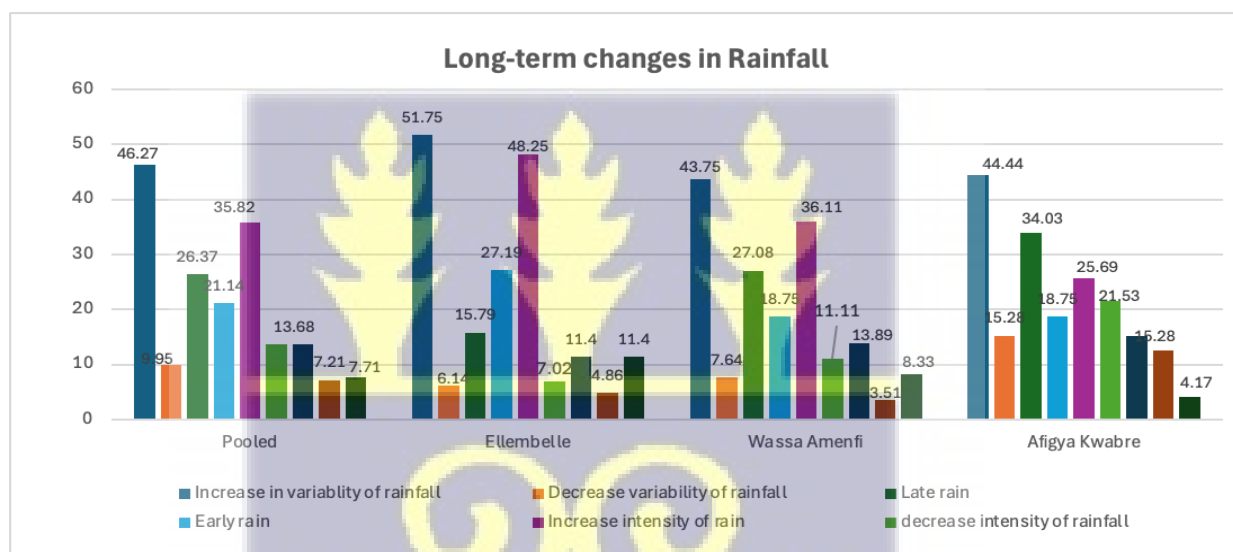


Figure 4. 4: Negative long-term changes in rainfall across Districts (Source: Baseline data, July 2022)

Figure 4.4 describes proportion of respondents who noticed negative long-term changes in rainfall. About 52%, 44%, and 44% of cocoa farmers indicated increased rainfall variability in the Ellembelle, Wassa Amenfi, and Afigya Kwabre North districts respectively. Perceived increase in the intensity of rain by cocoa farmers was high (48.25%) in the Ellembelle and 36.11% in the Wassa Amenfi Central. The least perceived long-term change in rainfall was lateness in rain.

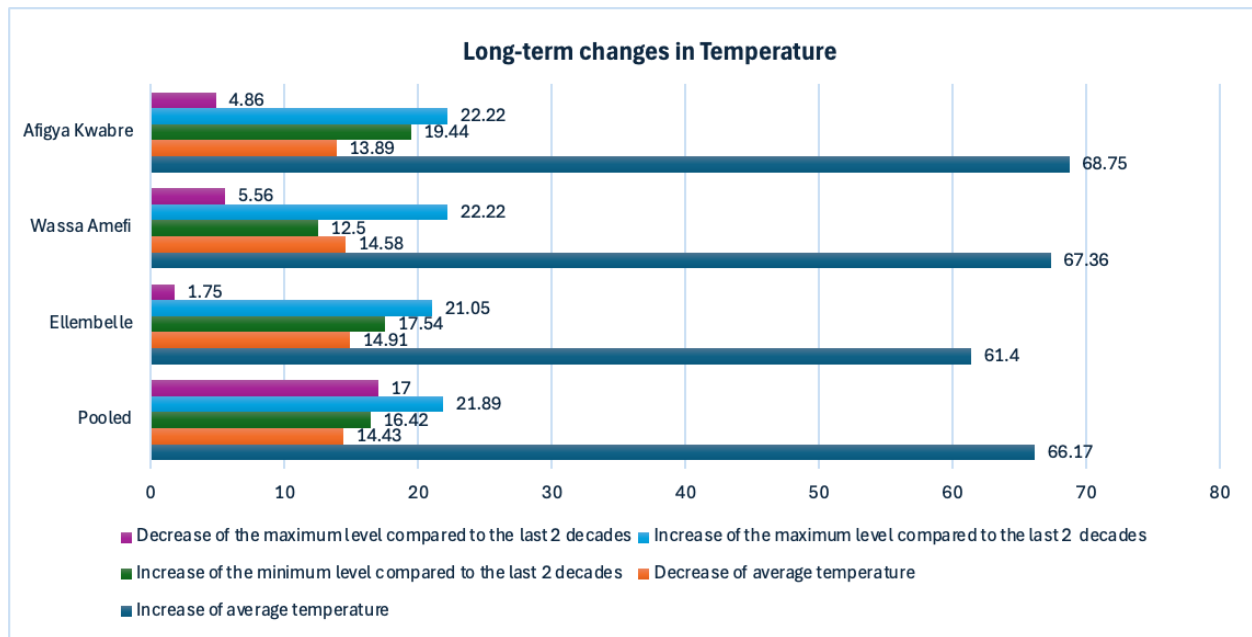


Figure 4. 5: Negative long-term changes in Temperature across Districts

Table 4.5 describes respondent proportions in their perceptions of negative long-term changes in temperatures across the three (3) districts. Perceived increase in average temperature was found to be the highest 61%, 67%, and 69% in Ellembelle, Wassa Amenfi central and Afigya Kwabre districts respectively. Perceived increase of the maximum level compared to the last two decades, about (22%) and perceived decrease in average temperature (13%) were indicated in all the districts.

4.3.2 Determinants of farmer perception of climate change variability effects on cocoa yields

It is estimated that there are factors that could influence cocoa farmers' productivity amidst the change in climatic conditions. The results of the determinants are reported in Table 4.10. The findings show the effect of each marginal adjustment in the significant explanatory variables on cocoa yields of cocoa farmers. The Prob>F value of 0.000 of the F-calculated shows that the overall model is significant at 1% significance level. The R-squared value of the statistical model is 0.123 showing that 12% cocoa farmers, productivity is explained by the independent variables.

Table 4. 10: Multiple linear regression results for farmer's perception of Climate Change variability effects on cocoa yields

Dependent Variable: Yield	Coefficient	Standard. Err.	
<i>Farm characteristics</i>			
Farm age (Years)	0.526	7.952	
Farm age (squared) (Years)	-0.138	0.201	
Experience in cocoa farming (Years)	4.758**	1.886	
<i>Environmental factors</i>			
The weather is Changing (Yes = 1)	77.284*	44.519	
Negative long-term change in rainfall (Yes=1)	-183.073**	78.772	
Planting more Trees (Yes = 1)	27.158	39.897	
<i>Socioeconomic characteristics</i>			
Age of cocoa farmers (Years)	-1.769	1.462	
Education level: Primary (Yes=1)	45.1	47.863	
Marital Status: Single (Yes = 1)	395.052***	141.27	
<i>Location (Afigya Kwabre North as base)</i>			
District (Ellembelle = 1)	117.609**	55.413	
District (Wassa Amenfi = 1)	41.008	48.466	
CSSVD (Yes=1)	25.296	54.711	
<i>Institutional factors</i>			
Participation in certification project (Yes = 1)	278.667***	106.355	
Training in agronomic practices in the last 5 years (Yes = 1)	70.4*	46.385	
<i>Cocoa variety</i>			
Cocoa variety (Hybrid = 1)	36.05	48.918	
Cocoa variety (Criollo = 1)	-168.241	286.604	
Cocoa variety (Amazonia = 1)	91.976*	47.453	
Constant	227.645*	132.858	
Mean dependent var	369.503	SD dependent var	404.754
R-squared	0.123	Number of Obs	402
F-test	2.537	Prob > F	0.000
Akaike crit. (AIC)	5957.715	Bayesian crit. (BIC)	6045.637

*** p < 0.01, ** p < 0.05, * p < 0.1

Results from Table 4.10 show that perceived long-term negative changes in rainfall, location, marital status, experience, participation in a certification project, and “the weather is changing” tends to induce statistically significant influences on cocoa seasonal yield. The significance of the F-test indicates that the model estimated is appropriate and adequate. Perceived negative changes in rainfall was negatively significant at a 5% level. This means that farmers’ perception of changes in the rainfall patterns negatively influences the yield of cocoa. The finding affirms Tham-Agyekum et al., (2023), Afriyie-Kraft et al., (2020), and Bamba et al., (2023) that cocoa farmers are sensitive and vulnerable to changes in rainfall patterns. Farmers who believe that there might

be fluctuations in the rainfall patterns will reduce their commitment (such as pruning, and pest and disease control) to the farm. This is because they may anticipate low yields due to the perceived fluctuations in rainfall patterns, therefore, they may not want to waste resources. As a result, cocoa yields decline, which translates into a negative impact on their livelihoods and food security. On the other hand, it appears cocoa farmers who plan towards *the changing weather*, improves their cocoa yields.

Cocoa farmers, through years of engaging with their local environments, develop an intuitive knowledge of how to adapt to changes in their local environment. This enhances their ability to anticipate and mitigate environmental risks, leading to more stable and higher yields. Whether cocoa farmers have participated in a certification project was positive and statistically significant at a 1% level. Certification projects often provide farmers with training on efficient farming techniques. This helps farmers to optimize their production processes and yields. Also, certified farmers may benefit from regular monitoring and technical support from certification bodies to ensure that farmers follow the best agricultural practices. Some certification bodies even offer financial incentives which can motivate farmers to invest more in their farms which can improve cocoa yields.

4.4 Cocoa farmers Climate Smart Agriculture Practices and factors influencing recommended practices for improved productivity and income

Climate-smart agriculture practices recommended by the farmer respondents (baseline survey) are analysed and presented in Figure 4.6. Avoiding deforestation is the key climate-smart agricultural practice recommended by most farmers in the three districts (Afigya Kwabre, 71.4%; Wassa Amenfi Central, 68.8%; Ellembelle 59.1%). Cocoa farmers value the non-market ecosystem services provided by trees on their farms including carbon absorption (Obeng et al., 2020).

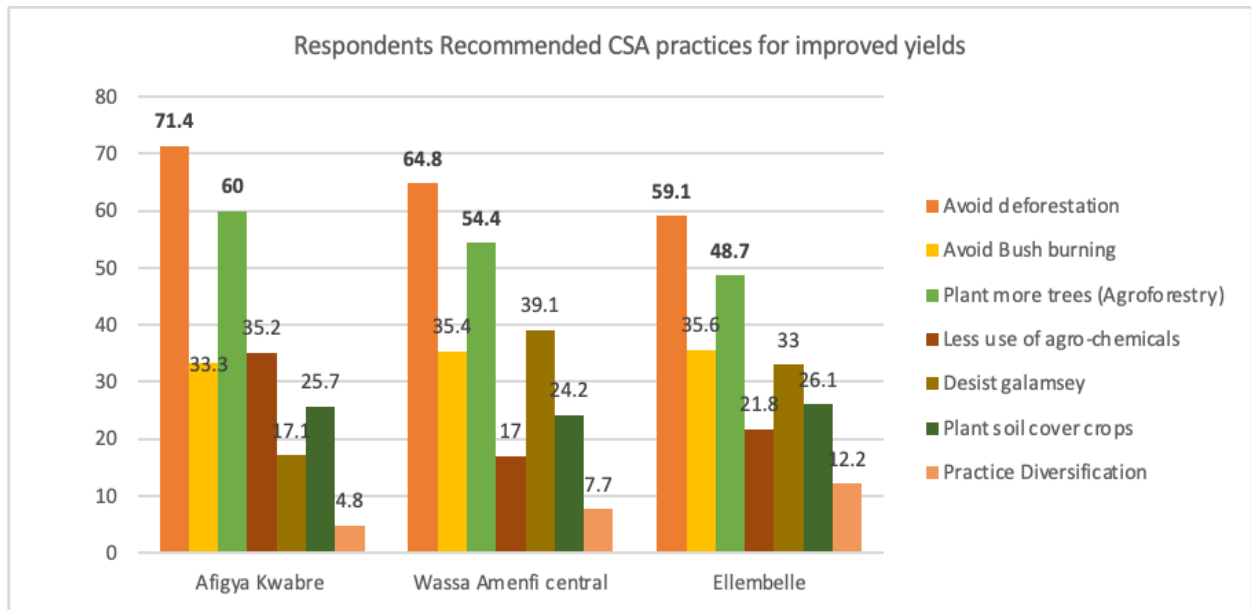


Figure 4. 6: Climate-smart agricultural practices by recommendations

Source: Authors computation, 2023

Trees significantly impact land-atmosphere feedback and can mitigate temperature extremes and improve crop yields (Mishra et al., 2021). However, owing to a reliance on rain for crop production, trees are viewed more favourably by some farmers towards the maintenance of the cocoa farms. Trees on cocoa farms mitigate local climate extremes and more importantly, local crop failure due to extreme weather patterns like unsteady rainfall. This could be from the fact that cocoa farmers may have observed that regions with high forest cover have less rainfall variability and more moderate temperature ranges which are conducive to optimal agricultural production. Followed by the avoidance of deforestation is the planting of more trees – agroforestry (Afigya Kwabre, 60%; Wassa Amenfi Central, 54.4%; Ellembelle 48.7%). The roots of trees hold soil firmly in place thereby reducing erosion (De Baets et al., 2020; Phillips et al., 2023), which helps especially in areas that experience heavy rains or wind erosion. As trees mature, they shed off their leaves that rot, thereby increasing soil fertility without the use of chemical fertilizers only. The rotten fallen leaves also improve the soil's consistency and water-holding ability such that crops can survive even during periods of low rainfall (Lal, 2020; Pankaj et al., 2023; Stavi, 2020). Many

farmers therefore practice agroforestry, as they have observed that healthy soils are attained that result in more reliable harvests. The least recommended CSA practice among the three districts (Afigya Kwabre, 4.8%; Wassa Amenfi Central, 7.7%; Ellembele 12.2%) is to practice diversification as an effective CSA practice.

Table 4.11 presents the regression results of the factors that influencing key CSA practices aimed at improving productivity and income are: avoiding deforestation, avoiding bush burning, planting more trees, reducing the use of agrochemicals, desisting from galamsey, planting soil cover crops, and practicing crop diversification. In table 4.11, generally, marital status (married, widowed, divorced), educational level and location, that is farmers in Afigya Kwabre North, positively influence perceptions on CSA practices as likely to improve cocoa productivity and income. Educational attainment shows a strong and consistent influence across practices. Farmers with primary, JHS, SHS, or tertiary education demonstrate a higher likelihood of supporting environmentally friendly practices such as avoiding bush burning, planting more trees, planting cover crops, and reducing agrochemical use. Basic and higher-level education often expose farmers to topics related to environmental stewardship, soil health, and climate change, making them more aware of the long-term benefits of CSA practices. This is consistent with studies suggesting that education enhances farmers' ability to process information and adopt sustainable innovations (Asante et al., 2022; Danso-Abbeam et al., 2023). On the other hand, farmers with Qur'anic education show mixed results, with significant negative and positive associations across different practices. This pattern may reflect differences in exposure to formal agricultural extension training and climate-smart farming concepts among households educated through religious schooling. As such, these farmers may be more aware of the adverse effects of deforestation and bush burning, which include soil degradation, the destruction of beneficial soil

organisms, and the depletion of organic matter. Planting more trees in cocoa farms creates a healthier ecosystem (Afele et al., 2021; Amponsah-Doku et al., 2022), which in the long-run, could increase cocoa (Amponsah-Doku et al., 2022; Asitoakor et al., 2022). Married (or ever married) farmers are relatively more experienced and would recommend the planting of more trees, avoiding deforestation and bush burning in their cocoa farms to improve productivity and income. This is consistent with the idea that farmers with family responsibilities or more social stability often have greater farming experience and are more cautious about long-term sustainability (Antwi-Agyei et al., 2021). Such farmers may better appreciate the risks associated with land degradation and are therefore more supportive of sustainable land-use practices. Both married and divorced farmers significantly recommend the practice of planting more trees and avoiding deforestation, which aligns with findings that household heads with more social obligations tend to adopt long-term sustainable farming behaviours (Dumenu & Obeng, 2022). Widowed farmers also show a positive association with several CSA practices, suggesting that their accumulated experience and reliance on land for livelihood shape a stronger preference for environmental conservation. A negative relation between Ellembele and Afigya Kwabre districts cocoa farmers recommending desisting from galamsey means that these districts are likely to recommend that others stop engaging in galamsey compared to Manso Amenfi. This negative relationship suggests that cocoa farmers in these two districts are more likely to recommend stopping galamsey activities than their counterparts in Manso Amenfi. The finding highlights the need for targeted interventions in Manso Amenfi, where illegal mining may be more entrenched or economically attractive (Arhin & Bondinuba, 2022). Given the destructive impact of galamsey on cocoa farmlands such as soil pollution, loss of cover crops, and reduced productivity addressing this issue remains crucial.

