UNIVERSITY FOR DEVELOPMENT STUDIES

EFFECTS OF ARTISANAL SMALL-SCALE MINING ON HOUSEHOLD

WELFARE: PERCEPTIONS AND COPING STRATEGIES OF FARM

HOUSEHOLDS IN ASUTIFI NORTH DISTRICT IN THE AHAFO REGION

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UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

EFFECTS OF ARTISANAL SMALL-SCALE MINING ON HOUSEHOLD WELFARE: PERCEPTIONS AND COPING STRATEGIES OF FARM HOUSEHOLDS IN ASUTIFI NORTH DISTRICT IN THE AHAFO REGION

BY

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MAY, 2022

DECLARATION

I, **Seiba Issifu** hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere:

Seiba   Issifu   …………………………..   ……………………………

(Name of Student)   Signature   Date

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

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ABSTRACT

In Ghana, both legal and illegal artisanal small-scale mining (ASM) activities have been described as a headache, a threat, and a problem that needs the search for and execution of a long-term solution. To some scholars, ASM is a source of livelihood destruction in mining communities hence ASM activities can be likened to the "the resource curse thesis." On the contrary, others argued that, ASM potentials in the area of wealth creation and employment makes it an important livelihood activity with better welfare implications compared to agriculture. With opinions on the effects of ASM on household welfare in mining areas divided, this study looked into farmers' perceptions of ASM's effects, as well as the adoption of coping strategies and their determinants, and how these coping strategies affect the welfare of farm households in the Asutifi North District. Though there are many studies in Ghana about ASM, the focus has been on the environmental and health ramifications of ASM operations. There is a chronic dearth of empirical research and literature on the various coping strategies that farm households are using to deal with the negative effects of ASM. The study was conducted to fill this gap and add to knowledge. Primary data collected from 317 respondents in the District through two stage sampling was used for this study. The perceived effects of ASM on key welfare variables such as food security, children's education, job creation, access to potable drinking water, housing condition among others were studied using descriptive statistics. Over 80% of welfare indicators, including but not limited to food security, food consumption, water quality, access to land, access to farm labor, children's education, housing conditions, and others, deteriorated moderately or significantly, according to the study, whereas income and employment generation were the only welfare indicators that improved moderately among households. Also, multivariate probit model was used to estimate the determinants of adoption of coping strategies by farm households in the study area. The results from the descriptive statistics of the adoption of coping strategies reveal that majority (75%) of households adopted coping strategies such as diversification (36.08%), social networking (34.18%), land reclamation (31.01%), borrowing (31.01%), dependence on market for food (30.38%) and resettlement to other communities (29.11%). Furthermore, the results from multivariate probit model reveal age, household size, sex, level of education, access to credit, farm size, extension visits, total household income, membership of FBO among others as being the main drivers of households' adoption decision. Finally, endogenous treatment effect model was used to estimate the effects of coping strategies adoption on household welfare with Household Food Insecurity Score (HFIS) and Consumption Expenditure used as the outcome variables. The ATET results show that, farm households who adopted at least three coping strategies had higher consumption expenditure and were less food insecure compared to non-adopters. However, households who adopted at least four coping strategies had comparatively lower consumption expenditure and were more food insecure than their counterparts who did not adopt at least four coping strategies. As per findings, the study recommends that farm households in mining communities to prioritize and encourage the formation of cooperatives and FBOs to ensure improved access to joint resources that can be used by farm households to cope with ASM induced shocks, provide credit facilities to farm households in mining areas so that they can effectively cope with ASM induced shocks and sustain their livelihoods and finally the need to encourage land reclamation measures.

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DEDICATION

This piece is dedicated to my mother (Salamata Issifu), brother (Fuseini Issifu), and wife

(Victoria Anis).

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ASM   Artisanal Small-Scale Mining

LSM   Large Scale Mining

GLSS   Ghana Living Standard Survey

GSS   Ghana Statistical Service

MVP   Multivariate Probit

MNL   Multinomial Logit

ILO   International Labour Organization

FBO   Farmer Based Organization

GDP   Gross Domestic Product

NGOs   Non-Governmental Organizations

OLS   Ordinary Least Square

PFJ   Planting for Food and Job

POM   Potential Outcome Means

ATE   Average Treatment Effect

ATET   Average Treatment Effect on the Treated

HFIS   Household Food Insecurity Score

PNDC   Provisional National Defense Council

NGGL   Newmont Ghana Gold Limited

DFID   Department for International Development

OECD   Organization for Economic Co-operation and

                        Development

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Mining is one of the most important fields of natural resource extraction, and it has had enormous consequences for humanity. Mining is an activity that involves the deliberate removal of precious mineral deposits or other geological elements from the ground (Amoah, 2003). Gold, bauxite, manganese, precious metals, diamonds, oil, coal, limestone, and a variety of other minerals could be found in these deposits. Mining activities have provided and continue to provide the means of subsistence and progress in human societies, from gold to limestone, copper to oil. Man has used minerals as a crucial tool in supporting life since the dawn of civilization, with the lion cave of Swaziland regarded as the oldest known mine (Hilson., 2006).

Based on the mode of operation, there are two fundamental ways of carrying out mining activities namely Artisanal Small-Scale Mining (ASM) and Large-Scale Mining (LSM). Because they both operate in places endowed with mineral resources, artisanal small-scale mining activities are increasingly competing with large-scale mining operations. As a result, the likelihood of conflict and the possibility for cooperation between the two sectors is higher than it has ever been. According to Tenkorang and Osei-Kufuor (2013), the common area of challenges and conflicts between ASM and LSM are contest over available land, duplicated concessions, and badly managed land distribution schemes. Whilst both ASM and LSM have received attention from researchers and policy makers across the world in the past, there is now an increasing emphasis on ASM activities due to its impacts on livelihood of households.

The number of operators, the level of output, the level of mechanization, and the size of capital investments distinguish artisanal small-scale mining from large-scale mining. According to

1

McQuilken and La Salvia (2019), the majority of ASM operators lack the necessary licenses and authorization. As a result, they conduct their mining operations in accordance with social and cultural norms, as well as regulations and practices that have evolved over many decades and provide them with a social permission to do so. Indeed, the informality that characterizes ASM activities exposes the sector to a slew of problems, including illegality and tax loss for local and national governments.

The global socio-economic benefits of ASM cannot be overstated, since it forms a large source of income for millions of low-skilled and impoverished people, particularly in developing nations, through direct and indirect employment. According to Hilson et al. (2017), the number of persons directly active in ASM has more than doubled in recent years due to factors like soaring mineral prices and the growing difficulties in making a living through agriculture. As of 2018, it was estimated that 40 million people worked in ASM, 150 million people relied on ASM in 80 countries in the global south, and the ASM sector produced 20% of the global gold supply (Hilson and Maconachie, 2020).

ASM has its ugly side across the various countries in the world where it is practiced. The major problems associated with ASM activities include but not limited to contamination of water bodies, the degradation of natural ecosystem and damage to agricultural lands (Hilson et al., 2017; Boateng et al., 2014). These problems have led to situations where households in communities on the mining sites live in deplorable and unsanitary conditions with severely degraded ecosystems that can hardly support their livelihoods. Furthermore, artisanal small-scale miners face a number of dangers that threaten their lives and the long-term viability of their income-generating capabilities. These dangers are linked to the same elements that make the activity appealing and, in some cases, profitable. Indeed, negative externalities such as environmental damage, disregard for property rights, violence, communal strife, disease

2

spread, injuries, and deaths all deserve to be mitigated in order to adequately account for the true benefits of ASM.

The picture of ASM in Africa in terms of its perceived effects is not much different from what pertains in other continents. It is estimated that there are over 9 million ASM operators in Africa, with approximately 54 million people relying on the sector for their living (Hilson and Maconachie, 2020). However, because of variables such as a lack of formal data on artisanal mining, which is generally informal and largely works illegally in various African nations, researchers have mixed emotions and consider this a cautious estimate. Despite the conflicting emotions regarding the figures on artisanal mining in Africa, academics have recognized the activity as difficult yet important for the economies of Sub-Saharan African countries, particularly in rural areas.

In Ghana, ASM refers to all mining activities carried out by any individual or group of individuals not exceeding nine in number, or by a cooperative society made up of ten or more people, using any method that does not need large cost (McQuilken and Hilson, 2016). Legally, ASM is only available to Ghanaians and is closely supervised by the Ghana Minerals Commission, which serves as a technical consultant to the Minister in charge of natural resources. The Minerals Commission's district offices are in charge of grassroots supervision and monitoring of ASM activities. According to Hilson (2016), the Ghanaian government authorized ASM in 1989 when it lifted the ban on small-scale mining.

According to Boateng et al. (2014), reports on environmental issues such as mercury contamination of soil and water, deforestation, health hazards, child labour, prostitution, and communal violence have all contributed to the negative public perception of ASM in Ghana. It is therefore not surprising that, stakeholders often tend to vilify ASM operations blaming it to be a major cause of destruction of livelihood and consequently an extreme poverty. In fact, it

has been argued that there is no wide departure from the so-called 'resource curse thesis' that provides overwhelming and compelling evidence that natural resource wealth is negatively linked to economic growth and living standards. To this end, opponents of ASM argued that, the activity subjects households living in mining areas to several livelihood shocks which affect their income since majority makes living from agriculture and small-scale industries which get affected by ASM invasion. Proponents of ASM, on the other hand, noted that the business has grown into a major industry in Ghana, providing a source of income for many households directly or indirectly through downstream industries.

Over the past fifteen years, Asutifi North District, one of the six administrative regions in Ahafo-Region of Ghana has gained prominence following formal operation of Newmont Ghana Gold Limited (NGGL) and the rapid expansion of ASM in the area. Many artisanal miners, popularly called "galamsey operators" in Ghanaian parlance have migrated from other parts of Ghana to the District, particularly the Ahafo Kenyasi area which falls within the concession of NGGL. This massive inflow of ASM operators into the area have predictably generated both positive and negative outcomes for households in the area.

1.2 Problem Statement

Artisanal Small-Scale Mining (ASM) has turned into an indispensable means of livelihood for many households in mineral -rich areas in developing countries. Without a question, the ASM sector is an unrivaled job creator, providing income directly and indirectly for many young people in Ghana's mining areas. According to Franks et al. (2020), an estimated 1.1 million people work directly in ASM activities, accounting for approximately two-thirds of Ghana's entire mining labour force, despite the fact that much of this work is informal, unregistered, and illegal in Ghana. Furthermore, there is mountain of evidence demonstrating that agriculture and ASM in Ghana are inextricably linked (flows of capital and labour), with many miners

using ASM revenues to fund their agricultural venture. Many ASM operators in the Northern Region, Brong-Ahafo Region, Eastern Region, and Western Region 'branch out' into ASM during the dry season, according to studies (Hilson and Garforth, 2012).

Despite the growing importance of ASM as an alternative means of livelihood for many young people in Ghana, donors and officials have continued to promote a "small farm first" agenda as a way of meeting people's fundamental needs and improving their well-being. Even when policymakers and scholars began to consider livelihood diversification few decades ago, the economic impact of ASM at the micro level was almost largely neglected. According to Hilson (2019), ASM was rarely discussed in many of the early historic assessments on livelihood diversification investigations, which highlighted many countries including Ghana, Tanzania, Burkina Faso, and Sierra Leone, all of which are now home of thriving ASM economies. To this end, decision makers who have supported assistance for agriculture as a remedy to poverty reduction in rural areas and advocated for large-scale resource exploitation as a means of propelling Ghana's economic growth left the ASM sector "out in the cold" until recent time (Hilson, 2016).

Over two decades, ASM has received increasing condemnation by the section of the general public, the media and political actors due to its social and environmental ills in the areas endowed with mineral resources (Zolnikov, 2020). As a matter of fact, negative externalities arising from 'entrepreneurs' actively evading regulations and subjecting mining communities to vulnerability have likened ASM scenario in Ghana to the popular economic concept of the paradox of plenty. As a result, it's not surprising that ASM operators, also known as "galamsey" operators, have been depicted as a nuisance and a threat in Ghana's public and official discourse, necessitating the search for and execution of a long-term solution (McQuilken and Hilson, 2016 ; Obiri et al, 2016).

According to Hilson and Maconachie (2020), the government of Ghana over the past three decades has tried to sanitize the ASM sector through regulations, policies and laws. Several laws have been enacted, including the Mining and Mineral Act, 2006 (Act 703), the Mineral and Mining (Amendment) Act, 2015 (Act 900), the Mineral and Mining (Health, Safety and Technical) Regulation, 2012 (LI 2182), the Artisanal and Small-Scale Mining Framework (2015), and the Ghana Mineral and Mining Policy (2016). To ensure that mining activities are not carried out, the government formed a task group comprised of military, police, and immigration officers. Unfortunately, these and other related interventions have not yielded the desired results as studies by Banchirigah, (2008) and Hilson et al. (2017) showed that, ASM activities have grown in volume due to inadequacy of enforcement of legislation, poor cooperation, minimal collaboration and insufficient consultation among relevant stakeholders as well as ASM being an important source of livelihood for many Ghanaians.

The Asutifi North District is dominated by agricultural activity with about 60 percent of the households relying on a single livelihood activity which is weather oriented agriculture (Asutifi North District, 2019). These households find it difficult to avoid, withstand or recover during times of economic stress and shocks. With the upsurge of mining activities in the area, there is both opportunity for livelihood as many households has resorted to ASM for additional income to sustain their families and their agricultural enterprises. Conversely, there is also a threat to existing livelihood of many households, especially tenant farmers in the area as many farm lands have been taken over by ASM operators.

Without a question, there is now a mountain of evidence pointing to opposing viewpoints on the consequences of mining, particularly ASM, on Ghana's growth. This study shifts the focus from macro to micro level viewpoints, with emphasis on ASM and farm household welfare. The basic premise of this study is that farm households' welfare levels are a good indicator of

their level of development. As a result, if mining has a good impact on a community, households are expected to transition from lower to higher levels of welfare. On the contrary, if mining has a negative impact on a community, then households are expected to experience deterioration in the major welfare indicators.

Farm households in an effort to sustain their livelihood in the midst of livelihood shocks arising from the negative effects of ASM activities have used variety of coping strategies which mostly have both short and long-term implications on their welfare (Guloba et al., 2014; Lawal, 2016). Previous studies on ASM in Ghana such as Hilson (2016), Aragon and Rud (2015), Yankson and Gough (2019), Akabzaa (2000), Amponsah-Tawiah and Dartey-Baah (2011), Obeng and Appiah (2019) among others have focused on ASM and the environment. At present, there is no empirical work on coping strategies that households in mining communities are using to deal with the negative effects of ASM and how the adoption of these coping strategies affects the welfare of households. To this end, this study fills a knowledge gap at a time when the activities of artisanal small-scale miners are creating a lot of discussion in Ghana's political, social, and economic landscape.

1.3 Research Questions

The following are the research questions that will lead the investigation:

1. What are the farmers' perceptions about the effects of Artisanal Small-Scale Mining (ASM) activities on farm household welfare in Asutifi North District?

2. What are the coping strategies used by farm households in the Asutifi North District to mitigate the negative consequences of ASM operations, and what variables influence their decision?

3. What impact does the adoption of coping strategies have on the welfare of farm households in the Asutifi North District?

1.4 Research Objectives

The main objective of this research is to assess farmers' perceptions of the effects of ASM, as well as the adoption of coping strategies and their effects on household welfare in Asutifi North District.

1. To investigate farm households' perceptions about the effects of Artisanal Small Scale-Mining (ASM) activities on farm households' welfare in the Asutifi North District.

2. To explore the coping strategies used by farm households to mitigate the consequences of ASM, as well as the factors that influence coping strategies adoption.

3. To assess the impacts of the coping strategies on farm households' welfare in Asutifi North District.

1.5 Justification of the Study

The finding of this research is expected to provide inputs for decision making by policymakers, development practitioners, NGOs, farmers and researchers.

Firstly, the findings of this research will deepen their understanding of ASM effects and motivate farm households in rural areas to actively adopt appropriate coping actions to help counteract the negative impacts of ASM and improve their welfare.

Secondly, the findings of this study will help policy makers and NGOs to design good and practical measures that can help farm households to effectively deal with ASM shocks. Specifically, the study will help develop policies on alternative livelihood activities that consider ecological, social and economic aspect of sustainable development.

Again, the study will provide researchers with important inputs for further investigation in the subject matter as well provide directions for further research. For example, supervisors can induce their students to undertake their dissertation on ASM related issue in order to solve food security problems at household level and also improve the welfare level of vulnerable

households in mining areas. Related to the above is that the study will contribute additional knowledge to the existing literature through publishing papers, conference presentation or workshop organization.

Last but not the least, the study will provide findings on the various effects of ASM, farm households' coping strategies and their influence on households' welfare. This will go a long way toward assisting international, national, and local agriculture and mining stakeholders with policy creation and execution.

1.6 Limitations of the Study

The purpose of this study was to determine the Impact of Artisanal Small-Scale Mining (ASM) on Household Welfare: Perceptions and Coping Strategies of Farmers in Asutifi North District. It is not possible for a study such as this to deal with all the aspects of ASM, farmers' income and livelihoods due to the limitations imposed by time and financial resources.

Household surveys are difficult as obtaining accurate data, particularly on household land holdings, output volumes, income, assets, and other variables with substantial economic and social implications, is not always straightforward. Most farm families could only recollect the most recent data, and obtaining prior data was difficult. Several methods, such as focus group discussions and informal interviews, were used to cross-check the data obtained via questionnaire administration in an attempt to address this constraint.

Most of the household heads were not available in their home during most of the daytime since they were busy with their farming and other economic activities and this disrupted the time scheduled for the data collection. As a result, the researcher has to visit them on their farms to gather the required information from them.

1.7 Organization of the Study

The rest of the thesis is organized as follows. The second chapter is devoted to a review of the literature, which includes extensive work by authorities as well as individual contributions on the consequences of ASM and household coping mechanisms in mining communities. The research methodology is described in chapter three whilst the discussion and findings of the study are presented in chapter four. Chapter five focuses on the summary of main findings, conclusions, and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents literature on the concept of Artisanal Small-Scale Mining (ASM), the empirical review of the effects of ASM on selected households' welfare indicators particularly food security, food consumption, employment generation, income, crop production level, households' health conditions, availability and access to portable drinking water, availability and access to land, availability of labour for agriculture among others. Additionally, the chapter explores the various coping strategies of households in dealing with livelihood shocks, the determinants of the coping strategies as well as the effects of coping strategies adoption on households' welfare.

2.2 The Concept of Artisanal Small-Scale Mining (ASM)

Despite its long history of dispute and scholarly and political debate, artisanal small-scale mining (ASM) has yet to be given a universally accepted term. In fact, different researchers, groups, and policymakers have defined ASM differently at different times and in different geographical areas around the world. In actuality, the often-used phrase "Artisanal Small-Scale Mining implies different things to different people" only shows the diverse arrays of a sector for which it seems difficult, if not impossible, to come up with a unified description. According to UNECA (2011), there is really no agreement on what constitutes an artisanal small-scale mining enterprise, and the line between them is not well defined. This is largely due to the variation in definitions by countries. Despite the differences in definitions, there are some

common characteristics: most artisanal miners are severely undercapitalized, rarely function as legitimate businesses, and lack contemporary technology.

Proposed definitions have mixed key features of ASM activities with the implications of the informal status that characterized the sector over the last three decades in the quest for a single universal ASM definition. Concepts like illegality and the usage of primitive technology have become prevalent variables highlighted by many scholars in various geographical places in their attempts to define ASM. According to Barreto et al., (2018), most definitions of ASM used by countries are purely public policy-oriented in nature intended for regulatory purposes. As a result, traditional metrics such as output, number of workers per productive unit, capital utilized, labour productivity, reserve quantity, operational consistency, mining claim size among others are commonly used in these definitions.

According to the World Bank (2015), ASM operators are miners who extract minerals using manual labour, low-tech, and less complex equipment. ASM is primarily a poverty-driven activity, according to the World Bank, and it is mostly carried out in the poorest and most remote rural areas of a country by a largely itinerant, poorly educated populace with few other work options.

Hinton (2006) defined ASM as a collection of mining activities ranging in scale from small to large that are distinguished from "formal" mining by a low degree of mechanization, high labour intensity, poor occupational and environmental health standards, a lack of capital investments, and a lack of long-term planning. This definition identifies ASM as a generally unstructured and unorganized activity.

In an effort to make a distinction between ASM and other mining activities and identify supply chain concerns associated with ASM, the OECD (2016) developed an ASM concept that reflects a development approach. Artisanal small-scale mining according to OECD comprise of formal or informal mining activities with largely simplified modes of exploration, extraction, processing, and transportation, and which is characterized by low capital expenditure and high labour-intensive.

For the sake of this study, ASM includes all formal or informal labour-intensive mining activities carried out by an individual or small group of individuals who use minimum capital investment and simple processes in the exploration, extraction and processing of minerals, particularly Gold. This conceptual formulation captures the most important ASM factors, which have been employed in various ways by different scholars in various nations.

2.3 Artisanal Small-Scale Mining in the Ghanaian Context

Large-scale mining, notably gold mining, has been the norm in Ghana over the years, but ASM, which predates such activities, has remained a vital economic activity, particularly in the country's rural and poorest areas. In terms of the number of persons involved in artisanal small-scale mining as a source of livelihood in Africa, Ghana is second only to Tanzania (Hilson, 2016). As a matter of fact, the need to regularize and formalize ASM operations is widely agreed upon among the many stakeholders as a measure of safeguarding the sector's long-term viability in Ghana.

According to Hilson and Garforth (2013), ASM in Ghana denotes to all mining activities that occur without the necessary governmental approvals and follow bad practices such as mining in water bodies, failing to adhere to buffer requirements, and failing to reclaim lands after mining. In this regard, ASM involves the extraction of mineral deposits with primitive tools characterized by low production levels with little financial input.

ASM has evolved in Ghana over time. In 1986, the government passed the PNDC Law 153 to register and regulate the activities of mining firms, as part of the implementation of modern governance in which the state is the custodian of the land (McQuilken and Hilson 2016). Heavy cash and technical ability were required under PNDC Law 153 for large-scale modern mining operations in Ghana. However, because artisanal small-scale mining (ASM) was not included in the PNDC Law 153, it was considered unlawful mining prior to 1989, including the commercialization of gold extracted from it (Onumah et al. 2013). Surprisingly, this did not deter the practice, and ASM activities thrived, with the output being smuggled out of the nation through a well-organized network.

Despite contributing nothing to the state in terms of revenue or development to mining communities in the 1980s, ASM activities in Ghana created severe environmental, health, social-economic problems, with the outputs from the sector empowering the neighbouring countries financially, which were discovered to be exporting gold while having no large gold reserves (Obiri et al., 2016). Accordingly, the growing awareness that the ASM's prolonged marginalization was harming the economy, a research into the problem was conducted, leading to the implementation of the Small-Scale Gold Mining Law (PNDC Law 218) in May 1989, which led to its regularization. Concurrently, the Diamond Marketing Corporation (DMC), the governmental entity in charge of diamond marketing, had its scope broadened and was renamed the Precious Metals Marketing to create a quick market for output generated by artisanal gold miners in Ghana.

Despite the fact that the Small-Scale Gold Mining Law (PNDC Law 218) regulated ASM operations in Ghana, it was and is still difficult to distinguish between legal and illegal ASM miners. Both legal and illegal ASM operators are referred to by the term "gather them and sell,"

which is well known in Ghana as "galamsey." In fact, the term "galamsey" encapsulates exactly what individuals participating in the activity do.

The Minerals and Mining Act, 2006 (Act 703), which is a continuation of the Small-Scale Gold Mining Law, PNDC Law 218 adopted in 1989, lays out the requirements for granting a license to an ASM operator. According to Hilson (2001), the laws of Ghana specifically state that, small-scale gold mining licenses may be issued to Ghanaians who are 18 years and above under the below terms and conditions:

- A permit issued to an individual is only valid for three years, but it can be renewed for up to three years for two consecutive terms;

- A permit issued to a cooperative is valid for five years, but it can be renewed for up to five years for two consecutive terms.

- A group of individuals not more than four shall be given an area no more than three acres; a group exceeding four but not more than nine shall be given an area not more than five acres; and a company or a co-operative society shall be granted an area not more than 25 acres;

- An applicant must complete the application form wholly and have it endorsed by the district administration;

- Small-scale miners are excused from payment of taxes and royalties for the first three years of business but they are not exempted from local imports;

- After a successful application, the mine operator must install concrete posts on top of the four discs (with numbers engraved) placed at the concession's corners and the concession's edges must be kept clean for concession reasons.

