UNIVERSITY FOR DEVELOPMENT STUDIES

SMALLHOLDER FARMERS' PROVISION OF LABOUR SERVICES TO ARTISANAL SMALL-SCALE MINING: DETERMINANTS AND WELFARE EFFECTS IN NORTHERN GHANA

AYUBA DAUDA

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BY

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FEBRUARY, 2023

DECLARATION

Student

I hereby declare that this thesis is the result of my original work and that no part of it has been presented for another degree at this university or elsewhere.

Candidate's Signature: …… Date: ……

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Supervisor

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

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ABSTRACT

Artisanal small-scale mining activities are on the rise with several concerns. Whiles these are issues of concern, farmers in the mining communities are providing labour services to ASM for wages. This study investigated the determinants of farmers' decision to provide labour services to ASM. It also assessed the welfare effects of providing labour services to ASM operations. Multi-stage sampling technique was employed to collect cross-sectional data from 200 farm households in two districts in northern Ghana. Probit model was used to investigate factors influencing farmers' decision to supply labour to ASM. Three main welfare outcomes were estimated: household per capita consumption expenditure, per capita income and household food security. An Endogenous Switching Regression (ESR) model was used to estimate the welfare effects of supply of labour services to ASM. Ownership of television, distance from home to mining site, access to agriculture extension and on-farm income were identified as factors influencing farmers' decision to supply labour to ASM. From the estimates of the welfare outcomes, it was found that ASM had a positive and significant incremental effect on the welfare of farm households who provided labour services to ASM. Specifically, farmers who supply labour services were more food secured, and had higher per capita consumption expenditure and per capita income than their counterparts who did not supply labour to ASM. It is therefore recommended that community mining which has been promoted in the south, should be promoted in Northern Ghana which will have positive spill-effect on the farmers. Also, agriculture extension services should be intensified to quick farmers' enthusiasm to enter into farming. Farmers should be sensitized to invest sums of money obtained from mining into their farming activities to expand their welfare net. Government should intensify the universal adult education which will help farmers in technology adoption and apply the best agronomic practices on their farms to boost their yields.

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DEDICATION

This work is dedicated to my family, especially my lovely mother, Mrs. Maria Ayuba

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AGA	Anglogold Ashanti
ALP	Alternate Livelihood Programs
AM	Artisanal Mining
ASM	Artisanal Small-scale Mining
ATT	Average Treatment effect on the Treated
ATU	Average Treatment effect on the Untreated
CIMFR	Central Institute of Mining and Fuel Research
COCOBOD	Ghana Cocoa Board
CSIR	The Council of Scientific and Industrial Research
ESRM	Endogenous Switching Regression Model
FAO	Food and Agriculture Organization
GCM	Ghana Chamber of Mines
GDP	Gross Domestic Product
GFGL	Goldfields Ghana Limited
GLSS	Ghana Living Standard Survey
GoG	Ghana of Government
GSOPP	Golden Star Oil Palm Plantation
GSR)	Golden Star Resources
GSS	Ghana Statistical Service
HDDS	Household Dietary Diversity Score
ILO	International Labour Organization
IM4DC	International Mining for Development Centre

IMF	International Monetary Fund
LSM	Large Scale Mining
MDA	Millennium Development Authority
MEI	Ministry of Economy and Industry
MMP	Minerals and Mining Policy
MoFA	Ministry of Food and Agriculture
MOFEP	Ministry of Finance and Economic Planning
OICI	Opportunities Industrialization Centres International
SAP	Structural Adjustment Programme
SDG	Sustainable Development Goal
SEED	Sustainable Community Empowerment and Economic Development
SSM	Small-Scale Mining
UNDP	United Nations Development Programme
WAPCB	West African Produce Control Board
WGC	World Gold Council
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The agricultural and mining industries are two of man's earliest civilization-building endeavours, so they have contributed significantly to altering the earth's surface (Down and Stocks, 1978). According to Kenk and Cotic (1983), agribusiness is the systematic, regulated use of living creatures and the environment for the benefit of humans. By contrast, mining involves excavating geological materials to acquire natural compounds, and minerals and contribute to the socioeconomic development of a community (Mackenzie et al., 2006; Crowson, 2009). Agriculture and mining have coexisted, predating the days of independence, and their contributions to socioeconomic development cannot be underestimated.

Before Ghana's independence in 1957, the early precolonial traders discovered abundant minerals during the 15th and 18th centuries, which led to the coinvention of the name Gold Coast, which refers to the abundance of gold found in the country's western, eastern, and southern regions **(**Ankomah, 2019). Historically, gold mining was a relatively cheap and straightforward since gold was plentiful enough that even sand around rivers was collected, rinsed, and crushed for gold (McQuilken and Hilson, 2016). Most mining villages that participated in it found it to be a significant source of wealth. As time progressed, deposits of diamonds, iron, limestone, kaolinite, and other clay minerals were discovered in varying quantities. Even though Ghana's economy was primarily agricultural, most individuals in the southern part of the country made a living

by engaging in small-scale mining (Aryee et al., 2003). This underscores the important role mineral resources played in Ghana's economy and for the welfare of rural household in the olden days. Communities with abundant mineral resources were regarded as affluent, attracting people from other non-mining communities.

The two basic categories of gold mining in Ghana are large-scale mining (LSM) and small-scale mining (SSM). However, Artisanal mining (AM), which indigenous peoples in Ghana largely control, is included in small-scale mining (SSM). The SSM and AM were combined and referred to as artisanal small-scale mining in this work. Small-scale mining (SSM) is regarded by the International Labour Organization (ILO) as being less labour-intensive and using basic or primitive equipment. As a rule of thumb, ASM is defined in Ghana as gold mining using minimal expenditures by a person or group of up to nine (9) people or a society that supports up to ten (10) people (Akabzaa & Darimani, 2001; Worlanyo & Jiangfeng, 2020). ASM sector is a category of mining which is less regulated, and more controlled by the local people. However, more recently, the government of Ghana has introduced the concept of Community Mining, which aims to promote local community participation in SSM and create jobs and improving livelihood in mining communities. Also, to mitigate the environmental and ecological effects of ASM.

On the other hand, large-scale mining typically refers to substantial financial investment, a large skilled and unskilled workforce, and sophisticated equipment to carry out their operations (Amponsah-Tawiah and Dartey-Baah, 2011). A total of 15 large-scale mining firms operate in Ghana today, 13 of which are gold mines, one of

which is a bauxite mine, and the other is a manganese mine (Ghana Chamber of Mines, 2019).

Like other developing countries, Ghana's mining sector is a critical tool for economic development. Ghana overcame South Africa to become Africa's greatest gold producer and one of the top ten gold-producing countries in the world in 2018 (Ministry of Economy and Industry (MEI), 2020). Mining currently contributes 9.1% to Ghana's gross domestic product (GDP) at the macro level, with gold accounting for 90–96% of all extracted minerals (Worlanyo et al., 2022). Ghana's mining sector has a greater impact on the economy at the community and the national level. It boosts the country's GDP at the national level, and it helps the community miners to improve their welfare and counteract their food insecurity.

In Ghana, ASM has become one of the significant drivers of socio-economic development as it evolves from its dark days (Mineral Commission, 2021). ASM is slowly but steadily becoming one of the critical livelihoods for the people living in rural areas where opportunities are limited. Despite its poor health, environmental and social repercussions, some rural inhabitants see ASM as a viable alternative or supplement to agriculture because of its higher return and open market. The ASM industry has grown rapidly worldwide, primarily in remote rural areas of emerging countries. It employs a diverse group of experienced and unskilled professionals to do various tasks, including general labouring, skilled machining, supervising, and bookkeeping (Yakovleva, 2007). It employs approximately one million people and supports another 4.5 million as it contributes to wealth creation, employment, and the economy. (McQuilken &

Hilson, 2016; Mineral Commission, 2015). Mining on a small-scale employs a greater number of people than mining on a large scale. About one million Ghanaians are employed directly and much more indirectly in the small-scale mining sector, according to Mineral Commission (2021). About 300,000 people are employed directly or indirectly by the large-scale gold mining industry (Ghana Living Standards Survey (GLSS) report, 2017). A study by Hilson and Garforth (2013) estimated that approximately 30,000 people work in Ghana's small-scale mining sector. The number of people performing licensed ASM is estimated at around 100,000, but the number of people performing unlicensed/unregistered ASM is at least twice as high (Bansah et al., 2018). A total of 4.5 million Ghanaians profit from the business, with over 1 million Ghanaians engaged in small-scale legal mining and another 1 million engaged in illicit small-scale mining (McQuilken and Hilson, 2016). Despite this contribution, the government of Ghana has focused on large-scale mining over the years. While the people who engage in small-scale mining are mostly Ghanaians, large scale mining is owned by foreigners. The money they obtained by large scale mining companies is sent out as capital flight.