Table 4. 11: Factors influencing recommended practices for improved productivity and income using the Multivariate Probit regression model

Variable	Avoid deforestation	Avoid bush burning	Plant more trees	Less use of agrochemicals	Desist galamsey	Plant soil cover crops	Practice diversification
Age (Years)	0.0004 (0.0017)	-0.0003 (0.0017)	-0.0011 (0.0018)	0.0016 (0.0015)	0.0003 (0.0017)	-0.0027* (0.0015)	0.0013 (0.0010)
Gender (Male=1; Female=0)	0.0130 (0.0540)	0.0170 (0.0545)	-0.0416 (0.0570)	-0.0669 (0.0485)	-0.0185 (0.0523)	0.0327 (0.0485)	-0.0103 (0.0319)
Married (Married=1; 0 otherwise)	0.4745*** (0.1560)	0.1078 (0.1575)	0.2985* (0.1648)	0.1470 (0.1402)	-0.4509 (0.1850)	0.3072** (0.1400)	-0.0065 (0.0921)
Divorced (Divorced=1; 0 otherwise)	0.6740*** (0.1908)	0.4848*** (0.1927)	0.4688** (0.2016)	0.2209 (0.1715)	-0.1893** (0.1720)	0.7238*** (0.1713)	-0.0340 (0.1126)
Widowed (Widowed=1; 0 otherwise)	0.3670** (0.1775)	0.0406 (0.1792)	0.0874 (0.1874)	0.1811 (0.1595)	-0.1893 (0.1720)	0.1872 (0.1593)	-0.0175 (0.1047)
Cohabitation (Cohabitation=1; 0 otherwise)	0.2043 (0.2369)	-0.1042 (0.2392)	0.2727 (0.2502)	0.0276 (0.2129)	-0.4573** (0.2296)	0.0671 (0.2126)	-0.0756 (0.1398)
Household size (number)	0.0211 (0.0101)	0.0049 (0.0102)	0.0050 (0.0107)	0.0091 (0.0091)	0.0083 (0.0098)	-0.0037 (0.0091)	-0.0023 (0.0060)
FBO (Yes=1; No=0)	0.0228 (0.0566)	-0.0117 (0.0572)	0.0936 (0.0598)	-0.0089 (0.0509)	-0.0269 (0.0549)	-0.0744 (0.0508)	0.0052 (0.0334)
Experience (Yes=1; No=0)	0.0008 (0.0022)	0.0025 (0.0022)	-0.0017 (0.0023)	0.0014 (0.0019)	0.0020 (0.0021)	0.0014 (0.0019)	-0.0004 (0.0012)
Primary (Primary=1; 0 otherwise)	0.0985 (0.0869)	0.1733*** (0.0694)	-0.0795 (0.0726)	0.1142* (0.0618)	0.1507** (0.0666)	0.0395 (0.0617)	0.0118 (0.0401)
JHS (JHS=1; 0 otherwise)	0.1348** (0.0611)	0.0754 (0.0617)	0.0422 (0.0645)	0.0461 (0.0549)	0.1238** (0.0592)	-0.0231 (0.0548)	0.0337 (0.0361)
SHS (SHS=1; 0 otherwise)	0.0916 (0.0869)	0.1041 (0.0877)	-0.0279 (0.0917)	0.1115 (0.0781)	0.1545** (0.0842)	-0.0622 (0.0780)	-0.0023 (0.0513)
Tertiary (Tertiary=1; 0 otherwise)	0.4304*** (0.1383)	0.1486 (0.1396)	0.1157 (0.1460)	0.2315* (0.1243)	0.1904 (0.1340)	0.3336*** (0.1241)	0.0170 (0.0816)
Qur'anic (Qur'anic=1; 0 otherwise)	-0.5345* (0.3272)	0.3054 (0.3304)	0.5043 (0.3456)	-0.0343 (0.2940)	0.6627** (0.3171)	-0.2277 (0.2937)	-0.0215 (0.1931)
Extension contacts (Yes=1; No=0)	-0.0419 (0.0532)	0.0042 (0.0538)	0.0932* (0.0562)	-0.0317 (0.0478)	-0.0581 (0.0516)	-0.0601 (0.0478)	-0.0849*** (0.0314)
Credit (Yes=1; No=0)	0.0561 (0.0478)	0.0076 (0.0482)	-0.0765 (0.0505)	-0.0665 (0.0429)	0.0220 (0.0463)	-0.0529 (0.0429)	-0.0667** (0.0282)
Ellembelle (Ellembelle=1; 0 otherwise)	0.0160 (0.0621)	0.0916 (0.0627)	0.0486 (0.0656)	0.0895 (0.0558)	-0.1406** (0.0602)	0.0574 (0.0558)	0.0342 (0.0367)
Afigya Kwabre North =1; 0 otherwise)	0.0851 (0.0627)	0.0574 (0.0633)	0.1834** (0.0662)	0.1326** (0.0564)	-0.265*** (0.0608)	0.1003* (0.0563)	-0.0297 (0.0370)
Constant	-0.1207 (0.2211)	0.0260 (0.2233)	0.1211 (0.2336)	-0.0857 (0.1987)	0.5010** (0.2143)	0.1324 (0.1985)	0.1300 (0.1305)
R-squared	0.0995	0.0624	0.0784	0.0687	0.1087	0.1219	0.0519
P>chi2	0.0008	0.1100	0.0175	0.0564	0.0002	0.0000	0.2850

*** $p < .01$, ** $p < .05$, * $p < .1$

Source: Author's compilation (2024)

4.5 Estimating seasonality in Cocoa output and its effects on farmer's income (Panel data)

The cocoa yield trends for the two-year period (2022/2023 and 2023/2024) panel exhibited a mix of fluctuations and growth (fig 4.7). In 2022/2023, the average cocoa yield was 157.19kg/ha, with a total production of 282.94tons/ha among the panel cocoa farmers. The year 2023/2024 had an average cocoa yield decreased by 53% to 102.20kg/ha, with a total production of 183.96tons/ha. Production declines among the panel cocoa farmers mirror the national cocoa output declines over the same period. National cocoa output in the 2022/2023 cocoa season reached 656,140 MT and declined to 429,323 MT in the 2023/2024 cocoa season (COCOBOD forecast, 2023).

In the panel data, major cocoa season (August-December) average yields decreased from 209.87 kg/ha in 2022/2023 to 121.30kg/ha in 2023/2024, representing a 42% decline in growth. Minor cocoa season (February-July) yields decreased from 83.44kg/ha in 2022/2023 to 75.46kg/ha in 2023/2024 (*see Table 4.12*), representing a 10% decline in growth. Overall, the cocoa yield trends in the panel survey indicate a negative growth trajectory, which could be driven by climate change variability, poor farming practices, and outbreak of pests and diseases in both major and minor cocoa seasons.

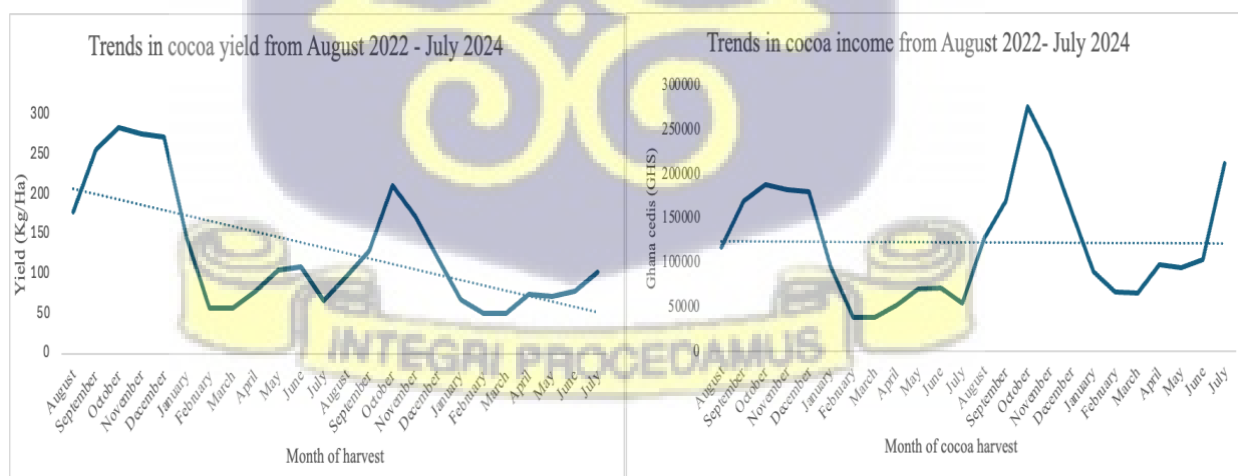


Figure 4. 7:Trend in cocoa yields and income (2022/2023 and 2023/2024) production years

Table 4. 12: Total seasonal production yield across production years

	Major season yield (Kg/ha)	Minor season yield (Kg/ha)
2022/2023 production year	209.87	83.44
2023/2024 production year	121.30	75.46

Source: Panel data survey

Although there are declines in yields, cocoa income increases progressively (fig 4.6). This could be due to increases in cocoa prices over the period, as suggested by Van Vliet et al. (2021), who found that fluctuations in global cocoa prices can significantly influence farmers' incomes even when productivity levels decline. The trend in cocoa income for the two-year period (Year 2022/2023 and Year 2023/2024) exhibited an overall undulating trajectory, with fluctuations across seasons. In the year 2022/2023, the total cocoa income was GHS1,253,377 with an average income of GHS104, 448.1 (USD 8704) with a relatively stable trend throughout the year. In the 2023/2024 year, the total cocoa income increased by 25% to GH¢1,681,858 with an average income of GHS 140, 254.8 (USD 11,070) indicating a growth trend.

Major Cocoa Season income increased from GHS 138,421.92 (USD 10,925) in 2022/2023 to GHS 158,664.84 (USD 12,523) in 2023/2024, representing a 13% growth. Minor Cocoa Season income increased from GHS 56,884.71 (USD4,490) in the year 2022/2023 to GHS 114,240.79 (USD 9,017) in 2023/2024, representing a 50% growth (*see table 4.13*). The monthly cocoa income fluctuated over the two years, with peaks during the major cocoa season (August to December) and troughs during the minor season (February to July). Overall, the cocoa income trends indicate a growth trajectory, driven by increases in both major and minor cocoa seasons.

Table 4. 13: Total seasonal production income across two production years

	Major season income (GHS)	Minor season income (GHS)
2022/2023 production year	138421.92	56884.71
2023/2024 production year	158664.84	114240.79

Source: Panel data survey

The results of the panel analysis of seasonality (major and minor periods in the year) and the effects on cocoa farmers' income is presented in table 4.14. The findings show the effects of each marginal adjustment on the significant explanatory variables on the productivity of cocoa farmers.

Table 4. 14: Fixed Effect regression results of seasonality on cocoa income

Dependent variable = <i>log</i> (Cocoa Income)		Coefficient.	St. Err.
<i>Farm characteristics</i>			
<i>log</i> (Farm Age) (Years)		39.383**	18.88
<i>Socioeconomic characteristics</i>			
<i>log</i> (Age of cocoa farmers) (Years)		1.551***	0.188
Education level: Primary (Yes =1, 0 otherwise)		0.249**	0.13
Senior High School (Yes =1, 0 otherwise)		0.365***	0.133
Tertiary (Yes =1, 0 otherwise)		-0.337*	0.181
<i>log</i> (Household size) (Number of people)		-0.398***	0.093
Credit access (Yes =1, 0 otherwise)		-0.259***	0.093
Savings (Yes =1, 0 otherwise)		0.798***	0.116
Participation in certification project (Yes=1, 0 otherwise)		-0.898***	0.224
Married (Yes =1, 0 otherwise)		0.059	0.194
Extension contact visit (Yes =1, 0 otherwise)		0.198*	0.108
<i>Institutional factors</i>			
Training on agronomic practices (Yes=1)		0.292**	0.145
Member of Farmer Based Organization (Yes=1)		0.770***	0.127
Practice diversification (Yes =1)		0.586***	0.148
Cocoa variety (Amazonia =1)		-0.012	0.115
Cocoa variety (Hybrid = 1)		0.100	0.117
<i>Control variables</i>			
Seasonality: base month = January			
February (Yes =1, 0 otherwise)		-0.645***	0.200
March (Yes =1, 0 otherwise)		-0.572***	0.193
April (Yes =1, 0 otherwise)		-0.471***	0.179
May (Yes =1, 0 otherwise)		-0.121	0.185
June (Yes =1, 0 otherwise)		0.028	0.183
July (Yes =1, 0 otherwise)		0.404**	0.187
August (Yes =1, 0 otherwise)		0.252	0.175
September (Yes =1, 0 otherwise)		0.619***	0.173
October (Yes =1, 0 otherwise)		0.726***	0.173
November (Yes =1, 0 otherwise)		0.685***	0.174
December (Yes =1, 0 otherwise)		0.468***	0.175
<i>Economic variable</i>			
Non-cocoa on-farm income (Ghana cedis)		0.0013***	0.00002
Constant		-245.225	143.993
Mean dependent var	11.499	SD dependent var	1.131
R-squared	0.404	Number of obs.	634
F-test	14.609	Prob > F	0.000
Akaike crit. (AIC)	1671.754	Bayesian crit. (BIC)	1800.863

*** $p < .01$, ** $p < .05$, * $p < .1$

Source: Field Survey, 2023/2024)

The Prob>F value of the F-calculated shows that the overall model is significant at 1% level. The R-squared value of the statistical model is 0.404 showing that 40.40% of the cocoa farmers, cocoa income is explained by the independent variables.

From Table 4.14 are the regression results from the estimation of seasonality (measured by monthly dummies) the seasonal cocoa income. These results demonstrate the extent to which seasonality affects yields and cocoa income in Ghana. The estimated parameters show that cocoa incomes were significantly higher from September through to December (major season) compared to February to May (minor season with negative effects). The months of September, October, November, and December on cocoa income are significant at 1% and positive. A percent increase in the major season's harvest increases the seasonal income of cocoa farmers by 61.9%, 72.6%, 68.5%, and 46.8% respectively. The positive and statistically significant effects of the seasonal dummies for the major harvest season suggests heightened cocoa income over this period, during which food supply improves and effective purchasing power and other means of accessing food considerably improves.

There are other covariates that influence seasonal cocoa income positively (farm age, farmer age, extension contact visit, training on agronomic practices, being a member of a farmer-based organization, practicing diversification, and savings improves cocoa yields and non-cocoa-on-farm income), and negatively (household size, credit access, participation in certification projects).

Farm age

At a 5% level of significance, a percentage increase in the age of farms increases the cocoa income of cocoa farmers by 39.4% (Asare et al., 2019) recorded similar results. Cocoa trees often have a unique productivity sequencing cycle, attaining its peak yield within 10 to 30 years depending on the variety and management practices (Ngwang & Meliko, 2021). Occurrence of higher proportion

trees of that age group in old farms will invariably enhance yield and thus, seasonal income. Also, as farms age, farmers may develop improved agronomic practices such as effective pruning, pest and disease management, and soil fertility enhancement. Such practices contribute to sustainable productivity improvements, supporting higher seasonal incomes. Over time, older farms often develop more stable agroecosystems. For instance, mature cocoa farms are likely to exhibit well-established shade management systems and balanced soil nutrient cycles. These factors may improve yield consistency and quality, thereby increasing income.

Age of cocoa farmers

Age of cocoa farmers was significant at a 1% level. A percent increase in the age of a cocoa farmer increases his seasonal cocoa income by 1.55%. Mostly, older cocoa farmers have more years of farming experience (Suh & Molua, 2022), and hence have an understanding of the finer details of cocoa production. Moreover, they may have undergone training on pest and disease management, which they can use in taking preventive or corrective action, thus reducing losses. Most of such knowledge is gained from long-term trial and error, attending training programs, or sharing informal knowledge with peers. Thus, their potential to ensure high productivity and process highly-priced cocoa allows them to charge better prices in the market.

As farmers age, they tend to establish stronger relationships with key stakeholders in the cocoa value chain. For example, older farmers are more likely to have built trust with buyers, cooperatives, or input suppliers over time, leading to benefits such as preferential treatment, credit access, or advance payments. Their social networks may also grant them better access to market information which helps them make more informed decisions. Furthermore, established relationships with extension officers may provide older farmers with priority access to improved seedlings, fertilizers, or technical advice, all of which contribute to higher productivity and income.

Educational Level

Primary, senior high school and tertiary educational levels of cocoa farmers were all significant factors that increased cocoa farmers seasonal income. Cocoa farmers who have at least a basic level of education have more cocoa income than that of cocoa farmers with no level of education. Cocoa farmers with some level of education can adopt improved farming practices (Adebayo et al., 2022; Daudu et al., 2021), actively participate in markets (Attipoe et al., 2020), and embrace innovations (Huffman, 2020). Education equips them with literacy and numeracy skills, enabling better management of farm resources, understanding of modern techniques, and record-keeping. It also allows them to navigate market dynamics effectively (Huffman, 2020). Additionally, educated farmers are more likely to adopt high-yield cocoa varieties (Adebayo et al., 2022; Olumide & Atanda Afolabi, 2020), sustainable farming methods (Maré et al., 2023; Sukayat et al., 2023), and modern technologies (Zegeye et al., 2022).

Household size

The household size of cocoa farmers is significant at 1% level. A percent change in the number of people in the household of a cocoa farmer decreases the income of the farmer by 0.39%. Larger household sizes place greater consumption pressure on cocoa farmers' incomes, as more resources are required to meet basic needs like food, clothing, and shelter. This reduces the amount of disposable income available for reinvestment in farm productivity or expansion. Additionally, larger households face higher costs for education and healthcare, as school fees, supplies, and medical expenses rise with the number of dependents. These financial demands strain the farmer's income, leaving little room for investments in improved inputs or equipment, ultimately limiting productivity and income growth.

Credit access

Credit access was significant at 1% level. Cocoa farmers who have access to credit have 0.25% lower income than cocoa farmers with no credit access. This may be due to the burden of repayment obligations, which can reduce their disposable income and investment capacity. High-interest rates and unfavorable loan terms often divert a significant portion of their earnings to debt servicing, leaving little for farm improvements. Additionally, credit is sometimes used for non-agricultural purposes rather than productive purposes among cocoa farmers (Darfor et al., 2021), which limits its potential to boost cocoa income.