- Successful applicants must install a signpost containing their name and phone number within the concession area.

Legally, prospecting is not permitted prior to the acquisition of small-scale mining license in Ghana. Locations of potential reserves are usually identified accidentally or based on the knowledge and experience of old miners. As a result, prospecting within the ASM sector is haphazard and the techniques used by operators are crude. There are plethora of laws, regulations and policies within the ASM sector in Ghana to responsible mining, capable of leading to local and national economic development (Hilson, 2001). Surprisingly, the enforcement of these laws, regulations and policies remains the greatest challenge for successive governments over the years in Ghana.

2.4 The Concept and Measurement of Welfare

Welfare has historically been associated to wealth and happiness in the field of economics, with its modern conception developing first in the twentieth century (Montgomery et al., 2000). While GNP and total societal spending on resources are included in the definition of welfare in economics, it has something to do with the perceived feeling of contentment by individuals as well as the number individuals within the low - income bracket (Howe et al., 2010). Both asset indices and money metrics have been used as proxies for welfare in many empirical studies across the globe.

2.4.1 Asset indices as a measure of welfare

Asset-based wealth indices have gained popularity as a quantitative measure of welfare in recent years. Wealth indices are the sole means to explore distributional characteristics in large-scale surveys like Multiple Indicator Cluster Surveys (MICs) and Demographic and Health Surveys (DHSs) that usually lack data on income and consumption (Howe et al., 2010). The argument in favour of this approach is that, wealth is a superior measure of long-term well-being compared to both income and consumption since it is less variable.

Asset-based indexes, on the other hand, are limited in their utility as a measure of welfare for a variety of philosophical and practical reasons. To begin with, the wealth index is a subjective measure of wellbeing, meaning that it compares a household's wealth to the wealth of other homes in the sample and fails to quantify the household's actual levels of welfare or poverty (Filmer and Pritchett, 2001). Also, with the asset-based approach, disparities in price levels across areas are neglected, and the quality of assets is overlooked (Moser, 1998).

2.4.2 Money-metric measures: Income or consumption as a measure of welfare

Researchers have disputed the merits and drawbacks of using income versus consumption as a measure of welfare, with a clear preference for consumption over income, particularly in developing countries. The argument is that, individuals derive material well-being from actual usage of products and services than from the receipt of income (Citro and Michael, 1995). As a result, consumption appears to be a more accurate representation of wellbeing compared to income.

Deaton and Zaidi (2002) observed that consumption accurately describes long-term income because it is far less volatile compared income and it is less affected by short-term income swings. Seasonal trends are more likely to affect income, which could result in either an underestimation or exaggeration of real income. Consumption is more consistent, particularly in agricultural nations, because it is stabilized over the seasons, accurately reflecting the true standard of living. Furthermore, collecting data on consumption is typically easier than collecting data on income, especially for self-employed households and those in informal employment.

Therefore, this research employed the consumption approach to measure the welfare of households. To create a reliable measure of consumption that covers the various components of consumption, the researcher used the methodology and criteria given by Deaton and Zaidi

17

(2002) and the International Labour Organization (ILO) (2003). The primary components of consumption captured in this study were food consumption, non-food items (health, education, rent and utilities etc) and consumer durables.

2.5 Effects of Artisanal Small-Scale Mining on Welfare of Households

The literature on the economic impact of resource exploitation on local communities has yielded varied results. On the one hand, several studies have stressed the importance of backward connections as the primary way by which persons living near the resource reap the economic benefits of resource extraction. This theoretical postulation has been used in many scientific investigations on the local economic consequences of resource abundance. Lippert (2014), for example, studied the economic gains of Zambia's Copper Belt mine on adjacent households and discovered that a 2% rise in actual household expenditures corresponds to a 10% rise in copper output at the local level.

On the other hand, other scientific investigations on the influence of resource exploitation on local economies have stressed the negative externalities arising from the destruction of livelihood, thereby likening the activities of resource extraction to the "Resource Curse Thesis" which postulates that, resource extraction can affect human welfare negatively. For instance, Amponsah-Tawiah & Dartey-Baah (2011) in their study on mining in Ghana reported that, natural resource extraction has caused severe environmental degradation which in turns has negatively affected the income and employment opportunities of people living in mining communities, hence subjecting them to poverty.

The review of literature in this sub-section focuses on how ASM affects key welfare indicators of households. The welfare indicators were based on OECD 2019 wellbeing indicators which include food security, food consumption, employment generation, income generation,

agricultural labour, human health, portable drinking water, land availability, housing conditions, children education, crop production level, access to fruit, game and firewood.

2.5.1 ASM and food security

Food security refers to a situation in which all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996). Many people residing in communities where ASM activities are prevalent find it difficult to feed their families (Tenkorang and Osei-Kuffour, 2013). Nutritional deficiencies can be worsened in ASM communities when commodities are difficult to come by due to increased expenses of local items and decrease in agricultural land quality.

Hilson (2009) in a study noted that ASM activities have caused farmers to lose their farmlands needed to ensure sustainable food supply in mining communities with the resultant effect being inadequate food supply to meet the consumption needs of residents. Also, Yankson and Gough (2019) remarked that a weakened agricultural sector in ASM communities may experience an increase in local demand for food but may not be able to respond adequately to the increase in demand for food from the mining sector, causing food prices to rise, and jeopardizing the food security of many residents. In this direction, it could be argued that, as more people find work in the mines, coupled with the lost farmland to the mines, farming activities in mining towns will diminish over time, resulting in a loss in food production and, thus, food insecurity among most people living in the mining areas.

2.5.2 ASM and food consumption

Kitula (2006) revealed that, rising cost of living in mining communities has serious consequence on food consumption by households. People from different geographical area sometimes migrate to the mining areas because of ASM operations hence food, which one of

the most important necessities becomes expensive due to excess demand over supply. Kelly (2014) validated this assumption in a research on the socio-economic implications of mining on local livelihoods in Geita District of Tanzania, reporting that ASM regions had higher Consumer Price Indices than the national average. Because of the higher price level of goods, people residing in mining areas who do not earn enough revenue from ASM activities may be able to buy less commodities with their typical low earnings from their failing agricultural enterprises.

Hilson (2006) found that, changes in disposable income among residents of ASM areas impact the outcome of diets and hence the nutritional status of persons living in mining areas. The implication is that, the quality and quantity of food consumption among households living close to mining areas is lower compared to households living in non-mining areas. Similarly, Tenkorang and Osei-Kufuor (2013) reported that people residing in communities in Ghana where the intensity of ASM activities are high experienced lower food intake than residents of neighbouring communities.

2.5.3 ASM and employment creation

The literatures on the linkage between ASM and job creation has been well documented. According to Hillson (2006), artisanal small-scale mining is a poverty-driven enterprise that engages displaced large-scale mine workers, seasonal farmers, and itinerant rural residents, most of whom are uneducated with limited skills and so receive low wages. In a study conducted in Ghana, Chuhan-Pole and Land (2015) reported that men have higher chances to gain from direct employment as miners, while women are more likely to benefit from indirect employment prospects in services. ASM helps to support and sustain rural population consumption expenditures by creating direct and indirect employment possibilities in mining communities.

According to the World Bank (2019), 3-6 people rely on ASM for each person who works directly in the sector. Additionally, Ghana Chamber of Mines report (2020) indicated that, about 60% of the mining labour force in Ghana worked in the ASM sector. This labour force also includes women who play crucial role in reducing poverty and hunger. Related to the report of Ghana Chamber of Mines is that of Hilson and McQuilken (2017) who opined that, ASM employs about 1 million people directly and about 4.5 million more depend on it for living in Ghana.

Again, in Tanzania, the ASM sector has been found to have greater multiplier effect in areas of employment creation and poverty alleviation, particularly in rural areas compared to large scale mining operations and agriculture. Lwakatare (1993) and Chachage (1995) reported clearly that, the ASM sector in Tanzania is a significant employer with far reaching impact on employment compared to large scale mining operations. The authors contend that, people in mining communities generate their livelihoods from ASM through direct engagement and boost in auxiliary economic activities that help the population in the area.

2.5.4 ASM and income generation

According to Bryceson and Jamal (2019), income generation is one of the main reasons why rural people in mineral-rich nations in Sub-Saharan Africa forego their primary source of income, which is farming, in exchange for ASM activities. That is, smallholder farmers participate in ASM to swiftly generate extra revenue, which could be reinvested in their farming enterprises and other off farm income generating economic activities. Agriculture, which is usually weather dependent in Sub-Saharan African has become risky and economically unreliable in recent years for farm households due to low and unstable farm output, caused by unpredictable rainfall patterns, volatile market prices for agricultural products, and poor returns on agricultural investments. As a result, ASM has become more

reliable in terms of income generation in countries in Sub-Saharan Africa that are endowed with substantial mineral resources. According to Banchirigah and Hilson (2010), ASM provides the quickest source of income for the most of the indigenous people in the mining areas through participation in the ASM value chain, as well as a boost in local economic activities. ASM operators according to earn about four to ten times as much as smallholder farmers according to Bryceson and Jamal, (2019). To this end, available literatures have established income generation as one of the positive benefits that residents in mining communities derive from ASM.

2.5.5 ASM and crop production level

According to Aragon and Rud (2015), farmers near mines experienced a relative reduction in total factor productivity of roughly 40% between 1997 and 2005, with pollution from mining being the most viable reason for the agricultural productivity decrease in mining areas. Given the importance of agriculture in rural economies, this finding demonstrates that mining has a negative impact on most of the rural people who rely on agriculture as their primary source of income. Also, ASM has been found to cause reduction in crop yield through its effects on the health of crops. Boateng et al. (2014) reported negative impacts of ASM on cocoa farming in Atiwa District of Ghana. The researchers observed that, ASM operations degrade the topsoil, which supports the healthy growth of plants hence farmers with cocoa fields near mining regions noticed untimely dropping of immature cocoa pods, withering and yellowing of leaves.

Furthermore, because ASM activities are concentrated in rural areas where agriculture is the primary source of income, Hilson and McQuilken (2014) found that expanding ASM activities results in increased contamination of the environment, resulting in significant yield reductions ranging from 30% to 60% depending on the type of crop. In a similar study, Boateng et al (2014) investigated the impact of ASM on cocoa production in Ghana and found that, ASM

activities have resulted in the conversion of farmland into minor pits, mining waste dumps, settlement areas, and roadways, resulting in the loss of farmland. The implication is that ASM operations change land use patterns in mining areas, making the land less productive for production and limiting farmers' access to farmland for farming purposes, leading to reduction in crop yields. Again, Agyei-Manu et al (2020) observed in their studies that, illegal miners have invaded between 1 and 2 million hectares of cocoa land in Ghana. According to the researchers, the drop-in cocoa's contribution to GDP from 3.6 percent in 2011 to 1.8 percent in 2017 can be ascribed in part to the country's rampant mining activities.

2.5.6 ASM and availability of labour for agricultural production

ASM activity has actual and measurable costs for farming communities. One such costs drivers in farming is labour, which becomes more expensive as the rural labour market tightens. According to Hilson (2006), ASM competes with agriculture for some inputs of production especially land and labour. The attractive and quick financial reward associated with ASM, coupled with the low returns from agriculture motivates many people in mining communities to offer their labour in the ASM sector over farming. The implication is shortage of farm labour in mining communities and consequent rise in the price of agricultural labour.

In a research conducted in Tanzania, Lwakatare (1993) discovered that practically all ASM operators were previously farmers who had turned to mining to make more money quickly. The implication is that farm labour in mining villages could be severely decreased as most young forsake farming activities in favour of jobs in the mining sector, thereby lowering agricultural production in these communities. As ASM competes with farming for labour, it be argued that, an expansion in ASM activities with its huge potentials of quick income generation will decrease the availability of labour for agricultural activities in mining areas thereby making the price of farm labour very expensive.

2.5.7 ASM and human health

According to Gyamfi et al. (2020), ASM has contaminated water sources with mercury, causing nausea, vomiting, headaches, fever, chills, abdominal cramps, and diarrhea among people living in Senegalese mining areas. The negative effects of ASM caused by mercury emissions by operators can be explained by a lack of legal understanding, insufficient monitoring of ASM activities, and poor enforcement of ASM rules.

Hilson (2001) discovered that the construction and subsequent abandonment of pits and trenches results in stagnant water and malaria-carrying mosquitoes in the nearby populations. The researchers revealed that, many pits and holes created as a result of ASM activities get filled with water and become mosquito breeding grounds, creating recurrent Malaria outbreaks both in mining and in the surrounding areas. Similarly, Amponsah-Tawiah & Dartey-Baah (2011) have indicated that the statistics from the Inspectorate Division of the Minerals Commission on occupational health problems caused by mining activities in Ghana from 2000 to 2004 include malaria and upper respiratory tract infection as the two leading causes of outpatient morbidity between 2000 and 2006.

2.5.8 ASM and potable drinking water

Through the use of chemicals and other hazardous substances, ASM operations exacerbate the rate and degree of change in the natural environment, as well as the impact on communities and water resources. The quantity and quality of potable water can have serious health consequence and hence the welfare of households living in mining areas. ASM activities by its nature consume, divert and seriously pollute water resources.

Amoah (2003) conducted a case study on the spread of surface mining in Tarkwa, a mining area in Ghana and reported that the high density of mining operations in Tarkwa has been a major cause of both surface and groundwater contamination. Chemical pollution of ground

water and streams, increased sediment load, and dewatering impacts, according to the study, have all contributed to the deterioration in the quality and availability of potable drinking water for communities in Tarkwa mining districts.

2.5.9 ASM and access to arable land

ASM activities lead to deforestation and land degradation through the clearing of the forest and digging of large trenches that leave the arable farmlands bare, thus exposing the soil to erosion and rendering the land less productive for agricultural development. According to Kusimi (2007), gold mining activities in Ghana have contaminated significant portions of land previously used for agriculture, making it difficult to access viable farmlands for agricultural purposes.

Duncan (2009) found that agriculture lost 661.54 hectares (ha) in the western region of Ghana between 1986 and 2006, a 15.5 percent reduction, owing to the conversion of 101.24 ha into major pits, 28.62 ha into minor pits, 195.97 ha into mine waste dumps, 199.02 ha into settlements, and 136.69 ha into roads.

ASM decreases the amount of available productive land that may be used for food production by seizing and destroying agricultural land. This also affects sustainable livelihoods in terms of aggravating poverty. Land is the most valuable assets for rural people. Limited access to land stifles local food production and goes to trap rural people in poverty since they lose a major source of livelihood asset.

2.5.10 AMS and children education

According to the World Bank (2015), there are two hundred and fifteen (215) million children worldwide who work between the ages of five (5) and fourteen (14) years old. These children are frequently mistreated and forced to work long hours in deplorable conditions. This may have an impact on their physical, mental, and emotional wellbeing in one way or another.

Furthermore, these children lack essential rights like as access to education and health care. The problem of children's participation in Ghana's booming artisanal small-scale mining (ASM) economy continues to get widespread attention both locally and globally.

Poverty is widely regarded as the leading cause of school dropout and employment among school-aged children. Families in rural areas, particularly those from impoverished backgrounds, are more likely to have more children, making it difficult for them to exist on the income of only one family member, which is also relatively low. As a result, they turn to their children as a source of income (Hilson, 2016).

ASM has a bad impact on children's education. According to Boateng (2017), students in Ghana's mining areas engage in galamsey activities during school hours, resulting in low school attendance as well as a reduction in academic achievement. The researcher went on to say that school-aged children who participate in galamsey activities and earn money see no reason to take education seriously. As a result, ASM has a greater chance of contributing to the long-term erosion of human capital quality.

2.5.11 ASM and housing conditions of households

Improved housing is critical to household well-being because it is intertwined with other well-being aspects such as health, the environment, and communal life (Carvalho, 2017). Mining activities create many economic opportunities which tend to act as a pull factor for rapid increase in population in mining areas, which has the potential to lead to housing shortages and affordability issues. Thus, rapid population increase in mining communities, particularly during discovery phases, can put undue strain on existing housing stock, driving up housing and rental rates.

Affordability issues resulting from high rental values in mineral-rich areas may have a negative impact on social cohesiveness hence limiting diversity and leading to the marginalization of

26

low-income population (Haslam and Rowley, 2013). As a result, people are likely to be frequently forced out of their neighbourhoods or compelled to travel long distances to work. Local people and other disadvantaged populations may be disproportionately affected when they compete for accommodation. According to Ivanova et al. (2007), housing deficit can lead to the provision of lower-quality camp quarters in order to accommodate temporary employees in various circumstances in mining areas.

2.5.12 ASM and biodiversity (access to game, access fruit and access firewood)

Mining poses a serious and unique danger to biodiversity at numerous spatial scales, both directly and indirectly through sectors that support mining activities (ICMM, 2020). The informality that characterizes the ASM sector has the potential to exacerbate the extinction of biodiversity. The economic potential of ASM in areas of employment and revenue creation, for example, might attract human population, posing new challenges or increasing existing ones such as biodiversity over exploitation or habitat loss for other land uses.

According to Obeng and Appiah (2019), the world's tropical forest ecosystem is being swept away at a rate of 25 million acres per year, with mining operations, particularly small-scale mining, playing a significant role in this tragic situation. The implication is that, ASM undoubtedly leads to degradation of the ecosystem which may have serious negative effect on special species of plants and animals thereby resulting in limited access to game, fruits and firewood which form integral part of livelihood opportunities for households in rural areas.

2.6 Types of Coping Strategies Against Livelihood Shocks

Coping strategies are livelihood tactics that are utilized when a person's livelihood is under threat (De Haan, 2012). Coping strategies aim to improve a system's ability to withstand external shocks or changes. The various economic, social and environmental shocks created by ASM activities could force poor households in communities endowed with mineral resources

to implement a wide range of coping techniques. In vulnerability analysis, the coping strategies adopted by households in times of livelihood shocks are as important as the vulnerability itself. The identification of these strategies is essential to aid policy makers develop effective protection measures to assist the different vulnerable groups in society.

Much of the research on livelihood shocks and coping mechanisms starts with the underlying lifecycle model, which contends that households aim to smooth consumption in order to maintain their marginal benefit of consumption constant (Deaton, 2005). As a result, additional resources may be needed to support current consumption above "shock-depleted" levels in order to smooth consumption during times of livelihood stress. In practice, households, particularly farmers, adopt a number of coping mechanisms to deal with the shocks to their livelihood. Typically, household coping mechanisms differ by geography, neighborhood, social group, household, gender, age, and season.

McPeak (2004) distinguished between ex-ante risk management methods and ex-post coping strategies in a study on income and asset shocks in Northern Kenya. According to the researcher, ex-ante risk management strategies are pro-active measures put in place afore time to deal with shocks and losses whilst-ex post coping strategies refer to reactive survival measures adopted by individuals or households when they are exposed to unanticipated livelihood failure either in a sudden or gradual sense.

Household coping techniques, according to Webb & Braun (1994) and Bedeke (2012), follow a sequence of strategies ranging from "risk minimization" to "risk absorption" to "risk taking." Asset acquisition, saving, and income diversification are all part of the risk minimizing process employed by households in times of livelihood stress. Households subsequently shift from risk reduction to risk absorption by using financial reserves, food reserves as well as reducing food and non-food consumption. The third stage is risk taking, in which households turn to desperate

measures such as household member migration, consumption of wild foods, eating less amounts of nutritionally poor meals, and sale of private property.

According to Dercon (2002), participating in safe activities, diversifying income sources, and adjusting labor supply are the key coping methods adopted by households to smooth consumption during times of livelihood shocks. To begin, an income-based approach is one in which households invest a major portion of their resources in one safe activity, even if it is not particularly profitable, in order to ensure a relatively consistent source and amount of income. Second, diversification refers to how households allocate their resources among various sources of income in order to spread risk. Finally, changes to labour supply include the use of family reserve labour. However, labour modifications such as bringing children into the workforce or involving them in home productive activities might have negative implications that last long after the livelihood shock has passed. Children's participation in mining, for example, can result in low human capital accumulation due to the risk of dropping out of school.

Bryan (2013) found that households used a variety of coping techniques, including selling livestock, engagement in off-farm employment, relocation, borrowing from relatives and doing nothing, in a research on Climate Shocks and Coping Strategies in Ethiopia.

The majority of farm households chose livestock sales and borrowing from relatives as their primary consumption smoothing techniques, according to the findings. It may be argued, however, that if the external shock also affects assets, the use of assets to cushion consumption in the face of an external shock will be limited. Similarly, in rural communities in less developed countries where community members have tight social links, using social capital (borrowing from relatives and friends) to cope can be helpful.

Eriksen et al. (2005) studied the dynamics of vulnerability and coping methods in Kenya and Tanzania, classifying them as formal social protection, informal social protection, and alternative coping strategies. They used official social safety measures such as government/district assembly aid and formal insurance policies. Assistance from non-governmental organizations (NGOs) and church groups, as well as family and friends, were used as informal social protection measures. Other coping strategies they mentioned were asset sales/pawning, relying on savings, borrowing and salary advances, reduced expenditure, migrating, changing jobs, and doing nothing. The outcomes of their study revealed that, despite the multiple coping techniques discovered, a big section of the population uses only a few and the same coping strategies, which are seeking aid from family and friends, borrowing, and drawing on savings. While selling or pawning assets has been found to be an important coping strategy in developing countries, Doss et al. (2011) found that women in Ghana were less likely than their partners to sell assets or draw on savings as a coping strategy because women are less likely to own assets or have their own savings account.

Yoshito et al. (2002) identified four categories of coping mechanisms namely alternative activities, precautionary savings, labour adjustment and informal insurance in their study on Risk Coping Strategies in Tropical Forests. The researchers observed that, resource exploitation, particularly wild fruit collection, fishing, and hunting were among the alternative activities. While extracting natural resources is a common source of income for the rural poor, they can also do it for insurance purposes if necessary. Second, precautionary savings includes food stock and asset disposition, both of which are common forms of savings reported by researchers working in rural areas in developing countries. Again, wage labour and migration, two other insurance substitutes mentioned in numerous literatures, make up labour adjustment. Finally, borrowing, remittance, and mutual insurance were all identified as forms of informal insurance.

Murata and Miyazak (2014) classified household risk coping mechanisms into three categories: household/community-based, market-based, and public sector-based in their study on Ex-post Risk Management Among Rural Filipino Farm Households. Dissaving, selling real estate, mutual aid (borrowing/transferring from neighbors, relatives, and friends), and labour reallocation were among the household/community-based coping mechanisms. The sale of financial assets and credit were also among the market-based coping measures (borrowing from banks and other financial institutions). Finally, catastrophe relief, social assistance (calamity relief) subsidies, and agricultural support programs were among the public sector-based coping mechanisms. Overall, the researchers discovered that the majority of the respondents used at least one of the coping techniques, with dissaving/selling assets being the most popular, followed by borrowing/transfer, and social aid being the least popular.

To sum up thoughts, there is ample evidence from the literature to show that households in developing countries frequently experience a mix of uninsured livelihood shocks for which they mostly pick from a limited set of coping methods, which can affect their wellbeing favourably or otherwise.

2.7 Determinants of Adoption of Coping Strategies

Over the years, researchers have found institutional and human capacities to be key determinants of adoption decisions. According to several empirical studies, age, household size, gender, household income, education, marital status, access to extension, farm size and access to credit are only a few of the key factors influencing households' adoption decisions during times of livelihood stress and shocks (Heemskerk, 2003; Deressa et al., 2008; Lawal, 2016; Bedeke, 2012; Ngenoh et al., 2018; Dercon, 2002).

Agyei-Manu et al. (2020) conducted research in Ghana to explore cocoa farming households' opinions of the impact of mining on their socioeconomic activities, as well as the factors that

influence their decision to pursue alternative livelihoods. According to the researchers, cocoa farming families agreed that mining had a detrimental influence on their socioeconomic activities, and that the majority of cocoa farming households have developed coping mechanisms in response to the negative effects of mining in the area. The multinomial regression results revealed that sex, years of formal education, possession of technical skills, access to extension services, farm income, perception that mining has reduced farm sizes, and farm outputs were the significant factors influencing a cocoa farming household's decision to adopt a specific coping mechanism as opposed to not adopting a coping strategy.

