UNIVERSITY FOR DEVELOPMENT STUDIES

THE EFFECT OF LIVELIHOOD RESTORATION TRAINING FROM LARGE-SCALE LAND ACQUISITION OWNERS ON SMALLHOLDER FARMER'S LIVELIHOODS IN THE TALENSI DISTRICT OF GHANA

AKUGRE AYINEMI

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FACULTY OF AGRICULTURE, FOOD AND CONSUMER SCIENCES

DEPARTMENT OF AGRICULTURAL AND FOOD ECONOMICS

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BY

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THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL AND FOOD ECONOMICS, FACULTY OF AGRICULTURE, FOOD AND CONSUMER SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY IN AGRICULTURE ECONOMICS

OCTOBER, 2025

DECLARATION

Student

I, Akugre Ayinemi, hereby declare that this thesis is the result of my own research work. Except where references to the work of other researchers have been duly acknowledged, no part of this thesis has been presented, in whole or in part, for any other degree or qualification elsewhere.

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Supervisors' Declaration

We hereby declare that the preparation and presentation of the dissertation was supervised in accordance with the guidelines on the supervision of a dissertation laid down by the University for Development Studies.

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ABSTRACT

Large-scale land acquisitions in Ghana have profoundly affected natural resources and the livelihoods of rural farm households. These acquisitions often lead to reduced access to arable land and disrupt traditional farming practices, creating challenges for household food security and farm income sustainability. This study examined the effect of livelihood restoration training from owners of LSLAs on household food security and farm income, and the factors influencing coping strategies adopted by the affected households. A sample size of 400 households were selected through a multistage sampling technique.

An endogenous treatment regression model was used to analyze the effect of livelihood restoration training on household food security and farm income. A multivariate probit model was used to examine the determinants of coping strategies.

The results revealed that participation in livelihood training increases household food security and farm income. Furthermore, the results from the multivariate probit regression showed that the factors that influence the adoption of coping strategies include household size, access to credit, age of household head, farming experience, relative in leadership position, FBO membership, LSLA training and others.

These findings emphasized the importance of livelihood training in improving welfare among affected households in the Talensi District. The study recommends that the Ministry of Land and Natural Resources, the District Assembly and the LSLA owners expand and intensify programs focused on providing livelihood recovery capacity-building training to more affected households.

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DEDICATION

I dedicate this work to Almighty God in gratitude for his unwavering protection and guidance throughout my journey. His presence has been a source of strength and inspiration, illuminating my path and helping me overcome challenges. I am truly thankful for the blessings I have received and for the wisdom that has guided my decisions.

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LIST OF ACRONYMS

MoFA	Ministry of Food and Agriculture
NGOs	Non-Governmental Organization
LSLAs	Large-Scale Land Acquisitions
LSLA	Large-Scale Land Acquisition
FBO	Farmer-Based Organization
CRS	Corporate Social Responsibility
FCS	Food Consumption Score
SLF	Sustainable Livelihood Frame Work
DFID	Department for International Development
TSPs	Transformation Structures and Processes
HDDS	Household Dietary Diversity Score
HFCS	Household Food Consumption Score
HHS	Household Hunger Scale
HFIAS	Household Food Insecurity Access Scale
SD	Standard Deviation
LR	Likelihood Ratio
FAO	Food and Agriculture Organization
ETRM	Endogenous Treatment Regression Model
RA	Regression Adjustment
WFP-	World Food Program
ATE-	Average Treatment Effect
ATET	Average Treatment Effect on The Treated

MVP	Multivariate Probit
CSI	Coping Strategy Index
SSA	Sub-Saharan Africa

CHAPTER ONE

INTRODUCTION

1.1 Background

Large-scale land acquisitions are defined as land acquisitions covering an area of at least 20.23 hectares (50 acres) (Lands Commission, 2016). These large-scale land acquisitions (LSLAs) have increased globally, especially in Africa, Latin America, and Southeast Asia, driven by factors such as rising global demand for farmland, extractive industries, biofuels and the 2007-2008 global food crisis (Cotula, 2012; Schoneveld, 2014).

The Land Matrix Analytical Report III shows that 1,865 transnational agricultural land transactions were recorded in the global Land Matrix database, out of which 1,560 were concluded, covering a total of about 33 million hectares (Land Matrix, 2021) .Recent studies of the Land Matrix database indicate that slightly more than one-third of all final global LSLAs are found in SSA, where insecure tenure and high agricultural potential constitute a combination of favourable conditions for large-scale investments (Nolte et al., 2016). For SSA, West Africa has been a specific hotspot (Nolte et al, 2024). Recent subregional estimates by the Food and Agriculture Organization (FAO) indicate that Ghana, Sierra Leone, and Liberia collectively represent more than 2.5 million hectares of reported large-scale agricultural transactions (FAO, 2021) . These statistics offer both the extent and geographical focus of current LSLA activity.

Ghana has witnessed these LSLA activities, primarily for mining, commercial agriculture, and real estate development (Boamah, 2014). Research indicates that

LSLA in Ghana has contributed to land tenure insecurity, declining food production, and increased vulnerability among rural communities (Schoneveld & German, 2014). According to GSS, the Upper East Region, where LSLA is increasing, is one of the country's highest-ranking household food insecurity regions (GSS et al., 2020). These national statistics confirm that Ghana is both a key destination for LSLAs and a country where food insecurity and rural livelihood remain relevant concerns.

The Talensi District, the focus of this study, has experienced large-scale land acquisitions driven by mining operations, leading to the displacement of smallholder farmers and significant disruptions to traditional agriculture. In response to these socio-economic challenges of LSLA, livelihood restoration training has been introduced to restore livelihoods in the Talensi District (Golder, 2018; Apubeo, 2023; Awuni, 2022; GNA, 2023). These programs are usually focused on building the capacity of affected individuals to enhance their economic activities and restore livelihoods (Borras et al., 2016). However, following a comprehensive review of literature, no study exists that evaluates livelihood training programs undertaken by large-scale land-acquisition (LSLA) owners in the Talensi District. This documented absence motivates this research.

This study addressed this knowledge gap by evaluating the effect of livelihood restoration training on household farm income and food security in Talensi District.

The findings of the study have contributed to the broader discourse on post-LSLA livelihood restoration training programs and offer relevant policy recommendations.

1.2 Problem Statement

Large-scale land acquisitions have emerged as a contentious issue worldwide, including the Talensi District of Ghana. The acquisition of 63 km² of land for mainly gold extraction (Cardinal, 2020), has caused massive disruption in the lives of affected households. In the Talensi District, many households have been relocated (Ngnenbe, 2022), and their access to land and other livelihood assets has been altered because of mining activities by companies. Though compensation packages are usually promised or given, most often, it is not sufficient to address the multi-dimensional challenges that confront affected households (Marsilio, 2008)

In response to the adverse effects of LSLAs, livelihood restoration training has been introduced by these LSLA owners. These programs included vocational skills training such as carpentry, bricklaying, tiling, electrical installation, and training in agriculture (GNA, 2023 ; Golder, 2018 Awuni, 2022) . Such initiatives are designed to restore and enhance the livelihoods of affected households, providing them with alternative sources of income and sustainable means of livelihood (FAO, 2015a).

However, upon a critical review of the literature, the lack of studies on the effectiveness of these livelihood restoration training in the creates a knowledge gap. While the provision of training is commendable, questions persisted regarding its actual effect on improving livelihood outcomes for participants compared to non-participants in the Talensi District.

Without this robust and thorough assessment of the training, it would be difficult to determine whether they restored and enhanced the livelihoods of affected households that participated in them.

This gap in understanding limits policymakers and development practitioners in designing effective livelihood restoration interventions. Hence, a wide-based assessment of the effect of training programs provided under livelihood restoration initiatives is very important. This study would not only provide stakeholders with information on the successes of the training program but would also offer an actionable understanding to guide future interventions and policy decisions.

Moreover, while considerable research has been conducted on the economic, social, and environmental effects of LSLAs on smallholder livelihoods (Cotula, 2013; Tania et al., 2011), there is a significant gap in literature concerning the coping strategies households adopt in response to LSLAs. Existing studies (Jonathan & Isaac, 2014; Desalegn, 2013) have begun to explore these strategies but rely primarily on descriptive statistics, offering a limited understanding of the determinants of specific coping strategies. My study addressed this gap by employing a multivariate probit model to analyze the factors influencing the adoption of various coping strategies. This provided a more rigorous understanding of how household characteristics, resource access, and institutional factors shape responses to LSLAs.

This study has effectively bridged these important gaps in literature. It assessed the effect of training programs introduced by LSLA owners on the livelihoods of affected households in the Talensi District and also examined the coping strategies used by

these households. Simultaneously examining the effect of training on livelihood and coping strategies in this study provided a clear understanding of the complicated relationship among LSLAs, livelihood restoration training, and household coping mechanisms.

1.3 Main Research Question

The main research question answered by the study is: What is the effect of livelihood training from LSLA owners on the livelihoods of smallholder farmers in the Talensi District of the Upper East Region?

1.3.1 Specific Research Question

1. What are the factors that influence the choice of coping strategies in the Talensi District of the Upper East Region?
2. What effect does the livelihood restoration training from owners LSLA have on household farm income in the Talensi District of the Upper East Region?
3. What effect does the livelihood restoration training from owners of LSLA have on household food security in the Talensi District of the Upper East Region?

1.4 Study Objectives

The main objective of the study is to assess the effect of livelihood restoration training from owners of LSLAs on the livelihood of smallholder farmers in the Talensi district.

Specifically, the study sought to:

1. Determine factors influencing the choice of coping strategies among affected households in the Talensi District
2. Examine the effect of livelihood restoration training from owners of LSLA on household farm income among affected households in the Talensi District
3. Examine the effect of livelihood restoration training from owners of LSLA on household food security among affected smallholder farmers in the Talensi District.

1.5 Hypothesis of The Study

The hypothesis that the study sought to test is:

1. Null Hypothesis (H_0): Training from owners of LSLA has no significant effect on household food security and farm income among affected households in the Talensi District.

   Alternative Hypothesis (H_1): Training from owners of LSLA has a significant effect on household food and farm income security among affected households in the Talensi District.

2. The null hypothesis (H_0): socio-demographic and economic characteristics, resource accessibility, and training programs are not factors influencing the choice of coping strategies adopted by affected households in Talesi District.

   Alternative Hypothesis (H_1): socio-demographic and economic, access to resources, and training programs all play an important role in the choice of coping strategies adopted by the affected household in the Talensi District

1.6 Justification

The justification for this study arises from the need to provide empirical evidence on the effectiveness of livelihood restoration training initiatives introduced by large-scale land acquisition (LSLA) owners in improving the livelihood of affected smallholder farmers. Although such training programs are typically implemented as part of investors' corporate social responsibility (CSR) and livelihood restoration obligations, their effects on rural livelihoods remain under-researched, particularly in Ghana (Cotula, 2009; Schoneveld, 2021).

To begin with, there exists a significant empirical gap concerning the extent to which livelihood training provided by LSLA owners influences the livelihoods of affected smallholder farmers. While studies have assessed the socioeconomic and environmental consequences of LSLAs (Nolte et al., 2016 Schoneveld, 2021), little is known about the livelihood outcomes of investor-led interventions (Dev et al., 2025). The CSR literature highlights that corporate-supported livelihood initiatives can enhance rural livelihood resilience, improve productivity, and promote income diversification (Uduji, 2019). Nonetheless, empirical validation of such outcomes within the context of LSLAs remains scarce. By investigating the effects of LSLA livelihood training on livelihood outcomes, this study contributes to filling this important knowledge gap.

Moreover, the Talensi District offers a very important setting for this study. The District has experienced significant large-scale land acquisition (LSLA) activities, and livelihood restoration training has been introduced by LSLA owners to support

affected households (Apubeo, 2023) . However, the effectiveness of these interventions in improving the livelihoods of affected households remains unexplored. Existing studies on LSLAs in northern Ghana have mainly focused on their negative effects, such as reduced access to farmland, displacement, and social tensions, without examining how investor-led training initiatives might enhance the livelihood of affected smallholders (Bugri & Yeboah, 2017). This study, therefore, fills a critical research gap by providing context-specific evidence on how livelihood training influences household farm income and food security outcomes in the Talensi District.

Furthermore, the study holds significant policy relevance. In Ghana and across Africa, there is growing recognition that although LSLAs may generate employment opportunities and stimulate rural infrastructure development, they can also increase inequality and food insecurity when not accompanied by appropriate livelihood support mechanisms (Cotula, 2009; Schoneveld, 2021). Understanding the effect of livelihood restoration training is therefore important for informing the formulation of socially responsible and inclusive land investment policies. The findings of this study will be valuable to policy institutions such as the Ministry of Food and Agriculture (MoFA), the Environmental Protection Agency (EPA) and the Ghana Lands Commission in strengthening policy frameworks that govern sustainable land-based investments.

1.7 Organization of The Study

The thesis is organized into five chapters. Chapter one covers the introduction, problem statement, research questions, objectives, hypothesis and justification of the study. Chapter two reviews relevant literature related to the research from other Authors. The chapter also outlines the conceptual and theoretical framework, detailing the assumptions and concepts utilized in the study. Key terms are defined, and the conceptual framework that guides the study is presented here. Chapter three covers the methodologies used for the study. It outlines the study area. The instruments for data collection are also presented here. Chapter four covers the results and discussion of the study. It, therefore, contains the estimated results of the socio-demographic characteristics of the sampled respondents, endogenous treatment regressions and the multivariate probit model with their discussed results. Chapter five summarizes the key findings, draws conclusions from the results, makes suitable recommendations and offers suggestions for future studies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviewed academic literature on some definitions of concepts, global trends and drivers of LSLA, its impact on agricultural production and farm income, coping mechanisms households adopt in response to LSLA, Livelihood Restoration Programs by LSLA owners in Africa while also discussing food security and its various dimensions.

2.2 Definition of concepts

2.2.1 Smallholder farmers

The term "smallholder" means a limited amount of land available (FAO, 2015). Other meanings may depict a broader view of “resource-poor” farmers: e.g. those with fragmented land holdings, limited capital, and limited access to inputs. Ahuja & Redmond, (2004) noted that several animals may be a misleading definition. Ghana's Poverty and Social Impact Analysis suggests that smallholders are defined by resource and risk conditions rather than landholdings alone (Chamberlin, 2008).

Chamberlin (2007) suggested that the definition of smallholder farmers should encompass different resources and risk conditions, but landholdings are the most adopted definition. The working definition of a smallholder farmer in Ghana refers to a farmer who cultivates less than 2 hectares of land, uses less sophisticated tools, and mainly relies on family members for labour for agricultural activities (Chamberlin,

2007). This perspective highlights the need for a more comprehensive understanding of smallholder farmers in Ghana.

According to Kamara et al. (2019), comparing two farmers with the same farm size who produce a high-value crop for the market versus a staple for consumption at home is not meaningful. Measuring smallholders on a more detailed level is challenging. Several major characteristics emerge from several working definitions for Ghana and other countries, notwithstanding the difficulty of obtaining precise quantitative data. These include holding size, affluence, market orientation, and risk exposure. Smallholders can be identified primarily based on their holding size. It can also be the most abused. According to Chamberlin (2014) a smallholder farmer in any region of Ghana has less than 5 hectares but provides no support or understanding of the prevalence of this description in Ghanaian agriculture. According to the Ministry of Agriculture (MoFA, 2006), agriculture in Ghana primarily involves smallholder farmers.

2.2.2 Defining Food Security

With over thirty definitions according to the literature, the term "food security" has steadily evolved throughout time to mean different things since it first emerged as a problem in the 1970s (Ouédraogo et al., 2017, p.149).

According to Kuwornu et al., (2011), food security is the state of having a sufficient global food supply of staple foods at all times to support adequate food consumption while minimizing production and price variations in the late 20th century. The concept of food security was originally coined during the early 1970s when there were food

crises in the world, and the concept was understood in terms of the food availability and supply (FAO, 1974). By the mid-1970s, the concept had also changed to focus on universal access to enough food for an active and healthy life, a notion which caught the imagination of academics as well as practitioners (Clay, 2002). Over the next decades, the idea was further developed, and scientists have captured its complexity by discovering over thirty different definitions in publications (Ouédraogo et al., 2017; Maxwell, 1994). Current research still captures this variety of ideas by defining food security in terms of availability, access, utilization, and stability (FAO & WFP, 2018).

Bashir et al. (2012) define food security as the consistent availability of food in a nutritionally adequate, high-quality, and culturally relevant manner. Their definition underlines the equitable distribution and sustainable production of food, ensuring that the food is safe and nutritious for the current and future generations. This is in line with a more extensive global concern relating to food security, which gained attention in the 1970s as an overriding issue.

In 1996, the FAO added the dimensions of nutritional value and food preferences to the definition of food security. During the World Food Summit, FAO developed an all-inclusive definition: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for a healthy and active life" (Pinstrup & Herforth, 2008). This broadened the food security concept from availability and access to also include food safety, nutrition, and cultural appropriateness.

The concept depicts some of the major dimensions: availability, access, utilization, and stability of food security. Availability refers to production and supply, generally from the local system or imports. The access dimension looks at how people obtain food through either economic or social means. Utilization: This is about the proper use of food in terms of nutritional value, preparation, and safety. Stability at the last place means that there must be consistent access and availability, not easily disturbed by economic, climatical, and other kinds of shocks.

The phrase "all people at all times" in the FAO's definition underlines the universality and continuity of food security. It expresses the moral imperative to banish hunger and malnutrition from all sections of the population, irrespective of socio-economic background, and ensures that resources are protected for generations to come. In another aspect, the interdependence between food security and sustainable agriculture comes into limelight here; this relation has to rest on equity within the economic system of each country and appropriate policy interventions to adjust for unequal access and distribution. The concept also emphasizes the need for safe and nutritious food, since food insecurity arises when available food is unhealthy, polluted, or consumed in excess (Khan, 1976). Food security is an essential concept that highlights the need for equitable access to sufficient, nutritious and safe food for all people, both at the present and in the future. A comprehensive approach is needed to take into account factors influencing the availability, accessibility, and use of food as well as its nutritional quality. While this definition is widely accepted, it has been criticized for failing to consider environmental and healthcare concerns while ensuring food safety.

Ingram (2020) Food security definition places focus on quality and environmental issues: a situation when all people at all times have physical, social, and economic access to sufficient, safe, and good-quality food that meets their dietary needs and preferences for an active and healthy life.

2.2.3 Large-Scale Land Acquisition

There are different definitions of the term "Large-Scale Land Acquisition" (LSLA) in literature. The FAO defines LSLAs as the transfer of rights of use, control, or ownership of land by sale, lease, or concession on the usual 200 hectares or more (Land Matrix, 2019; FAO, 2022). Also, the ILC (2013) defines LSLAs as land dealings that involve the purchase of large tracts of land by investors, often with very low transparency and poor community consultation processes, raising concerns about tenure security as well as equity of benefits sharing.

Academic literature also highlights that LSLAs are more than outright purchases. For example, Mazzocchi et al (2018) define LSLAs as encompassing long-term leases and rights of exploitation that provide investors with significant control over Sub-Saharan African land assets, frequently with foreign agriculture investments.

Also, the Ghana Lands Commission defines LSLA as any acquisition of land that is 20.23 hectares or above (Lands Commission, 2016). Because the study is in Ghana, the definition by the Ghana Lands Commission (2016) is adopted as the definition for LSLA in this study.

2.3 Theoretical Framework

This study is grounded in the Random Utility Theory (RUT). The RUT is used to estimate discrete choices based on sound mathematical foundations and is applied widely in agricultural economics in order to estimate household involvement in new technology, training programs, and contract farming schemes. The underlying assumption of RUT is that household i will choose an option that maximizes utility, recognizing that utility has both an observable and an unobservable component (McFadden, 1973).