By supplying full- and part-time work, small-scale mining aids in the socioeconomic development of individuals and communities. A licensed operator reportedly employs five to twenty groups of workers, each of which consists of five to ten individuals, who dig ore and refine gold (Akudugu et al., 2013). In addition to producing direct employment, small-scale mining generates a sizable number of indirect jobs in other areas of the economy due to the demand for transportation, other services, and other

productive inputs. According to Amankwah and Anim-Sackey (2003), employment projections will be higher if other lucrative industries are considered, such as gold mining, trading, and food sellers. By halting the rural flight and promoting local economic growth, mining has helped to reduce poverty in rural areas (Akudugu et al., 2013). According to Amankwah & Anim-Sackey (2003), small-scale mining also provides an excellent opportunity for indigenous entrepreneurs to thrive because there are few entrance barriers regarding finances and formal education. The lack of data on the ASM value chain has reduced the number of beneficiaries of ASM. However, ASM significantly contributes to the economy of the nearby mining villages by offering direct employment opportunities with little to no formal schooling requirements. It also provides a source of skill development for the community's economy.

The ASM labour groups consist of men, women, and children, as well as struggling families and individuals, students pursuing their education at the secondary and tertiary levels, farmers bolstering their income, and students (McQuilken and Hilson, 2016). Most of Ghana's small-scale and artisanal miners work in mining because it gives them access to rapid income. The ASM sector, which delivers relatively high incomes and is a key source of non-farm income, is easily accessible to women who are marginalized in agriculture (Yakovleva, 2007). Furthermore, mining anything other than precious metals and stones is never profitable (Hilson & Garforth, 2012). It is significant to mention that ASM offers developing nations several benefits. ASM is commercially viable despite having a high labour need and cheap production cost. Mining operations can significantly impact people and the community (United Nations Development

Programme (UNDP), 2016). A lot of people that engage in ASM are less privilege in society. ASM has the capacity to expand the employment envelop of emerging economies as its operations are highly labour intensive.

Most miners in Ghana mine informally due to the challenges involved in getting land and a license (Appiah, 1998 and Ministry of Finance and Economic Planning (MOFEP), 2015). This informality has contributed to several environmental and social problems in Ghanaian mining communities, such as water pollution and destruction, the degradation of arable farmland, and the adverse health effects of working in dangerous conditions. Ghanaian media has focused on these problems, which tend to paint the entire ASM sector in a negative and harmful light (McQuilken and Hilson, 2016; Mineral Commission, 2015). Despite ASM contribution to the economy and infrastructure development of affected communities and the country as a whole, many ASM operators work illegally because of the bureaucracy associated with obtaining a license to operate, which has resulted in a lot of the social vices emanating from ASM operations.

Livelihood diversification is viewed as a household approach to reduce income unpredictability and assure a minimum income level because the northern ecological zone's agricultural potential is constrained by a short rainy season, poor soil quality, and unfavourable climate conditions (Wouterse and Taylor, 2008). Also, environmental difficulties such as droughts, high temperatures, aridity, and erratic rainfall are forcing pastoralists to diversify their livelihoods beyond their traditional reliance on livestock (Wren and Speranza, 2010). Undoubtedly, households in the north that are less affluent stand to gain the most from diversification (Thornton et al., 2007). ASM has made it

possible for many towns in Northern Ghana to drastically reorient their livelihoods, giving hundreds of subsistence farming people a much-needed source of hope and stabilizing previously unstable economies (Hilson and Garforth, 2012). One method employed by poorer households to combat food insecurity and enhance their welfare is livelihood diversification. Thus, smallholder farmers in northern Ghnaa are the people who benefit largely from ASM as it helps them to diversify their income and livelihood to strengthen their welfare against any external shocks. Hence, farmers at mining communities in northern Ghana participate in ASM during the dry season and use the money obtained from ASM to invest in agriculture during the raining season.

1.2 Problem Statement

Empowering the smallholder farmer is one of the ways of achieving ruler economic development. Smallholder farmer empowerment can be achieved through non-farm activities. Non-farm activities such as ASM can be employed to improve farm households' revenue portfolio and welfare, which SDG1 and SDG2 aggressively seek to accomplish.

Economic growth and development in Ghana are largely driven by agriculture and mining. Agro-based activities contributed 35,047 million Ghana cedis (11.5 per cent) to the GDP in 2017, while mining contributed 21,901 million (Ghana Statistical Service (GSS), 2018). Both sectors complement each other. While miners get food from agriculture, some farmers provide labour services to the mining organizations during the dry season and get income in return. Farmers' incomes from the mining sector are used to procure necessary inputs to enhance agricultural productivity. Meanwhiles, both

make use of land. The country's geological environment has a varied range of mineral reserves, which are exploited legally and illegally.

ASM activities, whether legal or illegal, adversely affect the natural environment, destroying arable agricultural land and polluting water sources. Therefore, ASM activities have attracted the attention of the media and researchers. However, ASM is a well-known component of the government's poverty reduction programs because it contributes significantly to foreign exchange revenues and several thousand people are employed in many parts of the country (Mineral Commission, 2015). ASM sectors are perceived as having the potential to alleviate significant poverty in Ghana, where subsistence farming has long played a crucial role in rural economic development.

Any agricultural-led poverty alleviation plan in northern areas is unlikely to be successful due to poor climate conditions and short growing seasons. As a result, the region has been unable to retain its human capital, which would have boosted development. Nonetheless, the discovery of gold in parts of northern Ghana gives reason for optimism. It's important to note that ASM is frequently linked to poverty. As miners look for ways to earn more money in the nonfarm economy and alleviate food insecurity, many seek ways to improve their families' lifestyles (Cartier and Bürge, 2011). There is no better solution to alleviating suffering in a community where there are few viable jobs than combining low-skilled ASM labour with smallholder farming (Hilson & Garforth, 2013). A combination of agriculture and ASM is the best tonic for smallholder farmers in the mining communities in northern Ghana to move beyond the poverty line, because of the short raining season in the northern ecological zone, any

agriculture led programmes and policy always have minimal impact on the farmers' welfare.

The majority of persons that engage in ASM in Ghana are smallholder farmers who have branched out to supplement their agricultural produce with additional money (Hilson and Garforth, 2012). ASM activities have aided the financial stability of some disadvantaged families. It has also aided certain smallholder farmers in the acquisition of agricultural inputs and the capacity to counteract their food insecurity. In addition, several smallholder farmers branched out because they believed mining would be more profitable since mining has a ready market. According to Hilson & Garforth (2013), the majority of residents in northern Ghana's mining settlements consider themselves first and foremost farmers, despite the terrible climatic circumstances that have long limited their productivity to subsistence levels. Despite the benefits associated with ASM compared to agriculture, smallholder famers who engage in ASM see themselves as farmers and venture out into ASM to supplement their farm revenue. Due the seasnonality associated with the two sector, ASM generates revenue for farmers during the dry season, and agriculture generates revenue during the wet season.

The opponents of ASM ague that ASM has failed to achieve its core mandate, thus, it has not been able to bring miners out of poverty. As a result, mining communities have been hindered in their development, and their livelihoods are endangered. It is argued that, although ASM miners do almost as much work as large-scale miners, they make meagre profits. Some sell as little as $1 worth of minerals at a time, which does not suffice to lift them out of poverty (Akudugu et al., 2013). Moreover, they argue that

small-scale mining contributes little to government revenue and has serious environmental implications.

According to the opponents, ASM does not lead to long-term economic success and change for developing nations, nor is it necessary for it. Most developing countries, particularly in Sub-Saharan Africa, have mined for decades, but these countries have not overcome poverty as a consequence of mining. Using open pits and dangerous chemicals to extract minerals from ore can threaten the livelihoods of small-scale miners. Deaths from mines have been documented all across the world. The world is constantly in a dreadful state, especially for the poor and defenseless. Having a direct connection to mining, they are directly affected.