Savings

Savings was significantly positive at 1% level. Cocoa farmers who have savings accounts have about 0.79% more income than cocoa farmers who do not have savings accounts. This may be because cocoa farmers with savings accounts can better manage their finances and reinvest in their farms. Savings accounts allow farmers to set aside funds for purchasing inputs like fertilizers, pesticides, and improved seedlings, which enhance productivity. Savings accounts may also provide a financial cushion during off-season periods, reducing the need to sell cocoa prematurely at lower prices. Furthermore, access to savings promotes financial discipline, enabling farmers to plan for long-term investments that boost income. Farmers without savings accounts often face challenges in managing resources, leading to missed opportunities for farm improvements and income improvement.

Extension access

Extension access was significant at 10% level. Cocoa farmers who have access to extension services have about 0.198% more cocoa income than cocoa farmers who do not have access to extension services. Extension agents provide training on pest control (Toepfer et al., 2020), fertilizer use (Soekamto et al., 2022), and post-harvest handling (Aniagyei et al., 2024), which

leads to higher yields and better-quality beans that attract premium prices. They also connect farmers to subsidized inputs, credit, and cooperatives, enhancing resource access and bargaining power. Additionally, extension services build farmers' capacity to manage resources efficiently and adapt to challenges like climate variability (Alzahrani et al., 2023; Kingiri, 2021), ensuring more stable and higher incomes.

4.6 Estimating seasonality in cocoa output on seasonal household food security indicators (Panel data)

This section presents seasonality in cocoa output and their effects on seasonal variations in food availability and access (HFIAS) and dietary diversity (WDD) in the various districts.

4.6.1 Seasonal food Availability across the Districts.

This section discusses food consumption by the farm households sampled in the baseline and panel survey across the various districts.

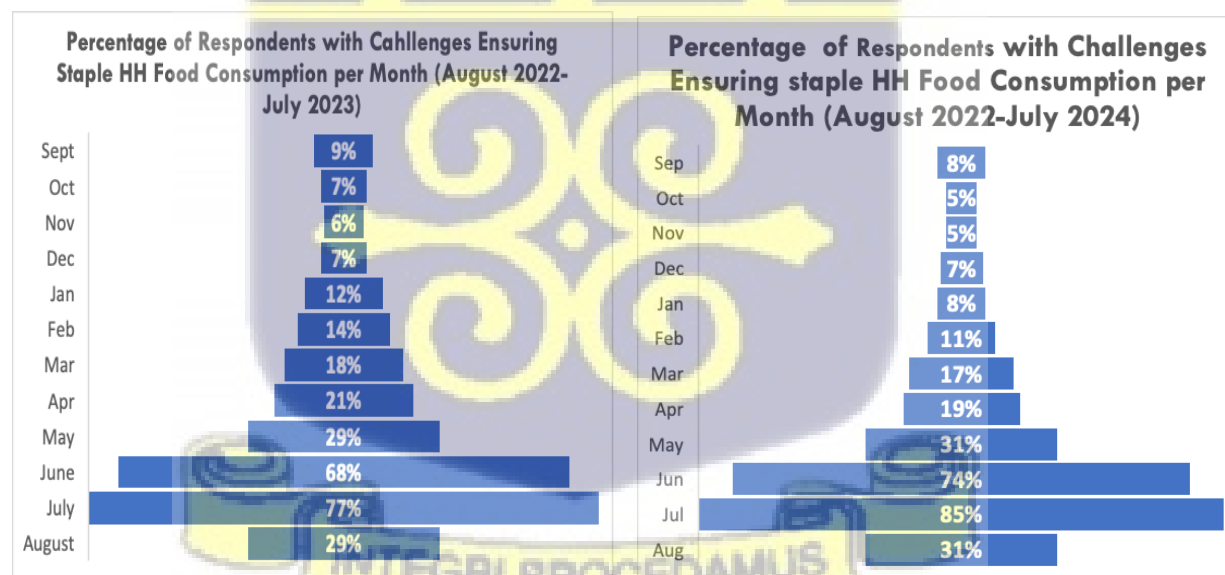


Figure 4. 8: Proportion of respondent's challenges with Household food consumption

Figure 4.8 shows that all the communities in the districts indicated that June (68%; 74%) and July (77%; 85%) are the most challenging months for ensuring the availability of staple food throughout the production year. The main cropping season (September/October to February/March) periods shows available staple foods for consumption. This complies with responses from the focus group discussions conducted:

“From January to May we always get food to eat. We face challenges with food consumption from May through to August but hunger is severe mostly in June and July. May, June, and July are the major rainy seasons, which usually destroy food crops and make poor households vulnerable to food insecurity. Hunger also sets in because there is no money and no food to eat because of too many heavy rains in the Western region (that is, Ellembele) and no rains to irrigate food crops. The heavy rains destroy the cocoa pods and drought causes less fruiting of pods. These instances do not make us generate enough income from selling our produce”. (Focus Group discussion, July 2023)

Food shortages are experienced from June, July, and August. In March, we usually do not have money but not food shortages. The main foods consumed here are Fufu, Banku, Ampesi, and Konkente. We do not get enough meat, chicken or fish to eat here, especially chicken, we do not get it often to eat. We do not drink tea here because of the hard work we do here, we do not drink tea. We make sure that we eat proper food which carries us through the day. We drink “This Way” chocolate drink which contains some milk only on good days.

4.6.2 Seasonal Harvest periods (Focus Group discussions)

Cocoa is harvested in two main harvest seasons, although farmers harvest cocoa pods throughout the year. Across all the study districts, the main harvest season is sometimes from August to December but typically from September to December. The light season is from April to May and the rainy season usually starts from June to August whilst the dry season is from November to March. The Western region districts (Ellembele and Manso Amenfi central) indicated that food shortages are experienced from February to May during the dry season when plantain is out of season and in the wet season from June to August due to rains destroying food crops. They mentioned eating the food crops they cultivate in the communities which excludes yam and rice.

The Ashanti region (that is Afigya Kwabre North district) indicated that cocoa is harvested in two main harvest seasons, sometimes from August to December, but typically from September to January. In October, harvesting peaks in large quantities but the month of November is when the bulk of harvest is more. The light season is from April to May and the rainy season is usually from June to August whilst the dry season is from November to March. In terms of food shortages due to periods between harvests, farmers in this district do experience food shortage from February to May during the dry season when plantain is out of season and in the wet season from June to August due to rains destroying food crops. However, the farmers here indicated that;

“Everybody in the communities get food to eat because most of us are farmers, so we all have food to eat”. You cannot farm if you do not have food to eat because you need the energy to work. Those who are not farmers have money to buy their food. The common food here is “fufu” and “ampesi” which is from the starchy staple’s food group.

However, consuming their food with fish or meat is where they encounter challenges. Shortages of fish or meat are usually experienced from January to March. Some people eat without fish or meat, and will normally buy groundnut and eat it alongside. Common foods eaten in the morning are Koko, Banku, and Konkonte. In the mornings, farmers hurry to go to the farm. Some also go to the farm and prepare “ampesi” there. Breakfast is mostly purchased outside the home and costs GHS 10.00 for adults and GHS 5.00 for a child. In the afternoons, most people skip lunch and munch on local snacks. In the evenings, women are given money (about GHS 50.00) to prepare food at home. If the woman is not well or indisposed, the man or children can prepare the food, but the man will, if the children are not grown. Households cook once a day, and it's usually during supper.

4.6.3 Seasonal Variations in Dietary Diversity of Women (WDD)

Women across all the districts consumed food groups at different levels. The baseline data results (see figure 4.9) show that during the major season (October to March) and some part of September depending on when the season opens in Ghana, reasonable proportions of the food groups (cereals, offals, dark leafy vegetables, eggs, milk, beans, peas and lentils, and dairy products) are consumed. There are observed changes in the food consumption patterns of the women (15-49 years) between the seasons. The months of August through to January (Major season), women were seen to have consumed more foods from the food groups as compared to the minor season (May through to July).

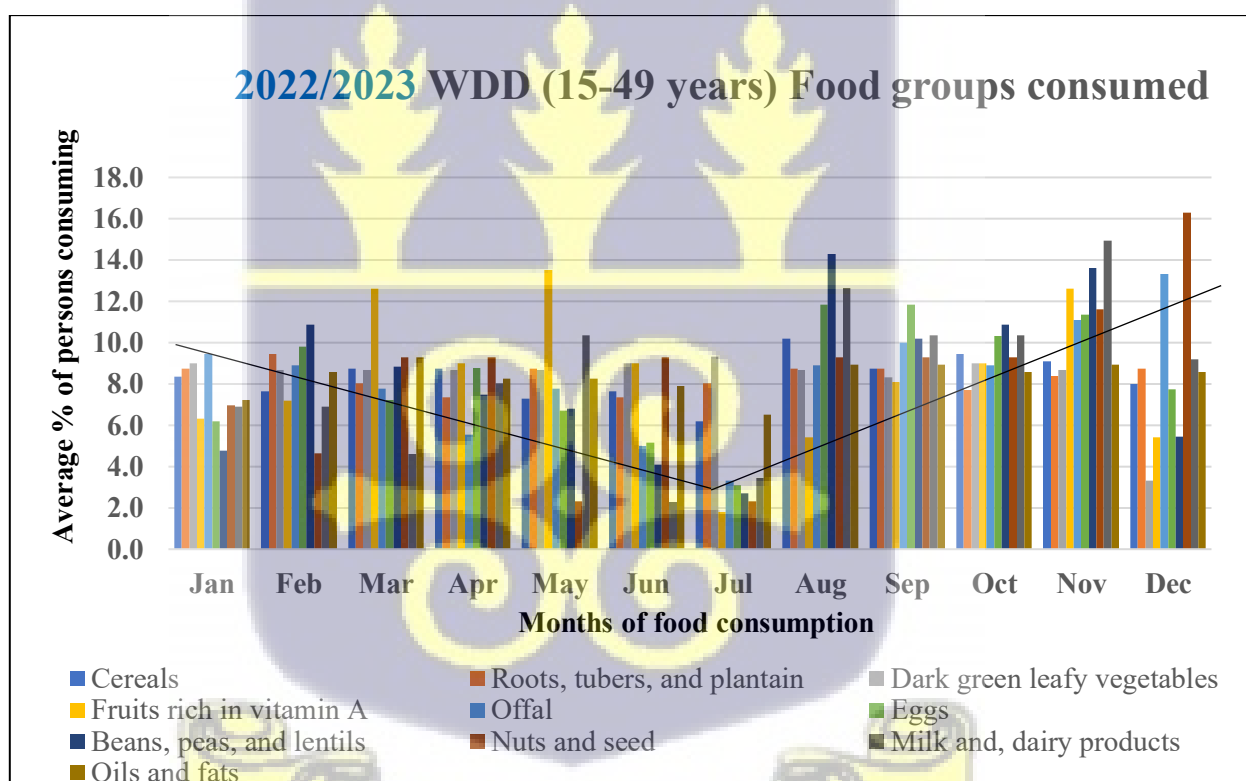


Figure 4. 9: Pooled Panel Food Groups Consumed by Women

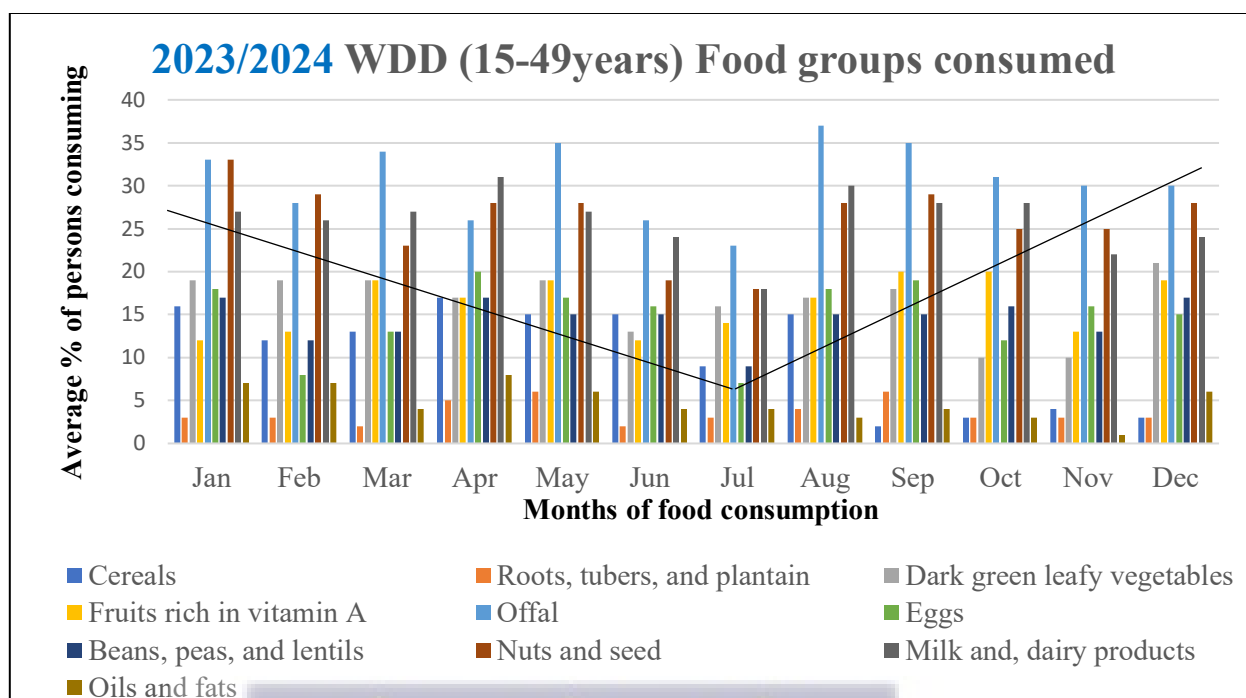


Figure 4. 10: Pooled Panel Food Groups Consumed by Women

From the pooled panel survey, one observes changes in the food consumption patterns of the women between the seasons, with the women consuming foods from more food groups in August compared with June/July. September and October were seen to have less food group consumption. Food consumption patterns in the baseline observation relatively mirrors patterns of the panel data observations. Women dietary diversity is better during the major cocoa season than in the minor season.

4.6.3.1 The effects of seasonal cocoa output on seasonal intrahousehold food security indicators

Seasonal effects on seasonal food security (WDD) are estimated using the fixed effect multinomial logistic regression model for the panel survey and is presented in table 4.15. Although the Wald χ^2 test indicates that the observed association is statistically significant and the model estimated is also appropriate and adequate, seasonal effects are not statistically significant. In other words, the monthly variations in food groups consumed do not vary over the months, meaning there are

no seasonal or monthly differences in food consumption patterns based on your data and model results.

Table 4. 15: Estimation of seasonal effect on food security indicator (WDD)

WDD: Base is Not Diverse	Mostly Diverse (2)	Diverse (3)
<i>log</i> (Per capita Income)	1.584 (0.144)	0.865 (0.353)
<i>log</i> (off-farm Income)	1.718** (0.036)	1.701* (0.055)
<i>Seasonality = Base is January</i>		
February	-61.149	-38.306
March	-0.846 (0.695)	22.225 (0.999)
April	-1.283 (0.598)	21.445 (0.999)
May	-0.819 (0.714)	22.671 (0.999)
June	-60.044 (.)	23.939 (0.999)
July	-2.294 (0.296)	20.663 (0.999)
August	20.205 (0.999)	43.550 (.)
September	-62.061 (.)	21.078 (0.999)
October	-3.072 (0.023)	-39.372 (.)
November	-4.160 (0.135)	20.480 (0.999)
December	-0.950 (0.674)	21.350 (0.999)
Constant	-29.004 (0.072)	-44.271 (0.999)
Var	0.960	4.383
Log likelihood -30.48011		
Wald chi2 1063.45		

*** $p < .01$, ** $p < .05$, * $p < .1$

Source: Authors computations, 2024

The regression results in table 4.15 shows that a positive relationship between off-farm income and women dietary diversity (WDD) for Diverse and mostly Diverse, relative to not Diverse, is statistically significant at the 10% level of significance. Women who tend to have more off-farm income sources generally have higher dietary diversity in their food consumption. The p-values of 0.999 indicates that there is no statistically significant difference in dietary diversity compared to January. The month of October for Mostly diverse with p-value of 0.023 suggests a small difference.



4.6.4 Estimating seasonal cocoa income effects on the food security status (HFIAS) of cocoa farmers (Panel data)

Table 4.16 presents household food security status by districts. It was observed that cocoa farmers and their households in the Wassa Amenfi Central were more food secured (food secured and mildly food insecure, 90%) compared to Ellembelle and Afigya Kwabre districts. This could be attributed to the combined income from cocoa, rubber and galamsey activities, relative to the other districts. High galamsey activities in the Wassa Amenfi district, which is considered as income from off-farm activities can increase households' purchasing power, enabling them to access more food and improve their overall food security (Babatunde & Qaim, 2010). The Ellembelle district cocoa farmers were found to be moderately (56%) and severely (15%) food insecure. The Ellembelle district's major source of income was from coconut and their production dwindled over the years due to climate change shocks and the competition with cocoa and rubber cultivation.

Table 4. 16: Household food security status (HFIAS) across districts (Panel data analysis)

Food security status	Pooled	Ellembelle	Wassa Amenfi	Afigya Kwabre North
Food secured	848 (23.56)	159 (13.25)	492 (41)	197 (16.42)
Mildly food insecure	1354 (37.61)	194 (16.17)	595 (49.58)	565 (47.08)
Moderately food insecure	1160 (32.22)	670 (55.83)	113 (9.42)	377 (31.42)
Severely food insecure	238 (6.61)	177 (14.75)	0 (0)	61 (5.08)
Total	3600	1200	1200	1200

Authors computation, 2024

The household food security status by gender is presented in Table 4.17, respectively as measured by the household Food Insecurity Access Scale (HFIAS). It is observed that males dominated across all four categories of the HFIAS. This could be due to the sample size difference of the respective gender groups.