In this study, affected households face a dichotomous decision: to participate in livelihood training ($D_i = 1$) or not participate in livelihood training ($D_i = 0$). The latent (unobserved) net utility of participating households can be written mathematically as:

$$U_i^* = V_i + \varepsilon_i,$$

where $V_i = X_i\beta$ denotes the deterministic component of utility derived from observable characteristics X_i(such as age, sex, years of education, farm size), $\beta$is a vector of coefficients to be estimated, and $\varepsilon_i$is the error term capturing unobserved factors and measurement error.

The household will participate if the expected utility of participation is more than that of non-participation:

$$D_i = \begin{cases} 1 & \text{if } U_i^* > 0, \\ 0 & \text{otherwise.} \end{cases}$$

Assuming $\varepsilon_i$follows a logistic distribution yields a binary logit model, while a standard normal distribution yields a probit model. Both provide the probability of participation as:

$$P(D_i = 1 \mid X_i) = F(X_i\beta),$$

where $F(\cdot)$is the cumulative distribution function of the chosen error term.

Applying RUT here recognizes that although the LSLA livelihood training was free of direct monetary cost, households still weigh the expected benefits (improved skills, higher future income, enhanced food security) against implicit costs such as time and foregone labour. The decision to participate is therefore a rational economic choice under uncertainty. This theoretical framework has been widely used to explain the adoption of agricultural technologies and farm household participation in rural development programs (Abdulai & Huffman, 2014; Ma & Abdulai, 2016).By grounding the analysis of training participation in RUT, this study can accurately estimate the factors influencing household participation and the causal effects of LSLA livelihood training on farm income and food security.

2.4 Conceptual Framework

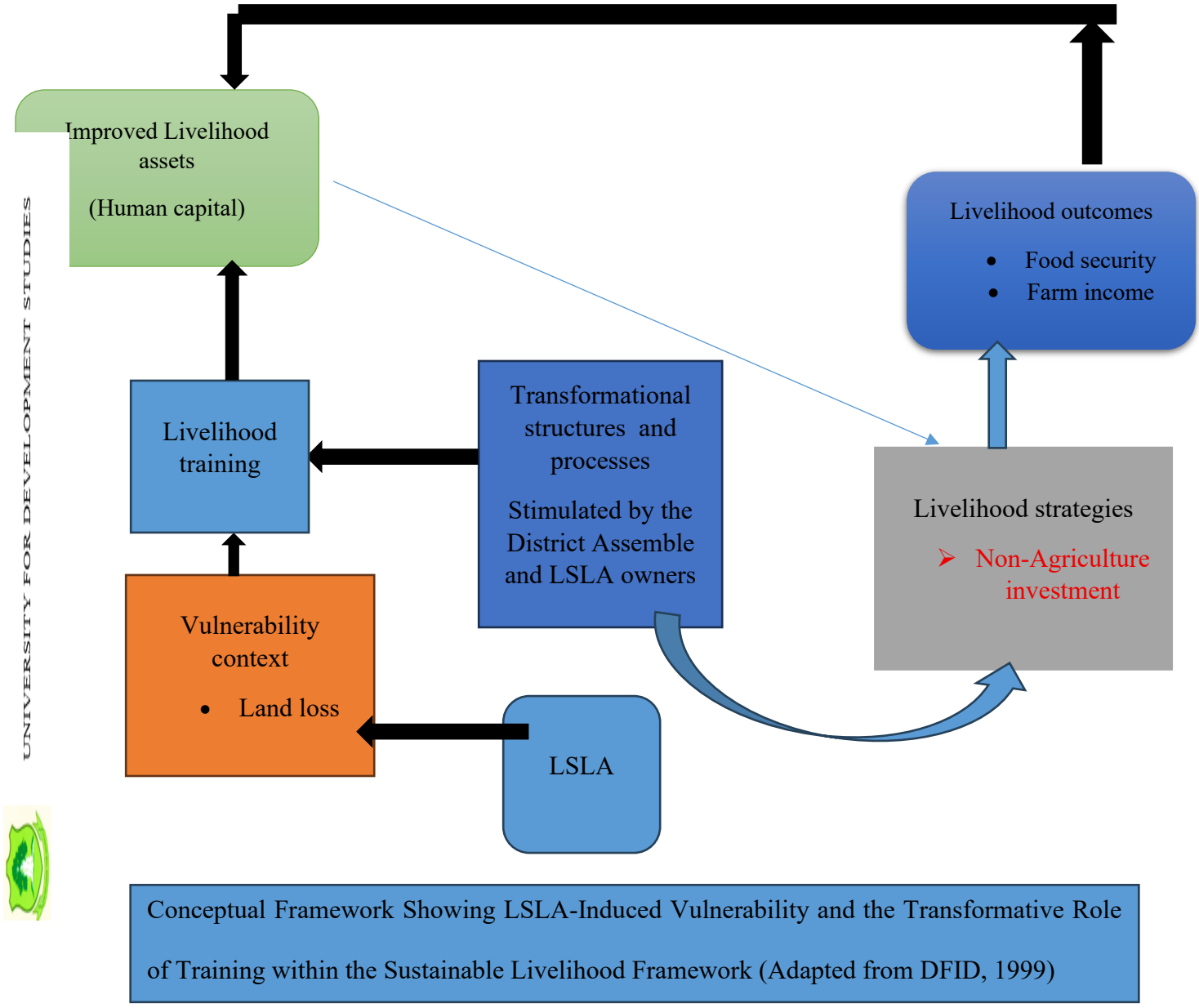

Figure 1: Conceptual Framework

Source: Authors construct

Figure 2.1 above illustrates the Sustainable Livelihood Framework (SLF), where the vulnerability context comprises external shocks and stresses that influence

households' ability to sustain or enhance their livelihoods. In this study, Large-Scale Land Acquisition (LSLA) is identified as a key source of vulnerability, as it disrupts households' access to land and other productive resources, thereby heightening their exposure to livelihood insecurity.

As part of mitigation efforts, LSLA owners introduce livelihood training programs that function as transforming processes within the framework. These training interventions are designed to build the capacities of affected farmers by enhancing their human capital, particularly skills, knowledge, and technical abilities. Through these trainings, households are better equipped to utilize their available assets and adapt to new livelihood opportunities.

Enhanced skills and knowledge enable households to develop and implement livelihood strategies such as the adoption of improved farming practices or engagement in non-farm investment activities. These strategies, in turn, lead to improved livelihood outcomes, including higher income levels, food security, and resilience. The improvement in outcomes subsequently strengthens the household's livelihood assets, creating a reinforcing cycle of empowerment and sustainability (DFID, 1999).

2.5 Large-Scale Land Acquisitions in Africa

Large-scale land acquisitions (LSLAs) continue to transform African agrarian and ecological landscapes, driven by international investment pressures as well as national political-economic agendas (Mechiche et al., 2021; Land Matrix, 2023). Although the initial wave of land transactions garnered international attention a decade ago, current

evidence suggests that new leases, renegotiations, and speculative holdings remain prevalent, indicating that LSLA is a process (Land Matrix, 2023). Analyses also highlight the significant role of national policy environments and domestic elites in structuring the extent and implications of such acquisitions (Rincón et al., 2024). Ethiopia marks the point of convergence between state development policy and foreign investment. The federal government has, since around the mid-2000s, leased massive tracts of lowland land to investors, but weak implementation of communal tenure schemes has resulted in grazing and forestland being switched to commercial agriculture (Gebreegizaber , 2025).

Ghana presents a different trend, with large-scale mining being a leading cause of land acquisition. A recent systematic review reveals generalized disruption of traditional land tenure and community displacement that is being attributed to mining activities (Adjei et al., 2024) . Empirical studies in the Amansie West and South Districts suggest mining reduces access to arable land and household food security (Amoako et al, 2023), while remote-sensing evidence confirms illegal gold mining has contributed to higher rates of deforestation, loss of biodiversity, and reduction in carbon stock from 2018 to 2023 (Abugre et al., 2025).

Mozambique continues to draw massive energy, forestry, and sugarcane projects. Land Matrix tracking reveals a persistent gap between announced and actualized hectares, where unfinished projects continue to hamper local land use and ignite conflict where there is inadequate consultation (Land Matrix, 2023).

Tanzania demonstrates LSLA's social and environmental issues of large biofuel and rice schemes along the coast and Kilombero Valley, which have caused water security issues and caused smallholder limited returns (Taylor, 2014).

Recent research also demonstrates that LSLA are substantial in Nigeria. Studies indicate that LSLA in Edo State has displaced smallholders and reduced livelihood opportunities, with women particularly affected (Ewododhe & Ogisi, 2025). A national cross-sectional comparison identifies that households residing in the vicinity of large-scale agricultural investment are vulnerable to food insecurity compared to those residing in unaffected locations (Edafe et al., 2023). Study from Lafia in Nasarawa State documents how compulsory land acquisitions for public projects have stripped urban poor households of farmlands and economic trees, undermining their income sources (Olagunju & Adejumo, 2024).

Many announced projects are never fully implemented, yet their mere announcement can restrict community land use or promote speculative clearing (Land Matrix, 2023). National actors national agribusiness companies, government ministries, and local elites are key agents of facilitating and profiting from land deals, discrediting LSLA's status as foreign-controlled (Adjei et al., 2024 ; Gebreegizaber, 2025). The majority of the transactions continue to fall short of international standards like Free, Prior and Informed Consent (FPIC), making rural users exposed to displacement and environmental degradation (CIRAD, 2022). All these observations combined suggest LSLA is a continuing and complex phenomenon whose effects center on the

intersection of international capital, state policy intervention, and the endurance of local tenure (Castet, 2024).

2.6 Global Land Acquisition Trends and Drivers

Biofuel production has led to an increase in LSLA, mainly in Africa, posing a significant threat to livelihoods and food security (Kedir & Doris, 2024). Studies have revealed that the biofuel industry has significantly impacted agricultural land acquisition (Deininger & Byerlee, 2011). The increase in biofuel production has led to a substantial amount of agricultural land being acquired, mostly affecting smallholder farmers (Cotula et al., 2009).

Urbanization and industrialization drive infrastructure development, leading to LSLAs worldwide. Governments and private companies purchase land for highways, industrial zones, and infrastructure, restricting access and control for smallholder farmers over their land (Zoomers, 2010). .

Despite the trend and investors pushing for LSLA, the drivers of LSLA throughout Africa appear to differ. The Land Matrix documents over 30 million hectares of completed agricultural land deals globally as of 2020, with sub-Saharan Africa representing some 37 percent of the total (Land Matrix, 2021). Even with such long-term expansion, the drivers of LSLAs vary across African countries, depending on resource availability, investment policies, and institutions of governance (Wolford et al., 2013; Schoneveld et al., 2011).Historically, land acquisitions were mostly driven by settlements and food production (Yeboah & Shaw, 2013). However, there is little consensus on what is driving the present growth in LSLA. According to some

literature, the current increase in LSLA can be attributed to the profit-driven nature of neoliberal capitalism (Ekumah, 2024). Scholars argue that the 2007-08 crises (food, energy, climate change, and financial) significantly impacted neoliberal capitalism and its capital accumulation methods (Lane, 2023 ; Appel & Orenstein, 2018). Today, LSLA is primarily driven by profit maximization (Ekumah, 2024).

Zoomers (2010) identified seven processes that drive global land acquisition: foreign direct investment (FDI) in food production, non-food agricultural commodities and biofuels, nature conservation, large-scale tourist complexes, urban extensions, rapid increase in retirement or residential migration, and land purchases by migrants in their home countries.

Other studies explain LSLA in terms of land scarcity and resource-abundant arguments. The land scarcity school of thought is based on the Boserupian intensification process (Headey & Jayne, 2014; Smetschka et al., 2014;Boserup, 2013), which links the convergence of LSLA to increasing population density. Scholars argue that population growth has led to increased demand for scarce land, resulting in monetization and an increase in LSLA. Resource-abundance school of thought argue that the increasing phenomenon of large-scale land acquisitions (LSLAs) in Africa has a strong connection with the belief that the continent is well endowed with unused land , creating possibilities for investors acquiring land at relatively low costs and earning high profits (Hall et al., 2015 ; Nunoo, 2017).

2.7 The Effect of Large-Scale Land Acquisitions on Food Security

Studies globally has shown that the majority of large-scale land acquisitions (LSLAs) are allocated for biofuels and cash crops production with little regard for national and household food consumption needs. Research establishes that most LSLA projects dedicate land to non-food or export crops such as jatropha, sugarcane, and oil palm, leaving limited land for local food crops such as maize, millet, and sorghum (Mueller et al., 2012). This allocation of land aggravates food insecurity by reducing access to major food staples, decreasing dietary diversity, and subjecting rural households to unpredictable food markets.

Food access is also one of the main channels through which LSLAs impact food security. LSLA compromise the ability of households to grow their food and meet their consumption needs (Cotula, 2012). Although some projects provide wage employment, the work is typically temporary, insecure, and not enough to replace the loss of rural livelihood (Nolte et al., 2016). Rising local food prices, caused by the scarcity of subsistence crops, further restrict household access to adequate diets (Borras & Franco, 2018).

Empirical evidence from Ghana perfectly mirrors these global trends. In northern Ghana, it is found that LSLA initiatives have significantly reduced household self-sufficiency by limiting land availability for the cultivation of stable food crops. LSLA activities in most parts of Ghana focus on the production of biofuel and cash crops over food staples, thereby undermining local food sovereignty (Nchanji et al., 2023). It has been established through current studies that domestic land deals may be more

damaging than international investments, since investors in the domestic sector have fewer monitoring and stricter control mechanisms, thereby exposing the land to more chances of acquisition and food insecurity (Wolford et al., 2024; Dzanku & Ankrah, 2021). Households displaced by LSLA projects therefore, resort to food purchasing most often, while rising prices and inadequate rural employment worsen their vulnerability (Boamah, 2014).

The nutritional implications of LSLAs are equally important. A cross-country study, including Ghana, indicated that land-use changes resulting from LSLAs have the tendency to translate into reduced dietary diversity when more wholesome subsistence food is substituted with plantation monoculture foodstuffs (Mueller et al., 2021). Furthermore, women, responsible for food production and nutrition within a household context, bear the disproportionate burden of land acquisition, further influencing household food security outcomes (Tsikata, 2016) .

In addition to agriculture, LSLAs, large-scale mining has also been a significant cause of land acquisition in Ghana with the same implications on food security. A study in the Amansie West and South Districts by Amoako et al, (2023) finds that mining activities lead to widespread land degradation, deforestation, and water pollution, all of which affect food availability and dietary quality in rural communities. Collectively, the literature suggests that although they are generally introduced as economic transformation policies, their impact on Ghana's food security is still generally negative.

2.8 An Empirical Review of Methods, Factors Influencing Food Security, and Food Insecurity.

Studies in Ghana and other developing nations have explored food security drivers at national, regional, household, and individual levels using different analytical strategies.

The work of Osman (2021) investigated the level of household food security and its causes, as well as the food insecurity coping mechanisms among farmers in the West Mamprusi and Mamprugu Moagduri districts in Ghana. The study aimed to assess the food security status, the factors influencing household food security, and the coping strategies employed by smallholder farm households in these districts located in the North East region of Ghana. Methodologically, the study employed food security indicators such as the Cost of Calories (CoC), Household Dietary Diversity Score (HDDS), and Household Food Consumption Score (HFCS) to assess the food security status of households. The determinants of household food security were examined using a logit model, while Kendall's coefficient of concordance was applied to rank the coping strategies adopted by households to address food insecurity in the study area.

The sampling procedure and technique employed was a multistage sampling approach. The results showed that Location, gender, education, and work access all had positive impacts on household food security. The study also found that reducing household expenditure on food, reducing food consumption within meals, reducing the frequency of meals daily and consuming lower-quality and relatively cheaper foods were the

coping strategies adopted by households to mitigate food insecurity effects. This study was limited to food security status and causes of food insecurity of households in two districts in the North East region of Ghana. This means that the results could only be generalized within the two districts.

The work of Christian et al, (2019) examined the association between household food insecurity, dietary diversity, and the mean micronutrient density adequacy for children, along with the factors influencing these indicators. This study aimed to identify the determinants of household food insecurity, dietary diversity, and the adequacy of children's mean micronutrient density, and to explore the relationships among these nutritional measures. Methodologically, baseline data from a quasi-experimental intervention study were analysed in twelve rural communities across the three agro-ecological zones of Ghana.

Results indicate that food insecurity is more pronounced among farming households when compared to their non-farming counterparts. The dietary diversity score was significantly higher for non-farming households, which benefit from greater purchasing power, allowing them to acquire a wider array of farm-produced foods from farming households. Furthermore, food insecurity exhibited a negative correlation with both household dietary diversity and the mean micronutrient adequacy for children. Notably, there was no direct relationship established between dietary diversity and the micronutrient density in children. Instead, children's mean micronutrient adequacy was significantly influenced by being part of a highly food-

insecure household and the size of the household. Additionally, household poverty emerged as a significant predictor of diminished nutritional intake among children...

The study concluded that household food insecurity is a strong indicator of lower nutrient intake in children.

Oyetunde & Olagunju (2019) examined the role of technical efficiency in household food security in Nigeria. Their study relied on secondary data from the General Household Survey conducted by the National Bureau of Statistics. To measure household technical efficiency, they applied a stochastic frontier analysis (SFA), which allowed for assessing production efficiency among agricultural households. Determinants of inefficiency were then analyzed using an inefficiency effects model, incorporating explanatory variables such as age and gender of the household head, household size, access to credit, number of assets, access to fertilizer advice, and access to market information. To estimate the likelihood of households being food secure versus food insecure, a binary Probit model was employed. The study found that technically efficient households were more likely to be food secure, demonstrating the link between agricultural productivity and access to sufficient food. The results highlight that enhancing farm-level technical efficiency can directly improve household food security outcomes.

The work of Yousaf et al. (2018), used the Dietary Intake Assessment, Household Food Insecurity Access Scale, and Household Dietary Diversity Score to assess the food security situation of farmers and non-farm households in Punjab, Pakistan. The main objective of this study was to examine the food security status of farmer and non-

farm rural households using the aforementioned three food security indicators. The study employed a cross-sectional survey design to assess the food security status of rural households in Punjab, Pakistan. Primary data was collected from 576 households, with an equal split between farmers and non-farmers, across six districts. Food security was assessed using three complementary indicators.

The study used descriptive statistics, including means, frequencies, and percentages, to summarize household characteristics and assess food security levels. In addition, comparative analyses, such as t-tests, chi-square tests, and correlation analysis, were conducted to examine differences between farmer and non-farm households. By analyzing the associations between household characteristics and food security indicators, the authors identified monthly income, family size, and family structure as key determinants influencing food security in both farmer and non-farm households.

This study was limited to assessing the food security levels of farmers and non-farmers without examining the underlying determinants of food security. However, the use of an endogenous switching regression or an endogenous treatment regression model could have provided more robust estimates of both the food security levels and their determinants for farm and non-farm households.

The work of Nkomoki et al. (2019) examine factors linked with food security and used the Food Consumption Score and Household Hunger Scale to assess food security in Zambia. The objective was to determine factors that are associated with food security in Zambia. This study utilized household questionnaire survey datasets from 400 smallholder farmers in four districts, conducted in 2016 in southern Zambia.

Regarding food security indicators, the study employed two indicators: the Food Consumption Score (FCS) and the Household Hunger Scale (HHS). Additionally, two ordered probit models were regressed with FCS and HHS as dependent variables. The findings for both FCS and HHS revealed that high educational level, increasing livestock income, secured land tenure systems, increased land size, and FBO membership increase the probability of household food and nutrition security.

The findings indicated that policies aimed at livestock development programs, including training for farmers in animal husbandry, enhancing land tenure security, and empowering farmer groups, have the potential to significantly improve household food and nutrition security in Zambia. However, it is important to note that the study was limited to only two indicators of food security at the household level. Additional measures, such as the dietary diversity score and the Household Food Insecurity Access Scale, among other relevant indicators, could have provided a more comprehensive assessment of food security within households.