Like most economic activities, small-scale gold mining operations have both good and negative consequences on the Ghanaian economy (Opoku-Antwi, 2010). Many previous studies (Teschner, 2012; Hilson and Garforth, 2012; McTernan, 2013; Baffour-Kyei et al., 2021; Adjaye & Ampofo, 2017) focused on the livelihood impacts of ASM, which are mostly qualitative in nature. Also, (Kessey and Arko, 2013; Bansah et al., 2018; Owusu et al., 2019), assessed the environment impacted of ASM. Despite the sector employing over 1 million people and supporting over 4 million in Ghana, labour and welfare issues have been understudied. The majority of this research neglected to look into the factors that farmers influence the provision of labour services to ASM. As a result, this study attempted to use an acceptable empirical method to critically examine the welfare effects of labour provision to ASM. Many people who engage in ASM in northern Ghana are smallholder farmers, according to several studies (Hilson and

Garforth, 2012 and Akudugu et al., 2013). As a result, the research aims to learn more about what socioeconomic reasons may have motivated impoverished mining villages in northern Ghana to offer labour services to the ASM sector and the implications for their wellbeing. The acquisition of knowledge concerning smallholder farmer engagement in small-scale mining is critical to the ASM sector's regularization. As a result, this effort will go a long way toward bridging the knowledge gap in policymaking cycles, allowing for the development of a comprehensive policy framework, the integration of mining into other sectors and the identification of sustainable livelihoods for rural people.

The claims mentioned above support the relevance of the following research questions.

i. What factors influence provision of labour services to artisanal small-scale mining?
ii. What are the effects of providing labour services to artisanal small-scale mining on household consumption expenditure?
iii. What are the effects of providing labour services to artisanal small-scale mining on household food security?
iv. What are the effects of providing labour services to artisanal small-scale mining on household income?

1.3 Research Objectives

The main objective of this study was to analyse the determinants and welfare effects of farmers' provision of labour services to ASM. Specifically, the study seeks to;

1. Identify factors influencing farmers' decision to provide labour services to ASM.
2. Estimate the effects of providing labour services to ASM on farm households' consumption expenditure
3. Assess the effects of smallholder farmers' provision of labour services to ASM on farm household food security.
4. Examine the effect of providing ASM labour services on farm household income.

1.4 Research Hypothesis

The hypotheses that this study seeks to test are:

1. Socioeconomic factors (education, age, farming experience, land ownership, TV ownership), institutional factors (extension services, bank account ownership, fertilizer subsidy), and farm characteristics (farm size, social facility) significantly influence farmers' decision to supply labour to ASM.
2. Farm hosuseholds who supply labour to ASM are more food secured than those who do not.
3. Farm households who supply labour services to ASM activities have higher consumption expenditure than their counterparts.
4. The supply of labour services to ASM improves farm household total income.

1.5 Justification

In recent years, policy makers are aggressively seeking to regularize and sanitize the mining sector, specifically the ASM subsector, to maximize its potential benefits and minimize its possible harms. This study has relevance in academia and policy-making circles. ASM is profitable but not sustainable. However, farming is sustainable but not profitable; therefore, the study would help policy makers to develop a comprehensive policy framework on how the two sectors can complement each other to lift farmers out of poverty. Highlighting the effects of ASM on farm households' welfare will again help policy makers to formulate policies targeting the residents of the mining communities to boost their welfare.

ASM is an important component of the rural economic growth and development. ASM has the capacity to lift miners out the poverty basket. The study presents empirically grounded results on the impact of ASM on a household's welfare. The model used in the study is the state of the art method of estimating impact, which can predict and solve selectivity bias. Thus, this gives truth and unbiased estimates of the various parameters.

The study will be a ready source of literature to fill the current gap in knowledge on farmers provision of labour to ASM and the effect of this on the welfare of farm households . It would reveal factors influencing farmers to provide labour services to ASM. The study will also help farmers to have information on the factors that contribute to why they choose to provide labour services to ASM and how that can improve their welfare.

1.6 Organization of the Study

Five (5) theme chapters make up the structure of the thesis. An introduction, problem statement, research objectives, and research questions about the study's relevance are covered in the first chapter. A review of pertinent literature is given in Chapter two for the topic. The study's methodology is described in detail in Chapter three. This includes study area, data requirement, research design, conceptual and analytical frameworks and empirical models. The study's results are presented and discussed in chapter four. The study's conclusions and policy recommendations are presented in chapter five.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents review of relevant literature which affect ASM and welfare and identifies regional disparities between Ghana and other countries. It also reviews literature on many ASM in Ghana; depending on their manner of operation and the status of their registration. This is to identify the gaps in the literature and place this current research within the broader context of the identified gaps.

2.2 Definition and Concepts of ASM

Small-scale artisanal mining (ASM) has advanced from manual labour including the use of basic equipment such as shovels and pick axes to semi-automated work utilizing excavators, bulldozers, and washing facilities (Mineral Commission, 2015). ASM is commonly performed by locals using basic tools and typically requires minimal financial commitment (Worlanyo et al., 2022). An operation that uses an efficient and effective method of extracting gold without incurring significant costs is considered to be a small-scale gold mining operation under Ghana's Minerals and Mining Commission Act 2006. The business is managed by a single person, a small team of up to nine employees, or a co-op society with at least ten members. As a result, ASM operations do not need a large investment or highly specialized labour because its operators often use simple or local instruments. thus, people in rural mining communities who are affluent can easily acquire these simple tools and engage in ASM.

In accordance with Arah (2015) and Al-Hassan and Amoako (2014), ASM can be split into two categories: surface mining and subterranean mining. Surface mining is a wide term that refers to the process of removing the soil and rock that covers a mineral deposit (Worlanyo et al., 2022). For instance, the exhumation of ores by open-pit mining, strip mining, dredging, and mountaintop removal all occurs relatively close to the surface (Arah, 2015). Open-pits and dredging procedures are the most prominent methods of surface mining in Ghana. Surface mining, as opposed to underground mining, necessitates a large amount of land. Small-scale surface mining is on the rise in Ghana as the country's drive for minerals picks up speed, and it is the form of mining that causes the most harm to the vegetative cover. This poses the biggest danger to Ghana's agricultural industry and other alternative land uses because it causes significant land degradation and water contamination (Worlanyo, et al., 2022). Historically, the ASM subsector in Ghana has been dominated by underground mining. However, more recently, surface mining is gaining grounds in the country due to the influx of Chinese national and other multinational organizations in the ASM industry.

Underground mining occurs when miners dig deep underground to get mineral ore that is beneath the earth's surface, as the name indicates, notably, hard-rock mining (Balasubramanian, 2017). Contrary to surface mining, underground mining frequently requires specialized technology, less manpower, and a substantial financial commitment. However, underground mining in Ghana makes use of inexpensive local tools including pickaxes, cutlasses, and hoes. Many of the miners in northern Ghana are local farmers who prefer underground mining since it is simpler and requires less cash.

They dig deep pits in the form of wells to remove the rock or soil contain minerals. The rocks are crashed and minerals washed using water.

In addition, the registration status of ASM in Ghana can be used to categorize them. The Minerals and Mining (Amendment) Act, 2019 (Act 995) distinguishes between those who are legally registered and so qualified to carry out their duties and those who are working illegally due to economic, social, political, regulatory, and technical limitations (Owusu et al., 2019). In Ghana, the Mining and Minerals Commission is entirely responsible for mining registration and permission. As of 2002, there were 420 SSM concessions in Ghana, with 411 gold concessions and 9 diamond concessions registered and approved for operation (Worlanyo et al., 2022). By 2016, there were 1,436 licenses available (Ntibrey, 2016), with gold licenses predominant. Bansah et al. (2018) report that chisel-and-hammer methods, underground "ghettoes," and "dig-and-wash operations" were previously applied to ASM in Ghana. As well as Changfan mining, other SSM mining methods in Ghana include the alluvial washing plants, blade mining, and dredging methods (Bansah et al., 2018; Botchway, 2015). despite the difficulty associated with obtaining license to operate as a small-scale miner, the number of SSM concession has seen astronomical jump over the years with gold concession dominating. However, because of capital constraints a lot of the ASM in Ghana still employ the chisel and hammer method.

A large-scale mine is described by the World Gold Council (WGC) (2019), as any firm with a significant number of employees at one or more major sites. As long as the metal or mineral is not completely removed, they are left in place. They've defined operational

goals, processes, and tenure, as well as paying particular attention to environmental damage. There is no specific definition of LSM in Ghana, but it is considered any mine with one hundred workers and a tenure of 10 years (Worlanyo et al., 2022). Unlike ASM, LSM has a lower environmental impact, as bulk of them mine underground (Mining and Commission, 2015). LSM is the most important direct contribution to the Ghanaian economy. LSM operations causes less environmental damages, as their operations are properly regulated and well defined. A lot of social responsibility programs and livelihood support programs are implemented by LSM to mitigate the negative effects of mining. As of 2019, 16 LSM in Ghana are registered, and a total investment of US$ 3.73 billion has been made (Worlanyo et al., 2022).

The total amount of gold produced in 2019 was 2,986,837 ounces (oz) (Ghana Chamber of Mines, 2020). The overall investment in 2018 was, however, smaller. LSM has had a significant impact in the creation of both direct and indirect jobs in Ghana. The total direct labour involved in LSM rose from 10,109 to 11,899 over the production years of 2018 and 2019 (GLSS, 2018).