Olawuyi et al (2011) conducted a study on Shocks and Coping Strategies of Rural Households in Ogo-Oluwa Local Government in Nigeria using a multivariate probit model. The results revealed that, majority of the households experienced multiples shocks that are linked to ecological, economic, demographic and social factors. According to the researchers, majority of the households adopted coping strategies such as borrowing, distress sale of assets, remittance, adjustment in food intake and drawing on savings in response to the shocks. The multivariate regression result revealed educational status, household size, per capita income, shocks type and off farm activities as being the most significant variables that influence the choice of coping strategies and are likely to affects on households' future welfare.

Ngenoh et al. (2018) used a count data model to analyze the socio-economic and institutional elements that influence households' decision to engage in coping mechanisms in response to shocks in Kenya. This allowed for simultaneous estimation of the decision and result stages. According to the findings, 76.9% and 82.1 percent of those interviewed who encountered production and marketing shocks, respectively, were able to employ various coping techniques. Furthermore, smallholder farmers' coping strategies were working more, diversifying agricultural portfolios, reducing consumption, selling assets, using savings and insurance,

borrowing and seeking help. Moreover, their findings showed that loan availability, family size, access to extension services, and membership in farmer associations are all relevant explanatory variables that influence families' decision to utilize coping mechanisms.

To crown it all, the adoption of coping measures by farm households in mining towns is largely influenced by personal, cultural, social, and economic aspects, as well as the characteristics of the numerous coping strategies under consideration. It is also worth noting that not all households employ coping methods in the face of artisanal small-scale mining-related shocks. The most common reason for non-adoption is that non-adopters fail to recognize the financial benefits of adopting a specific coping strategy or a combination of coping strategies that they are considering. In times of livelihood shocks, credit constraints and a lack of productive assets can equally make it difficult for farm households to adopt coping methods.

2.8 Effects of Coping Strategies Adoption on Welfare

In this study, consumption expenditure and household food insecurity level were used as proxies for household welfare. Intuitively, the level of households' welfare affects choices of coping strategies employed. Thus, ASM induced shocks (negative effects of ASM) have direct effect on households' incomes (agricultural and other income), hence influencing the spending patterns of households in the society. Furthermore, varied covariate and idiosyncratic shocks that households face result in distinct coping and adaptive mechanisms being used. As a result, these have an impact on welfare, although the researcher's focus in this study is on coping/adaptation choices and welfare correlations.

When coping mechanisms erode the household's physical, financial, human, or social capital, they may have negative repercussions on welfare of household members (Dercon, 2005). This may raise the likelihood of falling into poverty and making households more exposed to future problems. In this respect, short-term income preservation may come at the cost of long-term

enjoyment. Most empirical and theoretical papers, for example, found proof that, in the face of liquidity constraints and a lack of economic opportunity, livelihood shocks cause young people to drop out of school or engage in income generating activities while still in school, with long-term repercussions for their human capital development (Beegle et al, 2006; Hoddinott, 2006).
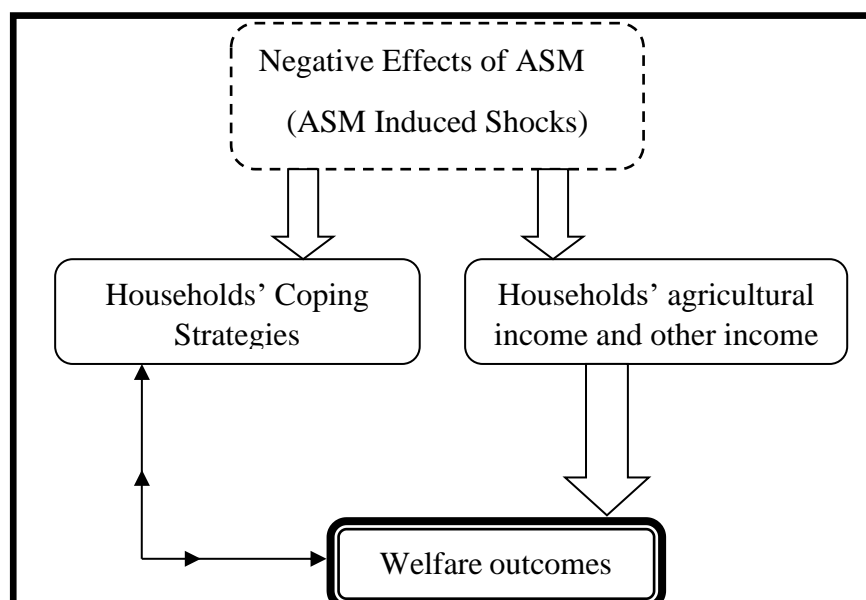
Figure 1: ASM induced shocks, Coping Strategies and Welfare Linkages

Source: Author's own hypothesis based on Skoufias et al., 2011

Figure 1 depicts how ASM-induced shocks influence the level of consumption mostly through their impact on current agricultural revenue and non-agricultural revenue. It may be claimed that because many rural households rely primarily on agriculture, ASM has a higher impact on agricultural households compared to non-agricultural households in the mining areas.

The negative effects of ASM (ASM-induced shocks) may result in a reduction in consumption/welfare, depending on the capacity of households to adapt to income fluctuations. Households in developing nations endure livelihood shocks that jeopardize their well-being in the near and distant future, and recovery is often sluggish and incomplete because the existing

coping techniques, almost all of which are informal are woefully inadequate and inefficient (Heltberg and Lund, 2009).

Intuitively, adoption of coping mechanisms might sometimes make households worse off in terms of well-being. For example, the quality of household members matters, so while expanding adult labour supply may be appropriate, pushing children to work in times of economic hardship in order to generate income to support the family can damage their human capital, thus harming well-being in the long run. It is also worth mentioning that, dealing with livelihood crises may necessitate the sale of household commodities such as agricultural harvests and assets such as land and cattle to pay off debts. This particular strategy depletes the household's asset base and jeopardizes the capacity of households to handle future shocks.

Guloba et al. (2014) investigated the impact of adaptation to covariate shocks on household welfare in Uganda using Ordinary Least Squares and Instrumental Variable Two Stage Least Squares approaches. According to the findings, aggregated coping mechanisms employed by households in times of livelihood shocks such as reducing food intake, increasing reserves, and increasing labour supply by withdrawing children from school to work on farms and perform family chores reduce welfare by 31.3%. On the contrary, coping mechanisms such as livestock sales which increase savings, raised household welfare by 15.4%. In some cases, including other explanatory variables affects the direction of the influence of shock-induced adaptation decisions on welfare.

According to Di Falco and Chavas (2009), there is considerable difference in food productivity between farm households that have responded to climate shocks and those that have not. Nonetheless, adaptation to climate-induced shocks boosts food yield. Similarly, Martina et al. (2016) discovered that households that used coping techniques to deal with rainstorm shocks fared better in terms of per capita consumption expenditure than those who did not.

Rashid et al. (2006) used the local average treatment effect to identify the beneficial influence on household well-being resulting from the adoption of coping methods against economic shocks among households in Bangladesh. The researchers discovered significant difference in total revenue between households who adopted coping mechanisms and their counterparts who did not. Furthermore, Carlos Andres Alpizar (2007) used propensity score matching approach to assess risk coping techniques and rural household production efficiency among households in El Salvador. The researcher found that, households who employed coping measures attain a higher consumption expenditure than their counterparts who did not. Moreover, using the endogenous switching regression approach and propensity score matching, Tongruksawattana et al (2010) found an increase in income and consumption expenditure among users of coping strategies in their study in Northeast Thailand.

However, not all research suggest that adoption has a favorable impact on wellbeing. In Nigeria, Oyekale and Yusuf (2010) discovered that adopting coping strategies impacted negatively on the poor households but positively on rich households whilst Di Falco and Veronesi (2013) who employed endogeneous switching regression approach to study climate change adaptation methods found negative correlation between adaptation measures and households' revenue. In addition, Gomes (2003) used multinomial endogenous treatment effects model in a study on an empirical analysis of households coping strategies in Ceara, Brazil. The researcher found that the adopting coping strategies negatively affect the income level of adopters.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter outlines the methodology of the study, with emphasis on the study area, data collection techniques, data analysis, conceptual framework, theoretical framework and empirical econometric models that guided the research.

3.2 The Study Area

The research was conducted in Asutifi North District, one of the six administrative districts in the Ahafo Region of Ghana. Geographically, the Asutifi North District which covers an area of 1,500 square kilometers is located between latitudes 6°40 and 7°15' north and longitudes 2°15' and 2°45' west (Asutifi North District Assembly, 2019). Agriculture is the primary source of income for the inhabitants. Cassava, plantain, maize, cocoyam, and vegetables such as cabbage, tomatoes, garden eggs, okro, and pepper are among the principal food crops grown. Cocoa remains the major cash crop produced in the area. The farmers mostly rely on the traditional methods of farming such as slash and burn with little or no technology. This indicates that food crop and vegetable production are generally on subsistence level with substantially low output.

Among the district's most significant development potentials are its large natural resources in the fields of timber and forestry products, rich soil with great agronomic value, and mineral deposits, particularly gold in communities like Kenyasi, Ntotroso, Nkrankrom, Acherensua, and Wamahinso. Figure 2 shows the map of Ahafo Region which contains the study's district, Asutifi North.

Figure 2 : Map of Ahafo Region Showing Asutifi North District

Source : Asutifi North District Assembly, 2019

3.3 Research Design

Cross-sectional research design was employed to assess farm households' perceptions of the effects of artisanal small-scale mining as well as adoption of coping strategies and their impacts on farm households' welfare. A cross-sectional research design which gathers data from individuals at a single point in time is cheaper and less time-consuming (Creswell, 2015). Descriptive analysis was used to explain the various forms of coping strategies used by farm households, as well as respondents' opinions and knowledge about the effects of ASM on farm households' welfare and their socio-demographic factors. Furthermore, quantitative analysis was employed to investigate the drivers of household's decision to use any of the coping strategies as well as the effect of the adoption of coping strategies on farm households' welfare.

3.4 Sources and Types of Data

Data for the research was primary data and was obtained from a cross-sectional survey of farm households in the Asutifi North District of Ahafo Region. In line with the main objective of this study, information on socio-demographic and economic variables, farmers' perceptions of

38

ASM effects on key welfare indicators, and types of coping mechanisms were collected. The variables in this study were measured on both continuous and discrete scales.

3.5 Sample Size Determination and Sampling Procedure

According to Hair (2006) and Saunders et al. (2009), among other things, the availability of funding, restricted time, and the type of statistical study make it necessary to pick a sample from a population. It is critical to select the right sample size for the study in order to derive conclusions that reflect the general population under consideration. The sample size for this research was arrived at using Snedecor and Cochran (1989) formula which states that;

$$n = \frac{z^2 pq}{d^2} \tag{1}$$

where;

n = the sample size

z = value for the selected alpha level (1.96) corresponding to 95% confidence level

d = degree of precision set at 5.5%

p = estimated proportion of persons who have knowledge and information concerning ASM. Since the number of respondents is not known, p will be taken as 50%.

q = 1- p

$$n = \frac{z^2 pq}{d^2}$$

$$n = \frac{(1.96)^2 (0.5)(0.5)}{(0.055)^2} = 317$$

Though, estimated sample size for the study was 317, the researcher actually used 316 due to missing responses in one questionnaire.

With regards to sampling method, a two-stage sampling technique was adopted to pick the respondents from the communities in the District. This sampling method permits larger groups to be reduced into smaller and more specific groupings for the purposes of data collection (Agresti & Finley, 2009). The first stage saw ten mining communities selected using simple random sampling technique from a sampling frame of twenty communities in the District where there is high incidence of ASM activities. This was done using a lottery method. In the second stage, a representative of three hundred and seventeen (317) farm households were selected using proportionate probability sampling and systematic sampling techniques which relied solely on the respective sizes of the communities as well as house numbers.

3.6 Data Collection Methods

The data was gathered using a semi-structured questionnaire containing both open-ended and closed-ended questions written in English. The questionnaire was designed to meet the study's specific aims. Face-to-face interviews were used to obtain information. This interviewer-administered questionnaire assisted in avoiding questionnaire incompletion, increasing answer rates, and obtaining first-hand information and understanding on ASM, coping mechanisms, household welfare indicators, and demographic factors. The questionnaire permitted the researcher to better define the situation and attitudes of farm households on ASM activities as well as quantify the welfare of farm households.

3.7 Reliability and Validity of the Research Instrument

The reliability of the questionnaire was determined by conducting a pilot study (pre-test) with twenty respondents in a mining town in the Upper East region in order to obtain first-hand information on question difficulty patterns. Lessons learnt from the pre-test helped in making crucial changes aimed at improving the questionnaire. The reliability of the survey instrument was also determined using Cronbach Alpha. The validity of the questionnaire was also

enhanced by allowing the supervisor and friends to face validate it for content. This gave the opportunity to ensure that the questionnaire obtained the correct information from the respondents.

3.8 Ethical Considerations

A letter of introduction was obtained from the Department of Agricultural and Food Economics before the commencement of the study. Consents of the participants were sought before the interviews were conducted. Participation in the study was optional. The confidentiality of the respondents was assured.

3.9 Conceptual Framework

The study of the effects of Artisanal Small-scale Mining (ASM) on farm households' welfare is conceptualized in the model presented in Figure 3. The conceptual model presents the various relationships that exist between effects of ASM, the decision to adopt coping strategies or otherwise and households' welfare. The conceptual model suggests that ASM presents opportunities through employment creation and income generation as well as threats to livelihood through loss of productive assets like land, water resources, biodiversity among others. As a result of the negative effects of ASM, farm households are having great challenges with their daily earning and spending, leaving them with the option of doing nothing or adopting some ex-post coping strategies in attempt to improve their situation and survive.
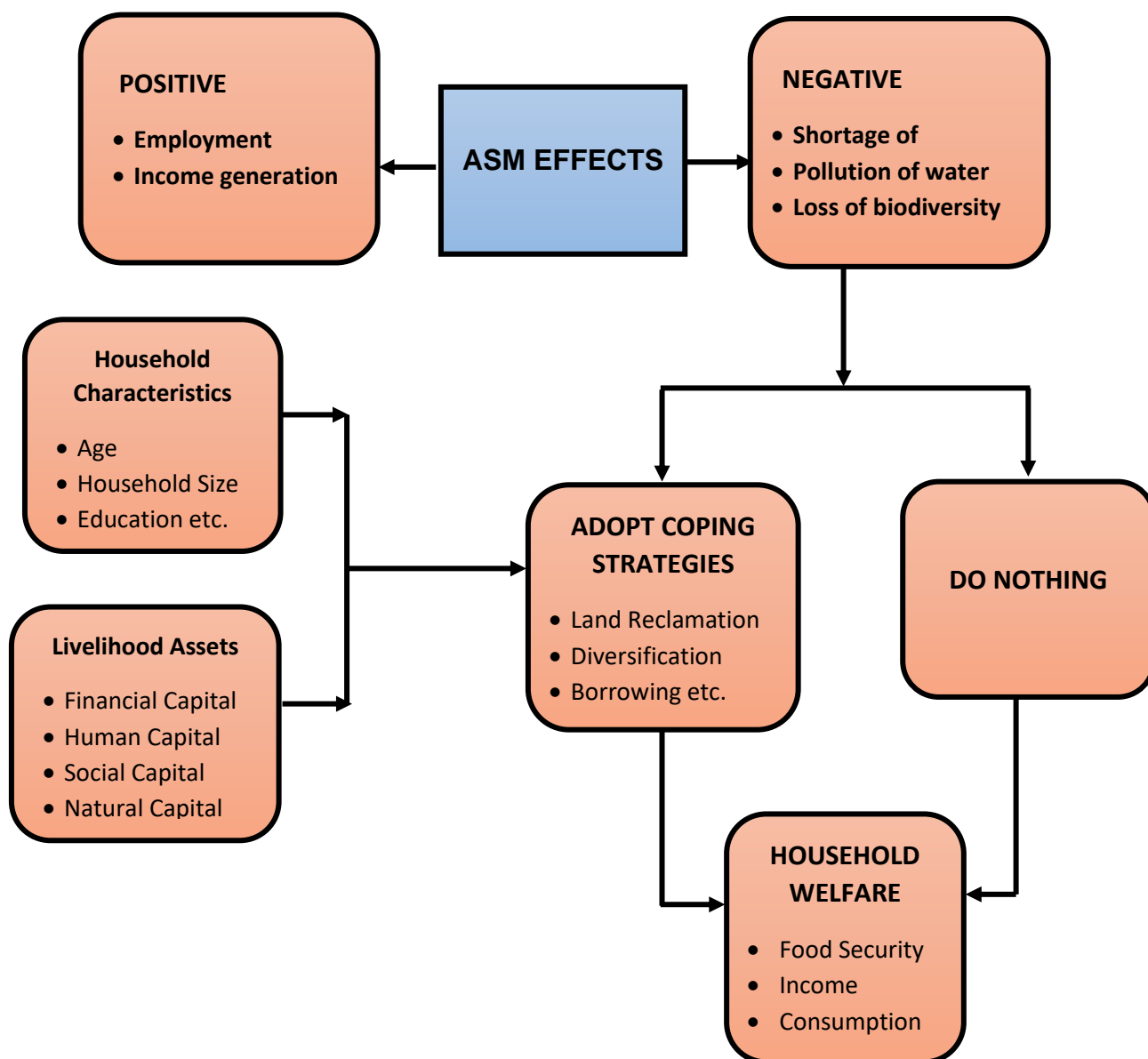
Figure 3: Conceptual Framework on ASM Effects, Coping Strategies and Households' welfare

Source: Authors's own conceptualization

From Figure 3 above, the decision to adopt coping strategies by farm household has been observed to be governed by numerous economic and non-economic factors. These factors in literature have been categorized into household socio-economic characteristics and availability of livelihood assets. The socio-economic characteristics of households that may influence the adoption of coping strategies against the negative effects of ASM include but not limited to

42

age, household size, sex, education among others. Example, education may influence the adoption of coping strategies against ASM effect through increased access to information on the potential consequences of using a particular coping strategy. On the other hand, availability of livelihood assets such as financial capital, human capital, natural capital, physical capital among others by the farm households may also affect their decision to adopt coping strategies in response to the negative effects of ASM. For example, social capital, which is concerned with the social resources, particularly networks, group membership, trust connections, and access to larger societal institutions may act as a buffer, assisting vulnerable households in coping with ASM-induced shocks as well as compensating for a shortage of other forms of capital in the society.

It can be seen again in Figure 3 that, the decision to adopt coping strategies or otherwise is expected to influence the level of household welfare either positively or negatively through changes in food security status, income level and consumption level.

3.10 Theoretical Framework

The random utility model of microeconomic consumer theory is used in this research. The Random Utility Model (RUM) is a decision-making model in which an individual i is given a collection of alternative coping techniques j from which to choose (McFadden, 1978). It is presumed that each coping alternative has its specific qualities which influence individual's choice. RUM aids us address farm households' choices over alternative coping strategies. This model is grounded on that an individual originates utility by selecting a number of alternatives. The utilities U_{ij} are latent variables, and the noticeable preference indicators manifest the essential utilities (us Saqib, 2004).

According to Uddin et al. (2017), the utility (U_{ij}) that an individual i obtains by choosing strategy j from a set of options (C) is as follows:

$$U_{ij} = V(X_{ij}; \beta) + e_{ij} \tag{2}$$

where

U_{ij} is the utility of the alternative coping strategies $[j = 1, \ldots, J_n]$ for decision-maker i.

X_{ij} is a vector of explanatory variables for alternatives j and decision-maker i.

β is a vector of unknown parameters;

V which is known as systematic utility is a function of the explanatory variables.

e_{ij} is the error term for i and j.

According to the notion of random utility model, a farm household will use any of the coping strategies if the expected utility is more than zero and will not use any of the strategies if the expected utility is less than zero. Asfaw et al. (2012) revealed that, the utility between coping strategy adoption *(UAI)* and non-adoption *(UAN)* can be expressed as G*, which means that a utility-maximizing farm household will choose to adopt a coping strategy if the utility gained from adopting is greater than the utility gained from non-adoption.

$$G^* = U_{AI} - U_{AN} > 0 \tag{3}$$

$$G_i^* = \beta X_i + e_i \quad \text{with} \quad G_i = \begin{cases} 1 \; adoption \; if \, G^*_i > 0 \\ 0 \; otherwise \end{cases} \tag{4}$$

Where G is a binary indicator variable equaling 1 if a farmer applies coping strategies and 0 otherwise; β is a vector of parameters to be estimated; X is a vector of explanatory variables; and e is the error term. The study's premise is that farm households' adoption decisions are optional, and that response variances can be attributed to the variation in farmers' demographic, socioeconomic, and institutional attributes.

3.11 Analytical Frameworks and Empirical Models

3.11.1 Perceived Effects of ASM operations on the Welfare of Farm Households

The perceived effects of ASM activities on farm households' welfare were assessed using descriptive statistics. Farmers were asked to indicate how their household welfare indicators have changed over the years due to ASM operations or activities. The welfare indicators used in this research were taken from the OECD Regional Well-Being Indicators (2019) which included food consumption, food security, income, employment generation, crop production levels, animal production levels, access to land, children education, potable water, health conditions, access to farm labour, access to fruits, game and firewood. A five-point Likert scale of *1=Highly decreased or deteriorated; 2=Moderately decreased or deteriorated; 3= Remained same; 4=Moderately Increased or Improved and 5=Highly increased or improved* were used. The data was analyzed using means and percentage frequencies.

3.11.2 Types of Coping Strategies Adopted by Farm Households

Descriptive statistics was used to analyze farmers' coping strategies for reducing the negative consequences of ASM activities on household welfare. Specifically, the data was presented using a frequency distribution table. This type of data visualization is simple to comprehend (Fisher & Marshall, 2009).

3.11.3 Drivers of Coping Strategies Adoption by Farm Households

The study used a multivariate probit model as opposed to univariate model to estimate the magnitude and direction of the factors influencing the various coping strategies adopted by farmers to minimize the effects of ASM activities on household welfare. The multivariate probit model simulates the effect of a combination of explanatory variables on each individual coping strategy while also allowing for the possibility of a relationship between unobserved disturbances and the association between the adoptions of various strategies (Mulwa et.al,

2017). Such correlations permit error term for both positive correlation (complementarity) and negative correlation (substitutability) between the different coping mechanisms (Ndiritu et al., 2014). As revealed from literature and reconnaissance survey, coping strategies such as land reclamation, resettlement to a different community, diversification, dependence on market for food, social networking, sale of asset and borrowing were considered. The assumption is that; farmers are more likely to jointly adopt a mix of these techniques to deal with the negative impacts of ASM than to adopt a single strategy. Neglecting the inter-relationships among the various coping strategies may result in bias estimates of factors influencing adoption of these coping strategies (Greene, 2008).

According to Teklewold et al. (2013), the MVP regression model for this investigation is represented by a set of binary dependent variables Y_{ij}^* which are as follows;

$$Y_{ij}^* = X_{ij}\beta_j + e_{ij} \quad (J = 1, 2, 3, \text{-------m}) \tag{5}$$

where

Y_{ij}^* for J = 1, 2, 3……m is the unobserved latent variable of the coping strategy J, applied by farmer i,

X_{ij} is a set of explanatory variables assumed to influence coping strategies,

β_j is a vector of unknown parameter to be estimated,

e_{ij} is the error term assumed to be normally and independently distributed with a zero mean and a constant variance.

The maximum likelihood method was used to estimate the multivariate probit model, and the interpretation of probit results was based on marginal effects treated as probabilities, which explain the slope of the probability curve relating one explanatory variable to prob (y=1|x), while holding all other variables constant.

The observable dependent variable is defined by:

$$Y_{iJ} = \begin{cases} 1 \ adoption \ if \ Y^*{}_{ij} > 0 \\ 0 \ otherwise \end{cases} \tag{6}$$

The probit model follows the Bernoulli distribution with probability;

$$\pi_i = prob(y = 1) = \Phi(X\beta) \tag{7}$$

Where;

π_i is the probability farm household has adopted a coping strategy, $X_i^{'}$ is the explanatory variables, β is the regression parameters to be estimated.