2.9 Effect of LSLA on Household Farm Income

Scholars outline several channels through which LSLAs affect farm income. The most direct is loss of land: dispossession or reduced access to farmland directly decreases the scale of household production and thus the volume of marketable surplus or subsistence output valued as farm income (Borras & Franco, 2012; Zoomers, 2010). A second pathway is through investment incentives, where insecure tenure and uncertainty following LSLA reduce household willingness to invest in land-improving technologies, thereby lowering future productivity and farm income (Abdallah et al.,

2023). Labour market linkages also exist, as investor projects may create wage opportunities that supplement income for labour-rich households, though these rarely substitute for the income foregone from lost farmland (Hall, 2011) . Finally, resource spillovers such as restricted access to water, grazing, and forests can erode complementary income streams (German et al., 2013) .

Empirical evidence indicates that LSLAs generally decrease household farm income for smallholder farmers who are directly affected, although the magnitude of this effect varies across contexts. In Ethiopia, household survey research has evidenced that affected households have recorded substantial reduction in total household income and asset ownership compared to their non-affected counterparts, and farm income accounts for the largest share of the reduction (Kebede et al., 2021). This is similar with Moreda (2017), whose research reveals that displacement from agricultural lands for commercial farm projects resulted in long-term decreases in farm household incomes. In West Africa, particularly Ghana, LSLA exposure has been associated with declines in farm investment and, by implication, farm income. Abdallah et al. (2023) finds that households residing in communities proximate to large-scale agricultural investors were less likely to engage in land-improving investments such as fertilizer application, terracing, and irrigation, outcomes that directly depress farm income. The study highlights that reduced incentives to invest stemmed from perceived tenure insecurity introduced by LSLA, resulting in income losses over the medium and long term.

Blekking et al. (2024), in a systematic review of food security and LSLAs emphasizes that reductions in farm income are the most consistent household-level outcome, particularly for those affected by LSLA. While some households gain short-term wage employment from investor projects, the income derived is typically seasonal, insecure, and insufficient to compensate for foregone farm income (Hall, 2011; German et al., 2013). Moreover, World Bank assessments indicate that the expected benefits of technology transfer and market integration seldom materialize at the household level in the form of sustained farm income growth (Deininger et al., 2011) .

The magnitude of income loss depends heavily on contextual factors. Tenure security and compensation quality are critical, as households with weak customary rights and inadequate or delayed compensation experience deeper and more persistent farm income declines (Cotula et al., 2009 ; Zoomers, 2010). Investor production models also matter, with labor-intensive projects that integrate smallholders through outgrower schemes partially mitigating farm income losses by providing market outlets for produce. However, evidence suggests these schemes are inconsistently applied and often exploitative (Oya, 2016). In contrast, capital-intensive monoculture plantations reduce opportunities for household farm income recovery (Borras & Franco, 2012). Local labour markets further determine whether wage work can supplement incomes; where jobs are scarce, mechanized, or gender-biased, LSLA effects on farm income remain largely negative (Hall, 2011).

Despite consistent patterns, methodological limitations remain. Selection bias is a concern, since investors often target lands with weak tenure regimes or high

agricultural potential, meaning displaced households are not a random subset (Deininger et al.2011). Income measurement is inconsistent across studies, with some estimating farm income via imputed values of subsistence output and others relying solely on cash sales (Abdallah et al., 2023). Furthermore, many studies are cross-sectional, capturing short-term effects while missing medium- and long-term income trajectories (Blekking, 2024). Nonetheless, emerging designs such as propensity score matching and endogenous switching regressions have strengthened causal inference, providing robust evidence of LSLA's negative impacts on farm income (Kebede et al., 2021).

In conclusion, the literature demonstrates that LSLAs have a predominantly negative effect on household farm income, especially for households directly affected by land acquisition. Short-term wage gains for some households are insufficient to counteract long-term reductions in agricultural revenues.

2.10 Coping Strategies of Smallholder Farmers

Smallholder farmers used several coping techniques in adapting to challenges they face as a result of land acquisition, some of these copping strategies include income diversification, non-agricultural investment such as small-scale enterprises, and migration to alternative areas in search of better agricultural opportunities. Smallholder farmers use these coping strategies as a mechanism to reduce the adverse impacts of land acquisition on their livelihoods (Mutekwa, 2009).The identification of the factors that influence the adoption of these strategies, such as access to credit and

social capital, is very important for an adequate assessment of their efficacy (Barrett, 2008).

According to Jonathan and Isaac (2014), one of the common coping strategies adopted by smallholder farmers facing LSLA has been livelihood diversification of income sources. This coping strategy explores alternative sources of income to reduce their reliance on agriculture and hence mitigate the economic impacts of land acquisition.

Migration is another coping strategy used by farmers when faced with land acquisition (Mutekwa, 2009). This could be the migration of farmers to areas where there are better agricultural prospects or alternative employment opportunities beyond agriculture for them to continue their living. The decision to migrate depends on a number of factors that include the size of land acquired and also the availability of alternative employment opportunities in various locations (Barrett, 2008).

Affected smallholder farmers often turn to non-agricultural occupations as a means of coping with land acquisition (Otsuka et al., 2014). Analyzing the determinants of coping strategies such as non-agricultural activities among farmers may help to build a greater understanding of the overall socioeconomic impacts that LSLA presents for rural communities (Woolcock, 2001). The determinants of these coping strategies are complex. Barrett (2008) highlights the access to credit as one of the most critical determinants that influence the choices of the smallholder farmers. Access to credit facilities would empower farmers to adopt migration, diversification, or non-agricultural engagement strategies more effectively. Furthermore, the social networks, as mentioned by Woolcock (2001) are helpful in determining the coping mechanisms

that the smallholder farmers adopt. Strong social networks can provide important support in times of uncertainty and help in the successful implementation of adaptive measures.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

Figure 2 presents a map of the Talensi District, which serves as the study area for this research. The Talensi District is one of the districts in the Upper East Region of Ghana. Its capital is Tongo. It shares boundaries with the Bolgatanga Municipal, Mamprusi, Kassena-Nankana, Bawku West, and Nabdam Districts as shown in figure 2. The district lies between latitudes 10°32′ and 10°48′ North and longitudes 0°56′ and 0°40′ West. The landscape in the district is characteristically rocky and hilly, with gentle slopes intermingled with a few low-lying areas. The soil type is predominantly clayey-loamy and sandy loams. However, the depth is shallow due to the stony nature of the landscape. Soil fertility is normally poor, with a small content of organic matter. Clayey soil with sloppy lands results in massive erosion when heavy rains hit; some very productive low-lying ones easily get flooded. It is predominantly Guinea Savannah woodland with scattered short deciduous trees and tall savanna grasses. The district is home to various economic tree species such as shea, dawadawa, baobab, and acacia. The district experiences two major seasons: a rainy season from early June to late September and a dry season from October to May. The rainfall is unimodal with an average of 95 mm annually oscillating between 88 mm and 110 mm Fagariba et al., 2018). The temperature conditions in the district vary from an average of 29°C to 38°C annually. The temperature reaches as high as 45°C during the peak of the dry season, which is usually from January to May (Fagariba et al., 2018). It covers a total land area of 845.3 km² with a total population of 87,021. It also has a population density of

102.9/km² and an annual population change of 0.65% (GSS, 2021). Agriculture is the main source of income for households in the district and accounts for about 90% of the total employment.

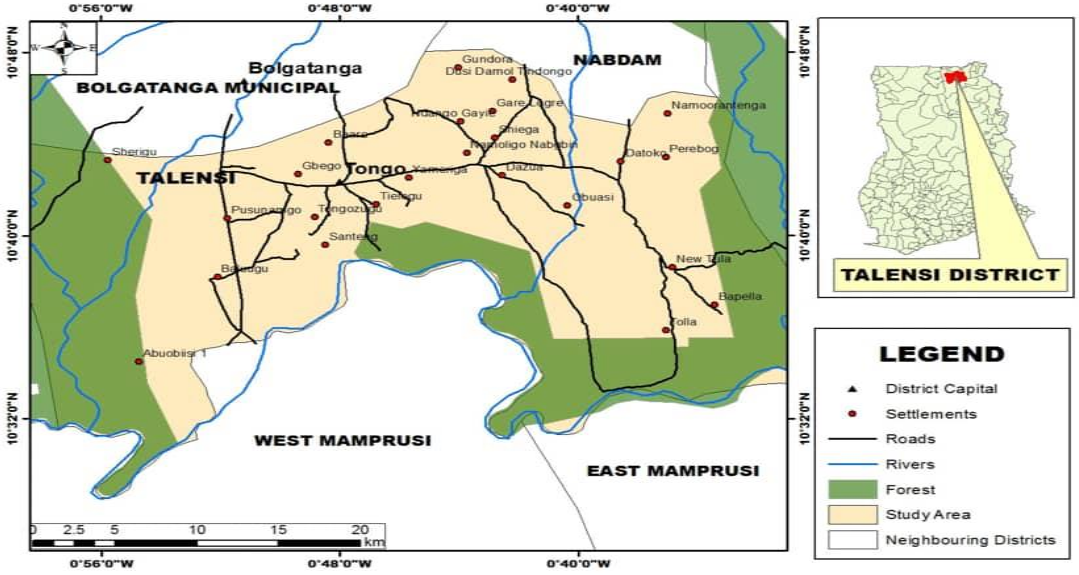

Figure 2: Map of Study Area (Talensi District)

Source: googlemaps.com

3.2 Research Design

Stadtländer (2009) defines research design as a plan and procedures for a study that encompass everything from broad assumptions to detailed methods of data collection and analysis.

This study adopted a mixed-methods cross-sectional design to capture both quantitative and qualitative dimensions of the research. The quantitative component comprises a household survey questionnaire administered to collect numerical data on farm income, household food security, participation in livelihood training and other important variables. The qualitative component involved brief key-informant

interviews conducted before the main survey. These interviews confirmed the specific training activities offered and other important information vital to the study. Notes from these discussions were used to refine the survey instrument and helped in discussing the results.

3.3 Sampling procedure, Technique and Sample size

A multi-stage sampling technique was employed in this study. In the first stage, purposive sampling was used to select the Talensi District because of its relevance to the study of LSLA. The Talensi district has been significantly affected by large-scale land acquisitions (LSLAs), especially by Cardinal Namdini Mining Limited, which has displaced and resettled several farming households. This made it an appropriate setting for this Study.

The target population was households affected by LSLA activities in the district. So, in the second stage, I obtained a comprehensive list of affected households through preliminary fieldwork and engagement with local community members. This stage was necessary to ensure accuracy and completeness of the sampling frame, as no pre-existing list of all affected households was available at the District Assembly at the time of this study, apart from those affected by the cardinal Namdini. Thus, the purposive step at this stage was justified by the need to identify and focus solely on households that have been affected by the LSLAs.

In the final stage, a simple random sampling technique was applied to the list of affected households. The random selection was carried out using Microsoft Excel. This process ensured that each affected household had an equal and independent

chance of being selected, thereby minimizing selection bias and enhancing the representativeness of the sample.

To determine the appropriate sample size for the study, the Cochran (1977) sample size formula was applied. A sample of 400 was used for the study. The Cochran's formula was used at a 5% margin of error (95% confidence level)

n = sample size

p = The estimated proportion of the target group being studied = 0.5=50%. By studying an estimated 0.5 of the target population, it gives a high degree of accuracy.

z = 95% level of confidence = 1.96 in the z table

d^2= error margin = 0.05

$$n = \frac{z^2 p\,(1-p)}{d^2} = \frac{1.96^2 * 0.5 * (1-0.5)}{(0.05)^2} = 384 \qquad (1)$$

However, a sample size of 400 was used , the basis for this was to provide more accurate estimates and to act as a buffer against non-responses or missing data from the field.

3. 4 Data Collection Methods and Instruments

The study was based solely on primary data, which were gathered using a survey questionnaire design in the Kobo Collect app on mobile phones. The questionnaire was used to obtained quantitative data on household demographic details, farm

incomes, food security, and coping strategies and among others. The questionnaire ensured that the collected data were directly related to the research objectives. A sample of the questionnaire is provided in Appendix 1 for further reference.

The application of Kobo Collect was justified since it offers some advantages over the normal paper questionnaires. Firstly, it allows real-time data entry, which eliminates errors and enhances data quality. Also, the program operates offline, hence very appropriate in rural areas like the Talensi District, where the internet connection is typically poor in some areas.

The qualitative component of the study involved brief key informant interviews conducted before the main survey. The interviews were held with the Assembly Member for the Gorogo Electoral Area, some community members from the Cardinal Namdini resettlement project in Biung, and some individuals affected by the operations of Early International Group (formerly known as the Shaanxi Mining Limited) in Gbane. These informants were purposively selected because of their direct knowledge and involvement in LSLA activities within the study area. The interviews were conducted using an interview guide developed to obtain information relevant to the study. Some of the major issues covered during these interviews were the specific training activities offered by the LSLA investors, how households are coping with the LSLA activities, the selection criteria for the training participation, whether there was cost involved in participating in the training, the limitations or constraints in accessing the training and how they perceived the sustainability of the livelihood training activities. The interview guide is provided in Appendix 1 for further reference.

3.5 Ethical Considerations

This study followed ethical considerations in ensuring the privacy and confidentiality of all respondents. Informed consent had been sought from the participants well in advance, ensuring that the context and scope of this research were fully explained. The data collection process was done under strict confidentiality, and the responses did not carry personal identifiers. The respondents were neither forced nor compelled to take part or provide any information against their will. These ethical considerations are considered best practices in social research (Bryman, 2016) and were crucial in gaining confidence and ensuring the integrity of the research process. Moreover, the research did not violate the cultural norms or values of the respondents and thus ensured that the questions themselves were not sensitive and intrusive. This approach considerably enhanced the validity and reliability of the data collected, ensuring the protection of participant rights.

3.6 Choice of Food Security Indicator

An appropriate indicator of food security measurement will be very instrumental in ensuring that the well-being of the households is assessed appropriately, and the impact of interventions on their access to and consumption patterns of food is understood.

For the purpose of this study, the Food Consumption Score (FCS) was chosen as the main indicator for the measurement of household food security. The FCS is an indicator commonly used by many organizations, such as the World Food Programme, in assessing food security at the household level (WFP, 2008). This is the most

appropriate indicator to use in this study because it captures dietary diversity, food frequency, and the relative nutritional value of the foods consumed. Compared to other measures of food security that may have longer recall periods or complex tracking of expenditures, the FCS is relatively quiet straightforward in data collection hence, very feasible in the context of rural households (Coates et al., 2007).

Among other food insecurity indicators, the FCS has been chosen over others like the HDDS, CSI, and FIES for at least three reasons. First, while the HDDS only captures dietary diversity without considering the frequency of consumption and weight in nutritional value, the FCS combines these dimensions making it far more holistic compared to the HDDS (Swindale & Bilinsky, 2006). In contrast, the CSI measures mainly behavioral responses of households to food insecurity rather than their actual consumption patterns and is, therefore, less suited to capturing the direct effects of training on household food security. The FIES is a perception-based measure that relies on subjective experiences of food insecurity, which is useful but does not provide a direct assessment of dietary intake (Terri et al, 2013) . To calculate the FCS, the frequency of consumption for each food group is multiplied by its standardized weight, and the weighted values are then summed to obtain the household's total food consumption score. Households are subsequently classified as having "poor," "borderline," or "acceptable" food consumption based on the WFP's recommended cut-off points.(WFP, 2008, p.8; Thompson & Subar, 2013). The household's food consumption status is determined based on the following thresholds: 0-21: Poor; 21.5-35: Borderline; >35: Acceptable (WFP, 2008).

Table 3. 1: Food Groups and Their Weights

Food Group	Main staples	Pulses	Vegetables	Fruit	Meat/Fish	Milk	Oil	Sugar
Weight	2	3	1	1	4	4	0.5	0.5

Source; (Thompson & Subar, 2013)

3.7 Analytical Framework and Empirical Models

3.7.1 Analytical Framework

This study adopts an analytical framework that explores the relationship between household participation in LSLA livelihood training and key livelihood outcomes such as farm income, food security, and coping strategy choices. The framework assumes that participation in training influences household capacity, which in turn affects farm income, food security, and coping behaviour. To empirically analyse these relationships and account for potential selection bias and interdependence among coping strategies, two econometric models were employed.

1. Endogenous Treatment Regression Model

Non-randomness in training participation is one of the major challenges in the study of the effect of livelihood restoration training on household food security and farm income, since those with greater access to information, better connections, or more resources are more likely to participate. This study addressed this by using an endogenous treatment regression model, where the true causal effect of this training is obtained by correcting for endogeneity. This ensured that the estimated effect on food

security and farm income truly reflects the effect of the intervention and rather than pre-existing differences in household characteristics.

2. Multivariate Probit Model

Households facing livelihood shocks often employ multiple coping strategies simultaneously for example, a household might borrow land, migrate, and sell assets. Other regression techniques like the binary probit assumes independent choices, which may lead to wrong conclusions. To properly account for this interdependence among coping strategies, the study applied the multivariate probit model. This approach allows for a more understanding of the factors that influence households' decisions, recognizing that the adoption of one coping strategy may influence the adoption of another.

3.7.2 Empirical Estimations

Factors Influencing the Choice of Coping Strategies

Major coping strategies adopted by households affected by LSLAs include livelihood diversification, non-agricultural investments, migration, land borrowing for farming, and the selling of assets. The Sustainable Livelihoods Framework assumes that households adopt strategies that sustain and enhance their livelihoods through available assets while minimizing risks and shocks. SLF emphasizes human, social, natural, physical, and financial capital in shaping the household choice set regarding its survival strategies.

For analyzing the determinants of these coping strategies, the multivariate probit model was used, which is very well-suited for handling interdependent and simultaneous decisions according to (Greene, 2012). The multivariate probit model estimates several correlated binary outcomes all at once; hence, it is ideal to be used in understanding the various factors that influence households' choices of coping strategies. The model accounts for the relationships between unobserved disturbances and different coping strategies, reflecting the interrelated nature of household decision-making.

The multivariate probit approach, as discussed above, fits with the SLF in many ways because it identifies the multidimensionality of livelihood strategies. For instance, the households may combine migration with the sale of their assets or diversify livelihood and undertake non-agricultural investments in order to build resilience against impacts brought about by LSLAs. The multivariate probit model, as seen above allows correlated error terms and therefore these strategies are usually not mutually exclusive but often used in a combination of ways for livelihood sustainability.

Dorfman, (1996) argues that Coping strategies against exogenous shocks are by nature multivariate, and any attempt at modeling individual strategies using separate probit or logit models is bound to produce biased results since these models cannot capture the interdependent and simultaneous nature of these decisions. The multivariate probit model represents a holistic perspective on household behavior that goes beyond such limitations in understanding the dynamics that influence their coping mechanisms.

The model is specified as follows:

$$w_{ij}^{*} = z_i\gamma_j + a_{ij} \qquad Eqn(2)$$

w_{ij}^{*}: The latent variable representing unobserved Influence of household i to choose coping strategy j

z_i: Vector of explanatory variables for household i

γ_j: Coefficient vector representing the influence of $z_i$on the latent propensity for strategy j.

a_{ij}: Error term capturing unobserved factors affecting the choice of coping strategy j for household i.

The actual choice of coping strategy is observed as a binary outcome. Specifically, a household i will choose coping strategy j if the latent utility w_{ij}^{*} is greater than zero. This decision is modeled using an indicator function as follows

$$W_j = \begin{cases} 1\ if\ w_{iJ}^{*} > 0 \\ 0\ if\ otherwise \end{cases} \qquad (3)$$

Where:

$W_j$is the binary outcome variable for household i, indicating whether or not the household adopts coping strategy j. A value of 1 indicates that a household adopted a given coping strategy, while a value of 0 indicates that the household did not adopt that particular coping strategy.

The latent variable w_{ij}^{*} captures the unobserved utility derived from choosing strategy j, and the indicator function translates this into a binary outcome based on whether the latent variable exceeds zero.