Table 1: Names of all registered LSGM in Ghana and their output as at 2019.

s/n	Name of gold producing company	Yearly output (ounce)		
1		2018	2019	% Change
2	Newmont Ghana Gold Limited	436106	643067	47
3	Goldfield Ghana limited	5248869	519072	-1
4	Newmont Golden Ridge Limited	414427	422099	2
5	AgloGold Ashanti Iduapriem limited	253487	274665	8
6	Asanko Gold Mines limited	222152	251044	12
7	Abosso Goldfields Limited	180844	208381	15
8	Chirano Gold Mines	226370	201037	-11
9	Perseus Mining (Ghana) Limited	217219	179574	-17
10	Golden Star Wassa Limited	149698	156168	4
11	Adamus Resources Limited	103731	84197	-19
12	Golden Star Bogoso Prestea	75087	47533	-37
	Total gold production	2804990	2986837	6

Source: Ghana Chamber of Mines (2020) * Computed from 2018 to 2019 production figures.

It's worth noting that just 144 expats were employed out of the direct workforce of 11,899 in 2019, with the remainder being Ghanaians (Worlanyo et al., 2022). This represents only 1.2 percent of the workforce in 2019, compared to 1.6 percent in 2018. Ghana's total actual value of finished goods and services climbed from GH 154.548 billion (more than US$ 26 million) in 2018 to GH 164.560 billion (more than US$ 28 million) in 2019 using 2013 constant prices (Ghana Chamber of Mines, 2019). In 2019, this equated to a growth rate of 6.5 percent, which is higher than the previous year's figure of 6.3 percent. One of the main causes of this enormous increase in actual economic output was the growth of the mining industry, especially large-scale mining (

Ghana Chamber of Mines 2019) .This was noteworthy because worldwide gold demand fell by a percentage point to 4335 tonnes in 2019 from 4401 tonnes the year before (World Gold Council report, 2019) . from Table 1, Despite a decline in gold demand globally in 2019, the Ghanaian gold market saw profits. From table 2, LSM produced more gold (2,989,446) than SSM (1,588, 191) in 2019. This explains why ASM is so important in underdeveloped countries like Ghana. Due to the significant investment in the mining sector, the sector has seen tremendous expansion over the years. Consequently, the number of employees has doubled and output from the sector has grown significantly. Despite the fact that LSM companies are largely owned by foreigners more than 90 % of its employees are Ghanaians. this explains the contributions LSM has made to the employment situation in Ghana. Table 2 compares LSM and SSM gold output in Ghana over a 20-year period (2000–2020).

Table 2: Comparative gold production of LSM vs ASM from 2000 to 2020

Year	Output LSM (oz)	Output ASM (oz)	Total output	% Change
2000	2168802	145662	2314464	6.3
2001	2184313	185596	2369909	7.8
2002	2075954	160579	2236833	7.2
2003	2085070	221063	2306133	9.6
2004	1783400	246570	2029970	12.1
2005	1913534	225411	2138945	10.5
2006	2095553	247063	2342616	10.5
2007	2239678	388594	2628272	14.8
2008	2378012	418943	2796955	15.0
2009	2564095	555737	3119832	17.8
2010	2624391	767196	3391587	22.6
2011	2697612	978611	3691587	27.0
2012	2848409	1464781	4313190	33.96
2013	2808405	1441497	4249902	33.92
2014	2851885	1489722	4341607	34.31
2018	2804990	-	-	-
2019	2986837	-	4819900	-
2020			4633100	-

Source: Ministry of Finance (2019) **and** https://www.gold. org/goldhub/data/gold-supply-and-demand-statistics *****The production outputs for 2015, 2016, and 2017 could not be sourced as it was not available in the sourced documents.

2.3 Artisanal and Small-Scale mining policy in Ghana

A government-designed and enacted plan with the goal of obtaining desired results is known as a policy (Mabe, 2018). The various ASM policies aimed to give mining community members the chance to engage in small-scale mining and reap direct financial benefits from mining activities. More specifically, the policies are designed by the government of Ghana to ensure that residents living in mining towns participate in ASM by adhering to Mines and Minerals norms and regulations **(**Minerals Commission, 2021). The policies' main goals are to improve the standard of living in mining areas and to create jobs.

There have been numerous policy documents that outline the investment priorities of the government and development partners for Ghana's mining sector over the years. The mines and minerals policy documents of Ghana include the majority of ASM policies. Several governments have put a lot of effort into regulating and developing the ASM subsector because of the significance of ASM for livelihood, employment in mining communities, and its impact on the economy. The government of Ghana convened a multi-stakeholder dialogue on ASM in 2016. Among the stakeholders present were small-scale miners, both licensed and unlicensed, farmers, municipal assembly and local government officials, assembly members, chiefs, and traditional council members. The International Institute of Environment and Development (IIED) planned a series of international dialogues on ASM to aid in the sector's formalization based on human rights (McQuilken and Hilson, 2016). The conversation offered three directions for formalizing the ASM sector.

1. Access to capital, Miners are able to formalize their activities and gain power by having access to sustainable formal financial services. Their operations can then be optimized through reinvesting in support services .
2. The forum urged that the government allocate area for ASM activities and come up with plans to strengthen the Geological Survey Department's responsibility in terms of geological prospecting.
3. It was suggested that the government simplify the license process in order to benefit as many artisanal and small-scale miners as feasible. Decentralizing the licensing procedure will allow all miners to take use of these streamlined services, making it possible and more desirable for even the most disadvantaged people to obtain a license.

In 2015 government of Ghana designed an ASM policy framework which was aimed at mitigating the various challenges fronting the sector and leverage on it potentials to get the full benefit the sector presents (Mineral Commission, 2015). Among the challenges that were enlisted are:

i. environmental problems involving pollution and degradation;
ii. societal tensions caused by mining operations;
iii. over-reliance on mining conventional resources like gold, diamonds, bauxite, and manganese;
iv. lack of sufficient geological data to aid potential investors in the small- and large-scale mining (LSM) sub-sectors;
v. Insufficient technical and financial backing for upgrading SSM activities;

vi. distribution of mining profits that isn't fair to all parties involved ;

vii. Bringing the sector into closer alignment with the rest of the economy to raise the amount of retained mining earnings.

Among other things, the 2015 policy statement outlined the requirements for submitting an application for a license as a small-scale miner. Small-scale mining permits have a five-year lifespan and are extendable with good performance during the initial year (mineral commission, 2015). Therefore, in order to be eligible for a small-scale mining license, applicants must fulfill the following requirements:

1. The applicant must be a Ghanaian national.
2. Is registered by the Commission's office in a location authorized under Section 90(1) of Act 703 and has reached the age of eighteen.

Some relevant policy papers were taken into consideration in order to achieve a holistic, inclusive, and comprehensive policy, most notably the Minerals and Mining Policy, National Environmental Policy, National Land Policy, and Ghana Shared Growth and Development Agenda (GSGDA) (mineral commission, 2015). The government has implemented a number of measures intended to control and advance small-scale mining, with varying degrees of success. These include (a) establishing District Offices staffed with Minerals Commission members to offer technical assistance to small-scale miners, (b) conducting geological research and identifying regions that are suitable for small-scale mining, (c) offering small-scale miners financing to help them run their businesses

more successfully, and (d) providing logistics for their businesses more efficiently and safely.

The government takes the following actions to encourage opportunities for expansion in the small-scale mining sector, according to mineral commission (2015). 1. The government has created policies to increase small-scale miners' access to financing; 2. The minerals license system enables Ghanaian citizens to get mineral rights for small-scale mining activities. Thus, the licensing application process is made simpler 4. To encourage the adoption of suitable, affordable, and safe technology, the government has sponsored the gathering and dissemination of information about acceptable technologies, the provision of extension services, and the demonstration of superior technologies. 5. The government constantly updates and disseminates occupational health and safety standards for small-scale mining and alerts the public to health, safety, and environmental dangers in order to lessen the negative consequences of small-scale mining.

The government of Ghana introduced the Community Mining Scheme (CMS) operating manual in 2021 with the intention of eliminating illegal mining by enticing residents in mining areas to engage in ethical and sustainable mining in accordance with the Minerals and Mining Act, 2006. (Act 703)(Mineral Commission, 2021). Among the CMS's primary attributes are:

i. It is community based.

ii. In accordance with Section 81-99 of the Mineral and Mining Act of 2006, it is a small-scale mining enterprise (Act, 703).

iii. The scheme can also be operated under Large Scale Mining lease in line with the tributer system.

iv. Shall be supervised by a Community Mining Oversight Committee.