The functional distribution of the error is critical in the multivariate probit model for constraining the values of the latent variable into the desirable feature of probability values of 0 and 1. The multivariate probit model is based on the cumulative distribution function of standard normal distribution represented by Φ (Xu & Craig, 2010).

$$\begin{aligned} prob(y = 1) &= prob(y_i^* > 0) = prob(\beta X + e > 0) \\ &= prob(e > -\beta X) \\ &= prob(e < \beta X) \\ &= \Phi(\beta X) \end{aligned} \tag{8}$$

In the case of normal distribution function, the model to estimate the probability of observing a factor influencing a choice of a specific coping strategy by farm households or otherwise can be stated as:

$$Prob(y_i = 1/X) = \Phi(\beta X) = \int_{-\infty}^{\beta X} \frac{1}{\sqrt{2\Pi}} exp\left[\frac{-z^2}{2}\right] \partial z \tag{9}$$

Where;

Prob is the probability of the factor being classified as having the influence,

X is a vector of the explanatory Variables,

z is the Standard Normal Variable [$z \sim N(0, \delta^2)$] and

β is a k by 1 vector of the Coefficients estimated.

The empirical MVP model is specified in the following form;

$$Y_{ij} = \beta_0 + \beta_1 AGE_i + \beta_2 SEX_i + \beta_3 EDU._i + \beta_4 HHSIZE_i + \beta_5 FMSIZE_i + \beta_6 FBO_i + \beta_7 CREDIT_i + \beta_8 FMYRS_i + \beta_9 HHINCOME_i + \beta_{10} ASMYRS_i + \beta_{11} DISSITE_i + \beta_{12} HHCONS_i + \beta_{13} EXTQTY_i + e_i \qquad (10)$$

3.11.4 Effects of Coping Strategies Adoption on Farm Households' Welfare

The choice of a respondent to adopt a coping strategy against the negative effects of ASM or otherwise is attributed to the respondent's inherent characteristics and other latent attributes. Selectivity bias emerges in the estimate of the adoption effect when the observed and unobserved features of farm households affect the probability of getting treatment as well as their outcome indicators. For example, farm households' managerial abilities cannot be observed but may influence both farm households' welfare and their willingness to utilize coping measures against the negative effects of ASM.

The linear endogenous treatment effect regression (ETR) model was used for a more robust approach and consistent estimation of the influence of coping strategy adoption on household welfare. The endogenous treatment effect model is a linear potential outcome model that provides for a specific correlation between unobservable that impact treatment and unobservable that impact potential outcome. The ETR model not only eliminates bias from observables and unobservable, but it also permits the estimation of the determinants of coping strategy adoption as well as the direct impact of that adoption on welfare outcomes. This is accomplished by jointly estimating one selection equation that represents agricultural households' decision to implement coping strategies and one outcome equation that models the influence of coping strategy adoption on household welfare.

Endogenous treatment effect model is applied to estimate the average treatment effect (ATE), the average treatment effect on the treated (ATET), and the potential-outcome means (POMs) from observational data when treatment variable is linked with the potential outcome variable (Stata Manual, 2015). As long as the treatment variable is binary, it can be utilized for continuous, binary, count, fractional, and non-negative outcomes. It is also predicated on the notion that the factors influencing the outcome variable differ between the treated and control groups.

The selection model, which employs probit, is the model's initial stage. It states that certain socioeconomic factors influence farmers' adoption (t=1) or non-adoption (t=0) of coping strategies.

$$\text{Prob}(t = 1 \text{ or } 0 | X) = f(X\alpha) = \alpha_0 + \sum_{j=1}^{j=J} \alpha_0 X_{ji} + \mu_i \qquad (11)$$

Where

X represents a vector of explanatory variables, f represents standard normal cumulative distribution function, α represents a vector of unknown parameters, j represents j^{th} socio-economic factor, μ represents the error term and i represents the ith farmer.

Because the option to use coping strategies or not is made by the respondent, there are unobservable traits in the respondents. These attributes can also have an impact on farm households' well-being. As Kassie et al. (2011) point out, this component can influence both the decision variable (adoption of coping techniques) in the first stage and the outcome variable (welfare) in the second stage. Adoption of coping mechanisms is also a potential endogenous variable. Endogenous treatment effect models use an estimate that integrates residuals from the treatment model (probit model) in the outcome model to overcome the problem of sample selection bias and endogeneity of coping strategy adoption. The outcome models which

estimate the direction and magnitude of the factors influencing welfare level for adopters and and non-adopters farm households are:

$$y_{i0} = E(y_{i0}|X_i) + \varepsilon_{i0} = \acute{x}\beta_0 + \varepsilon_0 \qquad (12.1a)$$

$$y_{i1} = E(y_{i1}|X_i) + \varepsilon_{i1} = \acute{x}\beta_1 + \varepsilon_1 \qquad (12.1b)$$

Where y_o and y_1 are the household welfare score for ith farmer who is non-adopter and adopter of coping strategies respectively; β_0 and β_1 are the vectors of coefficients; ε_0 and ε_1 are the error terms of the regime one and two respectively and X represents the explanatory variables that can affect welfare level of farm households. To test whether or not endogeneity exists, it is crucial to validate the null hypothesis that the treatment and outcome unobservable are uncorrelated. From the above equations, a postestimation can be done to find three treatment effect measures namely average treatment effect on the treated (ATET), average treatment effect (ATE) and potential outcome means (POMs). Each of these measures is estimated using the formulae below:

$$ATE = E(\,y_{1i} - y_{oi}/x_i\,) \qquad (13)$$

$$POM_t = E(y_t) \qquad (14)$$

$$ATET = E(\,y_{1i} - y_{oi}/x_i t_i = 1) \qquad (15)$$

Empirically, the potential outcome of welfare for farmers who did not adopt coping strategies (y_{0i}) and farmers who adopted coping strategies ($y_{1i}xz$) are represented below:

$$\begin{aligned}y_{0i} = \,&\beta_0 + \beta_1 AGE_i + \beta_2 SEX_i + \beta_3 EDU._i + \beta_4 HHSIZE_i + \beta_5 FMSIZE_i + \beta_6 FBO_i + \\ &\beta_7 CREDIT_i + \beta_8 FMYRS_i + \beta_9 HHINCOME_i + \beta_{10} ASMYRS_i + \\ &\beta_{11} DISSITE_i + \beta_{12} HHCONS_i + \beta_{13} EXTQTY_i + \varepsilon_0 \qquad (16)\end{aligned}$$

$$y_{1i} = \beta_0 + \beta_1 AGE_i + \beta_2 SEX_i + \beta_3 EDU._i + \beta_4 HHSIZE_i + \beta_5 FMSIZE_i + \beta_6 FBO_i +$$
$$\beta_7 CREDIT_i + \beta_8 FMYRS_i + \beta_9 HHINCOME_i + \beta_{10} ASMYRS_i +$$
$$\beta_{11} DISSITE_i + \beta_{12} HHCONS_i + \beta_{13} EXTQTY_i + \varepsilon_1 \qquad\qquad (17)$$

3.12 A Priori Expectation of Variables

Table 1 shows the *a priori* expectation of variables used in the models. In the subsection below, the dependent and independent variables are described.

3.12.1 Dependent Variables

The dependent variable for the multivariate probit model is adoption of the six coping strategies; land reclamation, resettlement, diversification, dependence on market for food, social networking and borrowing. These strategies were chosen in accordance with the literature on adoption of coping strategies against livelihood shocks, augmented by the focus group discussions with the selected farm households in the study area.

Two outcome variables, household consumption expenditure and household food insecurity score, were considered as proxies for welfare in the Endogenous Treatment Effect model. Consumption expenditure gives information on household food security and well-being. In comparison with total household income, Asfaw et al. (2012) argued that household consumption spending reflects households' effective consumption and is a more accurate wellbeing indicator with less measurement errors.

3.12.2 Independent Variables

Age, sex, years of education, household size, farm size, household income, membership of farmer-based organization, access to credit, farming experience, ASM years in the community, distance to ASM sites, total household consumption, and access to extension service were the main independent variables included in the models.

Age is captured as a continuous variable. The effects of respondents' age on coping strategies adoption could be positive or negative. According to some studies, age is closely connected with experience hence older farmers are more likely to employed coping strategies, especially farm-based strategies compared to younger farmers (Heemskerk, 2003; Ngenoh et al., 2018). Other studies, such as Deressa et al., (2008), Heltberg & Lund (2008), and Dercon, (2002), found that younger farmers have more exposure to different communication technologies used to spread information on livelihood shocks as well as coping strategies and associated benefits, and thus have a higher likelihood of adopting coping strategies.

Sex is included as a dummy variable with males being assigned 1 and females being assigned 0. Females are less likely than males to develop suitable coping methods, according to Ngenoh et al. (2018), due to factors such as cultural attitudes, resource access, and resource management. Males are hypothesized to have a higher likelihood of adopting coping strategies against ASM-induced shocks in this study.

Household size is included as a continuous variable. The size of a household has a significant impact on the availability of labour for agricultural and other off-farm activities. As a result, larger households, particularly those with a majority of members aged 18 to 60, are likely to have a higher probability of adopting coping strategies to counteract the negative impacts of ASM. For example, Lawal (2016) identified a positive correlation between household size and the level of coping technique employed by a family.

The respondent's education is measured by the number of years he or she has spent in school. Through enhanced access to information on the potential consequences associated with various types of coping methods, education influences the choice of coping strategy used by a family in times of livelihood shocks. Specifically, education enhances household members' awareness of the health repercussions of reducing diet quantity and quality as a coping technique, whereas

numeracy skills raise individuals' understanding of the economic consequences of borrowing money from money lenders as a coping strategy, according to Ngenoh et al., (2018). Years of education are likely to have a negative relationship with coping method adoption.

Farm size is included as a continuous variable and it is expected to be positively related to the adoption of coping strategies. The economic intuition is that, farm size could aid farmers to achieve production excesses and solve the issue of credit constraints, especially where land and farm output can be used as collateral for accessing credit to mitigate livelihood shocks.

The probability of adopting coping methods is expected to be positively correlated with household income. The higher a household's income, the more likely it is to apply a variety of coping techniques to deal with the negative effects of ASM. The intuition is that, adopting coping strategies requires financial resources hence higher income offers variety of options for households to use different mechanisms to mitigate livelihood shocks.

Farmer-based organization (FBO) membership is dummied, 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. The could be attributed to the fact that, being a membership of farmers' group is an important resource for limiting the impact of shocks because it helps farmers to build social connections that act as critical risk-coping mechanisms.

Access to credit facilities is expected to influence the adoption of coping strategies positively. According to Bryan et al. (2011), access to various forms of credit services increases the chances of farm households adopting a coping strategy against livelihood shocks. Accordingly, farm households' access to credit services relieves liquidity constraints, allowing them to adopt more appropriate technologies and diversify their livelihoods, reducing the potential impact of

shocks. Furthermore, loan access allows farmers to build assets and deploy them in new agricultural innovations or even off-farm economic activity, providing them with a stable foundation for coping with livelihood shocks.

Farming Experience which denotes the number of years a member of the household has been farming is expected to affect the adoption of coping strategies positively. A farm household member who has been in farming business for a long time is expected to have a better understanding of the livelihood shocks connected with farming in the mining area, as well as a strategy for dealing with them. In comparison to farm households with less agricultural expertise, a more experienced farm household member may have access to FBOs and other local organizations, offering an incentive to develop coping mechanisms.

ASM years in the community is included as a continuous variable. Since ASM competes with agriculture for common inputs, especially land resources, its existence for many years is expected to negatively impacts on the availability of land for farming hence farmers are more likely to employ coping mechanisms like land reclamation and diversification in order to safeguard their livelihood. As a result, the longer ASM has been present in a community, the more likely farm households are to adopt various coping techniques to minimize ASM shocks, and vice versa.

Distance to mining sites is anticipated to be negatively related with the adoption of coping strategies. Kitula (2006) in a Study in Tanzania found that, households who live close to mining sites are more likely to be exposed to various health related problems.

Access to extension service helps to improve the production methods and provide education to farmers as well as small-scale miners on the detrimental effect of mining on agriculture. Such education and awareness creation are expected to lead to the adoption of coping strategies.

Table 1: Definitions, measurements and a priori expectations of variables in the models

VARIABLE	DESCRIPTION	MEASUREMENT	EXPECTED SIGN		
			MVP Model	ETE Model Adoption	Welfare
1. AGE	Age of farmer	Number of Years	+/-	+/-	+/-
2. SEX	Gender of the respondent	Dummy: 1 if male; 0 if female	+/-	+	+
3. EDU	Educational level of the household	Years of formal education	-	-	+
4. HHSIZ	People in the house eating from same pot	Number of people	+	+	-
5. FMSIZ	Total land for cultivation	Size of households' farm(s) in acres	+	+	+
6. HH IN	Total money earned by the households	Money in GH₵	+	+	+
7. MFBC	Membership of an FBO	Dummy: 1 if member, 0 otherwise	+	+	+
8. ACCR	Households' access to credit	Dummy: 1 if Yes, 0 otherwise	+	+	+
9. FMYR	Years of farming by the household	Number of Years	+	+	+
10. ASM	Years of ASM existence in the community	Number of Years	+	+	-
11. DIST	Distance from residence to ASM site	Distance in km	+	+	N/A
12. HHCONS	Household expenditure on Consumption	Money in GH₵	+	N/A	N/A
13. EXT QTY	Access to extension service	Dummy: 1 if Yes, 0 otherwise	+	+	+

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This section presents and discusses the results and findings of the field study. In section 4.2, the respondents' socio-demographic characteristics are reported. Following that, a summary of respondents' food insecurity status and a detailed presentation of farmers' perceptions about the effects of ASM operations on household welfare are presented in section 4.3 and 4.4 respectively. Farmers' coping mechanisms for dealing with ASM are discussed in Section 4.5. The study analyzed the elements that influence farmers' decision to use a coping method in section 4.6. Finally, the effects of ASM coping mechanisms on farm household welfare in Asutifi North District are discussed.

4.2 Demographic Characteristics of Respondents

The demographic characteristics of the surveyed farm households are shown in Table 2. For many economic tasks, age is a critical factor in determining the quality of labour. Many economic tasks, such as artisanal small-scale mining and farming, require a high degree of energy and strength, which is often connected with age. The mean age of the respondents in the research area was 51 years old. The average age of 51 years in the research area indicates that there are more elderly people engaged in agricultural activities. In terms of gender distribution among respondents, the research area reveals a significant prevalence of male-headed households (67.7%) compared to female-headed households (33.3%). This conclusion corresponds to Ghana's male distribution, which shows that 65.3% of households have male heads whilst 34.7% have female heads (GSS, 2019).

The average number of years of schooling is 6.04 years, indicating that respondents' maximum level of education is primary education (approximately primary 6 years). With the majority of respondents in the research region lacking a secondary education, it may be assumed that they will find it difficult to engage in formal non-farm occupations, increasing their risk of resorting to the various activities along the ASM value chain. It is worth noting that, the relatively high primary education attainment in the study area is relevant for policy formulation. Addressing the menace of small-scale mining can be targeted at such educated farm households since such respondents can easily understand the environmental hazard posed by artisanal small-scale mining and can easily take on alternative livelihood activities.

Table 2: Descriptive statistics of key socio-demographic characteristics of respondents

Variable	Obs	Mean	Std. Dev.	Min	Max
Age (Years)	316	51.013	13.49	28	76
Sex (1=Male, 0 = Female)	316	0.677	.468	0	1
Educational level (Years)	316	6.0380	5.231	0	17
Household size (Number of People)	316	6.165	1.734	3	11
Farming experience (Years)	316	23.7595	13.2738	2	54
Membership of FBO(1=Yes, 0 = Otherwise)	316	0.5126	0.500	0	1
Off farm activity (1=Yes, 0 = Otherwise)	316	0.6392	0.4810	0	1
Access to credit facilities (1=Yes, 0 = Otherwise)	316	0.601	.49	0	1
Amount of credit received (GhȻ)	192	6717.708	4025.469	1200	18000
Access to ext. services (1=Yes, 0 = Otherwise)	316	0.81	.393	0	1
Farm size (Acres)	316	3.7879	2.1795	1	14
Participation in PFJ (1=Yes, 0 = Otherwise)	316	0.3165	0.4658	0	1
Total household income (GhȻ)	316	26198.35	19455.41	8000	99000
Years of ASM in community (Years)	316	10.26	1.84	3.5	13
Distance to mining site (Km)	316	3.04	1.14	1	7
Total household expenditure (GhȻ)	316	13883.04	5839.015	6396	34944
Adopt. of coping strategy (1=Yes, 0 = Otherwise)	316	0.7594937	0.471519	0	1

When it comes to agricultural production and the adoption of coping strategies by farm households in the face of ASM-induced shocks, household size is critical. The mean household

size is approximately 6 persons with a minimum of 3 persons and a maximum of 11 persons, according to the data. The findings are similar to those of Mabe et al. (2021), who discovered an average household size of 7.75 people in Ghanaian areas where small-scale mining is prevalent. It is also worth noting that the mean household size in the study area is higher than the national average of 3.6, according to the GSS (2019). The basis for this variance can be traced back to the sample's makeup. Mostly, agriculture-related households, particularly smallholders, can be found in rural areas with large household sizes. The fairly large household size in the study area can provide huge opportunity for farm households in terms of adequate supply of family labour for production as well additional source of income from non-farm activities.

For farming experience, table 2 reveals that households have an average of 23.76 years of agricultural experience, indicating more than two decades of farming experience in the research area. The average farming experience is adequate for farmers to be up to date on the expertise of farming activities as well as the adoption of farm-based coping measures against the negative effects of ASM.

In terms of FBO membership, 51.2 % of the respondents indicated their membership with FBOs whereas 48.8% of the respondents indicated no association with any FBO. Members of farmer-based organizations meet on average twice a month, showing that farmer-based organizations are moderately robust in the research area. It should be mentioned that communal labor is commonly used in communities for some fundamental farming tasks such as land clearing and weeding. The policy implication is that FBOs provide a channel for the effective transmission of new agricultural production technologies as well as the mobilization of financial resources required to deal with ASM-induced shocks.

Respondents were asked if they had received credit or not. Majority of farmers (60.01 %) received credit facilities while an estimated 39.9% received no credit facilities during the agricultural production year. Credit unions, microfinance institutions, family and friends were the most common sources of credit for those who received it, with commercial banks being the least common source of credit. The average credit received in the study area was estimated to be Gh₵6,717.71 (SD= Gh₵4,025.47). The average loan obtained is found to be high and can ensure some level of content among farmers leading to investment in household welfare as well as establishing other businesses to adapt to ASM threat in the research area. The field survey also showed that, farm households who obtained credit during the 2020/2021 calendar year used the money primarily to support farming, followed by ASM and petty trading. Of the 39.9% of respondents who had no access to credit, reasons given included unavailability of credit, high interest rate as well as lack of the required collateral by lenders.

According to the findings of the survey, 81% of the respondents indicated receiving agriculture extension services during the production year whilst19% of the respondents said they received no extension service during the year. This means that there is a lot of extended contact in the research region. This finding is contrary to that of Martey et al. (2012) who found that, majority of farmers (66 %) in Effutu Municipality of Ghana lack access to extension services. In the research area, the average number of extension visits for farming season was around two. Extension services linked to production, processing, and trading were primarily provided through public/communal gatherings, but individual services were also provided. The few farmers who reported not receiving extension services indicated that, extension officers concentrate mostly on powerful farmers who generally have more livestock and large farm sizes.

The mean farm size farmed by households in the research region was 3.79 acres, with the biggest farm size being 14 acres and the smallest farm size being 1 acre, according to the findings. The average farm size is 3.79 acres, which is within the national range of 1 to 5 acres (2 hectares). Higher landholdings encourage farmers to generate excess output for the market (Martey et al., 2012). Because the bulk of the cultivators in the research area are small-scale growers, the chances of engaging in large-scale production are slim. This could negatively impact on poverty alleviation initiatives. In a different light, the modest farm sizes in the research area may serve as an incentive to employ coping mechanisms and other environmentally friendly strategies to maintain the environment while preserving household welfare. This is because farmers may not be able to execute these tactics on a big scale. This reinforces the observations of Deressa et al (2010) who discovered negative association between adaption techniques and farm size.

Off-farm operations have become a safety net and a source of income for farmers, since the proceeds are utilized to supplement farming activities and maintain household food security. According to the research, 63.92 percent of farmers mix farming with additional off-farm activities. Previous research has also indicated that capital obtained from off-farm activities is used to start small-scale non-farm businesses (Osei et al. 2021).

With regards to household income, the average annual income in the study area was Gh¢26,198 with the minimum annual household income being Gh¢8,000 and maximum annual household income of Gh¢99,000. The average annual household income in the study area falls below the GSS (2019) national average of Gh¢33,937. It was revealed that, household income in the study area basically flows from sales of output of cocoa, compensation from ASM operators, compensation from Newmont Ghana Gold Limited, remittance and non-farm activities. Because mining settlements in Ghana are characterized by high poverty as a result of

agricultural damage and high living costs, public policy focused at increasing residents' wages is expected to enhance food security and other family welfare indicators.

The analysis found that the PFJ program benefited only 32% of households in the research area, showing low coverage of the program. Because the PFJ provides farmers with improved seeds and subsidized fertilizers aimed at increasing agricultural productivity and ensuring a sustainable food supply, increasing the proportion of households in the research area has the potential to improve a variety of households' welfare indicators, including food security and household income.

The average years of ASM existence in the study area was found to be approximately 10 years according to the field survey with 3.5 years being minimum number of years of ASM inception and 13 years being the maximum years of ASM birth in the community. With a decade of ASM existence in the community, policy intervention can gear towards assisting farm households to develop effective coping strategies that can mitigate the adverse impacts of ASM on households in the area.

The average distance from residence to mine sites was found to be about 3km with the closest and farthest distance from residence to mine sites being 1km and 7 km respectively. The close proximity of communities to mine sites has serious health implications on households. Hinton (2006) observed that the distance between households and mining sites is positively related to household pollution exposure, with a 1% increase in distance resulting in a 1.9 percent reduction in gas pollutant (NO_2) concentration. As a result, it is feasible to conclude that the study area's proximity to mine sites increases human exposure to ASM activities, leading in health problems and a decline in household food security.

UNIVERSITY FOR DEVELOPMENT STUDIES

Households in the study area spent an average of GH₵13,883.04 each year, with a lowest of GH₵6,396 and a highest of GH₵34944. The average household expenditure is slightly greater than the national average of GH12,857 as well as the national lowest and maximum of GH₵5,168 and GH₵19,421 per year, according to the GSS (2019) estimates.

For adoption of coping strategies, about 75% of the respondents adopted coping strategies to deal with the negative impacts of ASM in the research area whilst 25% did not adopt any coping strategy.

4.3 Household Food Insecurity Level

With food insecurity as one of the key welfare variables in this research, Household Food Insecurity Access Scale (HFIAS), which emphasizes on the access component of household food insecurity was calculated. This was accomplished with the aid of a series of nine questions that have been utilized in multiple countries and appear to identify food secure households from food insecure households in various cultural contexts. The HFIAS data was used to determine the prevalence of household food insecurity (access component) and to track changes in the food insecurity situation of farm households over time.

Table 3 contains the estimation results for the household food insecurity score for households in the research area. The results showed that majority (72.78%) of farming households in the research area are severely food insecure. The high food insecurity level among farming households could be attributed to the destruction of agricultural lands and hence decline in food production in the research area. Such high food insecurity level is unacceptable and needs policy intervention to curb the situation among farmers in the research area. In addition, 24.68% of the farming households are considered moderately food insecure with only 2.53% of farming households reported as food secure.

Table 3 : Household Food Insecurity Access Scale of Respondents

Levels	Frequency	Percentage
Food secured	8	2.53
Moderately food insecure	78	24.68
Severely food insecure	230	72.78
Total	316	100

Source: Field Survey, 2021

4.4 Households' Perception about the Effects of ASM activities on household welfare

Farm households' hold several perceptions about the effects of ASM operations on households' welfare. Respondents were interviewed using a five-point Likert scale about the changes they had noticed in certain major welfare indicators based on the 2019 OECD Regional Well-Being Indicators. The selected welfare indicators were food consumption, food security, income, employment generation, crop production, animal production, access to farm labour, access to potable water, housing conditions, health conditions, education of children, access to land, access to game, fruit and firewood. The results of the respondents' perceptions about effects of ASM on each welfare metric are shown in Table 4.

With respect to food consumption, the result as presented in the table 4 shows that, as high as 87.97% of the respondents in the study area perceived moderate deterioration in food consumption with less than 3% perceiving an improved food consumption level due to ASM activities. With ASM activities taking place on farmlands, the moderate decrease in food consumption may deteriorate in the long run when major agricultural lands are destroyed or rendered unproductive by ASM activities. The result on the perceived impacts of ASM on food consumption agrees with the findings of Kelly (2014), Hilson (2003), Tenkorang and Osei-Kufuor (2013). Specifically, Kelly (2014) discovered, for example, that ASM districts in Tanzania had higher Consumer Price Indices than the national average. Food consumption by households in mining towns who do not earn the higher revenues from ASM could worsen as

a result of rising commodity prices, as they can purchase less goods with their typical low incomes from their failing agricultural enterprises.