The Multivariate Probit model considers the adoption of coping strategies not to be an isolated decision. Households often use multiple strategies simultaneously, and the adoption of one strategy can influence the adoption of others. For example, a household may combine migration with land borrowing or diversify livelihoods while making non-agricultural investments. These interdependencies are captured by the error term a_{ij}, which is assumed to follow a multivariate normal distribution across different coping strategies.

This joint distribution allows the error terms across different coping strategies to be correlated, accounting for complementary or substitutive characteristics between the strategies. The correlations between the coping strategies are given through a covariance matrix Ω based on unobserved factors affecting the choice of one strategy that might be relevant to other strategies, too. This structure is very important when modeling complex household decision-making processes.

$$\Omega = \begin{vmatrix} 1 & \rho_{a_1a_2} & \rho_{a_1a_3} & \rho_{a_1a_4} & \rho_{a_1a_5} \\ \rho_{a_2a_1} & 1 & \rho_{a_2a_3} & \rho_{a_2a_4} & \rho_{a_2a_5} \\ \rho_{a_3a_1} & \rho_{a_3a_2} & 1 & \rho_{a_3a_4} & \rho_{a_3a_5} \\ \rho_{a_4a_1} & \rho_{a_4a_2} & \rho_{a_4a_3} & 1 & \rho_{a_4a_5} \\ \rho_{a_5a_1} & \rho_{a_5a_2} & \rho_{a_5a_3} & \rho_{a_5a_4} & 1 \end{vmatrix} \quad (4)$$

Where, w_{ij}^{*} represents a latent variable associated with the probability of adopting one of the five coping strategies considered in this study:

The five coping strategies considered in this study are:

- $j = 1$: Land borrowing for farming
- $j = 2$: Migration
- $j = 3$: Diversification of livelihoods

- $j = 4$: Non-agricultural investments
- $j = 5$: Selling assets, livestock, or machinery

The diagonal elements are normalized to 1, while the off-diagonal elements $\rho_{a_i a_j}$ represent the pairwise correlation coefficients between the unobserved factors influencing different coping strategies.

This structure is very important because it allows the MVP model to capture household coping strategy interdependence. For instance, unobserved household characteristics, which increase the probability of borrowing land, may also increase the probability of migration or diversification as well. Failure to observe these correlations would yield biased estimates, but all five equations are estimated by the MVP model simultaneously with such interdependencies. This makes the MVP model more suitable for modelling complicated household decision-making processes (Greene, 2012; Cappellari & Jenkins, 2003).

Dependent Variables

The dependent variables for the multivariate probit model are the adoption of five coping strategies: land borrowing for farming, diversification of livelihoods, non-agricultural investments, migration, and selling assets. These coping strategies were selected based on existing literature on household responses to shocks and were further validated through key informant interviews with some farm households participating in the study.

Description of Some Independent Variables in the Model.

Age**:** This was measured as a continuous variable in years. The age of the household head has been used in many studies, but the direction of its effects on the dependent variables has been varying and this may depend on many factors. For example, Yenesew et al., (2015) found that age has no significant influence on the choice of coping strategies. However, it would be expected that older household heads would most likely choose coping strategies ahead of their younger counterparts because older household heads have better access to and control over economic resources.

Farm Size: Farm size is one of the main factors influencing the adoption and efficiency of coping strategies by agricultural households. The larger the size of the farm, the more resources the household is bound to have, hence enabling the adoption of more resilient and diverse strategies to manage risks and sustain its financial viability. With increased access to capital, larger farms are in a position to invest in the latest equipment and high-quality inputs of high quality. This, therefore, promotes efficiency and enhanced risk management. Large farms tend to be more efficient since accessibility of resources and capital is not an issue; hence, they can always exploit the economies of scale to achieve higher efficiency, as noted by Chand et al (2011). One of the significant advantages of large farms is diversification into agricultural and non-agricultural activities. Large-scale farms can participate in non-agricultural businesses, livestock rearing, and crop diversification that supplement the source of income and decrease dependence on one commodity. Indeed, Chen et al.(2011) note that larger farms are more willing to diversify sources of income and forms of production, a situation that leads to economic stability. Generally, farm size will be

expected to positively influence the adoption of coping strategies. With the resources at their disposal, larger farms are more capable of investing in technology, diversification of operations, and risk management. Because they can afford diversification into high-value crops and non-farm enterprises, larger farms are less susceptible to market and environmental shocks, according to Muyanga & Jayne (2019)

Sex**:** Sex was a dummy variable, with males assigned a value of 1 and females assigned a value of 0. According to Ngenoh et al., (2018) females are generally less likely than males to adopt certain coping strategies due to factors such as cultural norms, limited access to resources, and challenges in resource management. In the context of this study, it is hypothesized that males have a higher likelihood of adopting coping strategies in response to the challenges posed by LSLA and related changes in their agricultural environment.

Household Size: Household size was measured as a continuous variable. Household size significantly determines the availability of labour for agriculture and other livelihood activities. Larger households, particularly those in which most members fall in the working-age group (18 to 60 years), are likely to have a greater likelihood of using coping mechanisms to cushion the negative impacts of LSLA. For example, Lawal et al (2016) study revealed that household size had a positive relationship with coping strategy adoption, implying that larger households have the ability to re-adjust and adopt coping strategies to reduce shocks.

Educational Level: The adoption and effectiveness of coping strategies in agricultural households are significantly influenced by the education level of the household. Higher levels of education among heads of households are linked to various advantages that improve the resilience and stability of the economy in the household. Additionally, education enables households to participate in both agricultural and non-agricultural activities, promotes income source diversification by reducing reliance on a single source of income, and diversification spreads risk and improves economic stability. According to research by Haggblade et al. (2010) education makes it possible for rural households to engage in the non-farm economy, generating additional revenue streams and reducing their vulnerability to shocks related to agriculture.

Access to Credit**:** This variable describes the availability of credit facilities to the household. It is coded as a binary variable, where 1 signifies access to credit and 0 signifies lack of it. Access to finance is very important for households, particularly in rural and agricultural areas where incomes are sometimes erratic and seasonal. Credit facilities give the means of getting cash needed to invest in various coping strategies, manage risks, and pursue new opportunities, as pointed out by Simtowe et al. (2016). Access to credit facilities allows for household investment in non-agricultural activities such as small enterprises, which would increase the household's income diversification and reduce dependence on agriculture. Credit therefore allows households to meet the costs of marketing and transportation, hence participating better in the marketplaces and bargaining for higher prices of their produce. Credit, according to Gebeyehu et al., (2025)allows diversification into non-agricultural

activities that may serve as a shock absorber for agricultural income shocks. A study by Khandker & Faruqee, (2003) found microfinance programs in Bangladesh significantly raise household income and foster diversification into non-farm activities. Access to credit is expected to positively affect coping strategies since access to credit facilities reduces the financial constraint that limits the ability of the household to invest in strategies that raise resilience and economic stability.

Amount compensated: Amount compensated was measured in Ghana cedis. It refers to money paid to farmers in compensation for farm loss or land use and is highly significant in influencing coping strategies households or farmers affected by LSLA. Compensation allows farmers to invest in other resilience-building strategies, restore losses, and enhance general economic stability. Compensation helps farmers by giving them money to invest in the inputs that are needed in agriculture. Examples of such inputs include machinery, fertilizers, and seeds. This investment increases the farmer's output, decreases the probability of crop failure, and develops resilience against shocks from both nature and the market .Carter & Barrett (2006) stress that the provision of financial support is crucial to helping households escape from poverty since it allows them to make investments in productive activities. This investment promotes long-term sustainability and economic growth in addition to increasing agricultural output immediately. Also, Compensation helps households diversify their sources of income in addition to supporting agricultural activities. Spreading financial risk and minimizing reliance on a single source of income are made possible by this diversification. Households can launch small businesses or make investments in non-agricultural endeavours with the financial support of compensation. This

diversification boosts overall economic stability in addition to offering new sources of income. According to Reardon et al. (2001), financial resources can help rural households engage in the non-farm economy, which will lessen their reliance on agriculture and increase their resilience to economic shocks. Reardon et al (2001), found that the amount compensated positively influences the adoption of coping strategies by providing the financial means for, livelihood diversification.

FBO Membership: FBO membership is a dummy, and it is anticipated to be positively associated with coping strategies adoption. Access to farmers' groups, according to Dercon, (2002) , influences and improves the likelihood of utilizing additional coping methods in times of livelihood and production shocks. This could be attributed to the fact that being a member of a farmers' group is an important resource for limiting the impact of shocks because it helps farmers build social connections that act as a critical risk-coping mechanism.

Table 3. 2: Prior Expectations of Some Variables in The Multivariate Regression

Variable	Definition	Measurement	Expected sign
Age	Age of household head	Years	+
Educational level	Educational of household head	Years	+
Farm size	Farm size of the household	acres	+
Relative in leadership position	If the household has a relative in a leadership position	Dummy (1= yes, 0= no)	+
Access to market	Whether household has access to the market	Dummy (1= yes, 0= no)	+
Farmer base organization	Whether the farmer has an FBO membership	Dummy (1= yes, 0= no)	+
Access to extension	Whether households have access to extension	Dummy (1= yes, 0= no)	+
Training	Whether a household received training or not	Dummy (1= yes, 0= no)	+/-
Household size	Number of people in the household	Number	-
Land ownership	Whether households own land or not	Dummy (1= yes, 0= no)	+
Farming experience	Number of years the household has been farming	years	+
Access to credit	Whether households have access to credit	Dummy (1= yes, 0= no)	+
Amount compensated	Amount household receive as compensation	Cedi's	+
Gender	Sex of household head	Dummy (1= male, 0= female)	+/-
Land value per plot	The average value per plot in the respondent community	Ghana cedis	+/-
Changes in mode of land acquisition	Whether the respondent observed changes in land acquisition practices (e.g., from customary to market-based).	Dummy (1= yes, 0= no)	+/-

Source: Author's, 2024

3.8 Effect of Livelihood Restoration Training from LSLA Owners on Household Food Security and Farm Income

One of the major challenges in examining the effect of livelihood restoration training introduced by LSLA owners on household food security and farm income is the issue of selection bias. Households do not participate randomly in training programs; rather, their participation is influenced by both observable and unobservable characteristics. Such characteristics, like household agricultural knowledge, experience, and skills, may also have a direct effect on household farm income and food security. Unless these are netted out or addressed properly, the estimated effect of training on food security or farm income could be biased, potentially leading to erroneous conclusions (Heckman, 1979). To address this methodological challenge, I have used the Endogenous Treatment Regression (ETR) model, which offers a robust approach to the estimation of the causal effect of training while addressing endogeneity

The ETR model allowed the use of instrumental variables that affect the probability of participation but do not directly influence the outcome of interest. Through the use of these instruments, the model ensures that the estimated effect of training captures only the causal effect, rather than being confounded by endogeneity or reverse causality (Maddala, 1983; Di Falco et al., 2011).

Moreover, regression methods like OLS, which assume independence between treatment assignment and unobserved characteristics, the ETR model permits correlation between the error terms of the selection and outcome equations. This feature is particularly important in agricultural household studies, where unobserved

factors such as farming skills, social networks, or leadership roles may simultaneously affect both the decision to participate in training and household income outcomes. By estimating this correlation directly, the ETR provides more robust and credible results (Lokshin & Sajaia, 2011).

The Endogenous Treatment regression is estimated by first specifying an equation for the endogenous treatment variable, Z_i , followed by the specification of an outcome equation, Y_i (in this case, the Food Consumption Score and household farm income). Given the outcome variable Y_i, which measures the FCS and the endogenous treatment variable Z_i which measures whether a household received training, I can specify the endogenous treatment-regression model as follows:

$$Y_i = X_i\beta + \delta Z_i + v_i \qquad (5)$$

$$Z_i = W_i\gamma + u_i \qquad (6)$$

Where $Z_i = \begin{cases} 1, & if\ W_i\gamma + u_i > 0 \\ 0, & if\ W_i\gamma + u_i \leq 0 \end{cases}$ (7)

Z_i is a dichotomous or binary variable with a value of 1 for households that received training from owners of LSLA, and 0 otherwise. X_i is a vector of outcome covariates (such as household characteristics and farm characteristics), W_i is a vector of endogenous treatment covariates (factors influencing the likelihood of receiving training), β and γ are unknown parameters, while $v_i$and u_i are the error terms with the following covariance matrix:

$$\begin{bmatrix} \delta^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix} \quad (8)$$

where, δ^2 represents the variance of the unobserved error term in the outcome equation, while the error term in the treatment equation is normalized to have a variance equal to one for identification purposes. The parameter ρ measures the correlation between the unobserved factors influencing training participation and those affecting household food security and farm income, and $\rho\sigma$ denotes the covariance between the error terms in the two equations.

This specification follows the standard assumption in endogenous treatment regression models (Wooldridge, 2010). The covariance matrix is important because it allows us to account for potential endogeneity: if $\rho \neq 0$, disregarding this correlation would result in biased estimates.

This study used distance to training centres and consultation during LSLA acquisition processes as instruments for the ETR model. The intuition is that households that were consulted during the land acquisition process, or that are located closer to training centres, are more likely to participate in training. This is because consultation increases household awareness and understanding about the LSLA project and its associated livelihood recovery interventions, while proximity to training centres reduces the costs and logistical challenges of participation. These factors, therefore, influence the probability of training participation but are not expected to directly determine household food security and household farm income.

According to Di Falco et al.(2011), the validity of an instrument depends on its ability to influence the selection into treatment without directly influencing the outcome variable of interest. Based on this understanding, consultation during land acquisition and distance to training center met both the relevance and the exogeneity criteria: they influence the decision to participate in training but do not independently affect farm income, aside from their indirect effect through participation.

Description of independent variables in the Model

The age of the household head, measured as a continuous variable in years, was expected to have a mixed effect on food security. Older farmers are likely to have more knowledge and experience in farming, which may enable them to make appropriate agricultural decisions that increase productivity and food security (Hendriks, 2015). At advanced ages, however, declining physical ability and lower adaptability to new agricultural technologies may reduce productivity and food security (OLuwatayo et al., 2019) .

Similarly, household size measured by the total number of household members, plays a key role in food security. The larger the household size, the higher the need for food consumption; this could increase pressure on available resources and therefore possibly cause food insecurity (Adepoju & Yusuf, 2012). However, if the larger household has more working-age members who contribute labour in farming or off-farm income generation, this could help alleviate food insecurity by increasing household income and food availability (Hoddinott et al., 2012).

Farming experience, measured in years. More experienced farmers are likely to have a better understanding of crop management, risk mitigation strategies, and market conditions that result in increased productivity and food security (Abdulai & Huffman, 2014). They are in a position to adopt sustainable farming practices and also respond effectively to external shocks, which makes them more resilient to food insecurity (Diiro, 2013).

The level of education of the household head captured as the total number of years of spent in school is one of the important determinants of food security. It increases the ability of a farmer to access information on agriculture, adopt modern farming practices, and hence diversify sources of income, all of which increase food security (Asfawa et al., 2016). Higher levels of education are associated with better decision-making related to input use and participation in markets (Feleke et al, 2013) .

Farm size was measured in acres. Larger farms would generally have more food production potential, thereby reducing food purchases and increasing household food security (Sibhatu et al., 2015). Food security, however, does not depend only on the size of the farm but also on land productivity, input use, and farm management practices (FAO et al., 2019).

The gender of the household head was measured as a binary variable (1 = male, 0 = female). Male-headed households have greater access to agricultural resources, such as land, credits, and inputs, which guarantees more food security (Kassie et al., 2014). On the other hand, female-headed households generally give more importance to food

and nutrition for children, ensuring satisfactory household food consumption even under conditions of resource constraints (Haidar & Kogi-Makau, 2009).

Land ownership was measured as a binary variable (1 = Yes, 0 = No). Households that owned land are more likely to invest in the long run, improving soil conservation, irrigation, and agroforestry, thereby increasing productivity and consequently ensuring better food security (Holden & Ghebru, 2016). On the other hand, insecure tenure households live in uncertainty and hence are not prepared to make any investment in sustainable agricultural practices that indirectly or directly hurt food security (Meinzen-Dick,et al, 2019) .

Access to extension was measured as a binary variable (1 = Access to extension services and 0 = No access). Extension services provide training to farmers on improved agricultural techniques, climate-smart practices, and efficient use of inputs to ensure better productivity and food security (Ragasa et al., 2013). Households that have access to extension services are more likely to adopt new practices that increase food production and competitiveness in the market (Anderson, & Feder, 2007) .

Access to credit was measured as binary (1 = Access to credit, and 0 = No access). Households that have access to credit can invest in high-quality seeds, fertilizers, and farming equipment to increase yields leading to food availability (Simtowe et al., 2016). Without access to credit, the households may not have the means to finance investments that will boost their agricultural productivity and food security (Diagne & Zeller, 2001).

Finally, access to markets was coded as binary (1= Access to market, 0 = no access). Households with access to markets can sell their produce at competitive prices, buy food in times of scarcity, and also efficiently source agricultural inputs (Aminu, 2022). On the other hand, poor market access deprives households of trading opportunities and income generation and thus makes them more likely to fall into the trap of food insecurity (Barrett, 2008).

Table 3. 3: Measurement, and Expected Signs of Variables in The Endogenous Treatment Regression for Food Security

Variable	Measurement	Expected Sign
Age of Household Head	Continuous (Years)	±
Household Size	Continuous (Number of people)	-
Farming Experience	Continuous (Years)	+
Education Level	Continuous (Years)	+
Farm Size	Continuous (Acres)	+
Gender of Household Head	Dummy (1 = Male, 0 = Female)	±
Land Ownership	Dummy (1 = Own land, 0 = No ownership)	+
Access to Extension Services	Dummy (1 = Yes, 0 = No)	+
Credit Access	Dummy (1 = Yes, 0 = No)	+
Training	Dummy (1= yes, 0= no)	+

Household Farm Income Computations

Household farm income in this study is obtained from various sources, including sales of livestock and crops, the value of retained crops and livestock products consumed

by the household and income received from hiring out draft animals. As the production of crops and livestock is directly dependent on land, LSLA may influence farm income by affecting the quantity of output produced.

For the estimation of total household farm income, the following components were considered:

- Income from the sale of crops, Livestock and their products.
- Value of Retained Crops and Livestock: The value of those crops and livestock which are not sold but retained by the household.
- Value of Consumed Products: The value of those crops and livestock products consumed by the household.
- Rent (income) received from hiring out draft animals.

Each product was valued by multiplying the amount of output from each enterprise (crops and livestock) by its respective mean market price or prices supplied by farmers. The resulting income from all products was summed up to give the total household farm income. A similar approach has been used in empirical literature (Asokan, et al., 1981 ; Deaton, 2019).

The justification for including livestock as farm income is that, although livestock are often considered assets, their retained value is legitimately classified as income in household farm income computations. This is because livestock directly generate income in kind, whether through home consumption of meat or through their role in substituting for market purchases. Ignoring this would understate the true welfare

contribution of livestock. As Ellis (2000) explains, rural farm household incomes consist of both cash incomes and imputed values of retained production. Thus, the inclusion of retained livestock in household farm income computation is consistent with established practices in literature., where total farm income is often conceptualized as the sum of marketed output, self-consumed output, and the imputed value of retained stocks (Asokan, et al., 1981 Deaton, 1997;FAO, 2011;Randolph et al., 2007)

Description of Some Variables in The Endogenous treatment Regression for household farm income.

The age of the household head was measured as a continuous variable in years. Younger household heads are usually more energetic and more open to using modern agricultural technologies, which may enable them to be more productive and earn more income (Asfaw & Admassie, 2004). Older farmers may be physically constrained but usually have an advantage due to acquired experience, knowledge, and well-developed market networks that can increase income (Abdulai & Huffman, 2014).

household size is measured as the total number of household members (a continuous measure). A larger household can provide more labor for farming, which reduces the cost of labor and may also lead to increased productivity (Doss & Morris, 2001). However, if there is a high dependency ratio within the household with few working-age members the increased burden of consumption may outweigh the benefit of additional labor, which could actually lower farm income.