The requirement for a person or group of persons to participate in the CMS is as follows:

i. The scheme is reserved for only Ghanaians.

ii. The shame will be organized under a body cooperate, co-operatives or partnerships and sole proprietorship based in the community.

iii. Valid company registration document.

iv. Obtain the requisite license, permits and any other authorization from relevant regulatory bodies.

v. Demonstrate the capacity to invest a mining capital of GHC 100000 (which may be reviewed from time to time).

The government also adds a new layer to the administration of ASM operations called the Community Mining Oversight Committee in order to ensure effective monitoring, promoting, and development of ASM operations. The Community Mining Committee is tasked with the following duties along with the District Office of the Mineral Commission (Minerals Commission, 2021).

i. Overseeing the administration of the permitted area under the scheme.

ii. The registration of holders of small-scale mining license within the designated areas.

iii. Ensuring that illegal mining activities do not occur within the community.

One important feature of the Community Mining Oversight Committee is that it is Multidisciplinary. Thus, it includes experts from other sectors which will help to regulate the sector.

Table 3: Ghana's Small-Scale Mining laws and regulation

YEAR	LAW OR REGULATION COVERING ASM	SUMMARY WITH RESPECT TO ASM MINING LAWS AND REGULATIONS
Mining laws and regulations		
989	Legalisation of small-scale gold mining	A law was established to allow artisanal and small-scale gold mining.: The following activities are governed under PNDCL 218 (Small-scale Gold Mining Law of 1989): registration, granting individuals licenses to mine for gold, teams, as well as authorized cooperatives, obtaining a buyer's license and establishing district centers to support candidates.
989	Law of 1989 Regulating Precious Minerals Marketing Corporations (PNDCL 219)	authorized the Precious Minerals Marketing Corporation (PMMC) to acquire and sell gold and renamed the Diamond Marketing Corporation to reflect the change.
993	The Minerals Commission Act of 1993 (Act 450)	defined the duties and authority of the Minerals Commission (MinCom), which was established as a corporate body.
006	Mining and Minerals Act of 2006 (Act 703)	Mining and mineral legislation revision and consolidation act. enables the minister to specify locations for ASM operations after contacting MinCom. repeals several laws, such as the Minerals and Mining Act of 1986 and the Small-scale Gold Mining Law of 1989 (PNSDCL 218) (PNDCL 153), and includes current rules for Mineral and mercury sales, explosives usage, environmental licensing requirements, etc.
015	Amendments to the Minerals and Mining Act, 2014 (Mineral Development Fund Bill)	Act 703 proposed amendments to the Minerals and Mining Act of 2006. First, allowing unlicensed small-scale mining equipment to be confiscated , and Furthermore, the rate of royalty payments can now be prescribed by the Minister of Lands and Natural Resources (previously 5%).
GENERAL LAWS AND REGULATIONS AFFECTING ASM OPERATIONS		
1994	Environmental Protection Agency Act,1994 (Act 490)	The agency's duties include prescribing and enforcing environmental regulations, as well as awarding environmental permits.
1994	Water Resources Commission Act, 1996 (Act 552) and Water Use Regulations, 2001	Regulation of residential and commercial water consumption is necessary when MinCom, in cooperation with the EPA, determines that the anticipated use of the water necessitates the creation of an environmental management plan.
1999	National Land Policy	For the first time, a land policy plan has included a variety of existing land laws and regulations.

Sources: Ghana Legal (2015); FAO (2015*); *McQuilken & Hilson (2016)

2.4 Concept of household welfare

Welfare refers to a better state of affairs characterized by an improved standard of living, improved health, improved literacy / education of all or some household members, adequate housing or shelter, and improved sanitation in a multi-purpose approach that is equitably distributed to all members of the household or community. Pragmatically, the cardinal dimension of wellbeing pertaining to household include, good living standard / better consumption, improved health, education, better housing and improved sanitation. Measures of consumption, income and food security are commonly used to estimate household welfare. In contrast, asset-based wealth indices have grown increasingly popular as an alternative measuring measure of welfare in recent years (Moratti & Natali 2012). This research aims to determine, in the end, the important effects of provision of labourr services to ASM on welfare outcomes, taking these aspects, household consumption expenditure, and household income and household food security as proxy.

2.4.1 Household Consumption expenditure

Consumption is widely regarded as the favored single metric of welfare in developing countries by researchers. Consumption data, however, takes a long time and effort to get. In some cases, homes are required to keep a spending diary, which is then gathered during a second visit. Other polls rely on recall questions and give respondents a slew of detailed questions on their spending habits and home production usage. Imputing a value for the consumption of dwellings, durables, and home-produced commodities requires special consideration. Importantly, one of the most popular denominators used

to estimate household living standards is consumption spending. Unlike Household income, which is typically acquired in spurts, consumption is consistent over time. Consumption over a short period of time, such as a week or a month, might provide a good estimate of consumption over the course of a year. Thus, consumption spending is closely link to current living standard as compared to other measures.

2.4.2 Household food security

The definition of food security is discussed in recent literature. Food protection was first proposed at the 1996 World Food Summit as a situation where "all people have access to sufficient, secure, nutritious food at all times" (Nation, 1996). Bandiera and Rasul (2003**)** used a similar conceptual framework to explain food security as the number of months the household has food on hand for consumption. Thus, if a household's food supplies were insufficient for three months out of the year, there would be a risk of food shortages.

Four needs must be accomplished at once in order to provide food security: For health to be ensured, food must be available, accessible to everyone, meet nutritional criteria, and be constant enough throughout a person's life. These elements are interdependent and arranged hierarchically. Therefore, we will use this notion of food security in this study. Food supply, access, and use must be guaranteed throughout each person's lifespan in order to achieve food protection (Brown, 2014). It is emphasized that improving food security requires more than just access to and availability of food. These, however, shouldn't be seen as the only variables influencing food security as they represent only a small part of a much wider list of other variables determining food

security (Kalkuhl et al., 2016). For people's overall wellness and specific health concerns, it is still essential that they can adequately meet their nutritional demands, including those for micro- and macronutrients and qualitative or subjective dietary preferences. The distribution and allocation of resources within the home, cultural or behavioural norms, and additional usage-related issues, such as diseases or other circumstances requiring special diets, all have an effect on this skill. It is difficult and expensive to identify what prevents the use of food supply (such as the availability of per capita calories) or accessibility metrics, despite the fact that using food security is a crucial element at the individual level (e.g. the proportion of households with insufficient incomes to meet food and nutrition demands).

2.4.3 Total Household Income

The size of the household, the age of household head and composition of the household, work, education, health, social capital, and possessions and endowments are among the important factors that affect household income. Infrastructure, pricing, and environmental factors in the area, according to Benin and Randriamamonjy (2008), had a substantial impact on income. It is commonly established that household size, composition, and income are related. Once more, it is well recognized that having a large household and having many dependents lowers income per capita (Tuyen et al., 2014a).

In the context of other determinants, it is reliably demonstrated that family members' education increases rural household income (Estudillo et al., 2008). However, it is questionable if the age of family heads has any bearing on income. Younger heads

households have a higher likelihood of working non-farm employment, which may result in higher incomes in the future. However, elder working members of families tend to have a high level of job experience, which may help the households to earn more money (Tuyen, 2015).

It has been demonstrated in various nations that households belonging to big ethnic groupings generally have higher household earnings than those belonging to minorities (Barnard and Turner, 2011)**.** In China, the Han majority typically has more money than the smaller ethnic groups, and in India, the Hindu majority typically has more wealth than the other ethnic groups (Shahabuddin, 2014; Bhalla and Luo, 2017). The majority ethnic groups who live in developed countries tend to be affluent. For instance, despite having the same number of years of education, African Americans typically earn less money than White Americans (Weiss, 1970). Smaller ethnic groups make up about 25% of the population, which is double the percentage of Caucasians who live in poverty (Kenway and Palmer, 2007). Social exclusion is one of the primary causes of low income and high poverty among smaller ethnic communities. Thorat and Newman (2007) discovered that minority ethnic groups are more likely to be excluded from society in terms of the economy, politics, and other spheres of influence, including the legal system. Being a member of a minority ethnic group may have negative implications, including market and non-market discrimination.

Income is also increased by household characteristics including productive assets, credit availability, and land. In several emerging economies, rural households' ability to obtain formal or informal financial support raised their standard of living (Cuong, 2008**).**

In many underdeveloped countries, owning land increases household income. Additional research revealed that rural household income is significantly influenced by employment status, particularly non-farm employment (Tuyen, 2015). Studies have demonstrated that non-farm employment boosts household income in a number of nations (Ruben and Berg, 2001; Micevska and Rahut; Pham et al., 2012).