Table 4. 17: Gender distribution of household food security status (Panel data analysis)

District	Pooled		Ellembelle		Wassa Amenfi central		Afigya Kwabre North	
Food Security Status	Male	Female	Male	Female	Male	Female	Male	Female
Food Secure	696 (26.17)	152 (16.1)	132 (15.31)	27 (7.99)	379 (47.97)	113 (27.56)	185 (18.35)	12 (6.25)
Mildly Food Insecure	995 (37.41)	359 (38.19)	141 (16.36)	53 (15.68)	347 (43.92)	248 (60.49)	507 (50.30)	58 (30.21)
Moderately Food Insecure	806 (30.30)	354 (37.66)	467 (54.18)	203 (60.06)	49 (11.95)	64 (8.10)	102 (53.13)	275 (27.28)
Severe Food Insecure	163 (6.13)	75 (7.98)	122 (14.15)	55 (16.27)	0 (0)	(0)	41 (5.08)	20 (10.42)
Total	2660	940	862	338	790	410	1008	192

Source: Author's computation, 2024

Out of the 2660 male-headed households and 940 female-headed households, more male-headed households (147 of the male sub-sample) in the Wassa Amenfi central were categorized under food secure as against only 44 of the female-headed sub-sample, as presented in Table 4.17. The percentage of female-headed households categorized under severely food insecure was, however, more as compared to their male-headed counterparts, thus 67.19% against 45.75%, females against males, respectively suggesting that women are generally more vulnerable to food insecurity than men (Addai et al., 2022; Adjei-Mantey et al., 2022; Egyir et al., 2023). Pooled data across the district show about 26% men and women (16%) are food secure. Most households fall into the mildly or moderately food-insecure groups, and a about 6% of men and 8% of women are severely food insecure. At the district levels, Wassa Amenfi Central performs the best overall, with nearly 48% of men and 28% of women being food secure and no cases of severe food insecurity reported. In Ellembelle, food insecurity is much more widespread, especially among women, where over 60% are moderately and 16% are severely food insecure. In Afigya Kwabre North, gender

differences are also clear where men are more likely to be food secure (18%) than women (6%), while a larger proportion of women experience severe food insecurity (10%).

Table 4. 18: Distribution of income composition of off-farm generating activities

Activities	Pooled		Ellembelle		Wassa Amenfi Central		Afigya Kwabre North	
	Income Amount (GHS)	Average Income (GHS)	Income Amount (GHS)	Average Amount (GHS)	Income Amount (GHS)	Average Amount (GHS)	Income Amount (GHS)	Average Amount (GHS)
Agricultural wage income	116158	2903.95	20340	1542.5	83008	3458.67	12810	1601.25
Galamsey income	537400	89566.67	57000	28500	30400	10133.33	0	0
Mass sprayer income	16120	2686.67	0	0	15320	3830	800	400

*1 USD = GHS 12.67 at time of data collection (Bank of Ghana, 2022, 2023, 2024)

Source: Panel field survey, 2024

Non-farm income includes self-employed activities such as agricultural wage, galamsey, and mass spraying (table 4.18). Cocoa farmers in the Manso Amenfi district, on average received about GHS 3,458.94 (USD 273) per year on agricultural income. In the same district, the bulk off-farm income from galamsey received was about GHS10,133.33 (USD 800). On average, cocoa farmers in the Ellembelle district received an average of GHS 1,542.5 (USD 122) per year from agricultural income. In the same district, galamsey average income is about GHS 28,5000 (USD 2,247.8). The and Wassa Amenfi central district happened to be the only district that indulges in mass spraying as an income generating activity, with average income of about GHS 3,830 (USD 302.3) per year. The income results show that households across the study districts rely on a combination of agricultural and non-agricultural (income diversification) activities for their livelihoods especially with improving household food access and dietary diversity (Hashmiu et al., 2022; Salifu & Salifu, 2023). Agricultural wage income remains a vital and relatively stable source of earnings, especially in Wassa Amenfi Central, where average incomes are the highest. In contrast, galamsey (small-scale mining) provides substantial but uneven income, concentrated mainly in Ellembelle, while absent in Afigya Kwabre North. Although profitable, such mining activities can draw labour away

from agriculture and contribute to environmental degradation, potentially undermining long-term food security (Mabe, 2022; Botchwey & Yankey, 2023). Income from mass spraying services, though limited, highlights emerging opportunities in agricultural service provision. Overall, the results indicates that rural livelihoods are diversifying, yet dependence on non-agricultural sources such as mining may weaken the sustainability of agricultural production and food system resilience.

Table 4. 19: Distribution of income composition of on-farm generating activities

Activities	Pooled		Ellembelle		Wassa Amenfi Central		Afigya Kwabre North	
	Income Amount (GHS)	Average Income (GHS)	Income Amount (GHS)	Average Amount (GHS)	Income Amount (GHS)	Average Amount (GHS)	Income Amount (GHS)	Average Amount (GHS)
Livestock	592100	21146.29		3459.09	507000	169000	9000	3000

*1 USD = GHS 12.67(average) at time of data collection (Bank of Ghana, 2022, 2023 & 2024)

Source: Panel field survey, 2024

Table 4.19 shows livestock as on-farm income generating activity in all the study districts. At the pooled level, average livestock income was GHS 21,146.29, cocoa farmers in the Wassa Amenfi Central district, on average received about GHS 169,000 (USD13,338.6). Invariably, Afigya Kwabre North recorded a much lower total (GHS 9,000) and average (GHS 3,000) livestock income, implying limited engagement in livestock rearing. The uneven distribution implies that while livestock serves as a significant source of income and financial security for some households, others rely on it slightly. The variation is consistent with the literature on rural livelihoods in Ghana, which highlights the diverse role of livestock acting as both a primary income source and a form of household savings or insurance (Adams et al., 2021; Santaa, 2019). Livestock income contributes directly to household welfare through the sale of animals and animal products, and indirectly through its role in income smoothing, and food access. Households with higher livestock income are often more resilient to seasonal food shortages and market shocks, as they can convert

animals into cash to purchase food or invest in farm inputs (Opoku Agyeman et al., 2021; FAO, 2025).

Factors affecting food security status of farmers are shown in Table 4.20. The findings show the seasonal and cocoa income effects on food security. The seasonal effects on seasonal food security (HFIAS) scores are estimated using the random fixed effect multinomial logistic regression model from the panel survey.

Table 4. 20: Seasonal cocoa income effects on food security status of cocoa farmers

HFIAS (<i>base is mildly food insecure</i>)	Food Secure (0)	Moderately food insecure (2)	Severely Food secure (3)
<i>log</i> (Per capita Cocoa Income)	0.300*** (0.003)	-0.216 (0.130)	-1.243 (0.499)
<i>log</i> (off-farm Income)	0.402*** (0.000)	0.225 (0.066)	-0.862 (0.599)
<i>District (location), base is Wassa Amenfi</i>			
Ellembelle	0.040 (0.905)	1.975*** (0.000)	14.951 (0.981)
Afigya Kwabre North	-0.705 (0.053)	0.972** (0.047)	-1.268 (0.999)
<i>Seasonality (base: January)</i>			
February	0.067 (0.920)	-0.093 (0.912)	-1.361 (1.000)
March	-0.380 (0.571)	-0.411 (0.639)	-2.359 (0.994)
April	-0.135 (0.827)	-0.283 (0.730)	13.744 (1.000)
May	-0.999 (1.126)	-0.643 (0.425)	-1.397 (1.000)
June	-1.126 (0.090)	-0.058 (0.941)	0.439 (1.000)
July	-2.220*** (0.004)	-0.474 (0.555)	-0.779 (1.000)
August	-1.186 (0.052)	-0.910 (0.264)	-0.078 (1.000)
September	-1.071 (0.074)	-0.763 (0.351)	-0.196 (1.000)
October	-1.358** (0.023)	-0.876 (0.287)	0.361 (1.000)
November	-0.783 (0.192)	-0.389 (0.624)	0.263 (1.000)
December	-0.702 (0.232)	-1.423 (0.137)	-0.040 (1.000)
Constant	-5.457*** (0.000)	-1.080 (0.578)	-11.644 (0.995)
Var (0,2,3)	0.200	0.180	0.000

*** $p < .01$, ** $p < .05$, * $p < .1$

From table 4.20, seasonal effects on household food security are negative across almost all months, significant statistically for the months of July and October, indicating the extent of cocoa household food insecurity across the major and minor seasons. Relative to the mildly food insecure group, per-capita cocoa income and off-farm income variables are statistically significant factors

influencing the food secure cocoa households. Wassa Amenfi farm households were relatively more food secured, compared to the farm households in Ellembelle and Afigya Kwabre North. On the other hand, more farmers were moderately food insecure in Ellembelle and Afigya Kwabre, than in Wassa Amenfi.

In summary, drawing on the seasonal effects on food security from the regression results, it is revealed that the minor season (month of July) and the major season (month of October) were significantly negative. Per-capita income and off-farm income of cocoa farmers significantly impacted food security. Per location, Wassa Amenfi cocoa households were more food secured whilst Ellembelle and Afigya Kwabre North districts were relatively moderately food insecure.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The chapter summarizes the studies key findings, draws key conclusions from the findings, and presents policy recommendations, and suggestions for future research.

5.2 Summary and Key Findings

Cross-sectional data from 402 respondents (baseline survey, July 2022) and two (2) years of seasonal panel data, collected every month between August 2022 to July 2024 from 150 farm households in the Ellembelle and Wassa Amenfi Central districts (Western region) and Afigya Kwabre district (Ashanti region) were used to analyse the objectives addressed in this study. To validate the findings, focus group discussion were conducted in December 2022 to understand production in cocoa farming and their food situation during the seasonal periods of harvests. A total of 258 farmer respondents from the two districts in the Western region and 144 farmer respondents in one district in the Ashanti region, were involved. Male respondents represented about 72% and the remaining 28% being female respondents in the baseline survey. Out of the 150 respondents selected from the baseline for the panel survey, male respondents represented 77% and 23% representing female respondents. In general, male constituted the majority for baseline and panel surveys.

Studies have provided evidence to help strengthen policies to improve the food security status of cocoa farmers and their households. However, this study assessed the effects of cocoa farmer climate change perceptions and seasonality in cocoa output on the food security status of cocoa farming households in the Western and Ashanti Cocoa Regions, Ghana. Specifically, the study

described and analysed farmer's perceptions of climate change variability and its effects on cocoa yields. The study also described and analyzed the perception of cocoa farmers' climate-smart agriculture practices and factors influencing recommended practices for improved cocoa yields and farm income. The study estimated, described and analyzed seasonality in cocoa output effects on the income of the cocoa farmers. Also estimated, described and analyzed seasonality in cocoa output on the seasonal intra-households (adult men and women of reproductive age 15-49 years) food security indicators. Finally, the study estimated seasonal cocoa income effects on food security status of cocoa farmers.

Descriptive statistics including frequencies, percentages, means and graphs were used to describe the socio-economic and farm characteristics of the cocoa farmers for both baseline cross-sectional and panel surveys. Descriptive statistics were also used to describe the climate change perceptions on yield and recommended CSA practices for improved yields and income. The multiple linear regression was used to analyse farmers' perceptions of climate change variability and its effects on cocoa yields. The multivariate probit regression was used to analyze the determinants of recommended CSA practices for improved yields and income. In estimating the seasonality in cocoa output effects on the income of the cocoa farmers, the Fixed Effect regression was used. The Random Effects multinomial logistic regression was used to analyze seasonality in cocoa output on the seasonal intra-household's food security indicators and estimates of seasonal cocoa income effects on food security status of cocoa farmers.

The key findings from the analyses of the objectives of the study are summarized as follows:

1. Farmers' perceptions of climate change variability and its effects on cocoa yields

About 71% of the farmers perceived that weather changes would induce an increase in temperature and a decrease in rainfall. A significant majority, 80% of farmers perceived that weather changes

will increase the variability of precipitation. Additionally, about 87% of the farmers perceived change in weather would increase land erosion. Finally, about 77% of the farmers perceived changes in weather changes will increase the likelihood of drought, flood, and flood affecting agriculture production. Most respondents in all the districts had heard about climate change, and perceived negative changes in temperature and rainfall will have negative effects on cocoa production. Perception of negative long-term changes in rainfall negatively influences cocoa yields negatively. Experience in cocoa farming, participation in a certification project, and participation in training in the last 5 years, and planting improved cocoa varieties significantly influences cocoa seasonal yields.

2. The perception of cocoa farmers CSA practices and factors that influence recommended practices for improving their cocoa yields and farm income

Planting more trees, avoiding deforestation, and avoiding bush fires are the most recommended CSA practices across the districts that cocoa farmers perceive could improve their cocoa yields and income. This confirms the second hypothesis that farmers perceptions and socioeconomic factors on recommended CSA practices adoption could induce increases in cocoa yields. The key variables that are simultaneously relevant in explaining factors influencing recommended Climate-Smart Agriculture practices for improved yields are education, marital status and location. Whilst cocoa farmers in the Ellembelle and Afigya Kwabre districts recommend desisting from the practice of “galamsey” to improve their cocoa yields, it is likely that cocoa farmers in Manso Amenfi central perceive galamsey differently. This negative relationship highlights the need for targeted interventions and strategies to address the complex environmental issues surrounding “galamsey” in the Manso Amenfi district on cocoa production.

3. Analyses of seasonality in cocoa output effects on the income of cocoa farmers

Cocoa incomes are significantly higher from September through to December (major season) compared to February to May (minor season with negative effects). The months of September, October, November, and December on cocoa income are significant and positive. Major season's harvest increases the seasonal income of cocoa farmers by 61.9%, 72.6%, 68.5%, and 46.8% respectively. The positive and statistically significant effects of the seasonal dummies for the major harvest season suggests heightened cocoa income over this period, during which food supply improves and effective purchasing power and other means of accessing food considerably improves. There are other covariates that influence seasonal cocoa income positively (farm age, farmer age, extension contact visit, training on agronomic practices, being a member of a farmer-based organization, practicing diversification, and savings improves cocoa yields and non-cocoa-on-farm income), and negatively (household size, credit access, participation in certification projects).

4. Analyses of seasonality in cocoa output on households' food security indicators

The study finds observed changes in the food consumption patterns of women (15-49 years) between the seasons. In the months of August through to January (major cocoa season), women consumed more foods from the food groups as compared to the minor season (May through to July). The study also finds changes in the food consumption patterns of the women between the seasons, with the women consuming foods from more food groups in August compared with June/July. September and October were seen to have less food group consumption. Food consumption patterns in the baseline observation relatively mirrors patterns of the panel data observations. Positive relationship between off-farm income and women dietary diversity are

observed which shows that women in off-farm activities, complementing cocoa income, have more diverse income sources for food group consumption.

5. Seasonal cocoa income effects on the food security status of cocoa farmers

The study finds that cocoa farm households in the Wassa Amenfi Central (Western Region) were more food secured compared to Ellembelle (Western Region) and Afigya Kwabre North (Ashanti Region) districts. Wassa Amenfi's food security status could be attributed to the combined income from cocoa, rubber and "galamsey" activities, relative to the other districts. High galamsey activities in the Wassa Amenfi district, which is considered as income from off-farm activities can increase households' purchasing power, enabling them to access more food and improve their overall food security. The Ellembelle district cocoa farmers were found to be moderately (56%) and severely (15%) food insecure. The Ellembelle district's major source of income was from coconut and their production dwindled over the years due to climate change shocks and the competition with cocoa and rubber cultivation. The findings in this study suggests that Ellembelle cocoa households derive significant income from "galamsey" activities that could impact on their food security. The study finds that seasonal effects on household food security are negative across almost all months, but more impactful for the months of July and October, indicating the extent of cocoa household food insecurity across the major and minor seasons and their detrimental effects on farm labour productivity. Minor season (month of July) and the major seasons (month of October) are all negative to cocoa households' food security. Relative to the mildly food insecure group, per-capita cocoa income and off-farm income variables influence the food security of cocoa households, hence farm (labour) productivity. Wassa Amenfi farm households were relatively more food secured, compared to the farm households in Ellembelle and Afigya Kwabre North. On

the other hand, more farmers were moderately food insecure in Ellembelle and Afigya Kwabre, than in Wassa Amenfi.

5.3 Conclusions

Drawing from the empirical findings, the following conclusions based on the thesis objectives and hypotheses are made:

Given that cocoa farmers perception of climate change variability in rainfall and temperature is negative on cocoa yields, the study concludes that climate change is a significant threat to cocoa production. Farmers are becoming more aware of the changing climate and its increasing influence on cocoa production and living standards. The farmers noted rising temperatures and changing rainfall patterns, longer dry periods influences the farming seasons of Ghana's cocoa producing regions. Farmers understood the effects of these changes on their farm lands and product yields. The majority of farmers across the study areas had heard of climate change and perceived its influence on cocoa production to be primarily negative. This confirms low rainfall and prolonged droughts affects cocoa yields and decrease bean quality. The implications of these concerns places emphasis on the sensitivity of cocoa-dependent households to climatic stress and the needs for more targeted adaptation assistance. At the same time, the findings indicate that some elements might strengthen farmers' coping and adaptability. Improved productivity was correlated with experience in the cocoa farming system, meaning experienced farmers are more likely to achieve higher yields. Investing in certification schemes and farmer training programs improves cocoa productivity. The utilization of high-yielding improved cocoa varieties contributes to increase yields.

Following from cocoa farmers climate smart agricultural (CSA) practices use that could induce cocoa yields, the study concludes on cocoa income as a driver to CSA adoption. The results of this

research show that cocoa farmers recognize that the implementation of Climate-Smart Agriculture (CSA) practices is critical to increasing cocoa yield and income in terms of tree planting and mitigate deforestation and bushfire occurrence.