Farming experience was measured as a continuous variable in years. Farmers with more years of farming experience has knowledge and work to enhance their capacity for soil management, crop selection, and understanding of market dynamics. This usually leads to higher yields and more stable streams of income, as more experienced farmers are better positioned to mitigate risks (Abdulai & Huffman, 2014).

The education level of the household head was measured by the number of spent in school. Higher education attainment enables farmers to access vital agricultural information, adopt innovative technology, and generally diversify income sources. All these gains most often translate to better farm productivity and higher levels of income among farmers (Levin et al., 1983).

Farm size is measured as a continuous variable. The benefits from economies of scale and higher productions leading to larger marketable surpluses have been observed often for large farm sizes of farms although lands poorly managed even at large tracts do not easily lead to huge gains in income (Dercon & Krishnan, 2000) .

The gender of the household head was captured with a binary variable where 1 represents a male and 0 represents a female. Some empirical evidence does suggest that male-headed households may have better access to key resources land, credit, and extension services than female-headed households, and this may translate into higher income (Kpoor, 2019). Meanwhile, female-headed households, while adopting more diversified farming strategies that at times prove to be resilient in nature, could face obstacles to their access of these resources.

Land ownership was measured as a binary variable: 1 indicates ownership, and 0 is non-ownership. The security of land tenure is important because it encourages farmers to make long-term improvements in the lands, such as soil fertility enhancement, irrigation systems, and high-value crops. Insecure land tenure may discourage the same efforts by farmers, likely raising farm income(Deininger & Jin, 2006).

Access to extension was coded as binary variable: 1 for access and 0 for no access. Farmers who have access to extension services have more current training on modern agricultural inputs and better market linkages, which will directly result in increased productivity and income for them (Anderson & Feder, 2004). For those who do not have access, may keep relying on traditional ways of farming, which are inefficient, and thus affect their income.

Access to credit is also a binary variable. Farmers with access to credit (coded as 1) can invest in high-quality seeds, fertilizers, and modern equipment; usually, this means better yields and greater income. Without credit, farmers may have to adopt low-input strategies that limit their production potential (Karlan et al., 2014).

Access to the market was measured as a binary variable: 1 for access to markets and 0 for no access. Proximity to markets enables farmers to sell their produce at competitive prices, thus maximizing their income. On the other hand, poor market access increases transaction costs, reduces selling prices, and increases post-harvest losses, thereby reducing farm profitability (Barrett, 2008).

Table 3. 4: Descriptions, Measurement, and Expected Signs of Variables in The Endogenous Treatment Regression for household farm income.

Variable	Measurement	Expected Sign
Age of Household Head	Continuous (Years)	±
Household Size	Continuous (Number of people)	±
Farming Experience	Continuous (Years)	+
Education Level	Continuous (Years)	+
Farm Size	Continuous (Acres)	+
Gender of Household Head	Dummy (1 = Male, 0 = Female)	+
Land Ownership	Dummy (1 = Own land, 0 = No ownership)	+
Access to Extension Services	Dummy (1 = Yes, 0 = No)	+
Credit Access	Dummy (1 = Yes, 0 = No)	+
Training	Dummy (1= yes, 0= no)	+

Source; Author, 2024

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussions of the study. The first part provided detailed descriptive statistics of the socio-demographic characteristics of the sampled respondents. Subsequently, the second section discussed empirical estimates of the multivariate probit model, focusing on the determinants of coping strategies adoption. Additionally, the chapter further discussed estimates of the endogenous treatment regression, the test for validity of instruments, as well as the treatment effects on food security and farm income.

4.2 Socio-demographic characteristics of the respondents

Table 4.1 presents the descriptive statistics of the continuous variables used in the study, showing the means and standard deviations of key socio-demographic variables.

Table 4. 1: Descriptive Statistics of Continuous Variables

Variable	With training (N=202)	SD	Without training (N=198)	SD
Age of respondents	50.31841	13.85	49.89394	14.25
Household size	9.492537	7.37	8.646465	5.53
Farming experiences (years)	23.97512	12.50	25.74747	13.03
Years spent in school	10.90955	9.16	8.658163	8.21
Farm size in acres	8.323232	6.87	7.84076	8.29

Source: Field Data, 2024

4.2.1 Descriptive Statistics of Continuous Variables

The demographic characteristics of continuous variables of the surveyed farm households are presented in Table 4.1. The average age of household heads with training was 50.32 years, compared to 49.89 years among those without training. The marginal difference suggests that the training programs were inclusive and cut across different age groups. This means that, since the ages are almost similar, participation would not be strongly influenced by the age of the household head. Also, the standard deviation (SD) for age among respondents who had training is 13.85, while for those who did not have training, it is 14.25. These values show a reasonable variation in age within each group, meaning that both young and older farmers were involved.

From the results in Table 4.1, households with training had an average household size of 9.49 members, compared to 8.65 members for households without training. This already points to the reasonable impact of labour availability on training participation. The larger the household size, the more diversified the labour resources; hence, some members can attend training without significantly disrupting household or farm activities. The household size is significantly larger in the SD for the group with training, at 7.37, compared to 5.53 for those without training. This higher SD indicates that there is a wider range of household sizes among the trained group, including both very large and relatively smaller households. The greater the standard deviation in the trained group could reflect that larger households are more likely to be involved in training due to having more labour and resources, but the programs are also representative of smaller households. This variability can be explained by the fact that different household sizes may have different needs and capacities to absorb the

training, thus influencing the program's outreach. This is in line with the work of Mendola (2007), who found that larger households can allocate more labour towards off-farm activities, like training programs, without compromising productivity on the farm. Training programs may also purposefully target larger households where their potential for adopting new livelihood restoration training programs introduced during training will be scaled up.

For farming experience, households without training have more years of farming experience, averaging 25.75 years, compared to those with training, who average 23.98 years. This difference suggests that less experienced farming households are more likely to participate in training, possibly due to their openness to adopting new techniques or practices. More experienced farmers may rely on traditional methods practiced over time and may be less inclined to participate in training programs unless they are perceived as highly beneficial. This result thus confirms the assertion made by Shiferaw et al (2003) that more experienced farmers tend to prefer traditional ways of doing things unless the training specifically addresses their needs. The SD is 12.50 for those with training and 13.03 for those without training. These relatively large SD values indicate considerable variation in years of farming experience within both groups. This variation suggests that farming experience is not a rigid determinant for training participation. Both experienced farmers and less experienced farmers are involved in the programs. The similar SDs in both groups suggest that training is accessible to farmers across various experience levels, and other factors such as education and household structure may be more influential in determining who receives training.

From the results, households that received training, their average number of years spent in school was 10.91 against that of those without training with 8.66, which shows clearly how education could promote awareness and facilitate access to such opportunities for households. Farmers become better at processing information about certain technology and may therefore know when there is a possible advantage. The result of years of education and training participation is consistent with Ignowski & Minten, (2021) finding of the crucial role of education in the training programs, participation and adoption of innovations. The standard deviation for years spent in school is greater for those with training, 9.16 and 8.21, than for those without training. This suggests greater dispersion in the educational attainment of the trained group, suggesting that the training programs attract people with low years of schooling and those with higher years of schooling.

For farm size, households that received training have larger average farm sizes (8.32 acres) compared to those that have not received training, 7.84 acres. This could indicate that a majority of the people who were trained have larger farm sizes. Larger farms provided more avenues through which agriculture training could be more widely adopted. This finding is consistent with Balija (2014), who argues that larger-scale farms are in a better position to absorb risks associated with the adoption of new agricultural practices. It also suggests that training programs may have a preferential outreach to households with larger landholdings, which could be an influence on the equitable distribution of benefits across farming households. The SD for farm size is 6.87 acres among those with training and 8.29 acres for those without training. The larger SD among the non-trained reflects greater variability in farm sizes.

This would, therefore, imply that farm size may influence the chance of receiving training.

Table 4.2 presents the summary descriptive statistics of some important discrete and categorical variables used in the study.

Table 4.2: Descriptive Statistics of Discrete and Categorical

Variable	Categories	Frequency (%)
Educational level	No formal education	161 (40.25)
	Primary	60 (15.00)
	JHS	45 (11.25)
	SHS	59 (14.75)
	Tertiary	38 (9.5)
	others	37 (9.25)
	Total	400 (100)
Religion	ATR	197 (50.26)
	Christian	122 (31.12)
	Muslim	68 (17.35)
	Others	5 (1.28)
	Total	392 (100)
Sex	Male	66 (83.5)
	Female	334 (16.5)
	Total	400 (100)
The dominant mode of land acquisition	Inheritance	370 (92.50)
	Gift	9 (2.25)
	Purchase	21 (5.25)
	Total	400 (100)
Marital status	Married	346 (86.50)
	Divorce	54 (13.5)
	Single	0 (0)
	Widowed	0 (0)
	Total	400 (100)
Household Received Training from LSLA owners	Yes	202 (50.5)
	No	198 (49.5)
Household or any member of the community Sought /training/services from LSLA owners	Total	400 (100)
	Yes	237 (59.3)
	No	163 (40.7)
	Total	400 (100)

Source: Field Data, 2024

4.2.2 Descriptive Statistics of Discrete and Categorical

From Table 4.2, the analysis of respondents' educational backgrounds provided an understanding of the level of formal education within the study population. The findings revealed that 40.25% of respondents lacked formal education. This represents a significant portion of those surveyed and highlights an important aspect of the demographic makeup of the participants.

The percentage of respondents with a primary school education was 15.00% and those who had completed JHS were 11.25%, while 14.75% had attained SHS education. These figures mean that beyond the primary school level, there was a gradual decline in higher levels of educational attainment that may be indicative of certain barriers that limit the pursuit of higher levels of education. Respondents with tertiary education attainment were 9.50%, reflecting a relatively small but significant representation in access to higher education. Finally, 9.25% of the respondents have other forms of education.

For religion, ATR had the highest number of respondents, with 50.26%. This was followed by Christianity, with 31.12% of the respondents identifying themselves as Christians. The Muslims were 17.35%, while a small 1.28% were practicing other religions. From this, it is evident that ATR and Christianity are the dominant religions in the study area, while Islam is a sizeable minority.

From the results, the distribution of respondents by sex was skewed as the males accounted for 83.5% of the sample, while females accounted for 16.5%. This disparity reflects the gender dynamics within the sampled population and suggests that the

majority of the household heads who were interviewed are males.

With respect to the mode of land acquisition, inheritance came out as the most significant source, where about 92.50% of respondents reported having acquired land through inheritance, 5.25% from purchases, and a negligible 2.25% was acquired through gifts. This shows the high relevance of traditional systems of inheritance to land ownership that can inform how land use patterns affect agricultural productivity.

Furthermore, a high percentage of 86.50% of the respondents were married, while 13.50% were divorced. Single or widowed respondents were not represented in this study as household heads. The high number of married persons implies that the overwhelming majority of the household heads were married.

For LSLA training, the results in Table 4.2 above indicate that 202 (50.5%) received training by LSLA owners, while 198 (49.5%) did not receive training. Also, when households were asked whether they or other community members had sought training or services from LSLA owners, 237 (59.3%) reported doing so, compared with 163 (40.7%) who had not. These findings suggest that the training programs introduced by LSLA owners reached a considerable proportion of households, reflecting an active effort to engage local communities in livelihood training activities. Evidence from the Talensi resettlements shows that many displaced households benefited from Cardinal Namdini's Livelihood restoration activities (Apubeo, 2023; Awuni, 2022). These programs also provided vocational skills training programs (GNA, 2023), by which members of the community could learn employable skills and expand their sources of income.

4.3 Summary Statistics of Major Crops Cultivated

Table 4.3 shows the summary statistics of the major crops cultivated by farm households in the study area. The table provides descriptive information on the key crops grown, including their mean yield and the standard deviations (SD). This summary helps to understand the relative importance of each of the major crops grown for participants and non-participants of training.

Table 4. 2: Summary statistics of major crops cultivated

Crop	Mean for households that receive training.	SD of households with training	Mean for households that did not receive training.	SD of households without training
Bags of Rice	5.16	2.55	3.23	3.02
Bags of Millet	5.96	4.10	4.51	5.91
Bags of Groundnut	3.10	2.32	3.43	4.39
Bags of Maize	12.50	65.59	4.61	3.13
Bags of Soybean	1.60	2.06	1.20	1.62
Bags of Cowpea	4.66	5.82	3.53	1.39

Source: Field Data, 2024

The summary statistics of major crops cultivated are presented in Table 4.3 above. From the results, rice clearly shows a positive impact from training. The farmers who participated in the training had an average of 5.16 bags of rice, while farmers without training had only 3.23 bags. This is a significant increase in average production for those who received the training. In addition, dispersion in production is less for the trained farmers, as evidenced by an SD of 2.55 bags compared to that of the non-trained farmers with 3.02 bags.

This therefore shows that the training not only brought in better average yields but also reduced variations in rice production. A lower SD suggests that the trained farmers may have adopted more standardized farming practices or better techniques that allowed them to achieve more reliable and consistent outcomes.

Millet also responds positively to training, with the mean yield increasing from 4.51 bags for households without training to 5.96 bags for households with training. This increase of about 32% , though not quite as significant as the gains observed for rice. Just like rice, millet production is also becoming more consistent after training, with the SD reduced from 5.91 for households without training and to 4.10 for households with training. The high variability of the initial yields for households without training indicated that millet farming was subjected to a wide range of influences, which could be from inconsistent practices or varying levels of resource access.

For groundnut, the average yield for households that received training fell slightly from 3.43 bags for non-trained households to 3.10 bags for trained households. This is a small decline in average production and might seem counterintuitive, given that training is generally designed to raise productivity. There are several potential reasons for this result. This could be because the response of the training program was less effective in addressing crop-specific challenges, such as soil fertility, pest control, or weather conditions. It is also possible that the practices taught to groundnut farmers were not implemented fully or that exogenous factors, such as unfavorable growing conditions, negatively impacted yields. While the average yields declined, the standard deviation for trained farmers went down from 4.39 bags to 2.32 bags, indicating that

with training, the output was more consistent. That implies that even though the training probably did not raise the average yields, it standardized farming practices to reduce variability in groundnut production.

The results in Table 4.3 showed that Maize is the crop showing the most dramatic change, whereas the average yield of non-trained farmers goes up to 4.61 bags, that for trained farmers increases to 12.50 bags an increase of more than 170%. This explosive average increase in yield was matched by an extreme increase in variability as the standard deviation also soared from 3.13 to 65.59 bags. This would imply that while some of the trained farmers realized high increases in the levels of maize production, some others might have had quite serious difficulties and hence extremely low yields. The sharp rise in dispersion with training likely reflects the unevenness of the impact of the training program; while some farmers benefitted greatly from the new techniques or inputs, others might have struggled hard to implement the new practices effectively. The large variability could also be associated with external factors, like weather conditions, soil quality, or availability of inputs that might have interacted with the effectiveness of the training across different farmers. This data highlights the need for targeted support and more tailored training programs to ensure all farmers can achieve consistent improvement in their maize production.

From the results, Soybean production is increasing in the average yield from 1.20 bags for farmers without training to 1.60 bags for those who received training, an increase of 33%. However, the standard deviation goes from 1.62 bags up to 2.06 bags. Hence, while the average yield was improved, the variability of this production increased. This increased variability could indicate that some of the farmers were challenged with

adopting new, perhaps more complicated techniques for farming soybeans or ones that required a very specific condition. It may be that the training program did affect some of the farmers, whereas others struggled with the new practices, which resulted in increased variability.

From the results, Cowpea also shows an average increase in yield, increasing from 3.53 bags for farmers without training to 4.66 bags for those with training, which is an increase of about 32%. Cowpea production also indicates variability, as shown by the increase in the standard deviation from 1.39 to 5.82 bags. What this means is that although the training program was successful in affecting average yields positively, it also resulted in variability in the production results. The increased variability in yields could be as a result of differential implementation of training practices, other external causes like pest attacks or drought, and the differential levels of resource availability across the different farmers. This emphasises the need for more holistic support of cowpea farmers, ensuring that the population consistently derives the full benefits of training programs

4.4 Multivariate Probit Regression: Determinants of Coping Strategies

Table 4.4 presents the results of the multivariate probit regression analysis used to identify the factors influencing the choice of various coping strategies adopted by smallholder households in response to the adverse effects of large-scale land acquisition (LSLAs) activities in the Talensi District. The MVP model simultaneously estimates the likelihood of choosing multiple coping strategies, recognizing that households often adopt more than one coping strategy simultaneously.

Table 4. 3: Multivariate Probit Regression: Determinants of Coping Strategies

VARIABLES	Livelihood diversification	Non-agricultural investments	Migration	Land borrowing	Selling assets
Age of household head	0.001	0.026***	-0.000	-0.016**	-0.005
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)
Household size	-0.017	-0.017	0.008	-0.022	-0.003
	(0.012)	(0.012)	(0.012)	(0.014)	(0.012)
Farming experience (years)	0.008	-0.021***	0.002*	0.018**	0.008
	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)
Years spent in school	-0.007	-0.006	-0.004	-0.006	0.009
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Training (=1, 0=no)	0.024	0.298*	-0.145	-0.116	0.058
	(0.165)	(0.161)	(0.156)	(0.161)	(0.162)
Farm size	-0.007	-0.002	-0.012	-0.004	0.007
	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)
Access to market (=1, 0=no)	0.008	-0.173	-0.022	-0.157	-0.156
	(0.178)	(0.178)	(0.170)	(0.176)	(0.175)
FBO membership (=1, 0=no)	0.210	0.072	0.018	0.437**	0.173
	(0.178)	(0.176)	(0.169)	(0.177)	(0.175)
Access to extension (=1, 0=no)	0.028	-0.094	-0.052	0.088	0.076
	(0.164)	(0.166)	(0.160)	(0.163)	(0.164)
Land value per plot (cedis)	0.000063**	0.000036	0.000014	—	0.020
	(0.029)	(0.026)	(0.000016)		(0.017)
Changes in mode of land access (=1, 0=no)	0.563**	0.081	-0.102	-0.051	0.046
	(0.231)	(0.175)	(0.179)	(0.177)	(0.170)
Land ownership (=1, 0=no)	-0.307	-0.097	-0.045	0.070	0.522**
	(0.227)	(0.242)	(0.227)	(0.231)	(0.251)
Relative in leadership position (=1, 0=no)	0.002	0.260*	0.323**	-0.314**	-0.329**
	(0.156)	(0.156)	(0.149)	(0.155)	(0.157)
Household head (=1, 0=no)	-0.168	-0.275	-0.096	0.142	0.328
	(0.220)	(0.230)	(0.213)	(0.222)	(0.228)
Gender (1=male, 0=female)	0.336	0.375	0.300**	-0.009	0.134
	(0.258)	(0.244)	(0.241)	(0.250)	(0.248)
Constant	-2.578** (1.086)	-1.052	-0.186	0.080	-2.512***
		(0.978)	(0.937)	(0.908)	(0.959)

Observations: 388
LR Test 0.0084
Wald chi² (10) = 93.600

Prob > chi² = 0.0616

Parameters	Coefficient	Std. Err
/atrho21	-0.017	0.096
/atrho31	0.218	0.096
/atrho41	0.121	0.096
/atrho51	0.210	0.096
/atrho32	0.197	0.098
/atrho42	0.019	0.099
/atrho52	0.035	0.098
/atrho43	0.224	0.092
/atrho53	-0.013	0.088
/atrho54	0.158	0.098
ρ21	-0.017	0.096
ρ31	0.215	0.092
ρ41	0.121	0.095
ρ51	0.207	0.092
ρ32	0.194	0.094
ρ42	0.019	0.099
ρ52	0.035	0.097
ρ43	0.221	0.087
ρ53	-0.013	0.088
ρ54	0.157	0.095

The multivariate probit model used in the analysis of factors influencing the choice of coping strategies among households affected by LSLA has strong diagnostic results, as shown in Table 4.4 below. The LR test statistic is 0.0084, which is statistically significant at the 10% level, implying that these coping strategies are interdependent and justifying the use of the multivariate probit model. The Wald chi-square = 93.60 and a p-value of 0.0616, indicate the relevance of the model in explaining factors that influence choices of coping strategy. The significant correlations between the error terms of various equations indicate interdependence in coping strategy, which further supports the use of the multivariate probit. These correlations, which indicate how the

likelihood of adopting one strategy affects the likelihood of adopting another, provide a valuable understanding of whether the coping strategies are mutually exclusive or complementary.