Rural people's income was also found to be influenced by community characteristics. For instance, the presence of rural roads as a necessary component of infrastructure raised 49 household income in Nigeria (Kassali et al., 2012). In Bolivia and Vietnam, rural residents' incomes were found to increase when power was made available to them (Khandker, 2009). Gauri (2001) also found that market accessibility and access to main roadways had a favorable effect on income in Bolivia. In a similar vein, local irrigation was introduced in Nigeria in order to raise household income (Tijani et al., 2014).

further, physical location has a substantial effect on income in a number of emerging nations. For instance, poor residents are more likely to reside in mountainous areas or remote areas of towns and cities (Gustafsson and Sai, 2009). Asmah (2011) discovered that the household head age coefficient is positive and significant, indicating that a farm household's welfare improves with age. According to the study, each extra child diminishes the likelihood of improved household welfare and increases the household's burden. In terms of education, the study found that the likelihood of enhanced wellbeing was higher the higher the level of education.

2.5 Farmers decision to mine and investigating income diversification

Recent literature has shown that miners have a variety of motivations that are caused by many different reasons. There are those who want to become wealthy quickly. According to Maconachie and Hilson (2011), the majority of miners merely look to the industry as a way to enhance their families' level of living and combat food poverty. Livelihood diversification into ASM sector with the purpose of expanding into the nonfarm economy since they feel doing so will provide them with additional revenue. Other regions of sub-Saharan Africa are seeing an increase in rural livelihood diversification as a way to make up for small-scale farming's inability to provide economically viable livelihoods (Maconachie and Hilson, 2011).

The decision to merge seasonal mining and farming operations is increasingly common in Ghana's mining communities. The connections between the rural agricultural and ASM sectors, according to Maconachie and Binns (2007), are essential for upholding sustainable lifestyles and may even be helpful in reviving the rural economy. Diversifying one's sources of income is also a common reality in metropolitan regions as people attempt to spread out their economic risks and opportunities.

Maconachie and Hilson (2011) attribute the surge in ASM to crisis-driven diversification. However, Cartier and Bürge (2011) report that artisanal mining should not be viewed as a substitute for sustainable lives; rather, it should be acknowledged and cherished as an additional source of income. Thus, in the rural communities with few prospects for young people and destitute rural populations, artisanal mining

presents an intriguing choice. ASM can rejuvenate small-scale agriculture by taking it beyond subsistence level thanks to the money it generates.

Agriculture's seasonal characteristics and ASM may be complementary (Cartier and Bürge, 2011). Due to wet season costs, mining is highly seasonal . Rising groundwater levels consequently affect other deposits, and in the case of northern Ghana, pits fill with water when the rainy season begins in May/June. Therefore, draining the pits costs a lot of money, making mining unprofitable. ASM is closely tied to and significantly improves the activities of the agricultural cycle in many ways, claim Maconachie and Hilson (2011). Beyond the obvious fact that farmers are miners and miners are farmers, i.e., their seasonal shift in labour, there are other instances of mining activities connecting with the local farming sector, which must be improved to create more sustainable livelihoods. A rise in consumer demand, especially for food, is evident in mining districts (Maconachie and Binns, 2007). Farmers engage in mining activities during the dry season when farming is considerably less labour-intensive. Due to the high costs of mining during the rainy season, agriculture may actually complement the mining cycle for some artisanal gold miners.

2.6 ASM and household welfare, microeconomic perspective

The impact of mining on livelihood has been minimal at the microeconomic level. Numerous studies show that the government and other important parties receive the majority of mining revenues, while the communities where the minerals are mined bear the brunt of the costs (Dontala et al., 2015). Despite having the potential to create local employment, the ASM sector is mostly unregulated, making it difficult to collect official

data and virtually impossible to evaluate (Worlanyo et al., 2022). ASM give a range of microeconomic livelihoods assistance to people, neighbouring communities, and distant communities in the midst of all of this.

Despite that the impact of mining on the microeconomic level has not been thoroughly studied. Widana (2019) asserted that some mining employees, particularly families that are actively involved in the industry, derive nearly 90% of their income from mining-related activities. Gold miners in Kenya earn roughly USD140 per month, according to Barreto et al. (2018), which helps to continue their livelihood in a number of ways. Reinvesting greater revenues and infrastructure in the same region where mining concessions exist, according to Hentschel et al. (2012), can have a multiplier effect, with the majority of individuals benefiting. Despite the lack of data on small-scale miners, a lot of the miners are locals who earn a lot of money from ASM and the proceeds are reinvested in the local economy which has the capacity to expand the local economy. Furthermore, presence of ASM in a particular location stimulates product and service demand by increasing buying power. In small-scale mining villages, the residents engage in income-generating activities dues to the increase in the population and increase in demand for basic necessities (Emmanuel et al., 2018). They also form supplementary enterprises or affiliates to ASM as a result of this. Some of the people who take part in these complementary activities go on to employ others. Thus, the existence of mining concessions in a locality has a positive spill-over effect on the other sector of the local economy.

Further, Bansah et al. (2018) revealed that most rural women have turned to ASM as a means of survival as a result of agriculture's marginalization. Consequently, the effects of mining on the microeconomies should be seen as a form of economic activity that encourages the creation of complementary and sustainable sources of financing for small business owners (Zhang and Moffat, 2015; Mason et al., 2014) .ASM contribution to the local economy is significant because it has given marginalized women in agriculture an alternative livelihood.

2.7 Influence of Mining on Livelihood Strategy of Smallholder Farmers

In order to achieve their intended livelihood outcome, In the sustainable livelihood framework developed by Scoones (1998), smallholder farmers in mining communities use three categories of livelihood strategies. Thus, "agricultural intensification, livelihood diversification, and migration. Numerous studies in Sub-Saharan Africa have discovered that all three livelihood options are widely used in diverse portfolios in the region's intertwined mining and farming economies (Hilson, 2016). Farmers increase food production to satisfy demand while boosting food costs as a result of reduced arable farmland due to mining activities (Danquah et al., 2017). A significant increase in food demand in mining communities has led to some smallholder farmers increasing agriculture production to meet the demand for food caused by the influx of migrants

As rural-rural migrations are well known for short-term coping mechanisms for disadvantaged families to adjust to shocks, they also contribute to population growth in mining communities (McDowell and De Haan, 1997; Davies, 1996). Smallholder farmers adopt the various forms of livelihood framework to mitigate the effect of

mining. Some of the farmers unfortunately abandon their homes and communities and seek shelter somewhere because of the threat mining poses to their farming livelihood. However, farmers transfer the traditional inputs of production between agriculture and mining at different time. Hence, in the dry season, farmers supply labour and capital for mining activities and in the raining season, farming use the labour and proceeds from mining to undertake farming activities.

Similar to this, research on livelihood techniques carried out in Tanzania and Malawi showed that smallholder farmers practice intercropping, Furthermore, the raising of livestock as an agriculture-based (on-farm) livelihood activity to maintain the household and bring in money (Kadigi et al., 2007; Ellis et al., 2003). According to Ellis et al. (2003), wealthy farmers in some villages in Malawi are obligated by social custom to hire their less fortunate neighbours.

2.8 Mining social responsibility programs in Ghana

Mining corporations in Ghana are able to provide Alternative Livelihood Program (ALPs) for displaced populations thanks to corporate social responsibility, which lessens their reliance on the mining companies for economic support (Doso Jnr et al., 2015). In order to help the affected communities, Golden Star Resources (GSR) established the Golden Star Oil Palm Plantation (GSOPP) in 2007. The initiative's purpose was to solve concerns related to the environment, food security, and community. Traditional authority provided more land, and deteriorated mining waste disposal sites were repurposed for oil palm agriculture. The effort, which aims to reduce unlawful ASM in the area, also serves as a source of employment and a means of

restoring damaged land. GSR supplied the first funding for GSOPP with a $1 per ounce of gold produced (GSR, 2013). LSM unlike ASM develop ALP for the people of the mining communities to put their deteriorated lands to alternative uses and make their economy resilient.

Together with Opportunities Industrialization Centers International (OICI), A partnership between Goldfields Ghana Limited (GFGL) and Anglogold Ashanti (AGA) has been established to empower and develop the mining community economically. In 16 stakeholder communities where the mining firms operations had an influence, the sustainable community Empowerment and Economic Development (SEED) program was started (GFGL, 2010). Projects such as oil palm plantations and fish farms were included. GFGL (2010) reports that over 263 farmers from stakeholder communities have been provided with over 1 7,000 oil palm seedlings, and eight tilapia and catfish ponds have been constructed and stocked (GFGL, 2010). Among the ALPs LSM provides to affected communities are programmes aimed at improving their wellbeing and developing their local economies.