Knowledge (education) and support obtained from extension access are crucial for sustainable cocoa production practices. Dynamics in the household, could influence environmental decisions. Additionally, the varying perceptions of “galamsey” across different districts offer a detailed insight into the intricate relationship between environmental practices and cocoa cultivation. While farmers in Ellembele and Afigya Kwabre view the cessation of “galamsey” as essential for promoting sustainable cocoa farming, those in Manso Amenfi Central adopt a more cautious stance, suggesting that interventions should be customized to meet specific local needs

The hypothesis of seasonality in cocoa production inducing seasonality in income of farm households, the study concludes that seasonality has a profound impact on seasonal income, with the major season's cocoa harvest exhibiting a positive effect on cocoa income. Diversifying non-cocoa farm income significantly increases the overall cocoa farm income. Hence, policymakers, extension agents, and other stakeholders can leverage these findings to design targeted interventions and support programs that enhance the productivity and livelihoods of cocoa farmer. Overall household levels of food security and women dietary diversity of cocoa farming households are improved with increasing cocoa incomes and their participation in off-farm income activities to complement cocoa income. Wassa Amenfi Central district was more food secured compared to Ellembele and Afigya Kwabre districts, and are observed as more diversified in their off-farm income activities. Farmer diversification of sources of income is therefore important in enhancing food security in cocoa households.

Over the cocoa seasons, cocoa income provides food security for cocoa households throughout the year, however, seasonality in the minor cocoa season poses a challenge to farmers. Being food-secured plays a crucial role in mitigating its negative effects. Food-secured cocoa farmers tend to have higher per-capita income and off-farm income, highlighting the importance of improving the cocoa income and diversification livelihoods of cocoa farmers.

5.4 Policy recommendations

Based on the conclusions from the findings, the study recommends the following to help improve cocoa yields and incomes from their seasonal yields, income and thus improving livelihoods and enhance food security status of cocoa farmers.

1. To induce increase in cocoa yields in the study areas amidst climate changes with negative long-term rainfall variability being detrimental to cocoa production, water is critical for cocoa production under climate stressed conditions, hence COCOBOD should lead efforts in innovative irrigation schemes for cocoa production. The irrigation systems could be beneficial for use during the dry seasons.
2. There should be policy support to cocoa farmers to adopt the practices of cocoa climate-smart agricultural practices such as agroforestry intergration and avoiding deforestation to mitigate rising temperatures that affect cocoa yield. Stakeholders such as the Tree Crop Development Authority (TCDA), Forestry Commission, and COCOBOD should collaborate to intensify their efforts in providing farmers with climate information and technical training on CSA practices. This is essential for long-term sustainability as well reducinf deforestation.

3. On climate change effects on cocoa production, agricultural insurance schemes could be promoted to protect cocoa farmers from climate risk and shocks from pests and disease infestations which can alleviate the negative effects of seasonality.
4. Interventions (diversification incentives, and living income for farmers) by COCOBOD, and private cocoa buying companies such as Touton, Cocoa Abrobopa amongst others need to continue to support activities beyond coca farming to stabilize income and build resilience. This will reduce the dependence on a single crop (cocoa) to ensure income sustainability during the minor seasons. The stakeholders must increase the frequency and quality of extension contacts to enhance cocoa farmers' knowledge and adoption of best diversification activities for increased farm/non income throughout the farming seasons as farmers also focus on agronomic practices, farm management, and business skills to improve cocoa yields and income.
5. The Ministry of Food and Agriculture (MoFA), ministry of Health (MoH), Ministry of Gender, Children and Social Protection (MoGCSP) should support nutrition-sensitive off-farm opportunities. These opportunities should focus on the month of April-July (minor season) to enhance women's access to diverse and nutritious foods. These can enhance their productivity and income, access to credit, and market support can have a positive impact on women's dietary diversity. Promoting women involvement in agricultural farm management and decision-making to improve their access to resources and income are important. Women in the study areas need to be trained and educated on nutrition and dietary diversity issues.
6. There is the need for policy support to incentivise year-round productivity. COCOBOD, Tree Crop Development Authority (TCDA), and Non-Governmental Organizations (NGOs) need to intensify the promotion of agronomic practices and alternative income streams, especially in the lean season.

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APPENDICES

Appendix 1: Questionnaire

Cocoa4Future Project Baseline Questionnaire 2022

Page/Section	Question	Question Code	Type	Options
Introduction	Name of Respondent		text	
Introduction	Consent		single-select	1 I Consent 2 I do not consent
Introduction	Enumerator Name		single-select	Jerome Kouame Bini Ekenleibe Lee Robert Kaku Osman Sauba Ali Abdul Mumin Dwamena Asamoah Kassim Alhassan Sulemana Abdul Nana Okyir Baidoo Nana Anima Akrofi Chris Chapman Japhet Okunor Emmanuel Kove Dr Yaw Osei Asare Prof Daniel Bruce Sarpong
FARMER LOCATION	Farmer location		option-tree	
FARMER LOCATION	Region	ID1a	option-tree	001 Western Region 002 Ashanti Region
FARMER LOCATION	District	ID2a	option-tree	001 Wassa Amenfi Central 002 Ellembelle 003 Afigya Kwabre North
FARMER LOCATION	Village/camp	ID3a	option-tree	Kramokrom Aku Nkwanta Anwiafutu K Boateng Subriho/Gyabra Nkwanta Adubrim Ayawura Dump

Page/Section	Question	Question Code	Type	Options
				Ngabawe Nkropong Tandan Ebi Amoako Soko Abroma Adukro Tetrem
FARMER LOCATION	Community Code	Community Code	option-tree	1106 1107 1108 1109 1110 1201 1202 1203 1204 1205 2311 2312 2313 2314 2315
HOUSEHOLD COMPOSITION	Number of persons in household	hh_count	number	
HOUSEHOLD COMPOSITION	MODULE A - HOUSEHOLD COMPOSITION		sub-form	
	Full name	A1	text	
	Family relationship of respondent	A2	single-select	1 Head of household 2 Spouse 3 Child 4 Father or mother of head or spouse 5 Grandson/granddaughter 6 Other relative 7 Not related
	Phone Number of Household head	phone_#	phone	
	Gps coordinates of dwelling	gps	gis	
	Sex	A3	single-select	1 Male 2 Female 3 Prefer not to answer
	Age	A4	number	
	Months of presence during the last year	A5	multi-select	January February March March April May June July August September October November December Year Round insyt other
	Nationality	A6	single-select	1 Ghanaian 2 Burkinabe 3 Malian 4 Guinea 5 Ivorian 6 Beninese 6 Other
	What ethnicity	A7	single-select	1 Akan 2 Ewe

Page/Section	Question	Question Code	Type	Options
				3 Ga-Adangbe 4 Guan 6 Mole-Dagbani 7 Other
	Religion	A8	single-select	1 Christian 2 Muslim 3 Traditionalist 4 Atheist 5 Buddhist 6 Other
	Place of birth	A9	text	
	Indicate if this place is located in:	A10	single-select	1 the same village 2 a nearby village 3 the same district 4 the same region 5 Ghana-Other Regions 6 Burkina 7 Mali 8 Ivory Coast 9 Guinea 10 Liberia 11 Other
	Educational level	A11	single-select	1 None 2 Some Primary Education 3 Completed Primary Education 4 Some JHS/MSLC 5 Completed JHS/MSLC 6 Some Secondary Education 7 Completed Secondary Education 8 Tertiary 9 Quranic
	Marital status	A12	single-select	1 Single 2 Married (Civil) 3 Married (Traditional) 4 Widowed 5 Divorced or separated 6 Cohabitation
	Economic activity of the members of the household	A13	single-select	1 Active 2 Inactive (dependent)
	If active, main activity (Single answer only)	A14a	single-select	1 Cocoa farming 2 Rubber cultivation 3 Palm cultivation 4 Other perennial crops 5 Food-producing (cereal, vegetables.) 6 Breeding Livestock 7 Lumbering 8 Fishing/fish farming 9 Mine (formal or informal) 10 Trade (fixed store) 11 Trade (itinerant) 12 Collector/tracker 13 Employee (craftsman, mechanic, driver) 15 Domestic employee (cleaning, babysitting, cooking, etc.) 16 Business manager (with employees) 18 Other, give details 17 Public Official (Government, administration, teacher, nurse...) 19 Retirement (with pension) insyt_other Other Company employee, specify
	specify for other	A14b	text	
	If active, secondary activity	A15a	single-select	1 Cocoa farming 2 Rubber cultivation 3 Palm cultivation 4 Other perennial crop 5 Food-producing (cereal, vegetables..) 6 Breeding Livestock 7

Page/Section	Question	Question Code	Type	Options
				Lumbering8 Fishing/fish farming9 Mine (formal or informal)10 Trade (fixed store)11 Trade (itinerant)12 Collector/tracker13 Employee (craftsman, mechanic, driver) 15 Domestic employee (cleaning, babysitting, cooking, etc.)16 Business manager (with employees)18 Other, give details17 Public Official (Government, administration, teacher, nurse...)19 Retirement (with pension)insyt_other Other Company employee, specify
	specify for other	A15b	text	
	Is this the selected respondent?		single-select	Yes No
	If yes, provide farmer number		number	
MODULE B - HOUSING & LIVING CONDITION	The household lives	B1	single-select	1 In the village 2 Farm camp
MODULE B - HOUSING & LIVING CONDITION	Does the household have electricity (national network)?	B2	single-select	1 Yes 2 No
MODULE B - HOUSING & LIVING CONDITION	The house is	B3	single-select	1 owned 2 rented 3 Other Family house Not rented or owned but living in house for free
MODULE B - HOUSING & LIVING CONDITION	Type of wall	B4	single-select	1 Brick/block2 wood boards3 Metal sheet4 mud5 other
MODULE B - HOUSING & LIVING CONDITION	Roof type	B5	single-select	1 Sheet 2 Tiles 3 Thatch 4 other
STANDARD OF LIVING INDICATOR	Give the number of Radio owned	B6	number	
STANDARD OF LIVING INDICATOR	Give the number of Cable channel/Satellite subscription owned	B7	number	
STANDARD OF LIVING INDICATOR	Give the number of Standard mobile phone owned	B8	number	
STANDARD OF LIVING INDICATOR	Give the number of Television owned	B9	number	
STANDARD OF LIVING INDICATOR	Give the number of smartphone mobile phone owned	B10	number	
STANDARD OF LIVING INDICATOR	Give the number of Personal cars owned	B11	number	
STANDARD OF LIVING INDICATOR	Give the number of living Room/Armchair owned	B12	number	
STANDARD OF LIVING INDICATOR	Give the number of motorbikes owned	B13	number	
STANDARD OF LIVING INDICATOR	Give the number of tables owned	B14	number	
STANDARD OF LIVING INDICATOR	Give the number of bicycles owned	B15	number	
STANDARD OF LIVING INDICATOR	Give the number of hi fi/stereo system owned	B16	number	
STANDARD OF LIVING INDICATOR	Give the number of Computer/Tablet owned	B17	number	
STANDARD OF LIVING INDICATOR	Give the number of Solar panels	B18	number	

Page/Section	Question	Question Code	Type	Options
STANDARD OF LIVING INDICATOR	Give the number of Beds (with a foam mattress)	B19	number	
GENERAL INFORMATION ABOUT THE PLANTATION	How long have you been growing cocoa?		number	
GENERAL INFORMATION ABOUT THE PLANTATION	What are the two main sources you use to learn new techniques or solve a technical problem on your farm?	C12	multi-select	1 Personal experience/observation 2 Family 3 Exchange with other producers 4 Group of producers – to be specified 5 Technician/adviser for a project 6 Extension agent/agricultural adviser from Ministry services 7 Radio 8 Television 9 Newspapers 10 Traders 11 Demonstration site 19 Other
GENERAL INFORMATION ABOUT THE PLANTATION	Have you already benefited from training in cultivation techniques for cocoa in the last 5 years?	C13	single-select	1 Yes 2 No
GENERAL INFORMATION ABOUT THE PLANTATION	If so, which techniques?	C14	multi-select	C14a Nursery C14b planting C14c Harvest C14d Pruning C14e Pollination C14f Spraying C14g Shelling C14h Fertilizer spreading C14i Phyto treatment C14j Other
GENERAL INFORMATION ABOUT THE PLANTATION	Are you in a certification project	C15	single-select	1 Yes 2 No
GENERAL INFORMATION ABOUT THE PLANTATION	If yes which?	C16	single-select	C16a UTZ-RA C16b Do Trade C16c Ethical C16d Fairtrade C16e Cocoa Practices CP C16h Don't know C16g Other
GENERAL INFORMATION ABOUT THE PLANTATION	Are you a member of any farmer-based cooperative group?		single-select	Yes No
CREDIT AND TRANSFER INCOME	Have you borrowed money in the past 12 months?	C26	single-select	1 Yes 2 No
CREDIT AND TRANSFER INCOME	If so, from whom?	C27	multi-select	1 Bank 2 Microfinance 3 Cooperative 4 Trader 5 Exporter 6 Family/Friends 7 Input Credit 8 Money lenders 9 Other Purchasing Clerk
CREDIT AND TRANSFER INCOME	How much interest was charged on your loans on the average?	C28	number	
CREDIT AND TRANSFER INCOME	What collateral was required before you could assess the loan?	C29	multi-select	Land Cocoa farm Car House Other agricultural equipment Livestock None Other

Page/Section	Question	Question Code	Type	Options
ADOPTION OF GOOD FARM MANAGEMENT PRACTI	Do you currently have a bank account that you use to deposit money from cocoa or other farm sales?	C34	single-select	1 Yes 2 No 998 Don't know
ADOPTION OF GOOD FARM MANAGEMENT PRACTI	In the last 12 months, did you take out any crop insurance?	C35	single-select	1 Yes 2 No 998 Don't know
ADOPTION OF GOOD FARM MANAGEMENT PRACTI	Do you currently keep written record of the following?	C36	multi-select	1 Cocoa harvested and sold 990 Other crop harvested and sold Crop production expenses None Other
ACTIVITY SYSTEM AND HOUSEHOLD INCOME	In the past 12 months, what income-generating activities have you carried out?	D1	multi-select	daily or piecework agricultural work agricultural wage earner livestock (livestock or small livestock) trade (fixed shop) trade (itinerant) civil servant office work (except civil servant) employee personal services (domestic help cleaning, babysitting/vigil, etc.) transport (driver) company manager (transport, other formal company) employee of a company Other None
	ACTIVITY SYSTEM AND HOUSEHOLD INCOME		sub-form	
	In the past 12 months, income-generating activities have you carried out?	D1	single-select	daily or piecework agricultural work agricultural wage earner livestock (livestock or small livestock) trade (fixed shop) trade (itinerant) civil servant office work (except civil servant) employee personal services (domestic help cleaning, babysitting/vigil, etc.) transport (driver) company manager (transport, other formal company) employee of a company Other
	Specify for other		text	
	In the past 12 months, what is the units for the work on this task?	D3b	single-select	1 days 2 weeks 3 months
	In the past 12 months, how many days/weeks/months have you worked on this task?	D3a	number	
	What is the amount of the last payment received (GHS) for this work?	D4a	number	
	Monetary income over 12 months (GHS)	D5	number	
	Is the person paying you a member of the household?	D6	single-select	1 Yes 2 No
Non-Labor Earnings or Revenues in the Last 12 Mont	Select types of income	D7	multi-select	1 Retirement pension 2 Widow's pension 3 Invalidity pension 4 Maintenance pension 5 Other pension 6 Rent for dwelling house 7 Rent for agricultural land 8 Rent for rental of agricultural

Page/Section	Question	Question Code	Type	Options
				equipment (tractor, tiller, trailer, etc.) or non-agricultural (hi-fi, TV, car, trucks, etc.) 9 Transfer income ((money received by the household from a person not living in the household) None insyt_other Other
	Non-Labor Earnings or Revenues in the Last 12 Months		sub-form	
	Selected type of income	D7	single-select	1 Retirement pension2 Widow's pension3 Invalidity pension4 Maintenance pension5 Other pension6 Rent for dwelling house7 Rent for agricultural land8 Rent for rental of agricultural equipment (tractor, tiller, trailer, etc.) or non-agricultural (hi-fi, TV, car, trucks, etc.)9 Transfer income ((money received by the household from a person not living in the household)
	Number of payments in the last 12 months	D8	number	
	Total amount for all household members for the last 12 months (GHS)	D9	number	
	Relationship to sender	D10	single-select	1 Spouse 2 Child 3 Father or mother 4 Brother or sister 5 Other relative 6 Not related
	Place of residence of the sender	D11	single-select	1 Same locality 2 In the district 3 In the region 4 elsewhere in Côte d'Ivoire 5 In Burkina Faso 6 Ghana 7 Mali 8 Other African country 9 France 10 Other European country 11 Other
	Main reason for the transfer	D12	single-select	1 schooling 2 Illness 3 Routine support4 Field work support5 Non-agricultural business support6 Events7 Other
MODULE E - HOUSEHOLD LAND HOLDING	How many are operated by you or members of your household?	E2	number	
MODULE E - HOUSEHOLD LAND HOLDING	How many plots in your possession are used by other households?	E3	number	
MODULE E - HOUSEHOLD LAND HOLDING	How many parcels do you own today?	E1	calculation	
MODULE E - HOUSEHOLD LAND HOLDING	How many plots are operated on under a tenurial arrangement (Abunu, abusa, cash rent, etc.) but not owned?		number	
PLOT DETAILS	PLOT DETAILS		sub-form	