Closely linked to food consumption is food security. All other things being equal, a decrease in food intake by households has the tendency to lower the food security level of households. The result of the study shows that, over 10% and 85% of the sampled household reported high and moderate decrease in food security respectively whilst less than 2% of the respondents reported positive outcome of ASM on food security. This conclusion implies that many residents in the research area are having a difficult time providing adequate food for their family probably because of decline in the quality of agricultural areas for production or a spike in prices of food items. This study reinforces Yankson and Gough's (2019) claim that a weakening agriculture sector in ASM communities, combined with a jump in food demand due to rapid population growth, renders foodstuffs increasingly expensive, putting the food security of the majority of the residents at risk. Similarly, Tenkorang and Osei-Kufuor (2013) discovered that inhabitants of ASM communities in Ghana reported lower food intake and hence increased food insecurity compared to neighbours of surrounding districts.

Income is one of the key drivers behind quality of life among household members. High income reflects greater living standards, allowing individuals to pursue their goals and equip themselves with skills and abilities. Empirically, high income earning has been connected to mining (Carvalho, 2017). The findings reveal a favorable association between ASM activities and income, with roughly 55 % of respondents in the research area reporting a moderate rise in their income, compared to 35% who disagreed. Households who reported an improvement in their income level due to ASM in the study area further indicated direct participation in ASM, receipts of compensation from ASM operators for carrying out mining activity on the land owned by farm households and direct selling of goods by farm household members at the

ASM sites. Bryceson and Jamal (2019) discovered that participation in the ASM value chain provides the quickest source of revenue for the most of indigenous people in mining communities, and that ASM operators make four to ten times more than smallholder farmers in the Democratic Republic of Congo.

Just like income, the level of employment generation is an important indicator of the level of welfare in the society. All other things being equal, employment empowers people to earn income needed to meet their basic and other needs. ASM seems to have positive impacts on local level employment as about 48% and 3% of farm household respondents in the study area indicated that, employment has moderately and highly improved as a result of ASM existence in their communities. This study concurs with the findings of Isung et al (2021) and Hilson (2006) that, ASM gives direct and indirect job chances to many unemployed young people in mining areas. This is unsurprising given the labour-intensive nature of ASM activities, as well as the low educational requirements and low investment costs. Young individuals who were unable to find meaningful employment with Newmont Ghana Gold Limited or the formal sector as a result of limited employable skills and educational qualification entered the ASM sector, according to focus group discussions and household interviews. However, approximately 29% indicated that employment creation has moderately decreased whilst 18% believed that, employment level has remained the same.

ASM activities compete with agricultural activities for common inputs particularly land and labour. With crop and animal production requiring the same inputs required by ASM, it is not surprising that, 71.52% and 26.5% of the respondents reported moderate and high decrease in crop production compared to less than 2 % of respondents who felt contrary. With regards to animal production, 91% and 4.6% of the respondents indicated moderate and high decline in the animal rearing compared to only 0.63% of respondents who believed otherwise. This

situation is worrying considering the relevance of agriculture and its sustainability potentials in Ghana on one side and unsustainability of ASM and its associated environmental consequences on the other side. The findings are consistent with those of Aragon and Rud (2015), who found that farmers living close to mine sites had about 40% decline in total factor production between 1997 and 2005, with mining induced pollution being the common reason for the slowdown. Again, the findings of this study corroborate Hilson and McQuilken's (2014) observation that expanding ASM projects in rural areas where farming is the primary occupation results in considerable decline in output in the range of 30% to 60%, depending on the nature of crops.

From the result in table 4, all the respondents (100%) perceived deterioration in terms of access to farm labour with 69% and 31% specifically indicating moderate deterioration and high deterioration in accessing farm labour in the study area. With farm households assumed to be rational, the attractive and quick financial reward associated with ASM, coupled with the low returns from agriculture may induce household members in mining communities to offer their labour in the ASM sector over farming. The implication is shortage of farm labour in mining communities and consequent increase in the price of agricultural labour. The finding of this study with regards to the nexus between ASM and access to farm labour confirms the remarks made by Lwakatare (1993) that, practically all ASM operators in Tanzania were once farmers who changed to mining to make more money rapidly. As a result, farm labour in mining areas could be dramatically decreased, as most young people forsake farming in favor of working in the mining industry.

Housing is important to household's welfare because it impacts people's capacity to meet most basic needs and it is intertwined with other aspects of well-being such as health, the environment, and community life. If all other factors remain constant, housing is a significant

portion of household spending and, as a result, might affect one's ability to spend on other essentials if the rental price rises. The majority of respondents (55.7 %) believe there has been a moderate worsening in housing conditions in the research area, while only 11.3% believe differently. However, about 30% of the respondents opined that housing conditions have remained the same over the period. The relatively large percentage of the respondents reporting a moderate deterioration in their housing conditions due to ASM is not surprising considering the fact that, mining activities act as a pull that attract people from other geographical areas for employment and related reasons. The findings of this study on ASM and household housing conditions conform to the findings of Ivanova et al. (2007), who concluded that high increase in the price of housing facilities in mining areas leads to reduced affordability and the provision of lower-quality camp housing, which leads to additional social challenges such as overcrowding, segregation, and drug use.

With regards to accessibility to potable drinking water, the result shows strong agreement by respondents about ASM having serious negative effects on quantity and quality of water for various domestic purposes. Specifically, 22.29% and 74.52% of the respondents in the study area reported high and moderate deterioration in terms of access to potable drinking water due to ASM operations in the research area. During the interviews and focus group discussions, it was discovered that the decline in access to potable drinking water was caused by chemical contamination of ground water and streams, as well as siltation caused by increased sediment load. The findings of this study with regards to ASM and potable drinking water agree with Amoah (2003), who observed that the contamination of surface and groundwater, resulting in decline in quality and quantity of potable water for people in Tarkwa area is primarily due to widespread mining activities.

Health is necessary for life and other aspects of well-being since it affects people's ability to work and earn a living, as well as participate in social and civic engagements. From Table 4, it can be seen that 74.68% of the respondents in the study area reported a moderate decrease in health condition whilst only 5.7% reported a moderate improvement in health conditions due to ASM. However, 19.6% of the respondents believed that, their health condition has not changed by the presence of ASM in their communities. The relatively large number of respondents who reported decrease in health status due to ASM may experience decline in welfare as poor health could have adverse effects on labour productivity by reducing working hours of household members. The findings of this study agree with those of Hilson (2001), who found that ASM operators' creation and eventual abandonment of pits and trenches leaves nearby neighborhoods with stagnant water and malaria-carrying mosquitoes, resulting in frequent Malaria outbreaks in areas dominated by mining activities as well as non-mining areas. However, the results of this study contradict those of Chuhan-Pole et al. (2015), who discovered that mining operations enhance the health outcomes of long-established households and that infant mortality rates in mining communities are much lower than in non-mining areas.

Education is a critical enabler not only for individual well-being but also for the country's progress. Graduate unemployment, lack of financial assistance to fund education as well as the desire to attain economic and financial independence drive many young people of school going age to enter into ASM activities (Banchirigah, 2008: Osei et al., 2021). The consequential effect of such decision is negative impact on education among youths and children in mining areas. According to the study, 59.24% of the respondents reported moderate decrease in education among children whilst 33.12% also opined that education among children has remained the same. Households who reported deterioration in their children education mentioned the direct involvement of their children in ASM activities as well as indirect involvement through selling of goods as well as rendering of auxiliary services at the mining sites. This conclusion is

consistent with the findings of Boateng (2017) that, pupils' participation in galamsey activities during school hours has led to low school attendance and a deterioration in academic progress of students in the mining areas of Ghana.

All other things being equal, access to adequate productive land for agricultural purposes can improve the welfare outcome of households and vice versa in the long run. The result from Table 4 shows clearly that, ASM has tremendous negative impacts on agricultural land as 53.16% and 46.84% of the respondents indicated highly and moderately decrease in access to arable land respectively. With mining activities competing with agricultural activities for land, this specific finding is not surprising but worrying because access to arable land can lead to sustainable food production which in turns can result in food security and improved income among households. The findings agree with Duncan (2009) who found that agriculture in Ghana lost 661.54 hectares (ha) between 1986 and 2006, a 15.5% reduction, owing to the transformation of 101.24 ha into main pits, 28.62 ha into small pits, 195.97 ha into mine disposal sites, 199.02 ha into settlements, and 136.69 ha into roads.

Access to game, fruits and firewood can have positive outcome on the welfare of households in rural areas through job creation and income. From table 4, over 90% of the respondents in the study area reported moderate deterioration in terms of access to firewood, game and fruits. Respondents in three of the communities (Ntotroso, Kenyasi No. 1 & No. 2 and Wamahinso) alluded to the abundance of snail, mushroom, pawpaw and bush meat (particularly grasscutter) in the study area before the commencement of mining operations in the research area. The respondents in these communities rated the current availability of mushroom, snail and grasscutter meat is very scarce and expensive. This study concurs with the observation by Obeng and Appiah (2019) that, illegal mining has resulted in a scarcity of non-timber forest products such as mushrooms, chewing sticks, pestles, herbs, and medicine in Ghana's Western North Region.

Table 4: Farmers' perception of the effects of Artisanal Small-Scale Mining (ASM) activities on household welfare

Welfare indicator	Highly decreased		Moderately decreased		Remain same		Moderately increased		Highly increased		Mean score
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	
Food consumption	20	6.33	278	87.97	10	3.16	6	1.90	2	0.63	3.97
Food security	34	10.76	268	84.81	8	2.53	4	1.27	2	0.63	4.04
Income	0	0	110	34.81	24	7.59	174	55.06	8	2.53	2.75
Employment generation	6	1.91	90	28.66	58	18.47	150	47.77	10	3.18	2.78
Crop production	84	26.58	226	71.52	2	0.63	2	0.63	2	0.63	4.23
Animal production	14	4.46	286	91.08	12	3.82	2	0.64	0	0	3.99
Access to farm labour	98	31.01	218	68.99	0	0	0	0	0	0	4.31
Housing condition	8	2.53	176	55.70	96	30.38	36	11.39	0	0	3.49
Potable drinking water	70	22.29	234	74.52	6	1.91	4	1.27	0	0	4.18
Health condition	0	0	236	74.68	62	19.62	18	5.70	0	0	3.69
Education of children	0	0	186	59.24	104	33.12	24	7.64	0	0	3.52
Access to firewood	2	0.63	306	96.84	6	1.90	2	0.63	0	0	3.97
Access to medicine	10	3.16	306	96.84	0	0	0	0	0	0	4.03
Access to fruits	26	8.23	288	91.14	2	0.63	0	0	0	0	4.08
Access to land	168	53.16	148	46.84	0	0	0	0	0	0	4.53

Source : Field Survey, 2021

70

4.5 Types of Coping Strategies Adopted by Farm Households and Intensity of Adoption

The frequency distribution of coping methods against the negative consequences of ASM activities is shown in Table. Considering the responses from respondents, it is clear that farmers relied on land reclamation, resettlement to a different community, diversification, dependence on market for food, social networking, sale of asset and borrowing as coping strategies to deal with the negative impacts of ASM on households' welfare. According to the result, diversification or petty trading forms the highest adopted strategy (36.08%), followed by social networking (34.18%), land reclamation and borrowing (31.01%), dependence on market for food (30.38%) and finally resettlement to a different community (29.11%).

Table 5: Farm Households' Coping Strategies Against the Negative Effects of ASM

Coping Strategies	Frequency	Percentage
Land Reclamation	98	31.01
Resettlement to a different community	92	29.11
Diversification / Petty trading	114	36.08
Dependence on market for food	96	30.38
Social networking	108	34.18
Borrowing	98	31.01

Field Survey, 2021

With regards to the intensity of adoption of coping strategies, farm households were asked which of the coping strategies they adopted. The number of coping strategies adopted by the sample are shown in table 6.

Table 6 : Intensity of Adoption of Coping Strategies by Farm Households

Number of Coping Strategies	Frequency	Percentage	Cumulative
0	78	24.68	24.68
1	20	6.33	31.01
2	102	32.28	63.29
3	84	26.58	89.87
4	30	9.49	99.37
5	02	0.63	100.00
Total	316	100.00	

Source: Field Survey, 2021

71

From Table 6, majority of the sampled households (32.28%) adopted two of the coping strategies, followed by 26.58 % of the respondents who adopted three of the coping strategies in the study area. The results further reveal that, 24.68 % of the sampled households did not adopt any of the coping strategies and thus, have a zero count while 6.33 % and 9.49 % of the sample adopted only one of the coping strategies and four of the coping strategies respectively with only 0.63% of the respondents adopting five of the coping strategies at the same time.

4.6 Determinants of adoption of coping strategies against the negative effects of ASM

The factors impacting farmers' decisions to employ coping mechanisms against the detrimental effects of ASM activities in the research area were investigated using multivariate probit regression. The log likelihood ratio (LR) of the model (-756.26) and Wald χ^2 (90) = 490.45 are significant (Prob > chi^2 = 0.0000).), as shown in Table 8. The likelihood ratio test based on the log-likelihood value leads us to infer that the model is well-fitting and that the null hypothesis of independent error terms is rejected. In this situation, multivariate probit is statistically superior since it demonstrates that the likelihood of adopting one set is dependent on whether or not another set is adopted. The correlation between the regression error terms is estimated to be both positive and negative, meaning that coping strategies for positive co-efficient values complement each other and that coping strategies for negative co-efficient values are interchangeable. More specifically, strategies with positive values suggest a joint usage of more than one of those strategies whilst strategies with negative values suggest that, coping strategies adoption against negative effects of ASM will be used as substitutes.

72

Table 7: Correlation Coefficients for MVP Regression Equations

Coping Strategies	Land reclamation	Resettlement/ Out-migration	Diversification /Petty Trading	Dependence on Mkt for Food	Social Networking	Borrowing of food
Land Reclamation	1.0					
Resettlement / Outmigration	0.4194*** (0.1133)	1.0				
Diversification / Petty Trading	0.2793** (0.1259)	0.0410 (0.1457)	1.0			
Dependence on Mkt for Food	0.2316* (0.1223)	0.1866 (0.1488)	-0.2938** (0.13170)	1.0		
Social Networking	0.2222** (0.0978)	-0.1919 (0.1168)	0.0418 (0.1079)	0.2094** (0.1035)	1.0	
Borrowing Food	-0.0913 (0.1212)	0.2051 (0.1259)	-0.1792 (0.1225)	0.0880 (0.1313)	-0.0515 (0.1226)	1.0

Source: Field Survey, 2021.   Note: *** $p<0.01$,   ** $p<0.05$,   * $p<0.1$

The results from Table 7 show that respondents will jointly use land reclamation and resettlement as coping strategies. Such joint usage of land reclamation and resettlement becomes more real and practical when residents affected by adverse effect of small-scale mining seek temporal relocation whiles they work to reclaim their damaged lands for their return. Under such condition, residents may move to nearby communities for temporal livelihood. Furthermore, the usage of diversification and social networking correspondingly improves the likelihood of farm households to embrace land reclamation. The accompanying factors of land reclamation are often investment in other income generating activities to cope with negative effects of ASM as well as creating a pool of social capital. Again, the likelihood of farm households depending on market for food increases with the use of social networking and land reclamation at 5% and 10% level of significance respectively.

It is worth noting that, adopting coping strategies against the negative effects of ASM may be affected by the availability of alternatives as shown by the negative correlation between diversification and dependence on market for food. This means that, the probability of adopting diversification is highly negatively correlated with dependence on market for food, suggesting that farm households to either adopt more of a diversification and depend less on market for food or substitute one for the other.

Table 8 shows that respondents' age has a negative and statistically significant impact on their decision to engage in land reclamation, relocation, and borrowing. As evidenced by the negative and significant sign of their age, younger farmers in the research area are more inclined to use land reclamation, relocation, and food borrowing as strategies to cope with the negative consequences of artisanal small-scale mining. In the case of land reclamation, practically, there is the need for high energy involvement in the highly mechanized mining processes to refill abandoned mining sites as well as the use of other land reclamation practices or projects. For this reason, older people may not have the requisite physical energy to carry out such physically demanding activities. With regards to resettlement, the negative coefficient of the respondents' age indicates that, the likelihood of adoption is higher for relatively younger farmers. This finding is in line with Doss and Doss (2006), who found that younger farmers are more likely to adopt new technologies because they are more innovative and risk-takers. Again, the negative but significant coefficient of respondents' age on borrowing of food suggests that, younger farmers are more inclined to borrow food. The possible reason could be that, older people are largely considered resourceful, hence may tend to rely on other household resource to cope with the negative effect of ASM rather than borrowing from peers or relatives or institutions. The findings support the findings of Deressa

74

et al., (2008) and Heltberg & Lund (2009), who discovered that as farmers get older, they are less likely to adopt measures to deal with livelihood shocks.

Table 8 shows that sex of the respondents has a negative and significant influence on the use of diversification and social networking as coping methods. The implication is that, males are less prone than females to use these coping mechanisms to deal with ASM-induced shocks. The negative coefficient for diversification can be explained by the fact that females do not fully engage in farming and instead engage in off-farm activities, particularly petty trading, to supplement their income to support their families. Males, on the other hand, are more likely to be fully engaged in physically intensive farming operations, and hence may not totally rely on petty trading or diversification to mitigate the negative impacts of ASM. With regards to social networking, men in the most societies are breadwinners and may be preoccupied with their farming work most of the time. This can limit their social relationship outside home thereby lowering the chances of relying on social networking as a coping strategy. The finding of this study in respect to gender and coping strategies adoption is contrary to the findings of Ngenoh et al., (2018) that, households headed by females have lower chances of adopting appropriate coping mechanisms against livelihood shocks than households headed males, due to cultural beliefs, access to resources as well as resource management.

Education prepares people to gain skills and knowledge needed to secure alternative jobs in the formal sector and at same time influences people's access to information on the technical aspects of the negative impacts of ASM on agricultural production and the environment at large. From Table 8, the respondent's level of education significantly and positively influenced the adoption of resettlement and borrowing of food but negatively affected the adoption of land reclamation. This means that, highly educated families are less likely to reclaim abandoned field of ASM but

75

will resettle in other communities. In practice, more educated households will demand for more environmentally sound communities free from pollution arising from ASM activities. Thus, at 5% level of significance, additional year of formal education of households increases the chances of resorting to resettlement to a different community. Also, the positive coefficient of education on borrowing suggests that, highly educated households are more prone to resort to borrowing as a coping strategy. This is contrary to the *a priori* expectation since it was hypothesized that education is accompanied with larger incomes that can be enough to meet household food needs.

The chance of adopting land reclamation, resettlement, and social networking was significant and positively correlated with household size. Households with a greater membership are more likely to implement a land reclamation method at a 10% significance level. Household size is a significant factor in determining labour availability hence households with a big membership are better positioned to engage in labour-intensive land reclamation activities like filling abandoned holes. Previous study points out that larger households provide helping hands in carrying out labour intensive activities such as land reclamation, farming among others (Mabe et al, 2021). Also, larger household size is a suggestive of several outlets of the household that establish several social networks for household members to rely on in times of livelihood shocks. It can therefore be argued that, larger households increase the likelihood of households adopting social networking as a coping strategy. The finding agrees with Mabe et al (2021) who reported a positive relationship between household size and the adoption coping strategies among households in mining areas in Ghana. Again, the positive relationship between household size and resettlement is highly unexpected since larger households cannot easily relocate to other areas due to their large number for economic and social reasons. However, the positive coefficient of household size on resettlement could be linked to the extreme adverse impacts of ASM like scarcity of food and high

76

cost of living which can impact severely on larger households in mining areas compared to smaller households. For this reason, households with more members may be compelled to relocate to other areas where the living condition is comparatively more favourable.

Household finance availability is critical for maintaining household wellbeing and recovering from shocks such as negative effects of ASM. Table 8 demonstrates that access to credit by farm households considerably increases the chance of relying on the market for food, diversification, and borrowing at 1% level of significance respectively. To begin with, the effect of credit on dependence on market for food can be based on the argument that credit, frequently in the form of cash, enhances purchasing power of households in the short run, allowing them to acquire food from the market. Also, the positive relationship between credit access and diversification can be explained by the fact that, cash credit helps people to increase their investment in various non-farm economic activities to generate additional revenue to serve as security in the event of agricultural production shocks or other forms of livelihood shocks. Contrary to the study's expectation, there was a positive correlation between credit access and borrowing of food indicating that, households with loan facilities have higher probability of borrowing food to deal with ASM-induced shocks.

Table 8: MVP results showing the determinants of adoption of coping strategies

Variables	Land reclamation	Resettlement	Diversification /Petty Trading	Dep. on Mkt for Food	Social Networking	Borrowing of food
AGE	-0.0245**	-0.0107**	0.0235	0.0042	-0.0015	-0.0677***
	(0.0201)	(0.0208)	(0.0208)	0.0208	(0.0172)	(0.0191)
SEX	-0.6746	0.4377	-1.1448***	-0.1287	-0.4895**	0.1432
	(0.2258)	(0.2369)	(0.2610)	(0.2406)	(0.1911)	(0.2426)
EDU	-0.0041**	0.0364**	-0.0290	0.0137	-0.014	0.0824***
	(0.0224)	(0.0246)	(0.0258)	(0.0261)	(0.0206)	(0.0239)
HHSIZE	0.2457*	0.2408*	-0.0354	-0.0110	0.2255***	0.0036
	(0.0712)	(0.0847)	(0.0772)	(0.0798)	(0.0636)	(0.07450
CREDIT	0.4057	-0.0871	2.2789***	1.1869***	0.2477	1.1874***
	(0.2528)	(0.2806)	(0.3515)	(0.2951)	(0.2317)	(0.3336)
FBO	0.3067	0.3136	0.0611	-0.3657	0.6375***	-0.6464**
	(0.2576)	(0.2935)	(0.3060)	(0.3036)	(0.2398)	(0.3027)
FMSIZE	-0.2528*	0.3724*	-0.0691	-0.3981***	-0.0772*	0.0432
	(0.0568)	(0.0566)	(0.0483)	(0.0714)	(0.0409)	(0.0500)
FARM YRS	0.0281**	-0.0103**	-0.0543***	-0.0186	0.0062	0.0150
	(0.0178)	(0.0186)	(0.0201)	(0.0205)	(0.0156)	(0.0183)
HHINCOME	$1.62\mathrm{e}{-05}$***	$2.11\mathrm{e}{-05}$***	$1.34\mathrm{e}{-05}$**	$2.45\mathrm{e}{-05}$***	$-4.76\mathrm{e}{-06}$	$1.62\mathrm{e}{-06}$**
	$(8.45\mathrm{e}{-06})$	$(7.68\mathrm{e}{-06})$	$(6.63\mathrm{e}{-06})$	$(6.81\mathrm{e}{-06})$	$(5.69\mathrm{e}{-06})$	$(6.98\mathrm{e}{-06})$
ASM YRS	-0.0640**	-0.1638*	0.0053	-0.3542***	-0.1245***	0.1610**
	(0.0484)	(0.0580)	(0.0582)	(0.0636)	(0.0454)	(0.0634)
DISTSITE	0.0556*	0.4631	0.1636*	0.4534***	0.0592	-0.3560***
	(0.0808)	(0.1031)	(0.0905)	(0.0989)	(0.0734)	(0.1058)
HH CONS.	$3.82\mathrm{e}{-05}$***	$2.34\mathrm{e}{-0.5}$**	$-1.47\mathrm{e}{-06}$	$-6.97\mathrm{e}{-07}$	$2.37\mathrm{e}{-05}$***	$1.15\mathrm{e}{-05}$
	$(8.45\mathrm{e}{-06})$	$(9.22\mathrm{e}{-06})$	$(1.08\mathrm{e}{-05})$	$(1.02\mathrm{e}{-05})$	$(7.50\mathrm{e}{-06})$	$1.08\mathrm{e}{-05}$
EXT QTY	-0.1396	0.1460	-0.3134**	0.0896	-0.0947	0.3069**
	(0.1178)	(0.1192)	(0.1274)	(0.1409)	(0.0998)	(0.1258)
CONSTANT	-0.8331	-1.5469	-1.3418	1.7342	0.0544	0.0933
	(0.9254)	(0.9412)	(0.8934)	(0.9740)	(0.7914)	0.9808

Multivariate probit (MSL, # draws = 5); n=316; Wald $\mathrm{chi}^2(90)$ = 490.45***;

Log likelihood = -756.26***; Prob > chi^2 = 0.0000

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho32 = rho42 = rho52 = rho62 = rho43 = rho53 = rho63 = rho54 = rho64 = rho65 = 0: $\mathrm{chi}^2(15)$ = 47.9795***   Prob > chi2 = 0.00 00

Source: Field Survey, 2021.   Note: *** p<0.01,   ** p<0.05,   * p<0.