2. 9 Institutional measures by the Government of Government

Ghanaian government has taking various institutional measures in order to minimize the negative effects of mining and leverage on its benefits to alleviate poverty and create wealth. Thus, Ghana's government has adopted a regulatory role and is rapidly privatizing the mining sector since the introduction of SAP (Minerals and Mining Policy (MMP), 2014). Mining governance is complicated by the fact that it involves a wide range of institutions. At the national level, the president, parliament, and central

government ministries, departments, and agencies are located, whereas Local state governments, as well as civic or non-profit institutions, are located at the state level (MMP, 2014). Mining is a sector which cannot be managed by one department or agency as its management is multifaceted and complicated. Thus, its governance requires a coordinated policy and programmes from well-defined department and agencies.

A study conducted by Danquah et al. (2017) examined how mining affects rural livelihoods through institutions in Ghana's Amansie West district, finding that only three institutions, out of the district's 13 stakeholder institutions, were effective in providing the needed support to rural households, according to the respondents. Farmers' rights against unlawful mining land takeover, demonstrations of new production techniques, and distribution of planting supplies and alternative livelihoods in the district were all covered by non-profit organization such as Care International and etc. (Ankomah, 2019).

Several institutional adjustments have been institutionalized since 2004 in order to mitigate environmental destruction and improve livelihood. Districts are prohibited from using tax transfer funds for capacity building, participatory ecological zoning, which includes land assessments. Thus, Water resources used by mining corporations can be tracked by scientists and stakeholders through participatory water monitoring (Bebbington and bury, 2009). Despite the fact that the innovations were born out of social disputes and some are yet imperfect, the possibility to resolve issues in their catchment areas amicably has been provided to mining enterprises. The state

government in Australia, however, is in charge of addressing the social effects of mining operations on host communities (Ankomah, 2019).

To address the environmental effects of mining, the Central Institute of Mining and Fuel Research (CIMFR) and the Council of Scientific and Industrial Research (CSIR) have worked in India on a number of initiatives (Ankomah, 2019). According to Singh & Singh (2016), different fragrant grass species are planted on contaminated soils to draw out heavy metals; to collect dust and turn it into fuel briquettes, a haul road dust collection system has been created; and to minimize noise, several opencast mines have implemented a scientific control blasting technology. Unlike Ghana, in other parts of the world the research institutes are well-resourced to develop initiatives to mitigate the environmental impact of mining.

2.10 Effect of ASM on the environment

Like all economic agents, mining has both favourable and unfavourable effects on society, the environment, and the economy. Some of it impacts are highlighted in this section.

One of the most fundamental and long-lasting environmental challenges of mining is land degradation. It is the sustained dysfunctional of ecosystem services brought on by shocks that the system is unable to recover from on its own (United Nations Evironment Programme (UNEP), 2016). Anthropogenic activities such as unsustainable mining and farming on dry land ecosystems can induce desertification (UNEP, 2016). Thus, more often, mining necessitates the removal plant cover in order to harvest mineral resources,

which lowers the amount of organic matter in the soil, depletes its nutrients, inhibits microbial activity, and weakens the soil's structural integrity. The soil particles are sealed when the soil surface is exposed for a long time.

The World Health Organization estimates that in 2012, 12.6 million individuals died as a result of residing or working in a polluted environment. Large amounts of waste rock materials containing dangerous trace elements are produced as a result of mining activities, causing widespread environmental damage. In samples of soil and food plantations from the Tarkwa mining in Ghana, Hayford et al. (2008) looked at the levels of dangerous elements concentration, and discovered that the amounts of arsenic and mercury in the cassava, plantain, and soil exceeded FAO and WHO recommendations for food and soil. According to Aragon and Rud (2012), pollution by mining companies, rather than a lack of inputs, has reduced agricultural output by almost 40% in certain Ghanaian communities employing agro production functions at the household level.

It is highly costly and difficulty frequently to remove contaminants from polluted water. Thus, Contaminants naturally accumulate in both surface and underground water as a result of the hydrologic cycle. The amount of poisons in the environment is nevertheless reduced by human endeavours like mining while simultaneously hastening the process by which these pollutants reach water sources. Surface water gets murky when suspended particles settle, dissolving soluble toxic chemicals and rendering the water unsuitable for human consumption. Pollutants are also leached into groundwater sources during rainstorms.

When lot of farmers fail to verify their ownership of farmlands in areas with informal land tenure arrangements, they are evicted unfairly. Conflicts between miners and farmers in society, particularly in places with limited fresh water resources, are also a result of water contamination caused by mining. Additionally, there is the conflict over land use between small-scale miners and farmers. Multinational firms and governments routinely deploy security forces to brutalize the weaker, smaller beneficiaries, such as farmers, in this case (Tockman, 2001).

Land use conflicts between miners and farmers have happened in rural areas across the world. Farmers' fears that mining is encroaching on areas that have historically belonged to them, along with the miners' lack of offer of alternative livelihood, can lead to violence (International Mining for Development Centre IM4DC, 2014). In Ghana, surface mining had resulted in the loss of 45 percent of agriculture, as relocated farmers build farms in forest reserves, this has had considerable spill-over impacts (Schueler et al., 2011).

2.11 Effect of ASM on smallholder farmers' welfare

On a more personal level, ASM acts as a lifeline for struggling farmers and citizens as well as a growth catalyst for SME's (small and medium-sized enterprises) (Worlanyo et al., 2022). Poor rural communities, according to proponents of mining and mineral growth, would gain from the expansion of the ASM sector because farmers will be able to use the money acquired from mining to expand their agricultural production (Wilson et al., 2015). Smallholder agriculture and ASM complement each other, according to Okoh & Hilson's (2011) argument; hence Many farmers depend heavily on ASM as a

source of income, therefore addressing both problems simultaneously is essential to bettering their lives. ASM provides farmers with an alternate source of income, particularly in places with long dry season such as northern Ghana. During the dry season, farmers provide labour services to ASM to generate income, however, during the rainy season, they invest heavily in agriculture (Okoh & Hilson 2011; McQuilken and , 2016). Furthermore, mining supply a range of fundamental amenities to mine towns, such as schools, clinics, and well-maintained roadways that allow agricultural goods to be transported (Aryee, 2012). The proponents of ASM argue that ASM is a complementary to Agriculture as oppose to substitute. Thus, a well-regulated ASM will help farmers to generate income to expand their agriculture productions. Additionally, people who currently mine their own land are more likely to reclaim and safeguard it for potential agricultural use in the future – taking advantage of mining's better profits to develop business acumen and raise money for upgrading, thus, becoming change agents who could influence the formalization of best practices in the future ASM (McQuilken and Hilson 2016). Figure 1 indicates that, from a downward spiral of conflicting land uses, depreciating assets, and declining productivity, the relationship between ASM and agricultural operations has improved, resulting in a cycle of investments and profitable livelihood activities.

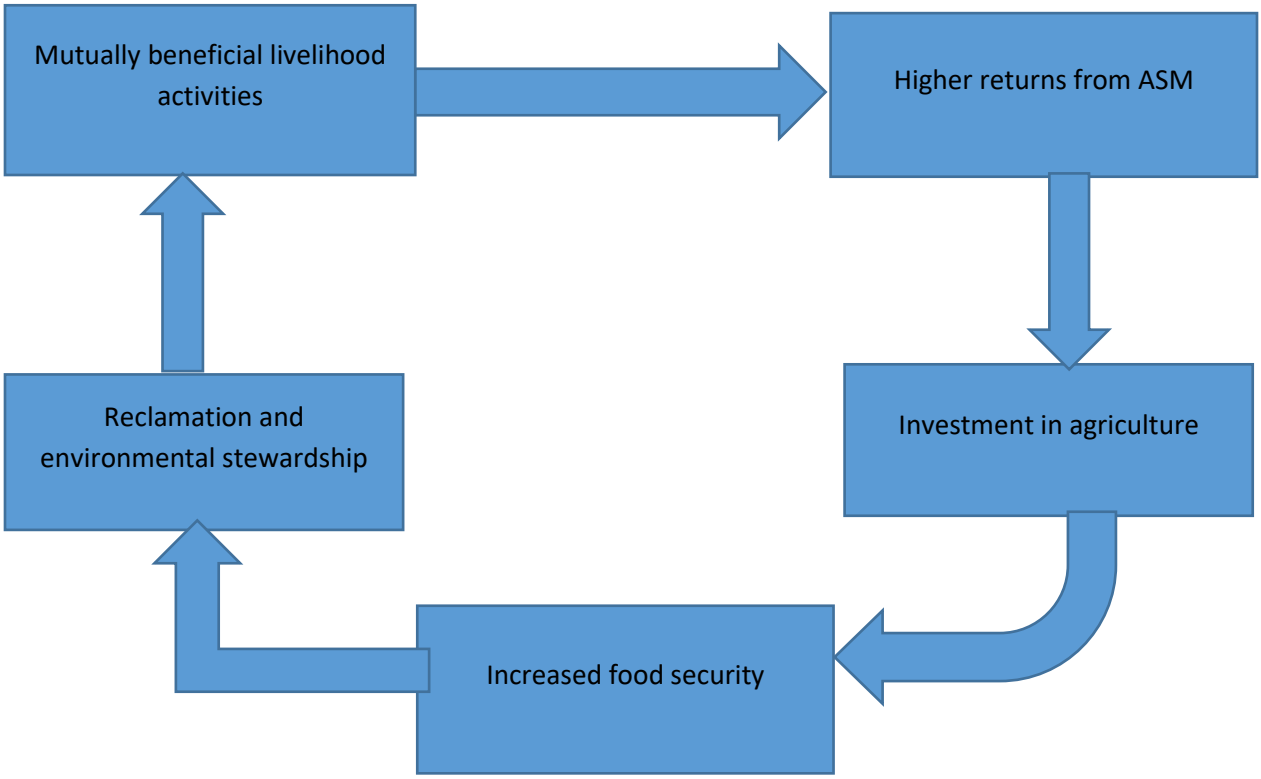

Figure 1 ASM and Agriculture: A Positive Feedback Loop.