Page/Section	Question	Question Code	Type	Options
	Status of plots owned or used by household	plot_owners hip_status	single-select	1. Parcels of land owned and managed by household property 2. plots under different tenurial arrangements 3. Plots under different tenurial arrangements 4. plots not owned but managed under contract 5. plot owned but not cultivated by the household
	Parcel order number	ID_PARC	text	
	Name of the plot	F1a	text	
	location description	F1b	text	
	Describe type of contractual agreement		single-select	AbunuAbusaFixed cash paymentinsyt other Other
MODULE F	Where is the plot located?	F2a	single-select	1 Near the village 2 In another village of the district 3 In another district of the region, specify 4 In another region, specify 5 In another country, specify
MODULE F	In another district of the region, specify	F2b	text	
MODULE F	In another region, specify	F2c	text	
MODULE F	In another country, specify	F2d	text	
MODULE F	Type of tenurial arrangement	H2	single-select	1 Take in Sharecropping (Abusa) 1/3 - 2/3 2 Take in sharecropping (Abunu) 50-50 3 Rent in 4 Take in on loan (Delegation of parents free of charge) 5 Take in on loan (extra-family) 6 Land taken as collateral/pledge 7 take in "planting and sharing" (share of the plantation/trees) 8 take in "planting and sharing" (sharing of harvest products) 9 Other
MODULE F	Precisions/ Details about the tenurial arrangement	H3	text	
MODULE F	How many miles from your house is the plot?	F3	number	
MODULE F	How did you get this parcel?	F4	single-select	1 Purchase2 Inheritance to the head by family member 3 Inheritance to the spouse by family member 4 Definitive donation to the head by family member5 Definitive donation to the spouse by family member6 Cleaning free land (pioneer)7 Other
MODULE F	What are the main current land use on this parcel?	F6	single-select	1 Cocoa 2 Other Perennial crop 3 Cocoa and associated perennial crops 4 Lowland rice 5 Other Cereals (maize) 6 Tubers (Yam, Cocoyam, cassava, sweet potatoes) 7 Vegetables 8 Pastureland /Livestock 9 Fallow 10 Secondary Forest 11 Pasture 12 Mining 13 Other
MODULE F	If perennial crop excluding cocoa, specify	F7	multi-select	Coffee Cashew Rubber tree Palm

Page/Section	Question	Question Code	Type	Options
				Coconut tree insyt other Other
MODULE F	If food crop alone, specify	F8	multi-select	1 Cereals (Rice, Maize...), specify 2 Tubers (Yam, Cocoyam, Cassava, sweet potato, etc.), specify 3 Vegetables, 4 Other
MODULE F	If livestock alone	F9	multi-select	1 Poultry2 Cattle3 Sheep4 Goats5 Pigs6 Other
MODULE F	If Cocoa and associated perennial crops, Specify the associated crop below		text	
	What is its area (acres)? (declarative)	F1	number	
	What is the main document that can prove your rights to the plot?	F4	single-select	1 Land title obtained 2 Land title requested (procedure in progress) 3 Payment receipt 4 Indenture obtained 5 Indenture in progress 6 Commitment form 7 Tax receipt 8 Deed of sale signed with the former owner only 9 Deed of sale signed with the former owner and validated by an institution 10 Act of donation or testament 11 No written document
	Are you worried that your right will be challenged? (Land insecurity on the plot)	F7	single-select	1 Yes 2 No
	On the plots you currently own/work on, have you ever been in conflict?	F8	single-select	Yes No
	If so, with whom?	F9	single-select	1 A member of the family 2 A neighbor (non-family) 3 The former owner (non-family) 4 A laborer 5 A tenant/sharecropper insyt other Other
	If so, when?	F10	single-select	Before 80's80's. 90's 90's 2000's2010's2020's
	Is the conflict resolved today?	F11	single-select	1 Yes 2 No
	If yes, how were they resolved?	F12	single-select	1 Family 2 Courts 3 Chief 4 ADR
	If there is conflict on the land today, how do you intend to resolve it ?	F13	single-select	Family Courts ADR Chief Don't know
	If rent out – Price per year (if the contract is for multiple years, convert the price for one year.)	I5	number	
	Years of beginning of the contract	I7	number	
	Year of end of the contract	I8	single-select	999 not defined insyt other Other
	Does the lessee have the right to cut down trees?	I9	single-select	1 Yes 2 Yes, he just has to let me know before

Page/Section	Question	Question Code	Type	Options
				3 No, it's me who makes this type of decision
	Have you the right to cut down trees?	I14	single-select	1 Yes 2 Yes, he just has to let me know before 3 No, it's me who makes this type of decision
	Does the lessee have the right to decide alone to plant trees?	I10	single-select	1 Yes 2 Yes, he just has to let me know before 3 No, it's me who makes this type of decision
	Have the right to decide alone to plant trees?	I15	single-select	1 Yes 2 Yes, he just has to let me know before 3 No, it's me who makes this type of decision
MODULE G - Property 2 – plots under different tenu	What is the current use of land?	G2	single-select	1 Cocoa2 Perennial crop excluding cocoa3 Associated crops: perennial + Cocoa4 Associated crop: food crop + cocoa5 Associated crop: food crop + perennial + cocoa6 Other associated crops7 Food-producing cultures8 Fallow9 Livestock10 Uncultivated Forest; wasteland11 Pasture12 Farmyard for small breeding13 Mining14 Other, give details...15 Do not know
MODULE G - Property 2 – plots under different tenure	If perennial crop excluding cocoa (or associated), specify	G3	single-select	1 Coffee 2 Cashew 3 Rubber tree 4 Palm 5 Other
MODULE G - Property 2 – plots under different tenure	If food crop alone or associated, specify	G4	single-select	1 Rice 2 Corn 3 Yam 4 Cocoyam 6 Cassava 7 Pineapple 8 Other
MODULE G - Property 2 – plots under different tenure	If for animal rearing, specify	G5	single-select	1 Poultry 2 Cattle 3 Sheep 4 Goats 5 Pigs 6 Other
MODULE G - Property 2 – plots under different tenure	What is its area (acres)?	G6	number	
	Does the lessee have the right to cut down trees?	G24	single-select	YesYes, he just has to let me know beforeNo, it's me who makes this type of decisionNot applicable
	Does the lessee have the right to decide alone to plant trees?	G25	single-select	Yes Yes, he just has to let me know before No, it's me who makes this type of decision Not applicable
MODULE J - MAINTENANCE OF CULTIVATED COCOA PLOTS	In the last 12 months, what type of weeding did you do in the field?	J1	multi-select	1 Chemical 2 Manual 3 Mechanical 4 Both 5 None
MODULE J - MAINTENANCE OF CULTIVATED COCOA PLOTS	If chemical, how many times per year	J2	number	
MODULE J - MAINTENANCE OF	If manual, how many treatments in the last 12 months?	J3	number	

Page/Section	Question	Question Code	Type	Options
CULTIVATED COCOA PLOTS				
MODULE J - MAINTENANCE OF CULTIVATED COCOA PLOTS	In the last 12 months, have you used fungicides in this field?	J5	single-select	1 Yes 2 No
MODULE J - MAINTENANCE OF CULTIVATED COCOA PLOTS	If you used fungicide, how many treatments per year?	J6	number	
MODULE J - MAINTENANCE OF CULTIVATED COCOA PLOTS	What is the name of the fungicide?	J7	single-select	xxx Ridomil Gold Funguran-OH Kocide 2000 Nordox 75 WG Champion insyt other Other
MODULE J - MAINTENANCE OF CULTIVATED COCOA PLOTS	In the past 12 months, have you used insecticides in this field?	J8	single-select	1 Yes 2 No
MODULE J - MAINTENANCE OF CULTIVATED COCOA PLOTS	If insecticides, how many treatments per year?	J9	number	
MODULE J - MAINTENANCE OF CULTIVATED COCOA PLOTS	What is the name of the insecticide?	J10	single-select	LambdaKilsect Sampirtons Duraban Confidor TermicostAkate SuroDont knowinsyt_other Other
	In the last 12 months, what type of fertilizer have you applied on the field?	J11	single-select	Chemical Organic Both None insyt_other Other
	If chemical, how many applications per year?	J12	number	
	What is the name of the fertilizer?	J13	single-select	Asaase Wura Cocofeed Confidor Organic insyt_other Other
	If organic, how many applications per year?	J14	number	
MODULE I - COCOA CULTIVATION	Year of Establishment of Cocoa plot		number	
MODULE I - COCOA CULTIVATION	Area under production (not just the farm size)	M3	number	
MODULE I - COCOA CULTIVATION	Previous crop at the time of planting?	M4	single-select	Primary forest; Secondary Forest; Fallow Unproductive cocoa plantation Other perennial crop Specify question below Food crop, specify Livestock, specify Do not know Other
MODULE I - COCOA CULTIVATION	If land has other plantation of perennial crop in production, specify	M5	multi-select	1 Coffee 2 Cashew 3 rubber trees 4 palm tree 5 fruit trees 6 Timber 7 Coconut 8 Other Don't know
MODULE I - COCOA CULTIVATION	What variety of cocoa is planted on the plot?	M6	multi-select	1 Tetteh Quarshie 2 hybrids 3 Criollo 3 Amazonia 4 Don't knowinsyt other Other

Page/Section	Question	Question Code	Type	Options
	Does your cocoa field include	M7	multi-select	Trees Food crops None) pure stand cocoa only) None (pure stand cocoa only) insyt other Other
	There are trees in the field that were preserved when the cocoa farm was created	M8	single-select	1 Yes 2 No 3 Don't know
	Have you introduced trees into the field since the creation of the cocoa plantation?	M9	single-select	1 Yes 2 No
	Are there any trees you don't like that are left in your field	M11	single-select	Yes No
	If yes, why?	M12	single-select	because I don't have the right to cut it because I didn't have the time or the money to cut them because I expect to need wood because it doesn't bother me insyt other Other
	Does your farm include other types of trees?		single-select	Yes No
	If your cocoa farm includes other types of trees, which ones?		multi-select	Plantain Coffee Orange Mango Oil Palm Coconut Rubber Timber species None insyt other Other
Cocoa Production and Yield	What is the area of your cocoa farm that is in production (declarative or measured?).	M16	number	
Cocoa Production and Yield	If land has other plantation of perennial crop in production, specify	M16b	single-select	Coffee Cashew rubber trees palm tree fruit trees Timber Coconut Don't know insyt other Other
Cocoa Production and Yield	In which months of the year do you harvest?	M18	multi-select	January February March April May June July August September October November December
2022-PRODUCTION	Production during the major season in bags in 2021	M28	number	
2022-PRODUCTION	Production during the minor season in bags in 2022	M29	number	

Page/Section	Question	Question Code	Type	Options
2022-PRODUCTION	Selling price per bags during the major season 2021	M30	single-select	620 660
2022-PRODUCTION	Selling price per bags during the minor season 2022	M30	single-select	620 660
2022-PRODUCTION	Total revenue for major season 2021	2021_revenue	calculation	
2022-PRODUCTION	Total revenue for minor season 2022	2022_revenue	calculation	
Cocoa Conversion and Reconversion	In the last 12 months, have you cut down any of your cocoa tree(s)?		single-select	Yes No
Cocoa Conversion and Reconversion	If, yes, in the last 12 months, how much cocoa trees have you cut down?		number	
Cocoa Conversion and Reconversion	Why did you cut down your cocoa tree(s)?		single-select	1 Cocoa trees were too old / not producing 2 cocoa trees were diseased 3 cocoa trees were dead 4 Cocoa trees planted too close together 5 Land tenure problems/conflicts 6 Producing trees, but need space for another crop 7 Other
Cocoa Conversion and Reconversion	If yes, did you replace the cut cocoa trees?		single-select	1 No 2 Yes, to make room for new cocoa / rehabilitation of plot 3 Yes, To make room for other crops,
Cocoa Conversion and Reconversion	If replace for other crop, name		single-select	1 Coffee 2 Cashew 3 Rubber 4 Palm tree 5 Fruit trees 6 Timber 7 Coconut 8 Food crops 9 Other
Cocoa Conversion and Reconversion	In the last 12 months, how many new cocoa trees have you plant to replace older ones?		number	
Cocoa Conversion and Reconversion	Which variety?		single-select	1 Hybrid/AGRIC/New Variety 2 Local/Traditional Variety 3 Grafted Seedling 998 Don't know
Cocoa Conversion and Reconversion	In the last 12 months, have you cut down any perennial crops to plant cocoa tree(s)?		single-select	1 Yes 2 No
Cocoa Conversion and Reconversion	If yes, what perennial crop did you cut down?		single-select	CashewRubberPalm treeFruit treesTimberCoconutFood crops, specifyinsyt other Other
Cocoa Conversion and Reconversion	Why did you cut this perennial crop down to plant cocoa?		single-select	1 too old / not producing 2 diseased 3 dead 4 Other
Fertilizer	Select fertilizer type on this farm plot for last cocoa season 2021/2022		multi-select	A Asaase Wura B Cocofeed C Sidalco D Confidor E Organic None insyt_other Other

Page/Section	Question	Question Code	Type	Options
Fertilizer	Enter the Quantity of Asaase Wura fertilizer (bags)		number	
Fertilizer	Enter the Quantity of Cocofeed fertilizer (bags)		number	
Fertilizer	Enter the Quantity of Sidalco fertilizer (bags)		number	
Fertilizer	Enter the Quantity of Confidor fertilizer (bags)		number	
Fertilizer	Enter the Quantity of Organic fertilizer (bags)		number	
Fertilizer	Enter the Quantity of Others fertilizer (bags)		number	
Fertilizer	Enter the Price/unit (GHS) of Asaase Wura fertilizer		number	
Fertilizer	Enter the Price/unit (GHS) of Cocofeed fertilizer		number	
Fertilizer	Enter the Price/unit (GHS) of Confidor fertilizer		number	
Fertilizer	Enter the Price/unit (GHS) of Sidalco fertilizer		number	
Fertilizer	Enter the Price/unit (GHS) of Organic fertilizer		number	
Fertilizer	Enter the Price/unit (GHS) of others fertilizer		number	
Fertilizer	Total (GHS) of Asaase Wura fertilizer		calculation	
Fertilizer	Total (GHS) of Sidalco fertilizer input		calculation	
Fertilizer	Total (GHS) of Cocofeed fertilizer input		calculation	
Fertilizer	Total (GHS) of Confidor fertilizer input		calculation	
Fertilizer	Total (GHS) of Organic fertilizer input		calculation	
Fertilizer	Total (GHS) of other fertilizer input		calculation	
Pesticides	Select Pesticides input type on this farm plot for last cocoa season 2021/2022		multi-select	A Akate Master B Actara None insyt other Other
Pesticides	Enter the Quantity of Akate Master Pesticides input type		number	
Pesticides	Enter the Quantity of Actara Pesticides input type		number	
Pesticides	Enter the Quantity of Others Pesticides input type		number	
Pesticides	Enter the Price/unit (GHS) of Akate Master Pesticides input type		number	

Page/Section	Question	Question Code	Type	Options
Pesticides	Enter the Price/unit (GHS) of Actara Pesticides input type		number	
Pesticides	Enter the Price/unit (GHS) of Others Pesticides input type		number	
Pesticides	Total (GHS) of Akate Master Pesticides input type		calculation	
Pesticides	Total (GHS) of Actara Pesticides input type		calculation	
Pesticides	Total (GHS) of Others Pesticides input type		calculation	
Fungicides	Select Fungicides input type on this farm plot for last cocoa season 2021/2022		multi-select	1 Ridomil Gold2 Funguran-OH3 Kocide 20004 Nordox 75 WG5 ChampionNoneinsyt_other Other
Fungicides	Enter the Quantity of Ridomil Gold Fungicides input type		number	
Fungicides	Enter the Price/unit (GHS) of Ridomil Gold Fungicides input type		number	
Fungicides	Total (GHS) of Ridomil Gold Fungicides input		calculation	
Fungicides	Enter the Quantity of Funguran-OH Fungicides input type		number	
Fungicides	Enter the Price/unit (GHS) of Funguran-OH Fungicides input type		number	
Fungicides	Total (GHS) of Funguran-OH Fungicides input		calculation	
Fungicides	Enter the Quantity of Kocide 2000 Fungicides input type		number	
Fungicides	Enter the Price/unit (GHS) of Kocide 2000 Fungicides input type		number	
Fungicides	Total (GHS) of Kocide 2000 Fungicides input		calculation	
Fungicides	Enter the Quantity of Nordox 75 WG Fungicides input type		number	
Fungicides	Enter the Price/unit (GHS) of Nordox 75 WG Fungicides input type		number	
Fungicides	Total (GHS) of Nordox 75 WG Fungicides input		calculation	
Fungicides	Enter the Quantity of Champion Fungicides input type		number	
Fungicides	Enter the Price/unit (GHS) of Champion Fungicides input type		number	
Fungicides	Total (GHS) of Champion Fungicides input		calculation	
Fungicides	Enter the Quantity of Others Fungicides input type		number	

Page/Section	Question	Question Code	Type	Options
Fungicides	Enter the Price/unit (GHS) of Others Fungicides input type		number	
Fungicides	Total (GHS) of Others Fungicides input		calculation	
Herbicides	Select Herbicides input type on this farm plot for last cocoa season 2021/2022		multi-select	A Round up B Gramoxone None insyt other Other
Herbicides	Enter the Quantity of Round up Herbicides input type		number	
Herbicides	Enter the Price/unit (GHS) of Round up Herbicides input type		number	
Herbicides	Total (GHS) of Round up Herbicides input		calculation	
Herbicides	Enter the Quantity of Gramoxone Herbicides input type		number	
Herbicides	Enter the Price/unit (GHS) of Gramoxone Herbicides input type		number	
Herbicides	Total (GHS) of Gramoxone input		calculation	
Herbicides	Enter the Quantity of Others Herbicides input type		number	
Herbicides	Enter the Price/unit (GHS) of Others Herbicides input type		number	
Herbicides	Total (GHS) of Others Herbicides input		calculation	
Labour (Paid)	Select Labour (Paid) for input type on this farm plot for last cocoa season 2021/2022		multi-select	A Clearing /weeding B Pruning (including mistletoe) C Spraying: Fungicides D Spraying: pesticides E Spraying : Herbicides F Fertilizer Application G Harvesting H Transport of beans I Other Labour Cost None
Labour (Paid)	Enter the Quantity of Clearing /weeding Labour (Paid)		number	
Labour (Paid)	Enter the Price/unit (GHS) for Clearing /weeding Labour (Paid)		number	
Labour (Paid)	Enter the Quantity of Pruning (including mistletoe) Labour (Paid)		number	
Labour (Paid)	Enter the Price/unit (GHS) for Pruning (including mistletoe) Labour (Paid)		number	
Labour (Paid)	Enter the Quantity of Spraying: Fungicides Labour (Paid)		number	
Labour (Paid)	Enter the Price/unit (GHS) for Spraying: Fungicides Labour (Paid)		number	
Labour (Paid)	Enter the Quantity of Spraying: pesticides Labour (Paid)		number	