The positive association between borrowing land for farming activities and migration (atrho43 = 0.224) in Table 4.4 implies that households adopting migration as a coping strategy are likely to borrow land to continue farming activities, which is complementary. Similarly, (atrho51 = 0.210) implies that households that adopt selling assets as a coping strategy also adopt livelihood diversification as a coping strategy. Moreover, the results from Table 4.4 reveal that (atrho32 = 0.197) households that adopted migrations as a coping strategy also adopted non-agriculture investment as a coping strategy and this association is complementary since the coefficient is positive.

Lastly, the correlation of selling and land borrowing for farming, arrho54 0.158, indicates that households that adopt selling of assets as a coping strategy also adopted land borrowing for farming, and this further explains that these two are complementary strategies. These significant positive correlations strongly suggest that the coping strategies adopted by households are complementary rather than mutually exclusive**.**

4.4.1 The Effect of Training on The Adoption of Coping Strategies Among Affected Households

Regarding the impact of training on the adoption of coping strategies, the results from the MPV probit model indicated that training was only significant for adopting non-agricultural investments as a coping strategy. The insignificance of training in influencing livelihood diversification can be attributed to its broad scope, which

involves engaging in multiple income-generating activities both within and outside of agriculture. Within agriculture, diversification may include mixed farming, such as crop-livestock integration, or adopting multiple crop enterprises. For non-agricultural activities, diversification overlaps with off-farm engagements, similar to non-agricultural investments. The insignificance of training in influencing livelihood diversification occurs because part of the LSLA training was focused on boosting agricultural output rather than encouraging diversification within agriculture. Consequently, households that independently diversified into livestock or other agricultural activities would report livelihood diversification without being affected by the training, rendering its effect statistically insignificant in this regard, thereby making non-agricultural investments significant among coping strategies, whereas livelihood diversification is not. Even though this did not meet prior expectations but is consist Mulia et al. (2021) found that training influences the adoption of non-farm investment and Kimathi (2022) found that interventions**,** including training, did not significantly influence livelihood diversification.

Moreover, the results in the MVP suggest that LSLA training did not significantly influence coping strategies like migration, land borrowing, or selling assets. This is because these coping strategies are largely driven by land shortages and unexpected shocks rather than skills or knowledge (Barrett & Carter, 2012 ; Dercon, 2002). Thus, while training played an important role in improving household income, food security and facilitated the adoption of non-agricultural investment as a coping strategy, it did not significantly influence broader diversification or other coping strategies conditioned by structural vulnerabilities (Barrett et al., 2019).

4.4.2 Factors Influencing the Choice of Coping Strategies.

The results from column 1 in Table 4.4 above revealed that land value per plot and household notice in change of mode of land acquisition were the factors influencing livelihood diversification.

The coefficient for land value per plot is 0.000063 and is significant at the 5% level. The positive relationship indicates that an increase in the value of land per plot is associated with an increased likelihood of livelihood diversification among affected households, holding all other factors constant. This is understandable because higher land values reflect the economic importance of the land, so owners of LSLA might have paid more compensation for affected households in communities where their land was of high economic importance or value. The compensation received by smallholder farmers for land can be used in pursuit of off-farm opportunities such as opening businesses, investing in education, or even migrating to urban areas in search of better economic prospects. In diversifying into such activities, households can better manage the negative consequences associated with the loss of agricultural land, which no longer provides much income due to the acquisitions by mining companies. Clark (2011) and Barrett et al. (2001) research shows that a household is likely to invest compensation in non-farm activities, especially if it receives higher compensation for the land. The increased compensation due to the sale or leasing of the land for mining purposes can provide the households with resources that may be used to cushion themselves from the economic challenges created by the displacement, especially in those cases where the agricultural land is critical for subsistence and its loss can significantly affect the livelihood of the household.

The change in the mode of land acquisition is a key determinant on livelihood diversification, as revealed by the coefficient (0.563) at a 5% significance level in Table 4.4. The positive relationship observed shows that households that perceive a change in the mode of land acquisition in their community were likely to diversify their livelihoods, holding all other factors constant. This result is understandable for several intertwined reasons emanating from economic and social dynamics. First, changes in land acquisition modes often symbolize changes in economic and environmental conditions that households are exposed to and thus need responses. For instance, the conversion of communal or smallholder agricultural lands to commercial purposes such as mining, large-scale agriculture, or infrastructural development disrupts the conventional farming activities of people. Probably, households find themselves with reduced access to high-potential land or communal resources, and the option of agriculture will not be as viable anymore. Faced with this uncertainty, diversification becomes a logical response that enables households to explore other sources of income and mitigate risks associated with land loss (Scoones, 1998; Deininger et al., 2011).

With respect to non-agriculture investment, the results in column 2 of Table 4.4. reveal that farming experience, relatives in leadership positions, age of household head, and training received were the factors affecting households' adoption of non-agriculture investment as a coping strategy.

The coefficient on the age of the household head in influencing non-agricultural investments is 0.026, statistically significant at the 1% level. This shows that as the

head of the household gets older, their likelihood of investing in non-agricultural activities increases, holding all other factors constant. This is especially true in the case of LSLA, where the households affected typically have limited access to land and must diversify their livelihood. Older household heads are likely to possess a higher degree of financial capital or income that they have accumulated from agriculture and other income activities. Such ownership of assets places them in a position where they can use the initial capital to invest in off-farm activities like trade, small-scale industries, or services. They may also be more risk-averse in their behavior, going for low-risk and certain investments outside agriculture, especially because of the uncertainty brought about by LSLA.

The negative coefficient for farming experience (−0.021) means that the more experienced the farmer, the less likely he is to invest in non-agricultural investments all else equal. This might result from a strong attachment to agricultural livelihoods and the desire to remain with traditional farming methods that offer a degree of stability. Given their experience, farmers usually have substantial expertise and networks within the agriculture sector and, therefore, do not find it worth exploring new, relatively risky non-farm activities. In addition, risk aversion characterizes experienced farmers. According to Moser, (1998), the more experience an individual has in a given field, the more they avoid diversification into areas in which they are inexperienced.

Relative in leadership position has a positive coefficient of 0.260 and is statistically significant at 10%. This implies that having a relative in a leadership position increases

the likelihood of adopting non-agriculture investment as a coping strategy, holding all factors constant. This might be because leadership networks increase social capital, which, in turn, enhances access to finance, information, and investment opportunities. According to social capital theory, (Morrow & Scorgie-Porter, 2017), leadership networks facilitate access to networks that open doors to economic opportunities and activities. Community leaders usually control access to resources and opportunities and favour their relatives, who, in turn, invest in other income-generating activities.

The results from column 3 in Table 4.4 reveal that farming experience, relative in leadership position, and gender were the factors that influenced the adoption of migrations as a coping strategy by households.

The positive coefficient for farming experience is 0.02 and is statistically significant at 10%. This suggests that increased years of farming are associated with an increased likelihood of households adopting migration as a coping strategy, holding all factors constant. This is so because farmers who have several years of farming experience would still want to engage in farming; this will increase their likelihood of household members migrating to areas where land is abundant to continue their farming. Furthermore, this reflects their ability to handle migration complexities such as job search, housing, and other forms of adjustment in the new environments. Migration has been viewed by Barrett et al. (2001) as a risk-mitigation and opportunity-capitalizing strategy for individuals who possess the relevant capability to overcome risk and use new opportunities.

Having a relative in a leadership position has a coefficient of 0.323 and is statistically significant at 5 %. This means that having a relative in a leadership position is strongly associated with a higher likelihood of migration, holding all other factors constant. This is expected because leadership networks may offer access to migration networks and resources, including job referrals or financial resources that the household member does not typically have. Moser, (1998) emphasizes that social networks decrease the transaction costs of migrating and make migration a plausible strategy for households with socially connected members. In a context where formal support structures are minimal, leadership links can be a source into which new opportunities open.

The positive coefficient of gender is 0.300 and is statistically significant at 5%. This indicates that members of male-headed households were more likely to migrate as compared to their female counterparts, all else equal. This is in line with the traditional gender roles of many rural communities where men are expected to seek employment elsewhere to support their families. (de Brauw et al (2014) observed that migration often occurs along the lines of male-dominated labour markets, providing greater access to physical mobility and a search for better economic opportunities for men. These impediments may be cultural or structural for women, yet this may not be the same for men.

The results in column 4 of Table 4.4 reveal that the Age of the household head, Farming experience, membership of FBO, and relative in leadership position are factors affecting land borrowing for farming.

The coefficient for the age of the household head is -0.016, and its statistical

significance at the 5% level indicates a strong negative relationship. This implies that an increase in the age of the household head is associated with a decreased likelihood of land borrowing for farming, holding all other factors constant. This is expected because, as one gets older, the physical strength to undertake intensive farming activities decreases. Land borrowing often comes with conditions, such as cultivating the land to meet certain expectations or repaying the borrowed land through labor or produce. Such demands may prove difficult for the elderly, who may turn to less labor-demanding strategies such as reducing their agricultural production, seeking remittances from other members of the family, or accessing social safety nets if possible. This aligns with the findings of Wossen et al., (2018), who observed that older farmers often prioritize livelihood strategies that require less physical labour.

The coefficient of having a relative in a leadership position is -0.314, which is statistically significant at the 5% level. This result implies that those households with members who have relatives in leadership positions have lower probabilities of borrowing land for cultivation as compared to their counterparts without relatives in leadership positions, ceteris paribus. Leadership positions often provide resources and networks that reduce the need for land borrowing. For instance, through influential relatives, households may be able to secure preferential treatment with regard to access to redistributed land, compensation, or other resources made available as part of LSLA mitigation measures. This finding is consistent with the work of Tomich et al., (2019), which highlights the role of social capital and leadership in accessing resources in rural contexts.

The coefficient for farming experience is 0.018 and is statistically significant at 5%. This indicates that households with more farming experience are more likely to borrow land for farming, all else equal. It is expected that experienced farmers usually have the knowledge and skills necessary to efficiently use borrowed land, making them more attractive candidates for such arrangements. Moreover, experienced farmers may be more committed to agriculture, which motivates them to seek alternatives like land borrowing when their landholdings are lost through the LSLA. This finding is supported by literature such as Reardon et al (2001) who found that experienced farmers are better positioned to manage risks and uncertainties in agricultural production. In the face of disruptions to land tenure systems, for example, LSLAs, borrowing of land becomes an important coping strategy that enables the continuation of agricultural livelihoods.

The coefficient of membership in FBO is 0.437. This positive coefficient implies that FBO membership increases the probability of households adopting land borrowing for farming as a coping strategy as compared to their counterparts without FBO membership, holding all other factors constant. This is understandable because FBOs often provide a collective action platform and resource pool among farmers. Members of such organizations might gain information about the availability of land to borrow or even obtain access through collective bargaining. In addition, FBOs may provide social capital that could facilitate trust and negotiation between landowners and borrowers (Boansi et al., 2023).

The results in column 5 of Table 4.4 reveal that land ownership and relative in leadership were the factors influencing the selling of assets as a coping strategy.

Land ownership has a positive coefficient of 0.522 and is statistically significant at 5%. The positive coefficient for land ownership suggests that households owning land have a higher probability of adopting selling assets as a coping mechanism, as compared to their counterparts, all else equal. This is understandable because land ownership normally provides a form of collateral, hence access to credit or liquidity. In those cases where such options are not available or not sufficient, a landowning household could sell movable assets, such as livestock or farm machinery, to meet immediate needs. This finding is supported by studies like that Carter & Barrett, (2006) work that details how landowners may smooth income shocks by selling off assets. Households in LSLA areas may face declining agricultural productivity that can result in the liquidation of assets as a coping strategy to replace losses in income or increased expenditure.

Relative in a leadership position has a negative coefficient of -0.329 and is statistically significant at 5%. The negative coefficient on having a relative in a position of leadership indicates that all else being equal, households with these connections are less likely to adopt selling assets as a coping strategy as compared to their counterparts. This is understandable because leadership is often associated with access to resources such as financial support, information, or help from various social networks. These could leverage their social capital to borrow loans, grants, and other forms of aid with reduced pressure for liquidating assets during shocks. This might be facilitated by the social capital theory presented by Morrow & Scorgie-Porter, (2017) , which focuses on how networks and leadership roles promote access to non-market resources. Access to livelihood restoration programs could be more easily extended to households with

members in leadership positions, thereby minimizing their need to sell any assets.

4.5 Determinants of Training Participation and Household Farm Income

Table 4.5 presents the results of the endogenous treatment regression analysis examining the determinants of training participation and household farm income among smallholder farmers in the Talensi District.

Table 4. 4: Determinants of Training Participation and Household Farm Income

VARIABLES	Training (Coeff.)	Std. Error	Farm Income (Coeff.)	Std. Error
Age of respondent	0.007	0.006	0.002	0.014
Household size	0.013	0.011	0.032	0.026
Farming Experience (Years)	-0.008	0.006	0.012	0.016
Years spent in school	0.018**	0.007	-0.021	0.019
Farm size (acres)	-0.009	0.009	0.081***	0.023
Gender (1= Male, 0=Female)	0.277	0.180	0.379	0.453
Land ownership (1=yes, 0=no)	-0.267	0.194	0.477	0.471
Access to extension (1=yes, 0=no)	0.270**	0.132	0.550*	0.247
Access to credit (1=yes, 0=no)	0.022	0.127	-0.098	0.322
Access to market (1=yes, 0=no)	-0.118	0.138	0.979***	0.351
Training (1=yes, 0=no)			3.450***	0.525
Consultation during LSLA process (1=yes, 0=no)	0.190*	0.089		
Distance to the training center(km)	-0.039**	0.017		
Relative in leadership (1=yes, 0=no)	0.212**	0.099	0.438	0.268
athrho			-1.092***	0.150
Lnsigma			1.147***	0.061
Constant	-0.165	0.589	1.375	1.485
Observations	394		394	

LR test = 0.0045
Prob > chi2 = 0.0000
Wald chi2(12) = 94.66

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

From the results in Table 4.5, the rho coefficient (-1.092***, significant at 1%) shows a strong negative correlation between the unobserved factors affecting the decision to participate in training (selection equation) and those affecting household farm income (outcome equation). This suggests that households with a higher probability of unobserved factors contributing to training participation tend to have a lower unobserved factor positively affecting farm income. The significance of athrho confirms selection bias and thus justifies the use of an endogenous treatment model to correct it.

The lnsigma is the log variance of the error term in the outcome equation. It is 1.147*** and significant at 1%, indicating that relatively large variability in household farm income has been accounted for by this model, and therefore reinforces the reliability of estimated coefficients and the overall explanatory power of the model. Additional diagnostics further support the model's strength. The LR test is extremely significant at 1%, again suggesting that the outcome and the selection equation are dependent on each other and should run together using the endogenous treatment regression rather than a separate OLS and logit. The Wald chi-square statistic, 1.147** still suggests the overall significance, hence the general relevance and strength of this model

4.5.1 The Effect of Training from Large-Scale Land Acquisition Owners on Household Farm Income

The coefficient for the training variable in the model is 3.450, which is significant at a 1% level, meaning that households that received livelihood restoration training experience approximately 3.450 % higher household farm income than those who did not receive the training, holding other factors constant. This statistically significant coefficient highlights the enormous positive effect of the livelihood training. This finding is understandable because the agricultural training covered improved agronomic practices, crop management, and better post-harvest handling methods (Ngnenbe, 2022; Ayuu, 2022), all of which directly enhanced yields and produce quality, leading to better household farm income for beneficiaries. Non-farm livelihoods training provided by the LSLA owners also extended to vocational and technical skills such as masonry, carpentry (Golder, 2018; GNA, 2023), etc. The positive and statistically significant coefficient of the training variable in the farm income regression may also be attributed to the vocational skills acquired by beneficiaries, which could have enabled them to engage in non-agriculture activities, generate income, and reinvest part of this capital into farming. Such reinvestment has the potential to enhance agricultural productivity and, consequently, increase household farm income.

This corresponds well with the current literature that has demonstrated access to training programs has a positive effect on household farm income and productivity. some scholars argue that agricultural extension and training programs induce farmer behaviour changes that, with time, alter farming techniques and influence economic

outcomes over time (Wordofa, 2018) .

4.5.2 Determinants of Training in Table 4.5

The results in Table 4.5 showed that "Relative in Leadership Position" has a coefficient of 0.212, which is significant at 5%. This implies that households having a relative in a leadership position are more likely to receive training as compared to their counterparts without relatives in leadership positions, holding all factors constant. This is understandable because households with relatives in leadership positions may have wider access to resources, information, and opportunities. Leadership positions often bring increased social capital, which can facilitate participation in development programs, including livelihood restoration training. A household having a relative in a leadership position could also increase the influence of the household within the community, making them more likely to be selected for training opportunities or be informed about available programs. These findings is in agreement with Eren, (2014) and Fafchamps & Minten, (2005) who found that social networks and influential community members are very important in access to opportunities .

From the results in Table 4.5, access to extension is statistically significant at 5% and has a positive coefficient of 0.270. This means that households that had access to extension were more likely to receive training than their counterparts who did not have access to extension, all else equal. This meets expectations because extension services are usually aimed at bridging the knowledge gap between researchers and farmers through knowledge dissemination, practical training and technical support to educate farmers on the availability of new agriculture innovations. Therefore, households who

have access to extension might have been educated on the benefits of participating in the programs thereby increasing their probability of participation as compared to their counterparts who did not have access to extension. Also, households that have access to extension were more likely to be aware of this training program either from peers or the extension agents who educate and provide extension services to them thereby making these households more likely to receive training for this livelihood restoration program. This finding agrees with the work of (Anderson & Feder, 2004; Fischer & Qaim, 2014) who found that extension services not only provide technical knowledge but also facilitate access to training.

The coefficient of years spent in school by the household head in the treatment equation of Table 4.5 is 0.018, which is statistically significant at the 5% level. This means that each additional year spent in school increases the probability of benefiting from the livelihood training. This positive relationship is understandable because education equips households with the requisite cognitive and technical skills, increasing their chances of participating in the training. The more educated a person, the more active and efficient he will be in the use and search for livelihood development opportunities. They also typically enjoy better access to information networks that help them learn about such programs more effectively. These findings are supported by the research work of Ragasa et al.(2013) who identify the key role education plays in bridging gaps in access to extension services.

From Table 4.5, distance to the training center has a coefficient of -0.039, which is statistically significant at the 5% significance level. This means that for every

additional kilometer of distance from a household to the training center, the probability of the household participating in training decreases, holding all other factors constant. This result points out the crucial role played by geographical proximity in facilitating access to capacity-building opportunities, especially in rural settings. This implies that far distance to training centers translates to higher costs not just financially, but also in terms of time, which poorer households may not be able to afford. The opportunity cost of attending training which could have been used in pursuit of income-generating or subsistence activities further decreases participation in training among households that live far away from training centers. These findings are consistent with previous studies. Research by Paladan,(2019) in the Philippines emphasizes that distance to training centers is one of the major factors affecting farmer participation. He found that as distance increases, the likelihood of farmers participating in agricultural training decreases.