Farm size has significant varied effect on adoption of land reclamation, resettlement, dependence

on market for food and social networking as coping strategies against ASM induced shocks.

Firstly, it can be seen from the results that farm size is negatively correlated with the usage of land

78

reclamation, dependence on market for food and social networking. This also implies that, households with relatively small farms are much more inclined to employ land reclamation, dependence on market for food and social networking as coping strategies. This result is intuitively apt and depicts reality as many small sized farmers are in advantage position to undertake land reclamation practices as the activity is expensive and physically demanding. Similarly, small farm size generally denotes smaller farm output thereby prompting farmers with smaller farm size to purchase additional food from the market to supplement own production. Again, holding other factors constant, farmers with smaller farm size are more prone to suffer severely from the negative effects and may have to resort to relying on existing social networks and relationships to survive, especially in the presence of credit constraints and poor yield. However, farm size positively influences households' decision to resort to resettling to other non-affected communities suggesting that, an increase in farm size by 1 acre raises the chances of households relocating to other communities, ceteris paribus.

FBO is positively associated with the adoption social networking. The positive sign is somewhat not surprising as membership of farmer groups provides social capital and network. Such groups lend support to members in times of difficulties. Previous study also points out that memberhip of a farmer group serves as an effective pathway for shock mitigation including ASM (Ma and Abdulai, 2016). To this end, membership of FBO provides members with extra benefit of capacity building in diverse ways to curb adverse effects of ASM. However, at 10% significance level, members of FBO are about 65% less likely to borrow food from friends and relatives.

Years in farming has a significant positive effect on land reclamation. The positive link between farming experience and land reclamation may be based on the argument that, households with many years of farming experience can have greater advantage to devise easy ways to reclaim their

79

farm lands for production. According to the result, at 1% significance level, an additional year in farming experience increases the likelihood of adopting land reclamation by 2.8%. On the other side, household with higher farm experience tend to have less likelihood of resettling to other communities as well as venturing into income diversification activities. The finding shows that at 5% and 1% significance level, a year increase in farming activities decreases the likelihood of households resettling to a different community by 1% as well as the likelihood of resorting to diversification by about 5%, holding all other factors constant.

Total household income has positive influence on the adoption of land reclamation, resettlement, diversification activities, dependence on market and borrowing. At 1% significance level, a rise in household income is positively related to the utilization of land reclamation, resettlement and dependence on market for food as coping strategies. Land reclamation is expensive activity and more financial resources are required to convert waste mined lands into fertile agricultural land. As a result, high-income households are likely to be in a better position to carry out reclamation activities. In the case of resettlement, the possible reason for a highly significant positive coefficient could be that, high income households may be able to afford the cost of relocating their families from ASM communities beset with many social, economic and environmental problems to other communities where living conditions may be comparatively better. For dependence of market for food, it could be that, high income households have the wherewithal to buy food from the market within or outside the community to supplement shortages of own production arising from the destruction of farmlands by ASM activities. The result further shows that, at 5% level of significance, households have higher propensity to engage in diversification and borrowing of food. In respect to diversification, the finding is not surprising because households need income to venture into such off-farm activities especially those that need high start-up capital. However,

the finding with respect to the effect of income on borrowing is highly contradictory to the study's expectation. The reason is that, higher income level of households is an indication of the ability to make the necessary purchases required to maintain household's food consumption level in the event of food shortages.

Years of existence of artisanal small-scale mining activities has significant negative influence on the usage of land reclamation, resettlement, dependence on market for food and social networking. However, years in the mining activities tend to be positively associated with borrowing of food. The negative coefficient on land reclamation is a suggestive that, many years of ASM operation might have caused significant degradation to the land, making land reclamation an expensive and less attractive option for poor farm households who lost their lands to mining activities. The highly significant and positive sign of ASM years of existence on borrowing of food may be attributed to the destruction of agricultural land through many years of ASM activities which probably might have resulted in reduction in households' food production thereby compelling households to borrow from family members, friends and neighbours with surplus food. The negative coefficient of ASM years of existence on dependence on market for food implies that, an increase in ASM operation by one year in the community decreases the likelihood of households relying on the market for their food needs. This is surprising because ASM activities have been found to have negative impact of food production (Hilson, 2001).

Distance to mining site has different effect on adoption of coping strategies. In the first place, 1 km increase in distance to ASM fields increases the likelihood of adopting land reclamation, and diversification by 5.6% and 16.3% respectively at 10% level of significance but increases the chances of depending on market for food by 45% at 1% level of significance. By implication, the farther the mining site from the community, the more likely mining fields will be reclaimed.

81

Similarly, the longer the distance of mining sites from the community, the more likely households will depend on market for their food needs while engaging in off-farm economic activities like trading. However, an increase in distance to mining fields reduces the chances of households resorting to borrowing food to cope with ASM-induced shocks by 10%.

Households' consumption expenditure has significant and positive influence on the usage of land reclamation, resettlement and social network implying that an increase in the consumption level significantly increases the decision to adopt these coping strategies. Specifically, a rise in household consumption expenditure by GH₵1.00 raises the propensity to adopt land reclamation and social network by 0.0038% and 0.0024% respectively at 1% level of significance. Similarly, a rise in consumption expenditure by GH₵1.00 increases the adoption of resettlement to a different community by 0.0023% at 5% level of significance.

Extension services provide education to farmers on the detrimental effect of mining on agriculture as well as the best practices in agriculture. Such education and awareness creation are expected to high yield as revealed by Martey et al. (2012). For this study, receipt of extension services decreases the likelihood of diversifying into other income generating activities but increases the adoption of borrowing of food. At 5% level of significance, an additional visit by extension agent reduces the chances of households adopting diversification by 31.3%. This can be attributed to improve yield arising from access to extension services, which probably make farming comparatively lucrative compared to investing in petty trading and other off-farm economic activities. However, additional visit received from extension officers raises the likelihood of resorting to borrowing food by 30.7%. This is quiet surprising considering the findings of Martey et al. (2012) who discovered positive relationship between the number of extension visits and farm output.

4.7 Effects of Coping Strategies Adoption on Household Welfare

This section deals with the impacts of coping strategies adoption on household welfare. Two outcome variables namely household consumption expenditure and household food insecurity score (HFIS) were used as proxies for welfare.

Tables 9 and 10 indicate the factors that influence the adoption of coping mechanisms on HFIS and household consumption expenditure, respectively. The TME1 model depicts the factors that influence the adoption of coping mechanisms on welfare. The OME0 and OME1 models look at the factors that influence household welfare for farm households who are not using coping strategies and farm households who are using coping strategies respectively. The household welfare indicators used for these analysis are consumption expenditure and household food insecurity score.

The null hypothesis of no endogeneity is rejected, as shown in Tables 9 and 10, because the chi-square values of 5.96* and 6.88** are statistically significant. This suggests that unobserved factors influence both coping strategy adoption on one hand and household consumption expenditure as well as HFIS on another hand, and hence the justification for using an endogenous treatment effect estimator approach. As a result, the researcher could not have estimated the model using any of the OLS estimators because this would have resulted in inconsistent and bias results. Due to endogeneity in the data, any analysis that ignores it will underestimate the true impact of coping mechanisms on Consumption Expenditure and HFIS.

The likelihood of a farm household adopting coping methods is highly influenced by sex, education, household size, access to credit, ASM years, distance to mine site, and number of extension visits. At 1%, sex is statistically significant. The coefficient of sex is positive is an

83

indication that being a man raises the likelihood of using coping techniques by 53%. This may be due to cultural attitudes and conventions that favour men over women when it comes to access to productive resources. This discovery is consistent with Ngenoh et al (2018). With regards to the years of education, the variable was discovered to be statistically significant at 5% with a positive direction of the effects on the propensity to adopt coping strategies. This suggests that as the household head spends additional year in school, the chances that a farm household will adopt coping strategies increases by 5.1%. This could be linked to a more in-depth understanding of the potential livelihood consequences of ASM activities as a result of increased access to information. For household size, the variable was found to be statistically significant at 1%. The positive co-efficient implies that an increase in the membership of a farm household by one person increases the likelihood of using coping strategies by 23.7%. This finding is in line with Lawal (2016) who discovered positive link between household size and the level of coping strategy used in a family.

Credit access significantly and positively influenced farm households' decisions to adopt coping strategies at 1%. The implication of the coefficient is that, farm households with access to credit are 93.5% more likely to adopt coping strategies than their counterparts without access to credit. The implication of the coefficient is that, farm households with access to credit facilities are 93.5% more likely to adopt coping strategies than their counterparts with limited or no access to credit facilities. This finding lends support to the assertion that credit access allows farm households to build assets, and spend in innovative agricultural practices and other off farm activities that give them stable foundation for coping with livelihood shocks (Bryan et al., 2011). Also, contact with extension agents was found to be statistically significant at 1%. The implication of the positive coefficient is that, farmers who have contact with extension agents are 41.1 % more likely to employ coping measures than those who do not have access to extension agents. Access to

84

extension services, particularly field visits, is a significant tool for motivating farmers to change and strengthen their resilience and capacity to manage agricultural production shocks arising from ASM operations. Furthermore, regular encounters between farmers and extension agents expose farmers to new farming technologies that can aid mitigate agricultural-related problems caused by ASM operations.

Distance to ASM Site was also found to be statistically significant at 1%. The positive coefficient is an indication that, 1km increase in distance to ASM site from residence increases the probability of adopting coping strategies by 36%. Contrary to the study's expectation, an increase in ASM activities by an additional year decreases the propensity of a farm household to adopt coping strategies by 14%.

Table 9 : Determinants of adoption of coping strategies on household consumption expenditure

Variables	TME1	OME0	OME1
AGE	0.0045	-111.4096**	-361.7354***
	(0.0087)	(60.2204)	(71.2312)
SEX	-0.5338***	3044.6000***	2673.2730***
	(0.1307)	(892.3288)	(1029.4630)
EDU	0.0505**	128.4600	65.9190
	(0.0223)	(100.9035)	(90.6789)
HHSIZE	0.2366***	1449.4400***	1278.2070***
	(0.0340)	(349.6138)	(383.6804)
CREDIT	0.9355***	-1365.3260	-1517.4120
	(0.1630)	(1709.9160)	(2017.4870)
FMSIZE	-0.0350	-269.7145	214.0879
	(0.0224)	(144.6978)	(201.6762)
FBO	0.0087	3029.0830**	1214.8800
	(0.1565)	(1085.5340)	(1108.3320)
FARM YRS	-0.0143	78.0866	204.0598***
	(0.0119)	(49.8121)	(58.5025)
ASM YRS	-0.1445***	240.2201	-209.6648
	(0.0199)	(252.6436)	(286.2724
DIST TO SITE	0.3683***	-----------	------------
	(0.0309)		
HH CONSU	2.18e-05***	0.0450	-0.0355
	(5.65e-06`)	(0.0443)	(0.0576
EXT QTY	0.1805***	-----------	------------
	(0.0559)		
CONSTANT	-1.0833*	1479.1520	18927.4700***
	(0.4108)	(4032.3880)	(3779.5250)
TEOM0_cons		-9796.2100**	
		(4041.3700)	
TEOM1_cons			919.9240
			(3220.6700)

Test of endogeneity: (1) [TEOM0]_cons = 0; (2) [TEOM1]_cons = 0; chi2(2) = 5.96*; Prob > chi2 = 0.0509

OM0 = Outcome Model 0; OM1 = Outcome Model 1;
OME0 = linear equation used to estimate the nontreated POM;
OME1 = linear equation used to estimate the treated POM
TME1 = determinants of adoption of at least three coping strategies
OME0 = factors influencing household consumption expenditure for non-adopters of at least
three coping strategies
OME1 = factors influencing household consumption expenditure for adopters of at least three
coping strategies

Source: Field Survey, 2021.   Note: *** p<0.01,   ** p<0.05,   * p<0.1

Table 10 : Determinants of adoption of coping strategies on Household Food Insecurity Score (HFIS).

Variables	TME1	OME0	OME1
AGE	0.0045	0.0365***	0.0882***
	(0.0087)	(0.0141)	(0.0222)
SEX	-0.5338***	-0.6437***	-0.3559
	(0.1307)	(0,1662)	(0.2264)
EDU	0.0505**	-0.0119	-0.0702***
	(0.0223)	(0.0275)	(0.0273)
HHSIZE	0.2366***	0.2363***	-0.1427
	(0.0340)	(0.0739)	(0.1080)
CREDIT	0.9355***	-1.1005**	-1.2309**
	(0.1630)	(0.3692)	(0.4357)
FMSIZE	-0.0350	0.0082	0.0224
	(0.0244)	(0.0346)	(0.0435)
FBO	0.0087	-0.4010*	-0.3339
	(0.1565)	(0.2423)	(0.2902)
FARM YRS	-0.0143	-0.0130	-0.0554**
	(0.0119)	(0.0099)	(0.0179)
ASM YRS	-0.1445***	-0.0091	0.3716***
	(0.0199)	(0.0490)	(0.0823)
DIST TO SITE	0.3683***	---------	------------
	(0.0309)		
HH CONSU.	2.18e-05***	16.8e-05**	2.94e-05*
	(5.65e-06)	(6.89e-06)	(1.11e-05)
EXT QTY	0.1805***	-----------	-----------
	(0.0559)		
CONSTANT	-1.0833*	7.3176***	3.2425**
	(0.4108)	(0.8510)	(1.0495)
TEOM0_cons		0.3420	
		(0.9883)	
TEOM1_cons			-1.9916*
			(0.7659)

Test of endogeneity: (1) [TEOM0]_cons = 0; (2) [TEOM1]_cons = 0; chi2(2) = 6.88**;
Prob > chi2 = 0.0320

OM0 = Outcome Model 0; OM1 = Outcome Model 1;

OME0 = linear equation used to estimate the nontreated POM;

OME1 = linear equation used to estimate the treated POM

TME1 = determinants of adoption of at least three coping strategies to negative effects of ASM

OME0 = factors influencing HFIS for non-adopters of at least three coping strategies

OME1 = factors influencing HFIS for adopters of at least three coping strategies

Source: Field Survey, 2021. Note: *** p<0.01, ** p<0.05, * p<0.1

With regards to OME0 and OME1 in Table 9, it is clear that, age, sex and household size are factors which significantly affect consumption expenditure of farm households who are both adopters and non-adopters of coping strategies. These variables (age, sex and household size) are statistically significant at 1% for both users and non-users of coping strategies. While FBO membership is statistically significant at 5% in the outcome model explaining the determinants of consumption expenditure of farm households who are non-adopters, farming experience is statistically significant at 1% level in influencing the consumption expenditure of adopters. The results in Table 8 show that sex and household size significantly and positively influence the consumption expenditure of both groups of farmers whilst the reverse is true for age.

From table 9, the coefficients for sex in OME0 and OME1 suggest that, males who are non-adopters of coping strategies attain GH₵3044.60 consumption expenditure more than their counterpart females compared to male adopters who attain GH₵2673.27 more than female adopters. Secondly, the coefficients for household size indicate that, an increase in household size by one person will increase the consumption expenditure of adopters and non-adopters by GH₵1,449 and GH₵1,278 respectively. Again, the coefficients for age imply that, as the age of the farm household increases by 1 year, consumption expenditure of non-adopters decreases by GH₵111.41 whilst that of adopters decreases by GH₵361.74

For farm households who are non-adopters, being a member of FBO increases consumption expenditure by GH₵1,085 but FBO membership has no significant effect on the consumption expenditure of adopters. Also, farming experience only has effect on the consumption expenditure of adopters. The positive coefficient implies that, engaging in farming activities by 1 more year increases the consumption expenditure of adopters by GH₵204.

With reference to OME0 and OME1 in Table 10, it can be seen that, age, access to credit and total household expenditure are factors which significantly affect the household food insecurity score of farm households who are both users and non-users of coping strategies. The age is statistically significant at 1% for both adopters and non-adopters whilst access to credit is statistically significant at 5% level for both adopters and non-adopters. For household's total expenditure, it is significant at 5% and 10% levels for non-adopters and adopters respectively.

Whist sex and FBO are statistically significant at 1% and 10% level in the outcome model explaining the determinants of HFIS of farm households who are non-adopters, education and ASM years are both statistically significant at 1% in influencing the HFIS of adopters. It is worth mentioning that, number of years in farming is statistically significant at 5% level in influencing the HFIS level of only adopters.

The coefficients for age in OME0 and OME1 in table 9 suggest that, an increase in age of a farm household by 1 year raises HFIS by 0.0365 points for non-adopters and 0.088 points for adopters. The implication is that, age has adverse impacts on food security of farm households.

Access to credit improves the food security level of both adopters and non-adopters. Specifically, access to credit decreases HFIS of both adopters and non-adopters by 1.101 and 1.23 points respectively. Household total expenditure has adverse effects on food security status of farm households who are adopters and non-adopters. An increase in household spending by Gh₵1.00 increases HFIS by 16.8e-05 points for non-adopters and 2.94e-94e-05 points for adopters.

Being a male as well as a member of FBO improve food security of non-adopters of coping strategies by decreasing HFIS by 0.644 points and 0.401 points respectively. Similarly, household size negatively affects the food security status of non-adopters by raising the HFIS by 0.236 points.

On the other hand, education and farming experience improve the food security status of farm households who are adopters by decreasing HFIS by 0.070 points and 0.055 points respectively. However, years of ASM existence in the community worsens food security of farm households by increasing the HFIS by 0.371 points.

Table 11 shows the actual effects of coping strategies adoption on household consumption expenditure. The average treatment effect on the treated (ATET) for the adoption of two coping strategies reveals substantial difference in consumption expenditure between adopters and non-adopters. The positive sign of the ATET aligns well with the study's expectation. According to the results, households that adopted two coping strategies have Gh₵7,989.0120 higher consumption expenditure relative to their counterparts who did not adopt two coping strategies at 5% significance level. This suggests that the adoption of two coping strategies improves the welfare level of adopters compared to non-adopters. This finding is in agreement with Carlos Andres Alpizar (2007) and Martina et al. (2016) who found comparatively high per capita consumption among households who adopted coping strategies against livelihood shocks. The potential outcome mean reflects the welfare effect of all farmers adopting two copping strategies. The potential outcome mean value of Gh₵6,852.17 implies that if all farmers were to adopt two coping strategies, they would have *ceteris paribus*, an average consumption expenditure of Gh₵6,852.17.

Regarding the adoption of at least three coping strategies, the results reveal that there is no significant difference in the consumption expenditure of households that adopted and their counterparts who are non-adopters as indicated by the ATET. However, the potential outcome mean was found to be significant at 1% significant level. This suggests that if all farmers were to adopt at least three coping strategies, they would have a mean consumption expenditure of Gh₵11620.07.

90

With regards to the effects of adoption of the individual coping strategies, the results reveal significant difference in the consumption expenditure of households that adopted only land reclamation and social networking. The ATET and the POM for the adoption of only land reclamation are positive and significant at 10% and 1% level respectively. The implication is that, households that adopted land reclamation obtained an average of Gh₵452.8376 higher than their counterparts who did not used land reclamation as a coping strategy. This revelation is intuitively apt as land reclamation has the potential of making once degraded lands fertile and available for production of more goods by farm households. It is also important to note that, all households in the study area would have attained a consumption expenditure of Gh₵15303.3100 if they had used land reclamation as a coping strategy. For the adoption of social networking, the ATET is positively signed and significant at 5% and 10% levels respectively. The ATET result suggests that, households that relied on social networking as a coping strategy obtained an average of Gh₵1442.8280 higher than their counterparts who did not used this strategy whilst all households in the study area would have achieved an average consumption expenditure of Gh₵13520.06 if they had resorted to social networking as a coping strategy. The ATET result for the social networking reflects the premise on which many groups and other social supports are established to provide either financial and other support for members in times of need.

Again, the results in table 11 further reveal no significant difference in the consumption expenditure of households that adopted only borrowing of food and only re-settlement and their counterparts who did not adopt any of these strategies as indicated by the ATET. Notwithstanding this, the potential outcome mean for the adoption of each of these single strategies were found to be statistically significant. At 1% significance level, if all households had adopted only borrowing of food, they would have attained an average consumption expenditure of Gh₵13,365.85 whilst at

91

5% significance level, all households would have attained an average consumption expenditure of Gh₵8949.6380 if they had migrated to settle in another community.

Furthermore, significant negative ATET was obtained for the adoption of only diversification and adoption of only dependence on market for food. With regards to diversification strategies, the negative value indicates that, households that adopted income diversification strategies have significantly lower consumption expenditure and that, non-adopters achieved an average of Gh₵3,762.31 higher than adopters, implying that, non-adopters are better off than adopters in terms of welfare. This finding is similar to the finding of Guloba et al. (2014) who reported decrease in welfare by households who increased savings in times of livelihood shock in Uganda. Intuitively, the possible reason for the negative coefficient of the ATET for diversification could be that pro-business households may divert funds meant for household consumption into businesses. In addition, returns on income diversification activities may not be channeled directly into household consumption but may be ploughed back into business. Regarding the potential outcome mean, the result points to the indication that at 10% significance level, if all households were to adopt only diversification activities, they would have achieved a consumption expenditure of Gh₵17,891.52.

Moreover, the results in Table 11 show that the ATET and potential outcome mean for reliance on market as a copping strategy are negatively and positively signed respectively. In the first place, the ATET shows that farmers who rely on market for food have significant lower consumption expenditure than adopters at 1% significant level. Specifically, non-adopters of this strategy attained an average consumption expenditure of Gh₵9,726.7220 higher than adopters suggesting a better welfare level for non-adopters than adopters. This finding supports the observation made by Dercon (2005) that, adoption of coping mechanisms might have negative repercussions if they

92

destroy or reduce a household's physical, financial, human, or social capital and increase their likelihood of falling into poverty and putting them vulnerable to future challenges. Also, at 10% level of significance, the potential outcome mean value indicates that if all farmers were to rely on the market for food, they would have obtained a consumption expenditure of Gh₵25,323.53.