Page/Section	Question	Question Code	Type	Options
Labour (Paid)	Enter the Price/unit (GHS) for Spraying: pesticides Labour (Paid)		number	
Labour (Paid)	Enter the Quantity of Spraying: Herbicides Labour (Paid)		number	
Labour (Paid)	Enter the Price/unit (GHS) for Spraying: Herbicides Labour (Paid)		number	
Labour (Paid)	Enter the Quantity of Fertilizer Application Labour (Paid)		number	
Labour (Paid)	Enter the Price/unit (GHS) for Fertilizer Application Labour (Paid)		number	
Labour (Paid)	Enter the Quantity of Harvesting Labour (Paid)		number	
Labour (Paid)	Enter the Price/unit (GHS) for Harvesting Labour (Paid)		number	
Labour (Paid)	Enter the Quantity of Transport of beans Labour (Paid)		number	
Labour (Paid)	Enter the Price/unit (GHS) for Transport of beans Labour (Paid)		number	
Labour (Paid)	Enter the Quantity of Other Labour Cost Labour (Paid)		number	
Labour (Paid)	Enter the Price/unit (GHS) for Other Labour Cost Labour (Paid)		number	
Labour (Paid)	Total (GHS) for Clearing /weeding Labour (Paid)		calculation	
Labour (Paid)	Total (GHS) for Pruning (including mistletoe) Labour (Paid)		calculation	
Labour (Paid)	Total (GHS) for Spraying: Fungicides Labour (Paid)		calculation	
Labour (Paid)	Total (GHS) for Spraying: pesticides Labour (Paid)		calculation	
Labour (Paid)	Total (GHS) for Spraying: Herbicides Labour (Paid)		calculation	
Labour (Paid)	Total (GHS) for Fertilizer Application Labour (Paid)		calculation	
Labour (Paid)	Total (GHS) for Harvesting Labour (Paid)		calculation	
Labour (Paid)	Total (GHS) for Transport of beans Labour (Paid)		calculation	
Labour (Paid)	Total (GHS) for Other Labour Cost (Paid)		calculation	
	On the average how many days per week did you and your family (or any unpaid		number	

Page/Section	Question	Question Code	Type	Options
	labour) work on this plot in the 2021/2022 cropping season			
	How many hours per day did you and your family combined (or any unpaid labour) work on this plot in the 2021/2022 cropping season?		number	
Cocoa Sales	What are your main considerations for selling to a selected LBC?		single-select	ProximityAccess to cash and input loansRelationship with purchasing clerkBrand name integritymember of LBC grouppeer influenceinsyt_other Other
Cocoa Sales	Which LBCs did you sell to		multi-select	PBC Armajaro Olam Akufo Adamfo Kuapa Kooko Kumankuma insyt other Other
	State the farm related costs [GHS] on LAND RENT incurred in the past 12months on this plot		number	
	State the farm related costs [GHS] on MACHINERY REPAIRS/MAINTENANCE incurred in the 12months on this plot		number	
	State the farm related costs [GHS] on ACQUISITION OF PROPERTY/ASSETS incurred in the 12months on this plot		number	
	State the farm related costs [GHS] on ACQUISITION OF WORK TOOLS incurred in the 12months on this plot		number	
	State the farm related costs [GHS] on TRANSPORT incurred in the 12months on this plot		number	
	State the farm related costs [GHS] on OTHERS incurred in the 12months on this plot		number	
MODULE P: Small Tools	Small Tools	inventory	multi-select	Hoe Cutlass Pickaxe Sickle Shovel Hand Fork SawAxe Watering Can Wheelbarrow Weeder Knapsack sprayer Manual seeder Noneinsyt other Other
MODULE P: Small Tools	Inventory of Agricultural Equipment Used	inventory	sub-form	
	Small Tools	inventory	single-select	Hoe Cutlass Pickaxe sickle shovel Hand Fork

Page/Section	Question	Question Code	Type	Options
				Saw Axe Watering Can Wheelbarrow Weeder Knapsack sprayer Knapsack sprayer Manual seeder
	Quantity owned		number	
	Year Acquired		number	
	Acquisition mode		single-select	Purchased in cash Received as an inheritance Gift received from a project Donation received from family Self made
	Acquisition Unit Price		number	
	Total Amount (or Value at time of acquisition if not purchased) if		number	
	Condition When acquired		single-select	New Used/Secondhand
MODULE P: Mechanical Tools	Mechanical tools	mechanical tools	multi-select	Cart Plough Harrow Pen rollerOther animal traction equipment TractorMoto cultivatorMotor pump Other irrigation equipment Chainsaw Motor tractor Milking equipment Power tillerNoneinsyt other Other
MODULE Q -FOOD SECURITY	During which months of the year did you encounter difficulties in ensuring the household's staple food consumption?	FAS1	multi-select	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec None
MODULE Q -FOOD SECURITY	In total how many months?	FAS2	number	
MODULE Q -FOOD SECURITY	During which months of the year did you encounter difficulties which resulted in a reduction in the quantity consumed per day, compared to what you would have liked?	FAS3	multi-select	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec None
MODULE Q -FOOD SECURITY	In total how many months?	FAS4	number	
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, were you concerned that your household did not have enough food?	PFS1	single-select	NeverRarely (1 to 2 times) Sometimes (3 to 10 times)Often (more than 10 times)
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, have you or someone in your household been unable to eat the types of food you	PFS2	single-select	Never Rarely (1 to 2 times) Sometimes (3 to 10 times) Often (more than 10 times)

Page/Section	Question	Question Code	Type	Options
	prefer because of lack of resources?			
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, did you or someone in your household eat a limited variety of foods because of insufficient resources?	PFS3	single-select	Never Rarely (1 to 2 times) Sometimes (3 to 10 times) Often (more than 10 times)
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, did you or someone in your household eat food that you did not want to eat due to lack of resources to obtain other types of food?	PFS4	single-select	Never Rarely (1 to 2 times) Sometimes (3 to 10 times) Often (more than 10 times)
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, did you or someone in your household eat a smaller meal than you wanted because there was not enough food?	PFS5	single-select	Never Rarely (1 to 2 times) Sometimes (3 to 10 times) Often (more than 10 times)
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, did you or any member of your household eat fewer meals per day because there was not enough food?	PFS6	single-select	Never Rarely (1 to 2 times) Sometimes (3 to 10 times) Often (more than 10 times)
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, Has the household ever been completely without food because there were no resources to buy it?	PFS7	single-select	Never Rarely (1 to 2 times) Sometimes (3 to 10 times) Often (more than 10 times)
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, did you or any member of your household go to bed hungry because there was not enough food?	PFS8	single-select	Never Rarely (1 to 2 times) Sometimes (3 to 10 times) Often (more than 10 times)
MODULE R - Household Perception of Food Security (	Over the last 4 weeks, did you or any member of your household go all day and all night without eating because there was not enough food?	PFS9	single-select	Never Rarely (1 to 2 times) Sometimes (3 to 10 times) Often (more than 10 times)
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Cereals (Corn, rice, wheat, sorghum, millet and other cereal like or bread, noodles, porridge, spaghetti, biscuits, etc.)	SDAF_G1	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Roots, white tubers and plantain (White sweet potatoes, cassava, potatoes, yams or all white roots and tubers, plantain bananas)	SDAF_G2	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Vitamin-rich vegetables and tubers (Any food such as pumpkins, carrots, or sweet potatoes that has a yellow pigment, including local yellow corn)	SDAF_G3	single-select	1 Yes 2 No

Page/Section	Question	Question Code	Type	Options
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Dark green leafy vegetables (Dark green leafy vegetables as well as local vegetables including leaf amaranth, cassava, sweet potato, mustard, pumpkin, cowpea, bean, etc.)	SDAF_G4	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Other vegetables (Any leafy vegetables such as Chinese cabbage, cabbage, tomatoes, onions, green pepper and green beans, leeks, cucurbits)	SDAF_G5	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Fruits rich in vitamin A (Ripe mango, melon, apricot (fresh or dried), ripe papaya, dried peach and pure juice obtained from these same fruits)	SDAF_G6	single-select	1 Yes2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Offal (Meats of liver, kidney, heart, or other blood-based organs or foods.)	SDAF_G7	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Meat (muscle) (Any meat, e.g. beef, lamb, pork, goat, rabbit, mouse, wild game, poultry, duck, flying insects, etc..)	SDAF_G8	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Eggs (all sorts)	SDAF_G9	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Fish / seafood (fresh or dried)	SDAF_G10	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Beans, peas and lentils (Any type of beans and ground peas, cowpeas, soybeans)	SDAF_G11	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Nuts and seeds (Peanuts, pumpkin seeds, sunflower seeds, cashews, macadamia nuts)	SDAF_G12	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Milk and dairy products (Milk and milk-based foods such as yogurts and cheeses)	SDAF_G13	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Oils and fats (Such as cooking oil, animal fats and margarine used for cooking or added to food)	SDAF_G14	single-select	1 Yes 2 No
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Sweets (Any sweet product, sugar, honey, soft drinks (Fanta, coca cola, sprite) drinks to which such a product has been added or sweet food, chocolate, sweets)	SDAF_G15	single-select	1 Yes2 No

Page/Section	Question	Question Code	Type	Options
MODULE S - WOMEN'S DIETARY DIVERSITY (WDDS)	Spices, condiments, drinks (Spices (black pepper, salt), condiments, hot sauce, Any tea or coffee.)	SDAF_G16	single-select	1 Yes 2 No
MODULE T - Migratory Trajectory of the FARMER	Your father was born in:	T1	single-select	1 This village 2 A nearby village 3 This district 4 Another district in the region, specify 5 another region, specify 6 Another country, specify 8 Don't Know
MODULE T - Migratory Trajectory of the FARMER	Another district in the region, specify	T1a	text	
MODULE T - Migratory Trajectory of the FARMER	Another region, specify	T1b	text	
MODULE T - Migratory Trajectory of the FARMER	Another country, specify	T1c	text	
MODULE T - Migratory Trajectory of the FARMER	Ethnic group of father?	T2	single-select	1 Akan 2 Ewe 3 Ga Adangbe 4 Guan 6 Mole Dagani 7 Other
MODULE T - Migratory Trajectory of the FARMER	Your mother was born in:	T3	single-select	1 This village 2 A nearby village 3 This district 4 Another district in the region, specify 5 another region, specify 6 Another country, specify 8 Don't Know
MODULE T - Migratory Trajectory of the FARMER	Another district in the region, specify	T3a	text	
MODULE T - Migratory Trajectory of the FARMER	Another region, specify	T3b	text	
MODULE T - Migratory Trajectory of the FARMER	Another country, specify	T3c	text	
MODULE T - Migratory Trajectory of the FARMER	Ethnic group of mother?	T4	single-select	1 Akan 2 Ewe 3 Ga Adangbe 4 Guan 6 Mole Dagani 7 Other
	Are you a native of this village	T5	single-select	1 Yes 2 No
	If the respondent is not native to the village, place of birth:	T6	single-select	1 Other village in the locality 2 This district 3 This region 4 in Ivory Coast 5 In Burkina Faso 6 Ghana 7 Mali 8 Other
	Last migratory experience (before settling here) - Before arriving here, did you live	T7	single-select	1 In the locality 2 In this district 3 in this region 4 in Ivory Coast 5 In Burkina Faso 6 Ghana 7 Mali 8 Other country, specify

Page/Section	Question	Question Code	Type	Options
	How many times have you migrated in your life before settling here?	T8	number	
	If not native, year of settlement (habitat) here?	T9	number	
	Are you a native of another country?		single-select	Yes No
	If native of another country, year of arrival in Ghana?	T10	number	
	Year of starting an economic activity in this village	T11	number	
	When you arrived, did you know anyone in the village?	T12	single-select	1 Yes 2 No
	If yes, who?	T13	single-select	1 immediate family 2 Close family of the spouse(s) 3 distant relatives 4 Distant relatives of the spouse(s) 5 An acquaintance from my region of origin 6 Other
	Did this knowledge (person you knew) give you work?	T14	single-select	1 Yes 2 No
	Main reason for migration	T15	single-select	1 Economic reason (related to agriculture) 2 Economic reason (unrelated to agriculture) 3 Crisis/conflict 4 Followed husband/wife 5 Other family reunification 6 Other
	In the last 12 months have you sent money to your village/country of origin?	T16	single-select	1 Yes 2 No
	How many times in the last 12 months?	T16b	single-select	1 2 3 4 5 6 7 8 9 10 11 12
	If yes, total amount per year (in GHS)?		number	
	In the past 12 months, who have you sent money to? (Two possible answers)	T17	multi-select	1 To yourself on an account (bank or telephone) in your village/country 2 Family 3 Friend 4 Creditors 5 Other
	If you sent money to the family, to whom?	T18	single-select	1 Father 2 Mother 3 Brothers 4 Sister 5 Son 6 Daughter 7 Uncle/aunt/nephews/, Other family of father 8 Parents-in-law

Page/Section	Question	Question Code	Type	Options
				9 Brothers/sisters-in-law 10 Other family of mother
	If agricultural investment in the village, is the money earned here used to finance cocoa farming?	T21	single-select	1 Yes 2 No
MODULE U- AGRICULTURAL PRODUCTION (PERENNIAL CROP)	Over the past 12 months, what have been the main agricultural productions from perennial crops?	agric_produce	multi-select	1= Rubber 2= African palm Oil palm 3= Cashew 4= Coconut , 5=Orange, Orange, 6=Avocado 7=Coffee None insyt other Other
	Agricultural Production (Perennial Crops)	agric_produce	sub-form	
	Over the past 12 months, what have been the main agricultural productions from perennial crops?	agric_produce	single-select	1= Rubber , 2= African palm , 3= Cashew 4= Coconut , 5=Orange, 6=Avocado 7=Coffee Other
	Who manages this culture within the household?		single-select	1= head of household ; 2=spouse 3= child 4=Other member of the household5= the couple; 6=all household members together; 7=Sharecropper; 8=Salaried crop manager; 9=other other
	Total area in production		number	
	Year of Establishment of productive area		number	
	Estimated proportion of produce sold %		single-select	1=100% marketed; 2=3/4 marketed; 3=50/50; 4=1/3 marketed 4=1/4 marketed; 5=less than a quarter of production is marketed 6=no marketing, own consumption no marketing, own consumption
	Quantity produced (sold + self-consumed) (last 12 months)		number	
	Unit of Quantity sold		multi-select	kg bags insyt other Other
	Quantity sold price per (GHS)		number	
	Annual Revenue	annual revenue	calculation	
	What was the total number of bags of fertilizer purchased for this production		number	
	What was the total amount (GHS) spent on fertilizer		number	
	What was the quantity (lts) of pesticide purchased?		number	

Page/Section	Question	Question Code	Type	Options
	What was the total amount (GHS) spent on pesticide?		number	
	What was the quantity (Its) of insecticide purchased?		number	
	What was the total amount (GHS) spent on insecticide?		number	
	What was the quantity (Its) of fungicides purchased?		number	
	What was the total amount (GHS) spent on fungicides?		number	
	What was the quantity (Its) of other agrochemicals purchased?		number	
	What was the total amount (GHS) spent on agrochemicals?		number	
	Amount spent on inventory/consumables /materials		number	
	Amount spent on labour		number	
	Amount spent on utilities (water, electricity, sanitation)		number	
	Amount spent on transport (for business purposes only)		number	
	Amount spent on maintenance/repairs		number	
	Amount spent on rentals		number	
	Amount spent on other expenses		number	
MODULE V - AGRICULTURAL PRODUCTION (FOOD CROPS)	Over the past 12 months, select the main agricultural productions from food crops?	food_crop_type	multi-select	1 rice 2 Plantain 3 Yam 4 Cassava 5 Vegetables None insyt_other Other
	Fill in selected agricultural productions from food crops	food crop	sub-form	
	Over the past 12 months, select the main agricultural productions from food crops?	food_crop_type	single-select	1 rice 2 Plantain 3 Yam 4 Cassava 5 Vegetables
	Who manages this production within the household?		single-select	1 head of household 2 spouse of the head 3 child 5 the couple 6 all household members together 7 Sharecropper 8 Salaried crop manager 9 Other 4 Other member of the household
	Estimated proportion of produce sold %		single-select	1 100% marketed 2 3/4 marketed 3 50/50 4 1/3 marketed

Page/Section	Question	Question Code	Type	Options
				5 ¼ marketed 6 less than a quarter of production is marketed 7 no marketing, own consumption
	Area in production		number	
	Units produced		multi-select	kg bags insyt other Other
	Quantity sold		number	
	Unit price		number	
	Annual Revenue	annual_revenue_2	calculation	
	What was the total number of bags of fertilizer purchased		number	
	What was the total amount (GHS) spent on fertilizer		number	
	What was the quantity (Its) of pesticide purchased?		number	
	What was the total amount (GHS) spent on pesticide?		number	
	What was the quantity (Its) of insecticide purchased?		number	
	What was the total amount (GHS) spent on insecticide?		single-select	
	What was the quantity (Its) of fungicides purchased?		single-select	
	What was the total amount (GHS) spent on fungicides?		single-select	
	What was the quantity (Its) of other agrochemicals purchased?		single-select	
	What was the total amount (GHS) spent on agrochemicals?		number	
	Amount spent on inventory/consumables /materials		number	
	Amount spent on labour		number	
	Amount spent on utilities (water, electricity, sanitation)		number	
	Amount spent on transport (for business purposes only)		number	
	Amount spent on maintenance/repairs		number	
	Amount spent on rentals		number	
	Amount spent on other expenses		number	
MODULE W - AGRICULTURAL PRODUCTION (LIVESTOCK)	Over the past 12 months, select the main agricultural productions from livestock?	livestock_type	multi-select	1 Poultry2 Cattle3 Sheep4 Goats5 Pigs6 Non-traditional animalsNone
MODULE W - AGRICULTURAL	Fill in selected agricultural	livestock_type	sub-form	