The consultation during LSLA variable has a positive coefficient of 0.190 and is significant at the 10% in Table 4.5. This indicates that, holding all other factors constant, households that were consulted during the land acquisition process are more likely to receive training by owners of LSLA than their counterparts. This result emphasizes the important role of consultation in livelihood recovery efforts. Being consulted may have built trust and improved understanding, relationships between households and the LSLA owners, making households more aware and willing to participate in livelihood training. On the other hand, those who reported that they were not consulted might have been excluded from access to some key information and may have been less informed about training or more resistant to accessing LSLA-related

programs. This finding aligns with the best international practice that prioritises Free, Prior, and Informed Consent (FPIC), which places consultation among the requirements of inclusive resettlement and recovery of livelihoods (FAO, 2016)

4.5.3 Other Determinants of Household Farm Income

From Table 4.5, the coefficient of farm size in the outcome equation is 0.081***which is statistically significant at 1%**.** This result implies that an acre increase in farm size is associated with approximately 0.08**%** increase in household farm income, holding all other factors constant. This meets prior expectation because larger farm sizes usually benefit from economics of scale, where the cost per unit of output decreases as the scale of production increases because of the more efficient use of resources such as labour, equipment, and inputs. As a result, larger farms can achieve higher output and income levels compared to smaller farms. Also, larger farms generally have better market access and are more capable of meeting market demands. This agrees with the work of Byerlee & Deininger, (2013) who also found that farm size has a positive correlation with farm income.

From Table 4.5 above, the coefficient for access to extension in the outcome equation is 0.550*, which is statistically significant at 10%**.** This implies that farmers who had access to extension had an average farm income of 0.55% more than their counterparts, holding other factors constant**.** This positive and significant relationship meets prior expectations and highlights the transformational potential of agricultural extension in the improvement of farming practices and productivity, hence enhancing the livelihoods of smallholder farmers. Extension services bridge the gap between research institutions and farmers in the area of disseminating breakthrough innovations

and best farming practices. In most instances, extension workers provide more than just technical advice but also assist farmers in the adoption of improved technologies, access to markets, and decision-making in their various agricultural enterprises. These services therefore, play an essential role in the growth and sustainability of smallholder agriculture. Asfaw et al., (2012) and Anderson & Feder, (2004) have also emphasized that extension services can perform an essential function of improving agricultural productivity, particularly in resource-constrained situations. Their work has focused on how agricultural extension, appropriately delivered, could lead to enhanced efficiency, higher output, and improved incomes among poor, smallholder farmers with access to limited forms of support.

Market access has a positive coefficient of 0.979 and has a 1% level of significance**.** This indicates that, holding all other factors constant, households with access to markets had an average farm income of 0.987% higher their counterparts. The positive effect of market access highlights its important role in improving rural household farm income. Farmers with access to markets can sell their produce at better prices, reduce transaction costs, and minimise post-harvest losses. . This aligns with existing literature, which emphasizes that better integration into markets is associated with higher earnings and improved welfare among smallholder farmers (Barrett, 2008; Oseni & Winters, 2009) .

4.6 Determinants of Training Participation and Household Food Security

Table 4.6 presents the results of the endogenous treatment regression analysis examining the determinants of training participation and food security among smallholder farmers in the Talensi District.

Table 4. 5: Determinants of Training Participation and Household Food Security

VARIABLES	Training (Coef)	Training (Std. Error)	FCS (Coef)	FCS (Std. Error)
Age of respondent	0.008	(0.006)	-0.004**	(0.002)
Household size	0.017	(0.011)	0.001	(0.003)
Years of Farming Experience	-0.009	(0.006)	0.002	(0.002)
Years spent in school	0.019**	(0.008)	0.004*	(0.003)
Farm size (acres)	-0.013	(0.010)	0.006**	(0.003)
Gender (1=Male, 0=Female)	0.280	(0.185)	0.086	(0.057)
Land ownership (1=yes, 0=no)	-0.190	(0.192)	0.142**	(0.058)
Access to extension (1=yes, 0=no)	0.313**	(0.135)	0.217***	(0.043)
Consultation during LSLA (1=yes, 0=no)	0.305**	(0.120)		
Distance to training (km)	-0.024*	(0.014)		
Access to market (1=yes, 0=no)	-0.182	(0.141)	0.174***	(0.043)
Relative in a leadership position (1=yes, 0=no)	0.256*	(0.132)	0.085	(0.062)
FBO (1=yes, 0=no)	-0.009	(0.140)	0.085**	(0.041)
Access to credit (1=yes, 0=no)			0.068*	(0.035)
Training (1=yes, 0=no)			0.403***	(0.148)
athrho			-0.667**	(0.285)
lnsigma			-0.968***	(0.092)
Constant	-0.365	(0.592)	3.777***	(0.187)
Observations	394		394	
LR test of = 0.09				
Prob > chi2 = 0.0000				
Wald chi2(12) = 107.05				

Standard errors in parentheses

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

The model diagnostics from the analysis of Table 4.6 below are robust and valid in explaining the factors that affect household food security. The parameter athrho (-0.667, significant at 5%) measures the correlation between the error terms of the selection and outcome equations. The negative sign indicates that unobserved factors affecting household participation in training (selection equation) are negatively related to the unobserved factors affecting FCS (outcome equation). The finding thus confirms the appropriateness of the application of the endogenous treatment model, given that its disregard may lead to estimates susceptible to bias.

lnsigma (-0.968, significant at 1%) is the natural log of the variance of the error term in the outcome equation. In this case, the significance of the parameter indicates that dispersion in the FCS is captured by the model, hence it is reliable enough for measuring the key determinants of food security. The constant term in the result equation, which is 3.777 at a 1% significance level, actually presents the baseline FCS of households when all independent variables take the value of zero. Although this is of limited interpretive value on its own, its significance strengthens the need for consideration of the baseline context in the assessment of food security outcomes.

The LR test is significant at 10% indicating that running the selection and the outcome equations together is more appropriate than running them separately. The diagnostic results overall confirm that the model is robust in solving issues of endogeneity, selection bias is well accounted for, and the determinants and effects of training on food security are well captured. This enhances the credibility of the findings and their implications for policy interventions aimed at household food security.

4.6.1 The Effect of Training from Large-Scale Land Acquisition Owners on Household Food Security.

Training is the treatment variable for this study. It is statistically significant at 1% and has a positive coefficient of 0.403. The positive coefficient of training implies that households that had a member who participated or received livelihood training had an average FCS of 0.403% higher than their counterparts who did not receive training, holding all other factors constant. This result is understandable and meets prior expectations because we expect that households that had their members train for various jobs, such as how to operate heavy-duty mining tractors and those who received training for various vocational skills, such as brick-laying and tiling, plumbing, carpentry, and electrical installation (GNA, 2023;Golder, 2018) should be able to set-up their own business or shops and take advantage of various employment opportunities in the quarrying or mining companies such as the Cardinal Namdini Mining Limited and earn income which can be used to purchase multiple varieties of food thereby resulting in higher FCS than their counterparts who did not benefit from the livelihood restoration training . Also, the positive correlation between training on FCS and training can be attributed to the improvements in agricultural output that these interventions naturally bring. Households who benefited in the agriculture training (Ngnenbe, 2022) , are expected to have higher yields and more diverse agricultural outputs, which directly contribute to improved food availability and access for the household. As yield increases, households are better able to meet their nutritional needs, resulting in higher FCS. This is in alignment with Asfaw et al., (2012) ,Dercon & Christiaensen, (2011) who found in their studies that households

engaged in such training and improved agriculture innovations have better food security outcomes.

4.6.2 Determinants Training in Table 4.6

The results from Table 4.6 showed that Relative in Leadership Position has a coefficient of 0.256, which is significant at 10%. This implies that households having a relative in a leadership position were more likely to receive training as compared to their counterparts without relatives in leadership positions, holding all factors constant. This is understandable because households with relatives in leadership positions may have wider access to resources, information, and opportunities. Leadership positions often bring increased social capital, which can facilitate participation in development programs, including livelihood restoration training. A household having a relative in a leadership position could also increase the influence of the household within the community, making them more likely to be selected for training opportunities or be informed about available programs. According to Eren, (2014), social networks and influential community members are very important in access to opportunities.

Results from Table 4.6 above showed that access to extension is statistically significant at 5% and has a coefficient of 0.313. This means that households that had access to extension were more likely to receive training than their counterparts who did not have access to extension, all else equal. This meets expectations because extension services households that have access to extension were more likely to be aware of this training program either from peers or the extension agents who educate

and provide extension services to them thereby making these households more likely to receive the livelihood training . This finding agrees with the work of Fischer & Qaim, (2014) who found that extension services not only provide technical knowledge but also facilitate access to training.

The coefficient of years spent in school by the household head in the treatment equation of Table 4.6 is 0.0185, which is statistically significant at the 5% level. This means that for each additional year spent in school the probability of participating in the livelihood training increases, holding all factors constant. This positive relationship is understandable because education equips households with the requisite cognitive and technical skills, increasing their chances of participating in the training programs. The more educated a person, the more active and efficient he will be in the use and search for livelihood development opportunities. They also typically enjoy better access to information networks that help them learn about such programs more effectively. According to Asfaw et al., (2012) educated household heads better understand the long-term benefits of different sustainable agricultural practices that may have been introduced through training programs.

From Table 4.6 distance to the training center variable has a coefficient of -0.0242, which is statistically significant at 10%. This means that for every additional kilometer of distance from a household to the training center, the probability of the household participating in training programs decreases, holding all other factors constant. This result points out the crucial role played by geographical proximity in facilitating access to capacity-building opportunities, especially in rural settings. This implies that far

distance to training centers translates to higher costs not just financially, but also in terms of time, which poorer households may not be able to afford. The opportunity cost of attending training which could have been used in pursuit of income-generating or subsistence activities further decreases participation in training among households who live far away from training centers. This is in agreement with Paladan (2019) in the Philippines who found that as distance increases, the likelihood of farmers participating in agricultural training decreases.

The consultation during LSLA variable has a positive coefficient of 0.305 and is significant at the 5% in Table 4.6. This indicates that, holding all other factors constant, households that were consulted during the land acquisition process are more likely to receive training by owners of LSLA than their counterparts. This result emphasizes the important role of consultation in livelihood recovery efforts. Being consulted may have built trust and improved understanding, relationships between households and the LSLA owners, making households more aware and willing to participate in livelihood training. On the other hand, those who reported that they were not consulted might have been excluded from access to some key information and may have been less informed about training or more resistant to accessing LSLA-related programs. This finding aligns with the best international practice that prioritises Free, Prior, and Informed Consent (FPIC), which places consultation among the requirements of inclusive resettlement and recovery of livelihoods (FAO, 2016) .

4.6.3 Other Determinants of Food Security

Age is statistically significant at 5% and has a negative coefficient of 0.00386. This coefficient (-0.00386) implies that for every additional year of age of the household head, household FCS decreases by approximately 0.004 %, holding all other factors constant. The main factor contributing to this phenomenon is the natural process of decreased strength and stamina, which has its consequences for agricultural output. Zezza et al. (2011) found that lowered physical capacity limits the extent to which aged farmers can perform physically demanding farming tasks, hence affecting food availability. This is more critical in labour-intensive subsistence farming systems where the physical input directly translates into output. Moreover, older household heads may also exhibit a higher degree of risk aversion. This conservative attitude toward decision-making could result in resistance to or hesitation in the adoption of improved agricultural practices. This is in alignment with Akudugu et al.(2014) who found similar results.

Land ownership has a positive coefficient of 0.142 and is statistically significant at 5% in the outcome equation. This implies that households that owned land had an average of 0.142% higher FCS than their counterparts, holding all other factors constant. This is understandable and meets prior expectations because land is an important asset for agricultural activities. Owning land allows households to engage in agricultural activities, directly contributing to their household food supply. This enhanced agricultural production capacity can lead to increased food availability and diversity, thereby leading to better food security outcomes. Also, Households that own land do not incur any cost in renting land for production or sharing produce with land owners

after harvesting, so they have enough variety of food for consumption. This finding is in line with Haddad et al., (1998) who found that land ownership is an important determinant of household food security, and owning land results in better food security outcomes.

The coefficient of access to credit is 0.0677 and is statistically significant at 10%. This positive and significant coefficient of access to credit implies that households having access to credit experience an average 0.068% increase in their FCS more than their counterparts who do not have access to credit, holding all factors constant. This relationship could suggest that the financial resources gained through credit allow the household to make critical investments in agricultural inputs, improve productivity, or smooth consumption over periods of shortfalls in income, thus enhancing food security. Moreover, Access to credit by households means they can afford improved seeds, fertilizers, and other vital inputs that raise agricultural output and, consequently, food availability. Empirical literature has indicated that credit is very crucial for farmers to adopt various productivity-enhancing technologies and practices (Simtowe & Zeller, 2006). Such investment can be translated directly into a more diverse and sufficient diet, hence an improvement in household food security outcomes.

Access to extension has a positive coefficient of 0.217 which is statistically significant at 1%. This implies that households with access to agricultural extension services had an approximate 0.217% higher FCS than their counterparts who did not have access to extension, all else equal. This finding is consistent with previous literature, which highlights the critical role of extension services in improving agricultural productivity

and food security. Extension services provide farmers with access to information and best practices that could improve their farming. This is in line with Asfaw et al., (2012) who found that extension services can greatly enhance the productivity of small-scale farmers by improving their knowledge of new farming techniques, management of pests, and better use of inputs.

Access to market is statistically significant at the 1% level, showing a positive coefficient value of 0.174. This means that households with access to the markets experience approximately 0.174 % higher FCS than their counterparts, assuming all other factors are held constant. This suggests that access to the markets significantly contributes to enhanced food security at the household level. Farmers who have access to the markets not only sell their produce at fair prices but also have a better range of foodstuffs to buy, thus improving their food security status compared to their counterparts. The income derived from the sale of surplus produce at fair prices gives households the purchasing power to afford a variety of foods, including fruits, vegetables, and protein sources and this leads to greater dietary diversity, which contributes to improved nutrition and higher FCS. This finding is in agreement with findings by Barrett, (2008) who found that market access enhances household income and dietary diversity, thus directly improving food security outcomes.

Farm size **is** statistically significant at 5%, and had a positive coefficient of 0.00596. This implies that, holding all other factors constant, a one-acre increase in farm size is associated with a 0.006% increase in FCS. This is understandable because larger farms are associated with the ability of households to grow a diverse range of crops and raise

livestock, as well as an opportunity to use sustainable agriculture practices. This directly relates to more food availability, better dietary diversity, and the possibility of generating income through sales in markets. This finding is consistent with Ruslan & Prasetyo (2024), who indicate that larger farm size is positively associated with food security outcomes

4.12 Tests for Validity of Instrumental Variables

The use of the maximum likelihood estimator in this study necessitated the use of instrumental variables to control the possible selection bias caused by the presence of endogeneity. For any of the instruments to be deemed valid, at least one needs to affect the farmer's decision to receive training, or the treatment variable, without directly affecting household food security and household farm income. In this study, distance to the training center and consultation during land acquisition process are selected for identification restrictions. These instruments are supposed to be those which can affect a farmer's decision to participate in the training, but will not directly influence the household's food security and household farm income. These instruments have been selected on the understanding that smallholder farmers are bound to be influenced by factors such as proximity to training centers and engagement in the consultation process increased the likelihood that households had better information, greater awareness, and deeper understanding of the LSLA project and the measures intended to restore livelihoods. These could, in one way or another, affect a farmer's likelihood of participating in livelihood restoration training. However, it was assumed that these instruments do not directly affect household food security or farm income but rather factors affecting training participation.

According to Di Falco et al (2011) the validity of an instrumental variable can be tested through a falsification test. A variable is considered valid if it influences the decision to participate in the treatment (in this case, training) but does not have a direct effect on the outcome variables (food security or farm income). This is because if the instruments directly influenced food security or household farm income, it would be a violation of the exclusion restriction.

A binary logit regression was used to test if the instruments affect farmers' decisions to join training programs. This is an important test since it shows if the instruments are relevant and impact the treatment training variable. The result of the relevance test from the logit regression, as reported in the appendix, showed that distance to the training center and consultation during the land acquisition process are highly significant. Therefore, both instruments strongly determine whether farmers participate in the training program and thus satisfy the relevance condition for instrumental variables. Furthermore, distance to the training center consultation during the land acquisition process were then run against the outcome variables, food security, and household farm income. The results showed that neither instrument was statistically significant for either food security or household farm income, indicating that they met the criteria of exogeneity.

4.7 Treatment effects of Training on Household Farm income and Food Security

Table 4.7 shows the estimated average treatment effects (ATE) of training on the two important livelihood outcome variables: household farm income and household food

security, estimated using Propensity Score Matching (PSM) in Stata. The motivation for this exercise is to serve as a robust check. Reporting both ETR and PSM estimates strengthens the robustness of the analysis and ensures that the observed effect of training is not reliant on only one estimation method.

Table 4. 6: ATE of Training on Household Food Security and Farm Income

Outcome variable	ATE	Robust Std. Err	P>|z|
FCS_ihstrans	0.075	0.045	0.092
Household Farmincome_ihstrans	0.695	0.315	0.027

Source: Authors' Own Estimation, 2024

For household food security, the estimated ATE is 0.075 with a robust standard error of 0.045, and the associated p-value is 0.092, as shown in Table 4.7. The ATE 0.075 means that if all households had participated in the training, their average FCS would be 0.075% higher than if none had participated. In other words, the average FCS of households that participated in training was 0.075% higher than their counterparts. This outcome is in line with existing literature, which demonstrates that interventions aimed at capacity building contribute to positive food security outcomes (Vermeulen & Cotula, 2010).

Furthermore, the estimated ATE for household farm income is 0.695 and a p-value of 0.027. This implies that households that benefited from the training had 0.695% higher farm income than their counterparts. This result means that the training improves farm income compared to the direct improvement of food security. The gap between the two results shows that while higher incomes are an important pathway to food security,

the translation of higher earnings into improved nutritional outcomes is not automatic, but may be influenced by additional factors such as household consumption preferences, household expenditure on food, e.t.c. This is in agreement with Ayanwale et al (2024).

Table 4.8 above reports the estimated Average Treatment Effect on the Treated (ATET) for two major livelihood outcome variables: Household food security and household farm income. The ATET provides an estimate of the effect of training on households that have actually received the training.

Table 4.8: ATET of Training on Household Food Security and Farm Income

Outcome variable	ATET	Robust Std. Err	P>|z|
FCS	0.089	0.051	0.078
Household Farm income	0.748	0.393	0.057

Source: Authors RA Estimation, 2024

The estimated ATET for household food security is 0.089. This implies that households that benefited from the training had 0.089% higher FCS compared to what would have occurred if these same households had not benefited from the training. This is consistent with the literature that says agricultural training and capacity-building programs enhance food security since human capital will be improved, leading to higher productivity in agriculture and better management of resources (Doss, 2006).

The ATET estimate of 0.748 for household farm income implies that for households that received training, their average farm income is 0.748% more than what it would have been if these same households had not received the training. This aligns with impact evaluation studies like Davis et al. (2012), who found that the Farmer Field School adopters in East Africa earned significantly more than respective counterfactuals without training, and Martey et al. (2021) who found that climate-smart cowpea technology adopters in Ghana had 24% more earnings than respective counterfactuals without training.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This final chapter of the study draws conclusions and policy recommendations based on the key findings. The chapter also outlines the limitations and offers suggestions for future studies.

5.2 Summary

With the main objective of examining the effect of training from LSLA owners on the livelihood of smallholder farmers in the Talensi district, the study provided a thorough understanding of the relationship between training, household farm income, food security, and the factors influencing the choice of coping strategies.

The first objective examined the factors influencing the choice of coping strategies that households adopt in response to the LSLA. The results from the multivariate regression indicated that the factors influencing the adoption of coping strategies included household size, FBO membership, access to credit, age of the household head, farming experience, relative position in leadership, and training, among others.

The second objective analyzed the effect of training from LSLA owners on household farm income. Findings from the study showed that households that received training from LSLA owners had better household farm income compared to their counterparts.

The third objective examined the effect of training from LSLA owners on household food security. Findings from the study indicated that households that participated in

training from LSLA owners saw significant improvement in their food security outcomes compared to their counterparts. These findings highlight the need to expand access to training programs for more affected households that have not benefited.

5.3 Conclusion

Based on the findings from the study, the following conclusion can be drawn.