Table 11: Effects of Coping Strategies Adoption on Household Consumption Expenditure

COPING STRATEGIES	SAMPLE		ATET	PO Means	TEOM0_cons	TEOM1_cons
	Treatment	Control				
Two Coping Strategies	152	164	7989.0120** (3498.4850)	6852.1730** (3448.7760)	-9796.2100** (4041.3700)	919.9240 (3220.6700)
At Least Three Coping Strategies	50	266	2218.7910 (2871.2680)	11620.0700*** (2794.6000)	-4667.610 (2914.388)	-5957.0190 (4303.3430)
Only Land Reclamation	98	218	452.8376* (3045.7980)	15303.3100*** (3010.6970)	2427.8570 (3081.5980)	-9985.6720 (8520.2280)
Only Resettlement	92	224	5271.4710 (3967.7710)	8949.6380** (3923.8920)	-7962.8340** (4005.9030)	-974.7140 (2277.2940)
Only Diversification	114	202	-3762.3110* (2157.9530)	17891.5200* (2061.2480)	2447.0650 (2511.5210)	-4481.1150 (6539.4070)
Only Dep. On Mkt For Food	96	220	-9726.7220*** (3297.0520)	25323.5300* (3135.1740)	11485.3400*** (3311.4280)	-3153.9530 (10275.2200)
Only Social Networking	108	208	1442.8280** (9673.5990)	13520.06* (7659.684)	-953.3328 (7833.6770)	-12438.6500 (11355.4700)
Only Borrowing of Food	98	218	325.7859 (4865.7060)	13365.8500*** (4856.9950)	-4170.4420 (5157.9480)	-2381.9760 (4899.8790)

Source: Field Survey, 2021.   Note: *** p<0.01,   ** p<0.05,   * p<0.1

93

Table 12: Effects of Coping Strategies Adoption on Household Food Insecurity Score (HFIS)

COPING STRATEGIES	SAMPLE		ATET	PO Means	TEOM0_cons	TEOM1_cons
	Treatment	Control				
Two Coping Strategies	152	164	-0.5280** (0.9363)	7.5280*** (0.9300)	0.3420 (0.9883)	-1.9916*** (0.7659)
At Least Three Coping Strategies	50	266	2.3517* (1.2038)	5.3683*** (1.1573)	-1.5489 (1.2389)	1.4392 (1.0490)
Only Land Reclamation	98	218	-2.3887* (1.2332)	-5.4481*** (1.2195)	-2.1097* (1.2764)	-3.6750** (1.4361)
Only Resettlement/ Out-Migration	92	224	0.8455 (0.8459)	6.5458*** (0.8423)	-0.4543 (0.8756)	-0.6685 (0.7041)
Only Diversification	114	202	2.8298*** (0.6853)	4.2930*** (0.6460)	-2.3775*** (0.7199)	-2.8009** (1.3061)
Only Dep. On Mkt For Food	96	220	-0.8424 (0.8869)	7.4674*** (0.8658)	0.5416 (0.9665)	8.7203*** (2.5914)
Only Social Networking	108	208	-6.5889*** (1.6108)	0.7630 (1.5211)	-6.7711*** (1.5294)	-14.8596* (4.1385)
Only Borrowing of Food	98	218	-4.6311*** (0.8453)	11.0189*** (0.7362)	4.2419*** (0.8086)	4.7381 (2.9026)

Source: Field Survey, 2021.   Note: *** p<0.01,   ** p<0.05,   * p<0.1

Table 12 shows the actual effect of adoption of coping strategies on Household Food Insecurity Score (HFIS). With regards to the adoption of two coping strategies, the ATET was negative and significant at 5% level. The implication is that, households that adopted two coping strategies were less food insecure compared non-adopters of at least two coping strategies. Technically, the adopters of two coping strategies are 0.5280 less food insecure compared to their counterparts who did not adopt two coping strategies. This finding is similar to the finding of Demeke et al. (2011) who reported an improved food security for households who adopted coping strategies against rainfall shock in rural Ethiopia. Similarly, POM was found to be significant at 1% level and

94

positively signed. This suggests that, if all households were to adopt at least two coping strategies, they would have had an average HFIS of 7.53, ceteris paribus. The positive coefficient value for the POM suggests a deterioration in the food insecurity status of households.

For adoption of at least three coping strategies, the ATET and potential outcome mean are positively signed and significant at 10% and 1% levels respectively. The positive coefficient of the ATET implies that, adopting at least three coping strategies increases food insecurity level of adopters by 2.35 suggesting further that, non-adopters of at least three coping strategies are better off in terms of food insecurity. With food insecurity level as a welfare indicator, this finding supports Guloba et al. (2014) who reported that, the aggregated coping strategies used by households in times of livelihood shocks decrease welfare by 31.3% and 15.9% respectively. Similarly, the POM implies that, if all households were to adopt at least three coping strategies, they would have had an average HFIS of 5.637. Looking at the POM of two coping strategies and at least three coping strategies, it is clear that the HIFS values found are relatively high. The high values can be attributed to the complexities faced by households in managing several strategies in times of shocks.

The results in table 12 reveal negative significant effect of adoption of land reclamation, dependence on market for food and borrowing. For land reclamation, the HFIS of -2.3887 for ATET implies that, adopting only land reclamation as a coping strategy reduces food insecurity level of households by 2.3887 which is an indication that, adopters of this strategy are better off than non-adopters in terms of food insecurity. Intuitively, land reclamation ensures availability of additional land for farming purposes which consequently can have positive effect on crop production and hence availability of food for consumption. The POM of HFIS for land reclamation is -5.45 and it is highly statistically significant at 1%. This potential outcome mean value implies

95

that if all farmers were to adopt only land reclamation, they would have obtained HFIS of -5.45 suggesting an improved food security status of all adopters. The coefficients of both ATET and POM indicate that, adoption of land reclamation decreases food insecurity level of households. This finding is in conformity with the initial expectation of the study considering the fact that land reclamation has the potential of turning waste lands in the mining areas into productive lands for food crop production.

Also, the ATET is negative and highly significant at 1% level for borrowing suggesting that, adopters of this strategy are -4.6311 less food insecure than non-adopters. Technically, this implies that, borrowing reduces the food insecurity status of adopters. This can be attributed to the fact that, borrowing enables households with food deficits to obtain food from friends, neigbours and relatives thereby ensuring availability of food for consumption. The POM however indicates that, all households would have experienced deterioration in their food security if they had used borrowing as a strategy.

Again, negative coefficient of ATET for the adoption of only social networking suggests that adopters of this strategy have significantly lower HFIS than their counterparts who are non-adopters of this strategy. In other words, the difference between the HFIS of adopters of only social networking and non-adopters is -6.59 and this indicates that, non-adopters are 6.59 more food insecure than adopters. This conforms with the initial hypothesis as social networks enable households to obtain cash and non-cash support from other people through social connections that they have established hence increasing their chances of having access to food from the market or loved ones in times of crises.

With regards to the effect of the adoption of diversification on HFIS, the coefficients of the ATET and the potential outcome mean are positive and highly significant at 1% level respectively. The

96

HFIS of 2.83 for ATET implies that, adopting only diversification increases food insecurity level of households by 2.83. This suggests that, adopters of this strategy are more food insecure compared to non-adopters. This could be attributed to the possibility of households diverting income that could be used to acquired more food for consumption into carrying out business activities with the hope of achieving stable income and consumption in future. The potential outcome mean value implies that if all farmers were to adopt only diversification, they would have had HFIS of 4.29.

The results in table 12 reveal no significant difference between adopters and non-adopters of only resettlement as well as only dependence on market for food as coping strategies. However, the potential outcome mean for these two single strategies are positive and significant at 1% level. The potential outcome mean value for adopting only resettlement shows that if all farmers had adopted resettlement as a coping strategy, they would have had HFIS of 6.55. By implication, there would be increase in food insecurity level if all households had adopted only resettlement. Similarly, the potential outcome mean value for adopting only dependence on market for food implies that if all farmers were to resort to dependence on market for their food, they would have obtained HFIS of 7.47. To sum up thought, adoption of only resettlement or adoption of only dependence on market for food by households is associated with deterioration in the food insecurity level of households

97

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATION

5.1 Introduction

This chapter contains a summary of the study's most important findings. Conclusions are drawn based on the key results, followed by policy recommendations as well as suggestions for future research.

5.2 Summary of Key Findings

The principal objective was to investigate farmers' perceptions of ASM effects, as well as the adoption of coping strategies and their drivers, and how these coping strategies affect farm household welfare in the Asutifi North District.

The data for the study was gathered from 316 farm households who were interviewed in person through the use of a semi-structured questionnaires. Farmers' demographic and socioeconomic characteristics as well as their perceptions of ASM's effects were investigated using descriptive statistics. The drivers of coping strategy adoption were assessed using a multivariate probit model, while the impact of coping strategy adoption on farm household welfare was assessed using an endogenous treatment effect model.

The results on the farm households' perceptions on the effects of ASM show that most of the farm households perceived ASM to have more negative effects on their welfare compared to the positive effects. Specifically, majority of the farm households interviewed reported either high or moderate deterioration in food consumption, food security, crop production, animal production, availability of farm labour, access to potable water, housing conditions, health conditions, education of

children, access to land, access to game, fruit and firewood. Employment and income were however found to be the only welfare indicators that witnessed moderate improvement by farm households in the research area.

On coping strategies adoption, majority (75%) of the respondents adopted a mix of coping techniques to counteract the negative effects of ASM. The highest adopted strategy was diversification or petty trading (36.08%), followed by social networking (34.18%), land reclamation and borrowing (31.01%), dependence on market for food (30.38%) and finally resettlement to a different community (29.11%). Farm households in the study area either used the above coping strategies as compliments or substitutes according to the result from the correlation matrix. With regard to the intensity of adoption, majority of the sampled households (32.28%) adopted two of the coping strategies at the same, followed by 26.58 of the respondents who adopted three of the coping strategies as well as 24.68 of the respondents who adopted none of the coping strategies.

The results from the multivariate probit model indicate that, the explanatory variables have some degree of influence on the adoption of various coping strategies. Firstly, older persons have lower probability of adopting land reclamation, resettlement and borrowing whilst being a male decreases the probability of adopting diversification and social networking as coping strategies. Secondly, educated households are less likely to use land reclamation and more likely to resort to resettlement and borrowing whilst household size positively affects the likelihood of adopting land reclamation, resettlement and social networking. Thirdly, credit access positively affects the usage of diversification, dependence on market for food and borrowing as coping strategies whilst being a membership of FBO increases the likelihood of using social networking but decreases the probability of resorting to borrowing. Also, a larger farm size is negatively linked to the use of

land reclamation, dependence on market for food, social networking but positively correlated with resettlement. Again, farming experience raises the chances of using land reclamation but decreases the likelihood of using resettlement and diversification as coping strategies. Furthermore, total household income is positively linked to a higher likelihood of using land reclamation, resettlement, diversification and dependence on market for food whilst years of ASM existence is negatively correlated with the use of land reclamation, resettlement, dependence on market for food and social networking but positively associated with borrowing. Moreover, distance from residence to ASM site has positive influence on the usage of land reclamation, diversification and dependence on market for food but is negatively associated with farm households resorting to borrowing. Finally, total household expenditure is positively correlated with the use of land reclamation, resettlement and social networking whilst access to extension service has negative influence on the usage of diversification but positive influence on the usage of borrowing as coping strategies.

5.3 Conclusions

Based on the findings of this study, the following conclusions are drawn.

- ASM on one side has serious negative implications on the welfare indicators such as food security, food consumption, health conditions, housing conditions, land availability, access to potable drinking water, children education among others on farm households in the study area.

- ASM on another side has positive implications on the welfare indicators such as employment generation and income of farm households living in mining areas, mainly through direct participation, receipt of compensation and boost in business activities in the study area.

100

- Majority of the respondents (75%) in the research area adopted coping techniques as compliments or substitutes to minimize the adverse impacts of ASM on welfare indicators of farm households in the research area.

- Majority of the respondents (58.58%) adopted two or three of the coping strategies at the same time to deal with the negative effects of ASM in the study area.

- All the explanatory variables such as credit access, access to extension services, membership of FBO among others included in the MVP model have different magnitude and direction of significance in influencing the usage of the various coping strategies against the negative effects of ASM in the study area.

- The adoption of two coping strategies by farm households in the study area has positive effect on welfare (Consumption Expenditure and Household Food Insecurity Status) whilst adoption of at least three coping strategies by households has negative effect on welfare.

- Using only diversification or only dependence on market for food negatively affect the welfare of farm households (Consumption Expenditure and Household Food Insecurity Status) in the study area whilst the use of land reclamation, social networking and borrowing have positive effect on welfare.

5.4 Recommendation

Based on the findings of this study, the following recommendations are given.

- Efforts should be made to encourage farmers to create cooperatives and farmer-based organizations to aid in the transmission of information about the benefits of coping methods

and to improve access to shared resources that farm households can utilize to cope with ASM-induced shocks. To this end, strengthening supportive social foundations might help vulnerable farm households in mining areas diversify their activities together, especially where social capital is more easily available than financial capital.

- Credit should be provided on priority basis by NGOs, financial institutions and government to farm households in mining communities in order to enhance their capacity to effectively cope with ASM induced shocks and diversify their income to reduce vulnerability. Since resource constraints constitute one major reason for non adoption of coping strategies in the study area, specific policies aimed at overcoming resource limits could result in widespread adoption of appropriate methods capable of enabling farm households to effectively adapt to ASM and its accompanying livelihood shocks.

- Government, through the Ministry of Lands and Natural Resources, should consider fully incorporating land reclamation measures into the sector's policies to promote sustainable food production and thus food security in mining areas. Although this approach may appear to be expensive in the near term, it will lessen household vulnerability in the long run by boosting farm households' access to land.

- Interventions by government and NGOs aimed at enhancing the welfare of farm households in mining communities should target providing alternative livelihood training that can ensure significant participation in off-farm economic activities as this will help farm household to generate off farm income to mitigate some of the shocks created by ASM.

- Government should make more effort to expand the coverage of planting for food and job program in the study area. With only 32% of farm households participating in PFJ in the study area, a larger coverage will certainly help to increase food production through improved access to subsidized fertilizer and improved seeds in the area which in turns can go a long way to improve the welfare indicators of households especially food security, income and employment.

- Further study investigating the effects of coping strategies adoption against ASM induced shocks in mining districts in Ghana and elsewhere, utilizing various welfare proxies and estimating methodologies as well as panel data to investigate the long-term effect, should be carried out. Additionally, further research could look at the impact of households' participation or non-participation in ASM value chains on the welfare of households in mining areas.

REFERENCES

Agyei-Manu, K., Nimoh, F., Owusu-Peprah, M,. Kyeremateng, B. G. (2020). Cocoa farmers' choice of alternative livelihood in mining communities in Upper Denkyira West District, Ghana. *Journal of Development and Agricultural Economics, 12 (13), 181-197.*

Agresti, A. and Finlay, B. (2009). Statistical Methods for the Social Sciences. 4th Edition. John Wiley and Sons. New York

Akabzaa, T. M. (2000). Boom and Dislocation. The Environmental and Social Impacts of Mining in the Wassa West District of Ghana. *Third World Network Africa, Accra.*

Amoah, B.A., (2003). Proliferation of Surface Mining in Ghana: A Threat or a Blessing to the Poor in the Mining areas? A Case Study of Tarkwa Mining Area. *An MSc. Thesis, Lund. Sweden.*

Amponsah-Tawiah, K. & Dartey-Baah, K. (2011). The Mining Industry in Ghana: A Blessing or a Curse. Accra – Ghana, West Africa. University of Ghana Business School: *An International Journal of Business and Social Science 2(12), 62 – 69.*

Aragón, F. M. & Rud, J. P. (2015). Polluting Industries and Agricultural Productivity: Evidence from Mining in Ghana. *The Economic Journal, 126 (597), 1980-2011.*

Aragon, F. M., Chuhan-Pole, P., & Land, B. C. (2015). The Local Economic Impacts of Resource Abundance: What Have We Learned?. *World Bank Policy Research Working Paper, (7263).*

Armah, E. (2013). The impacts of small-scale gold mining on some water quality parameters of

Asutifi North District Assembly (2019). Composite Budget for 2019 – 2022 : A Programme Based Budget Estimates for 2019.

Asfaw, S., Shiferaw, B., Simtowe, F. and Lipper, L. (2012). Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. *Food Policy, Vol. 37 (3). 283–295.*

Asfaw, S., Scognamillo, A., Di Caprera, G., Sitko, N., & Ignaciuk, A. (2019). Heterogeneous impact of livelihood diversification on household welfare: Cross-country evidence from Sub-Saharan Africa. *World Development*, *117 (2019), 278-295.*

Banchirigah, S.M., Hilson, G., (2010). De-agrarianization, re-agrarianization and local economic development : Re-orientating livelihoods in African artisanal mining communities. *Pol. Sci. 43 (2), 157–180.*

Banchirigah, S., M. (2008). Challenges with eradicating illegal mining in Ghana : A perspective from the grassroot. *Resources Policy, 33 (2008), 29–38*

Barreto, M.L., Schien, P., Hinton, J., and Hruschka, F., (2018). Understanding the Economic Contributions of Artisanal and Small-Scale Mining in Rwanda : Tin, Tantalum, and Tungsten. *East Africa Research Fund, UK Department for International Development.*

104

Barreto, M.L. (2016): Understanding the Economic Contribution of Small-scale Mining in East Africa. Project Inception Report: Introduction and Project Overview. Pact and ARM on behalf of DFID. Westcombe (UK) and Envigado (CO).

Bedeke, S.B. (2012). Food Insecurity and Copping Strategies: A perspective from Kersa District, East Hararghe Ethiopia. *Food Science and Quality Management. 5 (3), 19-27*.

Beegle, K, R. Dehejia, and Gatti, R. (2006). Child Labour, Crop Shocks, and Credit Constraints. *Journal of Development Economics, 81(1), 80-96*

Bryan, E., (2013). Climate Shocks and Coping and Adaptation Strategies in Ethiopia: An Analysis Based on Household Survey Data. *Journal of Rural Studies, 44 (22), 123 – 131*.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S. and Herrero, M. (2011). Coping with livelihood shocks in Kenya: Household and Community Strategies and Determinants. *Journal of Agricultural Sciences, 9 (7), 804 – 823*.

Boateng, A. (2017). Rethinking alternative livelihood projects for women of the pits: The case of Atiwa. *Academic Journal of Interdisciplinary Studies 6 (2), 17 - 25*

Boateng, O., Codjoe, F. and Ofori, J. (2014). Impact of illegal small-scale mining (galamsey) on cocoa production in Atiwa District of Ghana. *International Journal of Advance Agriculture, 2 (6), 89-99*.

Bryceson, D.F. and Jamal, V. (2019). Farewell to Farms : De-agrarianization and Employment in Africa. Routledge, UK. Caliendo.

Carvalho, F. (2017). Mining industry and sustainable development: Time for change. *Food and Energy Security, 6 (2) : 61-77*,

Carlos Andres Alpizar, M.A. (2007). Risk coping strategies and rural household production efficiency : Quasi-experimental evidence from El-salvador. *A Ph.D dissertation presented to the Graduate School of the Ohio State University.*

Chachage, C. S. L. (1995). The Meek shall Inherit the Earth but not the Mining Rights: The Mining Industry and Accumulation in Tanzania in Peter Gibbon (ed), *Liberalized Development in Tanzania: Studies on Accumulation Processes and Local Institutions, SIAS, Uppsala.*

Chuhan-Pole, P., & Land, B. C. (2015). The Local Economic Impacts of Resource Abundance: What Have We Learned?. *World Bank Policy Research Working Paper, (7263).*

Citro, C. F. and Michael, R. T. (1995). Measuring Poverty: A New Approach. *Washington, DC: National Academy Press.*

Creswell, J. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research (4thed.). Upper Saddle River, NJ: Pearson Education.

Creswell, J. (2015). A concise introduction to mixed methods research. Thousand Oaks, CA: Sage.

Deaton, A. (2005). Franco Modigliani and the Life Cycle Theory of Consumption. Research Program in Development Studies and Center for Health and Wellbeing. *Available at https://doi.org/10.2139/ssrn.686475*

Deaton, A. and S. Zaidi, S. (2002). Guidelines for Constructing Consumption Aggregates for Welfare Analysis, *World Bank LSMS Working Paper* 135.

Demeke, A. B., Keil, A. & Zeller, M. (2011). Using panel data to estimate the effect of rainfall shocks on smallholder's food security and vulnerability in rural Ethiopia. *Climatic Change, 108 (2), 185-206.*

Dercon, S. (2005). Risk, Vulnerability and Poverty in Africa. *Journal of African Economies*, *14(4), 483-488.*

Dercon, S. and Hoddinott, J. (2003). Health, Shocks and Poverty Persistence. *WIDER Discussion Paper, No. 2003 (08).*

Dercon, S. (2002). Income Risk, Coping Strategies and Safety Nets. *World Bank Research Observer*, *17(2), 141-166.*

Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf, M. (2008). Analysis of the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia. *International Food Policy Research Institute: Washington, DC.*

Deressa, T. T., Ringler, C., & Hassan, R. M. (2010). Factors affecting the choices of coping strategies for climate extremes. *The case of farmers in the Nile Basin of Ethiopia IFPRI Discussion Paper*, *1032.*

De Haan, L. J. (2012). The Livelihood Approach: A critical exploration. *Erdkunde, 66 (4), 345-357.*

Di Falco, S. and Chavas, J. P. (2009). On crop biodiversity, risk exposure and food security in the highlands of Ethiopia. *American Journal of Agricultural Economics 91 (20), 599–611.*

Di Falco, S. and Veronesi, M. (2013). How Can African Agriculture Adapt To Climate Change? A counterfactual Analysis from Ethiopia. *Land Economics, 89 (15), 743-766.*

Doss, C., Deere, A. D., Oduro, J, Y., Lahoti, W., Suchitra J. Y., Baah-Boateng, W. (2011). The Gender Asset and Gender Wealth Gaps: Evidence from Ecuador, Ghana and Karnataka. *Indian Institute of Management, Bangalore, India.*

Duncan, E.E. (2009). Open Pit Mining and Land Use Changes: An Example from Bogosu-Prestea Area, Southwest Ghana. *The Electronic Journal of Information Systems in Developing Countries, 36 (3), 1-10*

Eriksen, S.H., Brown, K. and Kelly, P.M. (2005). The Dynamics of Vulnerability: Locating Coping Strategies in Kenya and Tanzania. *The Geographical Journal, 171 (8), 287-305.*

Farid, K., Tanny, N. Z., & Sarma, P. K. (2015). Factors affecting adoption of improved farm practices by the farmers of Northen Bangladesh. *Journal of Bangladesh Agril. University, 13(2), 291-298.*

Filmer, D. and Pritchett, L.H. (2001). Estimating Wealth Effect Without Expenditure Data or Tears: An application to educational enrollments in states of India. *The Demography, 38 (1), 115-32.*

Fisher, M. J., & Marshall, A. P. (2009). Understanding descriptive statistics. *Australian Critical Care*, *22(2), 93-97.*

Franks, D. M., Ngonze, C., Pakoun, L., & Hailu, D. (2020). Voices of artisanal and small-scale mining, visions of the future: Report from the International Conference on Artisanal and Small-scale Mining and Quarrying. *The Extractive Industries and Society*, *7 (2), 505 -511.*

Ghana Chamber of Mines (2020). Performance of the Mining Industry in Ghana : *Annual Report 2014.*

Ghana Statistical Service (2019). Ghana Living Standards Survey Round 7 (GLSS 7). Main Report. Accra, Ghana.

Greene, W.H. (2008). Econometric Analysis, 6th Edition. New Jersey: Prentice Hall.

Guloba, M. Lokina, R. & Hisali, E. (2014). Impact of adaptation to covariate shocks on household welfare: evidence from panel survey data in Uganda. *Tanzania Economic Review, 11 (1), 90 -114.*

Gomes, R. (2003). An Empirical Analysis of Household Coping Strategies in CEARA, Brazil. *Master's Thesis, Department of Agriculture and Resource Economics, University of Arizona.*

Gyamfi, O., Sorenson, P. B., Darko, G., Ansah, E., & Bak, J. L. (2020). Human health risk assessment of exposure to indoor mercury vapour in a Ghanaian artisanal small-scale gold mining community. *Chemosphere*, *241 (12), 310 - 325.*

Hair Jr, J. F. (2006). Successful Strategies for Teaching Multivariate Statistics. In Proceedings of the 7th International Conference on Teaching Statistics.

Haslam McKenzie, F. and Rowley, S. (2013). Housing Studies and Housing Market Failure in a Booming Economy. *Journal of Housing Studies, 28 (3), 68 – 80.*

Heemskerk, M. (2003). Risk altitudes and mitigation among miners and other in the Suriname rainforest. *Journal of Natural Recourses Forum. 27(4),* 1 - 12.

107

Heltberg, R. and Lund, N. (2009). Shocks, Coping and Outcomes for Pakistan's Poor: Health Risks Predominate." *Journal of Development Studies*, *45 (6), 864-888.*

Hilson, G. (2016). Farming, small-scale mining and rural livelihoods in Sub-Saharan Africa: A critical overview. *Extract. Indus. Soc. 3 (2), 547–563.*

Hilson, G. (2019). Why is there a large-scale mining 'bias' in sub-Saharan Africa? *Land Use Pol. 81 (6), 852–861.*

Hilson, G. (2020). The "Zambia Model': a blueprint for formalizing artisanal and small-scale mining in sub-Saharan Africa. *Resource. Pol. 68, 101765.*

Hilson, G. and Garforth, C. (2012). Agricultural poverty and the expansion of artisanal mining in sub-Saharan Africa: experiences from South West Mali and South East Ghana. *Popul. Res. Pol. 31 (8), 435–464.*

Hilson, G. and Garforth, C. (2013). Everyone now is concentrating on the mining: drivers and implications of rural economic transition in the Eastern Region of Ghana. *J. Dev. Stud. 49 (3), 348–364.*

Hilson, G. and Maconachie, R. (2020). Entrepreneurship and innovation in Africa's artisanal and small-scale mining sector: developments and trajectories. *Journal of Rural Studies. 78 (4), 149–162.*

Hilson, G. M. (2003). The Socio-Economic Impacts of Artisan and Small-Scale Mining in Developing Countries. London: Taylor and Francis Group Company.