Page/Section	Question	Question Code	Type	Options
PRODUCTION (LIVESTOCK)	productions from livestock			
	Over the past 12 months, select the main agricultural productions from livestock	livestock_type	single-select	1 Poultry 2 Cattle 3 Sheep 4 Goats 5 Pigs 6 Non-traditional animals
	Who manages this production within the household?		single-select	1 head of household 2 spouse of the head 3 child 5 the couple 6 all household members together 7 Sharecropper 8 Salaried crop manager 9 Other 4 Other member of the household
	Estimated proportion of produce sold %		single-select	1 100% marketed 2 3/4 marketed 3 50/50 4 1/3 marketed 5 1/4 marketed 6 less than a quarter of production is marketed 7 no marketing, own consumption
	Quantity produced		number	
	Units sold		number	
	Unit price		number	
	Annual revenue	annual_revenue_sold	calculation	
	What was the total amount spent on feed		number	
	What was the total amount spent on vaccinations		number	
	What was the total amount spent on medications		number	
	What was the total amount spent on animal supplements and concentrates		number	
	Amount spent on labour		number	
	Amount spent on utilities (water, electricity, sanitation)		number	
	Amount spent on transport (for business purposes only)		number	
	Amount spent on maintenance/repairs		number	
	Amount spent on rentals		number	
	Amount spent on other expenses		number	
Non-Agricultural Income	In the past 12 months, have you had any non-agricultural income?		single-select	Yes No
Non-Agricultural Income	Fill in selected non-agricultural income		sub-form	
	Over the past 12 months, select the main nonagricultural income?		single-select	Trading Small scale mining Artisan/craft Provision of labour Motor/taxi driver Rental income Bartering/Hardressing

Page/Section	Question	Question Code	Type	Options
				Barbering/Hairdressing Tailoring/Dressmaking None insyt_other Other
	Who manages this production within the household?		single-select	Head of Household Spouse Child Other household member salaried manager insyt_other Other
	Estimated average monthly sales (GHS)		number	
	Amount spent on inventory/consumables /materials		number	
	Amount spent on labour		number	
	Amount spent on utilities (water, electricity, sanitation)		number	
	Amount spent on transport (for business purposes only)		number	
	Amount spent on maintenance/repairs		number	
	Amount spent on rentals		number	
	Amount spent on other expenses		number	
	Total expenses	total expense C37	calculation	
MODULE X - IDENTIFICATION OF SHOCKS	DOMESTIC SHOCKS - Identify major changes in the daily life of the household over the past 3 years.		single-select	Yes No
MODULE X - IDENTIFICATION OF SHOCKS	Select all major changes in the daily life of the household over the past 3 years.	C2	multi-select	C2a A death of one or more household members C2b Illness or serious accident of one or more members of the household C2c Birth C2d Divorced C2e Departure of one or more children C2f Other
PRODUCTION SHOCK	Over the past 3 years, have you experienced any exceptional events that have had a significant impact on your cocoa farm?	C38	single-select	1 Yes 2 No
PRODUCTION SHOCK	Select all exceptional events that have had a significant impact on your cocoa farm?	C3	multi-select	C3a Wandering of animals involving notable lossesC3b Tree felling by loggers involving lossesC3c Swollen ShootC3d Other cocoa pests/pestsC3e Fire in the plantationC3f Severe droughtC3g Significant floodingC3h Lag in the seasons (late rains) having an effect on productioninsyt_other Other
OTHER ECONOMIC SHOCK	Over the last 3 years, has your household suffered an event that has had a negative and lasting effect on the operation?	C39	single-select	1 Yes 2 No
OTHER ECONOMIC SHOCK	Select all economic shock your household	C4	multi-select	C4a Loss of family labor (departure, illness, accident, death)

Page/Section	Question	Question Code	Type	Options
	suffered an event that has had a negative and lasting effect on the operation?			C4b Exceptional loss of money (theft, repayment of debt or other) C4c Investment in other activities that has had a negative and lasting effect on the operation? C4d Reduced activity related to old age C4e Land conflict C4f Lack of labor (or significant increase in its cost) C4g Rising input prices C4h Other
OTHER ECONOMIC SHOCK	Over the past 3 years, has an exceptional event positively affected operation?	C40	single-select	1 Yes 2 No
OTHER ECONOMIC SHOCK	If so, what event? Specify in full	C41	text	
MODULE X - DISEASE PODS – BLACK POD AND SWOLLEN SH	Which of these types of Disease/problems did you find in your cocoa plantations?	disease pods	multi-select	Stem borer diseaseCapsid CSSVBlackpodMistletoeTermitesinsyt _other Other
MODULE X - DISEASE PODS – BLACK POD AND SWOLLEN...	Black Pod and Swollen Shoot Virus	disease pods	sub-form	
	For how many years have you had this problem?		number	
	What do you do when you find this disease/problem on your farm		single-select	A) 1= Remove the pods from the farm and bury them; Remove the pods from the farm and bury them; 2= Remove the pods from the farm and burn them Remove the pods from the farm and burn them 3= Bury the pods on my farm Bury the pods on my farm 4= Burn the pods on my farm; Burn the pods on my farm; 5= Remove pods from the trees and leave them on the ground Remove pods from the trees and leave them on the ground 6= Leave the pods on the trees Leave the pods on the trees 7= Spray with Agrochemicals Spray with Agrochemicals 8= No diseased pods No diseased pods Don't know Cut down affected trees
	How much of the farm is affected		single-select	1 - 25% 26 - 50% 51 - 75% 76 - 100%
	How many plots		number	
	Which ones		text	
MODULE Y - OTHER DISASTERS	Type Disease/Problem	other disasters	multi-select	Theft Damage as a result of lumbering Weather related disasters eg. flood, drought. None insyt other Other
OTHER DISASTERS	Other Disasters	other disasters	sub-form	
	What do you do when you find these problems on your farm		single-select	1= Report to the Police; 2= Report to the Forestry Commission 3= Invite National Disaster Management Organization 4= Burn the pods on my farm; 5= Remove pods from the trees and leave them on the ground 6= Leave

Page/Section	Question	Question Code	Type	Options
				the pods on the trees 7= Spray with Agrochemicals 8= No diseased pods 998= Don't know Report to the Police 2= Report to the Forestry Commission Report to the Forestry Commission 3= Invite National Disaster Management Organization Invite National Disaster Management Organization 4= Burn the pods on my farm; Burn the pods on my farm 5= Remove pods from the trees and leave them on the ground Remove pods from the trees and leave them on the ground 6= Leave the pods on the trees Leave the pods on the trees 7= Spray with Agrochemical Spray with Agrochemicals No diseased pods Don't know Report to chief or community leader Do nothing insyt_other Other
	How much of the farm is affected		single-select	1-25% 26-50% 51-75% 76-100%
	How many plots		number	
MODULE Z: Climate Change Perception	Have you noticed any long-term changes (≥ 20 years) in temperature?	Z1	single-select	1 Yes 2 No 998 Don't know
MODULE Z: Climate Change Perception	If yes please indicate the changes you observed on temperature	Z2	multi-select	Z2a Increase of average temperature Z2b Decrease of average temperature Z2c Increase of the minimum level compared to the last 2 decades Z2d Decrease of the minimum level compared to the last 2 decades Z2d Increase of the maximum level compared to the last 2 decades Z2e Decrease of the maximum level compared to the last 2 decades Z2e Refused to answer 998 Don't know
MODULE Z: Climate Change Perception	Have you noticed any long-term changes (i.e. ≥ 20 years) in rainfall?	Z3	single-select	1 Yes 2 No 998 Don't know
MODULE Z: Climate Change Perception	If yes please indicate the changes you observed on rain	Z4	multi-select	Z4a Increase of the variability of the rain Z4b Decrease of the variability of the rain Z4c Late rain Z4d Early rain Z4e Increase of the intensity of rain Z4f Decrease of the intensity of rain Z4g Increase of average rainfall Z4h Decrease of average rainfall Z4i Increase of minimum rainfall Z4j Decrease of the minimum rainfall Z4k Increase of maximum rainfall Z4l Decrease of maximum rainfall
MODULE Z: Climate Change Perception	Have these changes had any effect on your livelihood in terms of losses incurred in the past (5-10 years)	Z5	single-select	1 Yes 2 No 998 Don't know
MODULE Z: Climate Change Perception	If yes indicate the extent to which climate variability is responsible for	Z6	single-select	Z6a 1-25% Z6b 26-50% Z6c 51-75% Z6d 76-100%

Page/Section	Question	Question Code	Type	Options
	reduced income in your household			
MODULE Z: Climate Change Perception	Have you experienced flooding, drought or any natural disaster in the past (5-10years)	Z7	single-select	1 Yes 2 No 998 Don't know
MODULE Z: Climate Change Perception	How many times have you experienced flooding	Z8a	number	
MODULE Z: Climate Change Perception	How many times have you experienced drought	Z8b	number	
MODULE Z: Climate Change Perception	Did you receive any warning about the aforementioned disaster before it happened?	Z9	single-select	1 Yes 2 No 998 Don't know
	Was any one in your household injured during those events?	Z10	single-select	1 Yes2 No
	Did any member in your household die during those events?	Z11	single-select	1 Yes 2 No
	Were you displaced from your home during this event?	Z12	single-select	1 Yes 2 No
	If yes, where did you go to?	Z13	single-select	Z13a Friends' Z13b Relations Z13c Neighbors Z13d Refugee camp insyt other Other
	Has this event had any effect on your livelihood in terms of losses incurred in the past (5-10years)	Z14	single-select	1 Yes 2 No
	If yes indicate the extent to which these events are responsible for reduced income in your household	Z15	single-select	Z15a 1-25% Z15b 26-50% Z15c 51-75% Z15d 76-100%
	Do you get information from the media on climate change variations?	Z16	single-select	1 Yes 2 No
	What media channels do you use to obtain general information?	Z17	multi-select	Local Radio National Radio TV Mobile phones Newspaper Magazine SMS Services Internet Social media insyt other Other
	Do you think the government is adequately helping farmers to adjust to impact of climate change?	Z18	single-select	1 Yes 2 No
	What should be done by the government to help address climate change on your farming activities?	Z19	multi-select	Timely information/education for farming activities Provide more inputs to increase production Provide credit Provide drought resistant seeds/crops for planting insyt other Other
LEVEL OF AGREEMENT	The weather is changing	X20a	single-select	1 Strongly disagree 2 disagree 3 Neither agree nor disagree

Page/Section	Question	Question Code	Type	Options
				4 Agree 5 Strongly agree
LEVEL OF AGREEMENT	Change in weather will induce increase of temperature and decrease of rainfall	X20b	single-select	1 Strongly disagree 2 disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree
LEVEL OF AGREEMENT	Change in weather will increase the variability of precipitation	X20c	single-select	1 Strongly disagree 2 disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree
LEVEL OF AGREEMENT	Change in weather will reduce the availability of water	X20d	single-select	1 Strongly disagree 2 disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree
LEVEL OF AGREEMENT	Change in weather will increase land erosion	X20e	single-select	1 Strongly disagree 2 disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree
LEVEL OF AGREEMENT	Change in weather will increase the likelihood of drought and flood	X20f	single-select	1 Strongly disagree 2 disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree
LEVEL OF AGREEMENT	Change in weather will affect agricultural production	X20g	single-select	1 Strongly disagree 2 disagree 3 Neither agree nor disagree 4 Agree 5 Strongly agree
	What recommendations would you make for enhancing farmer's adaptation to climate change? (tick all that apply)	X21	multi-select	1 Avoid deforestation 2 Avoid bush burning 3 Plant more trees 4 Less use of agro-chemicals 5 Desist galamsey 6 Plant soil cover crops 7 Practice diversification. 8 Other



Appendix II: Focus Group Discussion checklist

Seasonality, Climate Change and Food Security among Cocoa Farming Households in Western and Ashanti Cocoa Regions of Ghana

December, 2022

Focus Group Discussion/Key Informant Guide Questions

Community/Name: District: Region:
..... Date: Time:

Introduction

Greetings and welcome. Thank you for taking the time to join the discussion. My name is Nana Anima Akrofi and I will serve as the documentor for today's focus group discussion. Assisting me is Japhet who will serve as the moderator. The purpose of the discussion is to better understand how seasonality in cocoa production and climate change affect food security in your area. You were invited because you have direct experience and knowledge on these issues in your areas. There are no right or wrong answers to the questions I am about to ask. We expect that you will have differing points of view. Please feel free to share your point of view even if it differs from what others have said. If you want to follow up on something that someone has said, you want to agree, disagree, or give an example, feel free to do that. Don't feel like you have to respond to me all the time. Feel free to have a conversation with one another about these questions. I am here to ask questions, listen, and make sure everyone has a chance to share their opinions. We are interested in hearing from each of you, so if you're talking a lot, I may ask you to give others a chance. And if you aren't saying much, I may call on you. We just want to make sure we hear from all of you. We will be taking notes to help us remember what is said. We are also tape recording the session because we don't want to miss any of your comments. We will also ask you to put your ID (Ghana/Voter's) card so we'll be able to better converse with you, but no names will be included in our reports. So, do you have any question? If not, then let's start.

Question	Response
1. I will like to know: a. In which months is cocoa harvested most? b. In which month is cocoa least in season? c. In which months is the Dry season? d. In which months is the Wet season?	<i>This is to gather the seasonal calendar in the production are.</i>
2a. What are the estimated number of the households in the area? b. What are the estimated number of female-headed households in the area?	

3a. Is there sufficient food in the community all year round? If seasonal, please explain further? What are the main sources of food? b. Can everyone access the available food? Explain further.	<i>To bring to the surface all the main issues related to food security in the community. The issues that participants will raise during this first question will help guide the rest of the discussions.</i>
4. What is a typical diet of people in the community? How frequent do people eat in a day? How many of these are prepared and eaten at home? And how many are consumed outside the home? <u>PROBE:</u> A. Breakfast B. Lunch C. Dinner D. Snacks	<i>To gain insight on people's typical nutritional intake per day, frequency of food intake and intra/extra household food consumption.</i>
5. How much does a typical diet cost? <u>PROBE:</u> A. Breakfast B. Lunch C. Dinner D. Snacks	<i>To gather information related to food access, food expenditure, livelihoods and nutrition. For example, depending on how much people are spending on meals everyday can give us an idea of their livelihoods and how much of their income is actually spent on food. If they are spending very little on food, this is additional information to further understand their nutrition status, i.e., if they are eating the minimum required calories/day.</i>
6a. Who usually does the cooking in the household? b. Is food cooked every day? If not why? c. In which months are there usually skips from cooking at home?	
7. What are the main sources of income in the community? a. How much do people (refer to the main activities) earn in a day? b. Normally, what age do people start working? How many typically work in a family? c. When income activities are not sufficient to provide for yourself or your family, what do you or members of the community do in this case? d. How would you describe the poorest people in your neighborhood?	<i>To get an idea on the main economic activities in the area; estimate the daily wage of the people involved in these economic activities; how old they are and how many members are contributing productively to the family. We are also looking here at livelihood coping strategies and the main characteristics of the urban poor. The data on daily wage can be compared with the official poverty and food thresholds.</i>
8. What are the issues/factors that affect food availability and accessibility in the community? a. How would you describe the food insecure in your community and why do you think people in your community are food insecure?	<i>To understand the main drivers of food insecurity and malnutrition, and the main characteristics of the food insecure in the community.</i>

9. What are the typical challenges that you face in this community? Could you tell us more on the challenges you encounter? A. Flooding/Drought/Erratic climate B. Increasing prices (food, energy, etc.) C. Earthquake D. Pests and diseases	<i>To gain insight on the main challenges people face on accessing basic services such as health and education.</i>
10. Have you experienced any negative impacts from climate change in your cocoa plantations? E.g., Floods/drought, pests and diseases, extreme winds, heat? a. Have these climate change impacts affected your cocoa production? (<i>Inquire about changes in types of activities done by women or in time or resources for existing activities</i>)	<i>To understand what people, identify as main hazards in their community, and how vulnerable they consider themselves to these hazards based on their location or other factors that they will raise during the discussion. Can be cross checked with the hazard map of Metro Manila.</i>
11. How have these impacts of climate change affected families in your area? (<i>Inquire about income, if they have new economic activities, changes in family dynamics</i>)	<i>To establish the level of knowledge of the people in the community on what to do in case of the occurrence of a natural disaster. Can be cross checked with standard operating procedure being advocated by the government. Understand how people would react in the event of a natural hazard, where would they first go (e.g. nearest evacuation centers).</i>
12. What worries you most about the impacts of climate change on your crops (e.g., yields, production, access to inputs, etc.)? a. How would that affect a) your food availability and accessibility, b) livelihoods? b. How do you address these impacts when they happen? And in your opinion, which one is the best strategy?	<i>The question has three objectives, namely: (a) To generate answers that will describe the impact of climate change hazards on food security and livelihood; (b) To understand the coping mechanisms that community applies in the event that typical situation in the area deteriorates and (c) To identify which are the best strategies to address multi-hazard scenarios.</i>
13. Is there anything else you would like to say or discuss about seasonality, food security, and climate change in your area?	<i>To generate information that are of utmost importance to the participants to discuss but which the research team might have missed and/or overlooked when preparing the initial list of questions</i>