The study examined the effect of training on the livelihood outcomes of affected households in the Talensi District and the factors influencing the choice of coping strategies. The findings of the study revealed that LSLA livelihood training had a significant positive effect on household farm income and food security, indicating that livelihood training was effective in mitigating some of the adverse effects of the LSLA.

Findings further reveal that LSLA training influenced the adoption of non-agricultural investment activities, such as small-scale businesses, which created more stable and less land-dependent sources of income. On the other hand, training did not significantly influence coping strategies like migration, land borrowing, or selling assets, as these responses are largely driven by land shortages and unexpected shocks rather than skills or knowledge.

These findings imply that while the LSLA training intervention was effective in restoring household food security and incomes, its influence on coping strategies was selective. They promoted non-agricultural investment as a sustainable alternative, but had a limited effect on the adoption of other coping strategies.

5.4 Recommendations

1. The District Assembly and LSLA owners should expand and intensify programs focused on restoring livelihood by offering training to more affected households.
2. Affected households should diversify and invest in non-agricultural enterprises to reduce their dependency on agriculture as their only source of livelihood**.**
3. LSLA owners should collaborate with the Ministry of Food and Agriculture and the District Assembly to ensure that training and livelihood support are sustained beyond the initial interventions.
4. The study also recommends that the LSLA owners should give opportunities to individuals affected by the LSLA in their mining firms, especially those who acquired employable skills through the vocational skills training.

5.5 Suggestions for Future Studies

1. Future research should consider using time series or panel data to examine the dynamics of livelihood training over time. Unlike cross-sectional data, these data types allow the tracking of changes and trends, enabling a more detailed or robust analysis of the key relationship between variables and the long-term impacts.

2. Future research should look at the relationship between livelihood restoration interventions and multidimensional poverty. In addition to income, dimensions such as education, health, housing, and access to social services should be considered.

3. Future studies should include many districts or regions. By examining how the effects of livelihood restoration programs vary across different socio-economic, cultural, and ecological contexts, researchers can identify region-specific factors that influence the success of these interventions.

5.6 Limitations of The Study

1. The study's reliance on cross-sectional data limits its ability to establish causal relationships or observe changes over time, making it difficult to assess the long-term impact of the livelihood restoration training programs.

2. Response bias is a limitation in this study, as respondents may provide socially desirable answers, such as inflating or underreporting the amount of compensation received, rather than providing accurate responses. This can affect the results, leading to inaccuracies in self-reported data.

3. The study was conducted in the Talensi District, which means that its findings may not be fully applicable to other districts or regions of Ghana, where agricultural practices, economic conditions, and community dynamics differ.

4. Data collection was carried out in a specific period that may not be able to capture seasonal variations of household livelihoods and food security status, which may affect the study's ability to present a complete picture of the programs' impacts on food security throughout the year.

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APPENDIX

Appendix 1: Research questionnaire

My name is Akugre Ayinemi, and I am an MPIL student at the University for Development Studies, Nyankpala campus. I am conducting research for academic purposes on the topic: "The Effect of Livelihood Restoration Training Programs from Large-Scale Land Acquisition Owners on Smallholder Farmers' Livelihoods in the Talensi District of the Upper East Region of Ghana." I appreciate your cooperation and value your responses. Please be assured that your answers will remain anonymous and confidential. Thank you.

Name of community…… GPS……

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

Question	**Response**
1. Age of respondent?	
2. Religion?	a. Christian b. Muslim c. Traditional
3. Are you the household head?	a. Yes b. No
4. If no, what is your relationship with the household head?	a. Spouse b. Child c. Brother/sister d. Any other, specify…...
5. Political affiliation of household head?	a. NDC b. NPP c. PNC d. None e. Other specify…...
6. Household Size?	
7. Education Level	i. No formal education ii. Primary iii. Secondary iv. Tertiary
8. Years of Farming Experience?	
9. Gender of household head?	i. Male ii. Female iii. Other (please specify)
10. Do you have any family member in leadership position?	a. Yes b. No
11. Farm size in acres?	
12 Specify the number of years spent in school	

SECTION B: FARM PLOT AND INSTITUTIONAL CHARACTERISTICS

1. Do you own land?

    i. Yes
    ii. No

2. How did you acquire it?

    a. Inheritance
    b. Gift
    c. Lease
    d. Tenant farming
    e. Sharecropping
    f. Purchase
    g. Others (please specify): _____

3. What was the dominant mode of land acquisition/transaction in this community in the last ten years? (tick what applies)

    i. Inheritance
    ii. Gift
    iii. Lease
    iv. Sharecropping
    v. Purchase
    vi. Others (please specify): _____

4. Have you currently noticed some changes in the mode of acquisition?

    i. Yes
    ii. No

5. If yes to question 4, what changes have you noted so far in mode of acquisition in the ten years?

6. What was the average fallow period before the large-scale land acquisition? (in years)
7. What is the land value in this community per plot, in Ghanaian cedis?
8. Do you have access to extension services? 1. Yes 2. No
9. DO you have access to credit for farming? 1. Yes 2. No

SECTION C: INFORMATION ON CROP AND LIVESTOCK PRODUCTION

Please provide the production information for each of the crops during the 2023 cropping season

Crop	Number	Quantity Sold	Number of Acres	Price per Unit	Quantity given as Gift
Rice (in bags)					
Sorghum (in bags)					
Millet (in bags)					
Maize (in bags)					
Groundnuts (in bags)					
Cowpea (in bags)					
Soybean (in bags)					
Other Legumes (bags)					
Okro (basin)					
Pepper(bowls)					
Bito (basin)					
Ayoyo (paint rubber)					
Alefu (basin)					
Tomatoes (box)					

Livestock	Number	Price per Animal	Quantity sold	rent (income) received from hiring out draft (cattle and donkey) animals	Quantity given out as gift
Chicken					
G. Fowl					
Ducks					
Turkey					
Pigeon					
Rabbit					
Goats					
Sheep					
Cattle					
Donkey					
Pigs					

Information for animal products

Animal Products	Number	Price per Unit	Quantity Sold	Quantity given as gift
Eggs (in crates)				
Milk (in bottles)				

Production information before large-scale land acquisition

Crop	Number	Price per Unit	Number of Acres
Rice (in bags)			
Sorghum (in bags)			
Millet (in bags)			
Maize (in bags)			
Groundnuts (in bags)			
Cowpea (in bags)			
Soybean (in bags)			
Other Legumes (bags)			
Okro (basin)			
Pepper(bowls)			
Bito (basin)			
Ayoyo (paint rubber)			
Alefu (basin)			
Tomatoes (box)			

Livestock	Number	Price per Animal
Chicken		
G. Fowl		
Ducks		
Turkey		

Pigeon		
Rabbit		
Goats		
Sheep		
Cattle		
Donkey		
Pigs		

Information for animal products

Animal Products	Number	Price per Unit
Eggs (in crates)		
Milk (in bottles)		

SECTION D: INFORMATION ON LARGE-SCALE LAND ACQUISITION

10. Has your household been affected by large-scale land acquisition?

    a. Yes
    b. No

11. If yes **8**, how many acres were acquired?

12. If yes to **8** which company acquired it?

    a. Cardinal Mining Company
    b. Shaanxi Mining Company
    c. Quarrying companies

13. Can you indicate how it was acquired? (tick what applies)

    a. Through the family head
    b. Through the chief and elders
    c. Through the "Tendana"
    d. Others (please specify)

14. Were you consulted during the acquisition processes?

    a. Yes
    b. No

15. Were you compensated for your loss?

    a. Yes
    b. No

16. If yes, how much were you paid (GHS)?
17. If you were not compensated, what was the reason?

18. Have you or any member of your household ever received any TRAINING from owners of LSLA?
    Yes/No

19. Have you or any member of your household ever received ever BOUGHT from or SOLD to workers or owners of LSLA?
    Yes/No
20. Have you or any smallholder farmer in your community ever hired any machine from workers or owners of LSLA?
    Yes/No
21. Have you or smallholder farmers operating in your village ever RENTED IN or HIRED any OTHER farm machinery service from workers or owners of LSLA?
    Yes/No
22. Have you or any smallholder farmer operating in your community ever PURCHASED anything from workers or owners of LSLA?
    Yes/No
23. Have you or any smallholder farmer in your community ever sought any ADVICE, TRAINING, or OTHER services from workers or owners of LSLA?
    Yes/No
24. Are there any NEW TECHNOLOGIES or PRACTICES you have learnt/adopted from medium/large scale farms operating in your community?
    Yes/No

SECTION E: HOUSEHOLD COPING STRATEGIES AND PERCEPTIONS OF THE EFFECT OF LAND ACQUISITION ON OVERALL WELL-BEING

For each coping strategy listed below, please indicate whether your household has employed it in response to the effects of large-scale land acquisition.

25. Diversification of livelihood

    1. Yes
    2. No

26. Non-agricultural investment

    1. Yes
    2. No

27. Migration:

    1. Yes
    2. No

28. Land borrowing for farming:

    1. Yes
    2. No

29. Other (please specify): [ ]

    1. Yes
    2. No

30. Selling assets (livestock, machinery, etc.):

    1. Yes
    2. No

31. How effective have these coping strategies been in mitigating the impacts of land acquisition on your household?

    I. Very effective
    II. Somewhat effective
    III. Not effective at all

On a scale of 1 to 5, please indicate how you perceive the impact of land acquisition on your household

32. How satisfied are you with your life overall?
    1. Very dissatisfied
    2. Dissatisfied
    3. Neither satisfied nor dissatisfied
    4. Satisfied
    5. Very satisfied

33. How has your overall life satisfaction changed since the land acquisition project began?
    1. Significantly decreased
    2. Somewhat decreased
    3. No change
    4. Somewhat increased
    5. Significantly increased

34. How has the land acquisition project affected your access to basic services like education and healthcare?
    1. Significantly worsened
    2. Somewhat worsened
    3. No change

4. Somewhat improved
5. Significantly improved

35. Overall, how satisfied are you with the impact of the land acquisition project on your overall well-being?
    1. Very dissatisfied
    2. Dissatisfied
    3. Neither satisfied nor dissatisfied
    4. Satisfied
    5. Very satisfied

SECTION F: INFORMATION ON FOOD SECURITY

Household food insecurity access scale

In the past 30 days:

Did you worry that your household would not have enough food? 1. YES 2. NO	If YES, how often? 1. Rarely 2. Sometimes 3. Often
Did you or any household member eat less preferred food because of a lack of resources? 1. YES 2. NO	If YES, how often? 1. Rarely 2. Sometimes 3. Often
Did you or any household member eat just a few kinds of food day after day because of a lack of resources? 1. YES 2. NO	If YES, how often? 1. Rarely 2. Sometimes 3. Often
Were you unable to even eat less-preferred foods due to lack of resources to obtain other types of food? 1. YES 2. NO	If YES, how often? 1. Rarely 2. Sometimes 3. Often
Did you or any household member eat a smaller meal than you felt you needed because there was not enough food? 1. YES 2. NO	If YES, how often? 1. Rarely 2. Sometimes 3. Often
Did you or any other household member eat fewer meals in a day because there was not enough food? 1. YES 2. NO	If YES, how often? 1. Rarely 2. Sometimes 3.Often
Was there ever no food at all in your household because there were no resources to get more? 1. YES 2. NO	If YES, how often? 1. Rarely 2. Sometimes 3. Often
Did you or any household member go to sleep at night hungry because there was not enough food? 1. YES 2. NO	If YES, how often? 1. Rarely 2. Sometimes 3. Often
Did you or any household member go a whole day without eating anything because there was not enough food? 1. YES 2. NO	If YES, how often? 1.Rarely 2.Sometimes 3.Often

Food consumption score

36. In the past 7 days, did you or any member of your household consume rice, maize, sorghum, millet, bread, other, other cereals, cassava, potatoes or sweet potatoes?

    a. Yes
    b. No

37. If yes, how many days did you consume it in the past 7 days?
38. In the past 7 days, did you or any member of your household consume beans, peas, groundnuts or cashews?

    a. Yes
    b. No

39. If yes, how many days did you consume it in the past 7 days?
40. In the past 7 days, did you or any member of your household consume vegetables relish or leaves

    a. ,Yes
    b. No

41. If yes, how many days did you consume it in the past 7 days?
42. In the past 7 days, did you or any member of your household consume fruits?

    a. Yes
    b. No

43. If yes, how many days did you consume it in the past 7 days?
44. In the past 7 days, did you or any member of your household consume beef, goat, eggs or fish, poultry or pork?

    a. Yes
    b. No

45. If yes, how many days did you consume it in the past 7 days?
46. In the past 7 days, did you or any member of your household consume yoghurt, milk or any dairy product?

    a. Yes

b. No

47. If yes, how many days did you consume it in the past 7 days?
48. In the past 7 days, did you or any member of your household consume sugar or any sugary product
    a. Yes
    b. No

49. If yes, how many days did you consume it in the past 7 days?
50. In the past 7 days, did you or any member of your household consume oil, fats or butter
    a. Yes
    b. No

51. If yes, how many days did you consume it in the past 7 days?.

ey-Informants Interview Guide

Section A: Background Information

Community: _____

Date of Interview: _____

LSLA Company affected _____

Section B: Training Activities

1. What specific training activities are offered by the LSLA owners in this community?
2. Who delivers or facilitates the training?
3. Do LSLA owners recruit people who have acquired vocational skills into their company.
4. Do affected households have other training interventions that they are participating in apart from the LSLA livelihood training?

Section C: Participation and Access

5. How are households or individuals selected to participate in the training activities?

6. Are there any monetary costs involved in participating in these livelihood training activities?

7. How do you perceive the sustainability of these training activities?

Section D: Coping and Challenges

8. How are households coping with the activities of the LSLA in this area?

9. How effective are these coping strategies?

Appendix 2: Test for multicollinearity

VARIABLES	(1) Household Farm income_ihstrans
Age of household head	0.0154
	(0.0111)
Household size	0.0559***
	(0.0203)
Farming Experience	-0.346
	(0.517)
Farm size	0.0736***
	(0.0184)
Gender	0.890**
	(0.361)
Extension access	0.213
	(0.267)
Credit access	0.110
	(0.260)
market access	0.813***
	(0.279)
Distance to training center	0.338
	(0.517)
Relative in leadership position	0.166
	(0.376)
edu13(Tertiary)	0.266
	(0.409)
edu14(Primary)	-0.452
	(0.346)
edu15(JHS)	-0.271
	(0.373)
Constant	3.015**

	(1.206)
Observations	399
R-squared	0.362

Standard errors in parentheses

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

Variance inflation factor

Variable	VIF	1/VIF
Farming Experience	2704.101	0
Distance to training center	2699.405	0
Age of household head	1.509	.663
edu14	1.477	.677
edu13	1.323	.756
edu15	1.315	.761
Farm size	1.213	.824
Gender	1.118	.894
Extension access	1.118	.895
Household size	1.118	.895
market access	1.098	.911
Credit access	1.048	.955
Relative in leadership position	1.041	.961
Mean VIF	416.683	.

Appendix 3: Test for validity of instruments

```
. logit received_training were_consulted distance_training_centter

Iteration 0:   log likelihood = -276.55445
Iteration 1:   log likelihood = -272.34463
Iteration 2:   log likelihood = -272.33948
Iteration 3:   log likelihood = -272.33948

Logistic regression                                     Number of obs =    399
                                                        LR chi2(2)    =   8.43
                                                        Prob > chi2   = 0.0148
Log likelihood = -272.33948                             Pseudo R2     = 0.0152

------------------------------------------------------------------------------
   received_training | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
---------------------+--------------------------------------------------------
      were_consulted |   .4328877   .2039393     2.12   0.034     .0331739    .8326014
distance_training_centter |  -.0259631   .0133119    -1.95   0.051    -.0520539    .0001277
               _cons |   .1283464   .1902304     0.67   0.500    -.2444983     .501191
------------------------------------------------------------------------------

. test were_consulted distance_training_centter

 ( 1)  [received_training]were_consulted = 0
 ( 2)  [received_training]distance_training_centter = 0

           chi2(  2) =    8.05
         Prob > chi2 =    0.0179
```

```
. reg FCS_ihstrans were_consulted distance_training_centter

      Source |       SS           df       MS      Number of obs   =       400
-------------+----------------------------------   F(2, 397)       =      1.17
       Model |  .354787528         2  .177393764   Prob > F        =    0.3118
    Residual |  60.2552678       397  .151776493   R-squared       =    0.0059
-------------+----------------------------------   Adj R-squared   =    0.0008
       Total |  60.6100553       399   .1519049   Root MSE        =    .38959

------------------------------------------------------------------------------
 FCS_ihstrans | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
--------------+---------------------------------------------------------------
were_consulted |    .056565   .0391268     1.45   0.149    -.0203567    .1334867
distance_training_centter |   .0011607   .0024297     0.48   0.633     -.003616    .0059374
        _cons |   4.653595   .0361228   128.83   0.000     4.582579    4.724611
------------------------------------------------------------------------------

. test were_consulted distance_training_centter

 ( 1)  were_consulted = 0
 ( 2)  distance_training_centter = 0

       F(  2,   397) =    1.17
            Prob > F =    0.3118
```

```
. reg HouseholdFarmincome_ihstrans were_consulted distance_training_centter

      Source |       SS           df       MS      Number of obs   =       400
-------------+----------------------------------   F(2, 397)       =      0.91
       Model |  13.5874561         2  6.79372803   Prob > F        =    0.4014
    Residual |  2948.33465       397  7.42653565   R-squared       =    0.0046
-------------+----------------------------------   Adj R-squared   =   -0.0004
       Total |  2961.92211       399  7.42336368   Root MSE        =    2.7252

------------------------------------------------------------------------------
HouseholdFarmincome_ihs~s | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
--------------+---------------------------------------------------------------
were_consulted |   .3478466   .2736942     1.27   0.204    -.1902246    .8859178
distance_training_centter |   .0075716    .016996     0.45   0.656    -.0258418     .040985
        _cons |   6.797911   .2526809    26.90   0.000     6.301151    7.294671
------------------------------------------------------------------------------
```

Appendix 4 ; PSM Results

```
. teffects psmatch ( FCS_ihstrans) (received_training Age_of_respondent Household_size fbo Years_of_Farming_Experience Speci
> fy_the_number_o_ears_spent_ Farm_size_in_acres  Land_ownership Extension_acess Credit_acess  market_acess hired_machine_f
> rom_lsla  )

Treatment-effects estimation                Number of obs      =       394
Estimator      : propensity-score matching  Matches: requested =         1
Outcome model  : matching                               min =         1
Treatment model: logit                                  max =         1
```

FCS_ihstrans	Coefficient	AI robust std. err.	z	P>|z|	[95% conf.	interval]
ATE						
received_training (yes vs no)	.0752422	.0447049	1.68	0.092	-.0123778	.1628622

```
. teffects psmatch ( FCS_ihstrans) (received_training Age_of_respondent Household_size fbo Years_of_Farming_Experience Speci
> fy_the_number_o_ears_spent_ Farm_size_in_acres   Land_ownership Extension_acess Credit_acess  market_acess hired_machine_f
> rom_lsla  ), atet

Treatment-effects estimation                Number of obs      =       394
Estimator      : propensity-score matching  Matches: requested =         1
Outcome model  : matching                               min =         1
Treatment model: logit                                  max =         1
```

FCS_ihstrans	Coefficient	AI robust std. err.	z	P>|z|	[95% conf.	interval]
ATET						
received_training (yes vs no)	.0890603	.0505886	1.76	0.078	-.0100915	.1882122

Appendix 5 : Test for heteroskedasticity

Breuschâ€“Pagan/Cookâ€“Weisberg test for heteroskedasticity

Assumption: Normal error terms

Variable: Fitted values of FCS_ihstrans

H0: Constant variance

chi2(1) = 0.76

Prob > chi2 = 0.3843

Breuschâ€“Pagan/Cookâ€“Weisberg test for heteroskedasticity

Assumption: Normal error terms

Variable: Fitted values of HouseholdFarmincome_ihstrans

H0: Constant variance

chi2(1) = 0.67

Prob > chi2 = 0.2632