Hilson, G., Amankwah, R. and Ofori-Sarpong, G. (2013). Going for gold: Transitional livelihoods in Northern Ghana. *J. Mod. Afr. Stud. 51 (1), 109–137.*

Hilson, G., Maconachie, R., McQuilken, J. and Goumandakoye, H. (2017). Artisanal and small-scale mining (ASM) in sub-Saharan Africa: Re-conceptualizing formalization and 'illegal' activity. *Geoforum, 83 (2), 80–90.*

Hilson, G. and McQuilken, J. (2014). "Four decades of support for artisanal and small-scale mining in sub- Saharan Africa: a critical review." *The Extractive Industries and Society, 1(1), 104– 118.*

Hilson, G. (2009). Small-scale Mining, Poverty and Economic Development in Sub- Saharan Africa: An Overview. *Resources Policy, 34 (2), 1–17.*

Hilson, G. (2001). A contextual review of the Ghanaian small-scale mining industry. *International Institute for Environment and Development, London.*

Hilson, G. (2006). The socio-economic impacts of artisanal and small-scale mining in developing countries. A A Balkema Publishers, Lisse.

Hinton, J. (2006). Communities and Small-scale Mining: An Integrated Review for Development Planning. *Communities and Small-scale Mining (CASM), Washington DC.*

Hoddinott, J. (2006). Shocks and their consequences across and within households in rural Zimbabwe. *Journal of Development Studies*, *42(2), 301-321*

Howe, L.D., Hargreaves, J.R., Ploubidis, G.B., De Stavola B.L. and Huttly, S.R. (2010). Subjective Measures of Socio-economic Position and the Wealth Index: A comparative analysis. *Health Policy and Planning* May;26(3):223-32.

ILO (2003). Household income and expenditure statistics. *Report prepared for the 'Seventeenth International Conference of Labour Statisticians, Geneva, 24 November-3 December 2003.*

Isung, C.B., Salifu, Y. and Agana, T.A. (2021). The Socio-Economic Implications of Artisanal and Small-Scale Mining on Mining Communities in Northern Ghana. *Open Access Library Journal, 8 (3), 1-17.*

ICMM (2020). Mining and Biodiversity: A Collection of Case Studies. *International Council on Mining and Metals, London, UK.*

Ivanova, G., Rolfe, J. and Lockie, S. (2007). Social and Economic Issues Associated with the Bowen Basin Coal Industry: Community Engagement to Reduce Conflict Over Mine Operations. *Australian Journal of Regional Studies, 13(2), 80 – 105.*

Lawal, J.O. (2016). Shocks and Welfare Transitions among Cocoa Farming Households in South-West, Nigeria**.** *An Unpublished Ph.D. thesis submitted to the Department of Agricultural Economics in-partial fulfilment of requirement for the award of Ph.D. Degree at University of Ibadan.*

Lippert, A. (2014). Spill-Overs of a Resource Boom: Evidence from Zambian Copper Mines. *Oxford Centre for the Analysis of Resource Rich Economies, University of Oxford, UK.*

Lwakatare, S. (1993). Small Scale Mining in Tanzania: Study on Institutional Framework. UNDP Project No. URT/90/020, Ministry of Water, Energy and Minerals, Dar es Salaam, Tanzania.

Kassie, M., Shiferaw, B. and Muricho, G. (2011). Agricultural Technology, Crop Income and Poverty Alleviation in Uganda. *World Development, 39 (2), 75 – 90.*

Kelly, J.T.D. (2014). This mine has become our farmland: critical perspectives on the co-evolution of artisanal mining and conflict in the Democratic Republic of the Congo. *Res. Pol. 40 (5), 100–108.*

Kitula, A. G. N. (2006). The environmental and socio-economic impacts of mining on local livelihoods in Tanzania: A Case Study of Geita District. Morogoro-Tanzania. *Journal of Cleaner Production 14(5), 405-414.*

Kusimi J. (2007). Groundwater Hydro-geochemistry and Land Cover Change in The Wassa West District of Ghana. Royal Institute of Technology, Sweden.

Mabe, F. N., Owusu-Sekyere, E., & Adeosun, O. T. (2021). Livelihood coping strategies among displaced small-scale miners in Ghana. *Resources Policy*, *74*, *102291.*

Martey, E., Al-hassan, R. M. and Kuwornu, J. K. M. (2012). Commercialization of smallholder agriculture in Ghana. A Tobit regression analysis. *African Journal of Agricultural Research, 7(14), 2131–2141.*

Martina, B., Smale, M., and Di Falco, S. (2016). Climate, Shocks, Weather and Maize Intensification Decisions in Rural Kenya. *FOODSECURE Working paper no. 39.*

McPeak, J. (2004). Contrasting Income Shocks with Asset Shocks: Livestock Sales in Northern Kenya. *Oxford Economic Papers, 56 (20), 263-284.*

McQuilken, J., and La Salvia, T (2019). Artisanal and Small-scale Mining Hidden economies and the 'leave no one behind' agenda. *Pact Briefing Note.*

McQuilken, J., and Hilson, G., (2016). Towards Inclusive Formalization of ASM in Ghana: Background Research for an Action Dialogue. *International Institute of Environment and Development, London.*

McFadden, D. L. (1978). Conditional Logit Analysis of Qualitative Choice Behavior: Frontiers of econometrics. *Newyork: Academic Press. 105-142.*

Montgomery, M., Gragnolati, M., Burke, K. and Paredes, E. (2000). Measuring Living Standards with Proxy Variables, *Demography, 37 (2), 155-174.*

Murata, A and Miyazak, S. (2014). Ex-post Risk Management Among Rural Filipino Farm Households. *JICA Research Institute, JICA-RI Working Paper. No. 67*

Moser, C. (1998). The Asset Vulnerability Framework: Reassessing urban poverty reduction strategies.' *World Development, 26 (1), 1-19.*

Ndiritu, S.W., Kassie, M.,   Shiferaw, B. (2014). Are there systematic gender differences in the adoption of sustainable agricultural intensification practices? Evidence from Kenya. *Food Policy, 49 (2014), 117-127.*

Ngenoh, E., Kebede, S.W., Bett, H.K. and Bokelmann, W. (2018). Coping with Shocks and Determinants among Indigenous Vegetable Smallholder Farmers in Kenya. *Journal of Agricultural Sciences, 9 (1), 804-823.*

Obeng, E.A. and Appiah, M. (2019). Impact of Illegal Mining Activities on Forest Ecosystem Services: Local Communities' Attitudes and Willingness to Participate in Restoration Activities in Ghana. *ELSEVIER. Volume 5.*

Obiri, S., Mattah, P.A.D., Mattah, M.M., Armah, F.A., Osae, S., Adu-kumi, S., Yeboah, P.O. (2016). Assessing the Environmental and Socio-Economic Impacts of Artisanal Gold Mining on the Livelihoods of Communities in the Tarkwa Nsuaem Municipality in Ghana. *International journal of environmental research and public health, 13 (2), 160 - 190*

UNIVERSITY FOR DEVELOPMENT STUDIES

OECD (2016): OECD Due diligence guidance for responsible supply chains of minerals from conflict-affected and high-risk areas. *ISBN: 978-92-64-25247-9. Available at: http://www.oecd.org/daf/inv/mne/OECD-Due-Diligence-Guidance-Minerals-Edition3.pdf.*

OECD (2019). OECD Regional Well-Being. OECD Regional Well-Being. *Available at https://www.oecdregionalwellbeing.org/ (accessed on 27 May 2021).*

Olawuyi, O. S., Olapade-Ogunwole, F. and Raufu, O. M. (2011). Shocks and Coping Strategies of Rural Households: Evidence from Ogo-Oluwa Local Government, Oyo State, Nigeria *International Journal of Agricultural Management & Development, 2 (1), 57 -75.*

Onumah, J., Leeuwis, C., Boamah, P. O., & Salifu, T. (2013). Operations and frames of illegal small-scale mining in Ghana. *International Journal of Agriculture Innovations and Research*, *6 (20), 307-312*.

Osei, L., Yeboah, T., Kumi, E., & Antoh, E. F. (2021). Government's ban on Artisanal and Small-Scale Mining, youth livelihoods and imagined futures in Ghana. *Resources Policy*, *71*, *102008.*

Oyekale, T.O. and Yusuf, S.A. (2010). Multidimensional Poverty of Shock-Exposed Households and Coping Mechanisms in Rural Nigeria. *Medwell Journal of Social Sciences, 4(1): 200-223.*

Rashid, D.A., Langworthy, M. and Aradhyula, S. (2006). Livelihood Shocks and Coping Strategies: An Empirical Study of Bangladesh Households. *Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23-26, 2006*

Saunders, M., Lewis, P., and Thornhill, A. (2009). Research methods for business students. Pearson education.

Skoufias, E., Vinha, K. and Conroy, H. V. (2011). The Impact of climate variability on welfare in rural Mexico. *Policy Research Working Paper WPS5555. The World Bank*

Snedecor, G.W. and Cochran, W.G. (1989). Statistical Methods. 8th Edition, Iowa State University Press, Ames.

Stata Manual (2015). Stata treatment effects reference manual: potential outcomes / counterfactual outcomes, release 14, Stata Press, Texas

Teklewold, H., Kassie, M. and Shiferaw, B. (2013). Adoption of multiple sustainable agricultural practices in rural Ethiopia. *Journal of Agricultural Economics, 64 (3), 597-623.*

Tenkorang, E. Y. and Osei-Kufuor, P. (2013). The Impact of Gold Mining on Local Farming Communities in Ghana. *Journal of Global Initiatives: Policy, Pedagogy, Perspective*, *8 (1), 78 – 110.*

111

Tongruksawattana, S., Waibel, H. and Schmidt, E. (2010). Shocks and Coping Actions of Rural Households: Empirical Evidence from Northeast Thailand. *A paper presented at the CPRC International Conference, Brooks World Poverty Institute at the University of Manchester, September 8-10, 2010.*

Uddin, M.N., Bokelmann, W. and Dunn, E.S. (2017). Determinants of Farmers' Perception of Climate Change: A Case Study from the Coastal Region of Bangladesh. *American Journal of Climate Change, 6 (20), 151-165.*

UNECA (2011): Minerals and Africa's Development: The International Study Group Report on Africa's Mineral Regimes. *A report by United Nations Economic Commission for Africa (UNECA), Addis Ababa.*

us Saqib, N. (2004). Willingness to Pay for Primary Education in Rural Pakistan. *The Pakistan Development Review*, 43(1), 27-51.

Webb, P. and Braun, J., (1994). Famine and Food Security in Ethiopia: Lessons for Africa. New York. John Wiley and Sons.

World Bank (2019). State of the Artisanal and Small-Scale Mining Sector. Washington, D.C.: World Bank.

World Bank (2015). Socioeconomic Impact of Mining on Local Communities in Africa. *Report No. ASC14621*

World Food Summit (1996). Rome Declaration on World Food Security. Rome.

Xu, H., & Craig, B. A. (2010). Likelihood analysis of multivariate probit models using a parameter expanded MCEM algorithm. *Technometrics*, *52 (3), 340-348.*

Yankson, P.W.K., Gough, K.V. (2019). Gold in Ghana: the effects of changes in large-scale mining on artisanal and small-scale mining. *Extract. Indus. Soc. 6 (8), 120–128.*

Yoshito, T., Bradford, L. B., and Oliver T. C. (2002). Risk Coping Strategies in Tropical Forests: Flood, Health, Asset Poverty, and Natural Resource Extraction. *The Extractive Industries and Society*, *2 (1), 80 -116.*

Oyekale, T.O and Yusuf, S.A. (2010): Multidimensional poverty of shock-exposed households and coping mechanisms in rural Nigeria. *Medwell Journal of Social Sciences, 5(3), 254-263.*

Zolnikov, T.R. (2020). Effects of the government's ban in Ghana on women in artisanal and small-scale gold mining. *Resources Policy, 65, 101561.*

112

Appendix 1: Research Questionnaire

University for Development Studies
Faculty of Agricultural, Food and Consumer Science
Department of Agricultural and Food Economics

Topic

Effects Of Artisanal Small Scale Mining (ASM) On Household Welfare: Perceptions And

Coping Strategies Of Farmers In Asutifi North District In The Ahafo Region

Serial Number………………………………………………………………………………

Informed Consent

Hello, my name is Seiba Issifu. I am a research student from the University for Development Studies, Ghana in the Department of Agricultural and Food Economics. I am conducting a research which principal objective is to assess farmers' perceptions about the effects of ASM on household welfare and the various coping strategies they use in Asutifi North District.

In the frame of this research project, I would ask questions relating to households' perceptions about the effects of ASM on household welfare. Your knowledge is key for understanding the situation. The conversation will last about 30 minutes, and objectivity in your responses are very important to me. I would like to assure you that your responses would be used for academic purposes only and will be treated confidentially. The information you will provide would remain confidential, and your name will never be mentioned in any report or publications.

I would like to know if you have questions to ask me.

REFERENCE INFORMATION

Name of Interviewer_____   Date of Interview_____

Name of Community ……………………………..   House Number:…………………………

Tel. Number …………………………………………

Section A: Demographic data of respondents

1. How old are you?..years

2. Age of household head……… years

3. Sex   a. male ( ) b. female ( )

4. What is your educational level? a. None ( ) b. Primary ( ) c. JHS ( ) d. SHS ( ) e. tertiary ( )

5. Number of years of schooling……………

6. Household number of infants (age< 3)   :   male……   female…….

7. Household number of children (3-9)   :   male…..   female……

8. Household number of children (10-14)   :   male……   female……

9. Number of economic active members (15-64) :   male…..   female……..

10. What is your main occupation?   a. farming ( ) b. salaried worker ( ) c. petty trading ( )

    d. mining (   )   e. others (specify)……………………………………………………………

11. Do you engage in off-farm activities? a. Yes (   )   b. No (   )

12. If you engage in off-farm activities, what is it? a. salaried worker ( ) b. mining ( )

    c. petty trading ( )   d. student ( )   e. farmer ( ) f. other (specify)…...

13. What is your marital status? a. never married ( )   b. married ( ) c. separated ( ) d. divorced ( )

14. What is your household size?..

15. What is your position in the household? a. Household head ( ) b. Spouse ( ) c.   Others ( )

    If others, please specify …………………………………………………………………….

16. How long have you stayed in the study area? …………years.

114

Section B: Farmers' perceptions about the effects of Artisanal Small Scale Mining (ASM) activities on household welfare

17. How have the following welfare indicators of your household changed over the years due to ASM operations in your catchment area? *1=Highly decreased or deteriorated; 2= Moderately decreased or deteriorated; 3= Remained same; 4= Moderately Increased or Improved and 5=Highly Increased or Improved*

Welfare Indicators	1	2	3	4	5
Food consumption					
Food security					
Income					
Employment Generation					
Crop production levels					
Animal production levels					
Housing conditions					
Availability and access to portable drinking water					
Health conditions of households					
Education of children					
Availability and access to firewood					
Availability and access to game					
Availability and access to fruits and wild foods					
Availability and access to land					
Availability of labour for agricultural activities					

18. Is there ASM activities in your community? a. Yes ( )   b. No ( )

19. If Yes in reference to Q18, how long has the ASM been going on in your community?
…………………..years

20. How far are mining sites from your house?   ………km

21. Have you lost land to mining activities? a. Yes ( )   b. No ( )

22. If you have ever lost land to mining activities, how long is it now? ……………years

23. How many acres of land have you lost? …………acres

115

24. Have you lost crop farms to mining activities? Yes ( ) (b) No ( )

25. If you have ever lost crop farms to mining activities, how long is it now? ……………years

26. Indicate the assets lost and their values in the table below;

Type of assets lost	Size/number	How long now (years)	Current value of the lost (GHc)	Compensation received (GHc)
Maize	…………acres			
Cassava				
Banana or plantain	…………acres			
Cocoa	…………acres			
Cashew	…………acres			
Goat	…….. (numbers)			
Sheep	…….. (numbers)			
Fowls	…….. (numbers)			
House				
Family member				

27. Have you benefited from the ASM activities in your community? Yes ( )   No ( )

28. If Yes, state the benefit you got from ASM activities in your community.

i) …………………………………………………………………………………………………

ii) …………………………………………………………………………………………………....

iii) …………………………………………………………………………………………………

iv) …………………………………………………………………………………………………

v) …………………………………………………………………………………………………

Section C: Household Welfare And Policy Variables

29. Specify household annual income from:

(a) Agriculture GH₵ ……………   (b) Mining GH₵ …………. (c) Remittances GH ₵ ………

(d) Craftsmanship GH₵ ………   (e) Full/ part time salary employment GH₵ ………

(f) Trade GH ₵ ………………   (g) Others GH₵…………………………

30. If you are engaged in farming as a major occupation, indicate annual household;

(a) Crop wealth: GH¢ …………   (b) Livestock wealth: GH¢ ………………

31. **Household Expenditure on Food Items (Total consumed in the last 7 days, Household only)**

| | | *Own produced Food* | | *Food Bought* | | *Food received from friends* | | | |
		Qty	*Cost if had sold GH¢*	*Qty*	*Cost of buying GH¢*	*Qty*	*Cost if had bought GH¢*	*a*b + c*d + e*f*	Unit classification
Staple Foods	Unit	*A*	*B*	*c*	*D*	*e*	*f*		
Maize									Bowls/Pans/Bags
Rice									Bowls/Pans/Bags
Cassava									Bowls/Pans/Bags/tubers
Yam									Large/Medium/Small tubers
Plantain									Large/Medium/Small Size
Cocoyam									Bowls/Pans/Bags/tubers
Groundnut									Bowls/Pans/Bags
Beans									Bowls/Pans/Bags
Vegetables									
Tomatoes									Bowls/Pans/Bags
Pepper									Bowls/Pans/Bags
Salt									Bowls
Fruits									
Oranges									
Mangoes									
Pawpaw									
Banana									
Pineapple									
Meat									
Beef									
Chevon									
Mutton									
Eggs									
Bush meat									
Chicken									
Fish									
Beverages/Drinks									

117

Tea									
Soft Drink									
Fruit juices									
Alcoholic drinks									
Water									
Fats and oils									
Cooking oil									
Bread									
Pastries									

32. **Household food Insecurity Experience Scale (HFIES)**

During the last 12 months, was there a time when, because of lack of money or other resources;	
You or others in your household were worried you would not have enough food to eat?	(1) Yes [ ] (2)No [ ]
You or others in your household were unable to eat healthy and nutritious food?	(1) Yes [ ] (2) No [ ]
You or others in your household ate only a few kinds of foods?	(1)Yes [ ] (2) No [ ]
You or others in your household ate food you do not like?	(1)Yes [ ] (2) No [ ]
You or others in your household had to skip a meal?	(1)Yes [ ] (2) No [ ]
You or others in your household ate less than you thought you should?	(1)Yes [ ] (2) No [ ]
You or others in your household ran out of food?	(1)Yes [ ] (2) No [ ]
You or others in your household were hungry but did not eat?	(1)Yes [ ] (2) No [ ]
You or others in your household went without eating for a whole day	(1)Yes [ ] (2) No [ ]

33. Have you or other members of the household ever receive advice from agric. extension officer in the 2019/2020 cropping season? (a) Yes [   ]   (b) No [   ]

34. If yes, how many times did an agric. extension officer visited/had contact with this household in the 2019/2020 cropping season? …………………………………….

35. Ownership status of land used by the household for agricultural production for 2019/2020 cropping season: (a) Owned [   ] (b) rented [   ] (c) family land [   ]

36. If rented, amount paid per acre as rent GH ⊄ ……….

37. What is the size of the land used for agricultural production in 2019/2020 cropping season? …….acres

38. Did you or any other members of the household obtain credit in 2019/2020 cropping season? (a)Yes [ ] (b) No [ ]

39. If yes, specify source.   Commercial bank [ ]   rural bank/microfinance institutions   [ ] credit union [ ] government credit program [ ] NGO credit program [ ]   friends and family [ ] Susu/Village Savings and Loan Associations (VSLA) [   ] others [ ] (if others, please specify) ……………………………………………………………………………………………………..

40. What was the purpose of the credit? (a) Agricultural activities [ ] (b) ASM activities [ ] (c) others [ ] (Specify) ……………………………………………………………………………….

41. Did you get the full amount of credit you apply for? Yes [ ] No [ ]

42. if no, state the reasons
……
……
……

43. What was the total amount you applied for? GH⊄ ………

44. What was the total amount you received? GH⊄ ………

45. How much of the credit was used for agricultural purposes? GH⊄ …….

46. How much of the credit was used for ASM purposes? GH⊄ …….

47. Are you a beneficiary of Planting for Food and Jobs?   (1) Yes [ ] (2) No [ ]

48. Are you a beneficiary of government's mass cocoa spraying from? (1) Yes [ ] (2) No [ ]

49. How many years have you been farming since you started your own farm? ……………..

50. Do you belong to farmer-based organization? (1) Yes [ ] (2) No [ ]

51. Are you aware there is mining policy for ASM activities? (1) Yes [ ] (2) No [ ]

52. What is your level of knowledge about the policy (a) not at all ( ) (b) aware ( )

53. Briefly explain what you know about the policy regulating ASM activities in Ghana.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

54. Do you own telecommunication gadget? (1)Yes [ ]   (2) No [ ]

55. If yes, specify: (1) TV [ ]   (2) Mobile phone [ ]   (3)Radio [ ]

Section D: Coping strategies adopted by farmers to minimize the effects of ASM activities of household welfare

56. Have you adopted any strategy in order to respond to the negative effects of ASM?

a Yes ( ) b. No ( )

57. If No in reference to Q56, what are the reasons?..

……………………………………………………………………………………………………

58. If Yes in reference to Q56, what are the practices you have adopted in order to deal with the

negative effects of ASM? Please use the key below the table to indicate which of the coping

strategies you have adopted and indicate its effectiveness.

Coping Strategies	1. Yes 2. No	Level of Effectiveness in reducing the effects*
Land reclamation		
Resettlement to a different community		
Diversification / Petty and other activities		
Dependence on Market for food		
Social Networking		

120

| Sale of Asset | | |
| Borrowing | | |

*1. Most effective   2. Effective   3. Less effective   4. Not effective at all

59. What are other coping strategies you adopt? Please list the other coping strategies in the table and

indicate their effectiveness.

Coping Strategies	Level of Effectiveness *
1.	
2.	
3.	
4.	
6	

*1. Most effective   2. Effective   3. Less effective   4. Not effective at all

60. Did you ever receive any training on alternative livelihood strategies? a. Yes ( ) b. No ( )

61. If yes, give the name of the provider of the training _____

Thank you very much for your time

Respondent telephone: ……………………………..

Name of respondent ……………………………………

Appendix 2: Matrix for Objectives, Methods, Key Findings, Conclusions and Recommendations

Objectives	Method	Key Findings	Conclusions	Policy Recommendations
To investigate farm households' perceptions about the effects of Artisanal Small Scale-Mining (ASM) activities on household welfare in the Asutifi North District.	Descriptive Statistics	With the exception of income and employment generation, respondents reported either high or moderate deterioration in food consumption, food security, crop production, animal production, availability of farm labour, access to potable water, housing conditions, health conditions, education of children, access to land, access to game, fruit and firewood	Farm households perceived ASM to have more negative effects on their welfare compared to the positive effects.	Efforts should be made by government and civil society organizations encourage land reclamation measures, improve access to potable water, improve food security among others in the mining areas.
To identify the coping strategies used by farm households to minimize the effects of ASM as well as the drivers of the coping strategies adoption.	Descriptive Statistics and Multivariate Probit Model	Age, sex, total household income, household size, educational status, farm size, access to credit, membership of FBO, ASM years in the area, years of stay in the area, access to extension service among others have different magnitude and direction of significance in influencing the adoption of coping strategies in the study area	The adoption of coping strategies is influenced by both socio-demographic and institutional factors.	Interventions by NGOs and government in mining communities, should target providing alternative livelihood training, increasing access to credit among others.
To assess the effects of coping strategies adoption on households' welfare	Endogenous Treatment Effect Model (ETE)	With consumption expenditure and HFIS as two outcome variables for welfare, the ATTET result shows that, farm households who adopted at least 3 coping strategies were better off in terms of welfare compared to their counterparts who did not adopt any coping strategy. However, households who adopted at least 4 coping strategies were worst off in terms of welfare	The adoption of at least 3 coping strategies against ASM induced shocks is associated with improved welfare compared to non-adoption whilst adoption of at least 4 coping strategies decreases welfare compared to non-adoption.	Farm households in mining communities should be educated and supported to adopt appropriate ex-ante coping mechanisms to deal effectively with ASM and other livelihood shocks.

122