Source: McQuilken and Hilson 2016.

Earlier and more recent studies on welfare effect of ASM (Amponsah-Tawiah and Dartey-Baah, 2011; Haddaway et al., 2018; Worlanyo et al., 2022) have outlined the various ways in which the operations of a ASM in a certain region may benefit and impact the lives of the local residents. According to these researchers, in addition to creating jobs, developing infrastructure, and providing basic services, such as adult literacy training and skills training, ASM has significant microeconomic impacts. Specifically, David et al. (2016) pointed out that mining companies provide residents with a range of services and amenities, such as clean drinking water, private schools, and community clinics. In addition, large-scale miners offer capacity-building workshops to farmers and other individuals within the operational region, as well as

inputs and extension services (Akudugu et al., 2013). For smallholder farmers, ASM is a source of non-farm revenues over the course of the year (Maponga & Ngorima, 2003; Hilson & Garforth, 2012; Akudugu et al., 2013). ASM helps farmers to boost their welfare, counteract food insecurity and protect them against external shocks. In light of the forgoing, this work investigates the welfare effect of ASM on smallholder farmers in the northern enclave of Ghana.

CHAPTER THREE

METHODOLOGY

3.1 Introduction.

An overview of the methodology of the study is presented in this chapter.

3.2 The Study Area

The study was conducted in northern Ghana. There are five regions in northern Ghana, namely Northern, Upper West, Upper East, North East and Savannah regions. Agriculture is the people's main source of income in northern Ghana. Most people are subsistence food crop growers who produce primarily for domestic consumption. Ivory Coast, Republic of Togo, and Burkina Faso border the northern region of Ghana on the west, east and north, respectively. For the south east, it is bordered by the Oti region and on the south west by then Brong-Ahafo region. The five regions have a combined land area of 95,000 km^2 and a population of 6371013 people (GSS, 2021). Two regions were chosen for this work (ie. Savanna region and Upper East region). The research was conducted in two districts: Bole in the Savannah area and Bawku West in the Upper East region. The districts were strategically chosen because they are the most populous in northern Ghana, where mining occurs. Figure 2 and 3 show the map of the selected regions and the study districts.

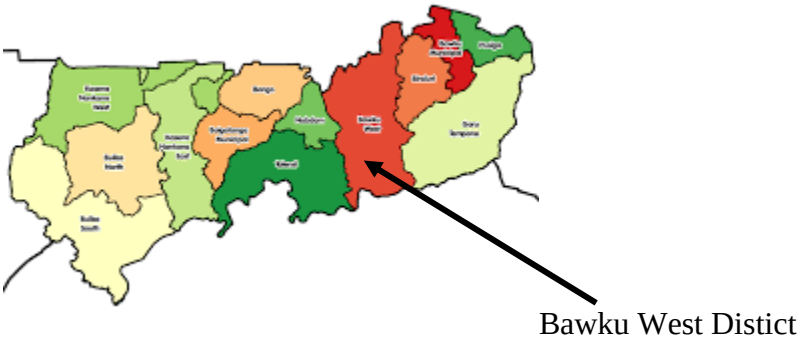

Figure 2: map of the Upper East Region

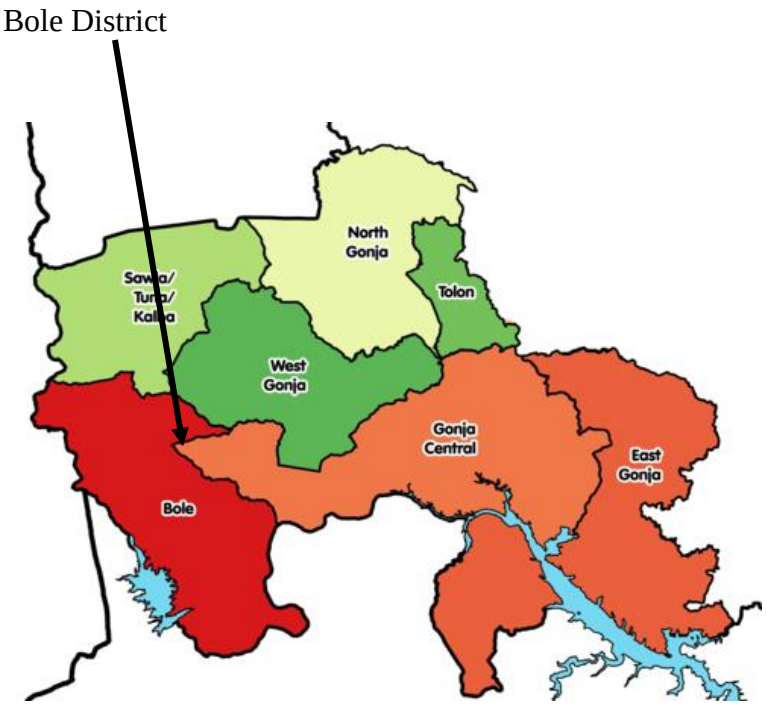

Figure 3: Map of the Savanna Region

3.3 Research Design

The study used a quantitative research design. Quantitative research design, according to Bryman, (2012) is a tool that deals with quantification in data gathering and analysis. The research was chosen based on the objectibve of the study.

3.4 Data Sources

An in-depth field survey was used to gather primary data for the study. Cross-sectional data from households in the targeted communities were gathered using a semi-structured questionnaire. The dataset includes details on household characteristics such as agriculture, work status, education, financial services, income, consumption spending, food security, etc. The information was gathered in 2019/2020 cropping season. Utilizing both probability and non-probability sampling procedures, interviews were performed with 200 households in eight mining communities. Face-to-face interwiews were conducted with household heads or their representatives who were older than 18 years.

3.5 Sample Size determination and Sampling technique

It is required to choose a sample from a population for a variety of reasons, including the availability of funds, time constraints, and the type of statistical investigation (Hair, 2006 and Saunders et al., 2009). However, it is important to choose the right sample size so that the conclusions and recommendations made will reflect the total population under study. Accondinly, the sample size (N) of the study was inspired by the formula of Green (1991), who estimated that the sample size should be equal to or more than 50+ 8(m), where m is the number of the explainatary variables used in the model. Given

that 18 explainatary variables were used in the models, the sample size was therefore determined as, N=50+8(18) = 194. However, the sample size was increased to 200.

A multistage sampling technique was employed. The five regions of northern Ghana were divided into regions having ASM and non-ASM activity in the first stage using a stratified sample technique. Two regions, namely Upper East and Savanna regions, were then selected purposively. The districts from the two regions were divided into districts with and without ASM activities using the stratified sampling technique; one district each with ASM activities was selected from upper East and Savanna regions using simple random sampling approach. At the community levels, eight communities, four each from each district, were selected using a purposive sampling due to the presence of ASM activities. Using simple random sampling technique, 25 households were selected from each of the eight communities.

3.6 Conceptual framework

A conceptual framework in social science research demonstrates the links between variables, ranging from a simple to a complex model (Mabe, 2018). As a result, it necessitates an in-depth examination and visualization of the interconnections between the various factors under consideration. Farmers' labour supply decisions and household welfare are influenced by institutional, farm-specific, and household specific factors. Figure 2 demonstrates the conceptual framework showing the connections between the dependent and independent variables.

Agricultural extension services, bank account ownership, access to credit, and access to subsidized fertilizer are among the institutional elements hypothesized to affect labour supply decisions. A farmer's decision to supply labour to ASM may be influenced by the availability and accessibility of institutional variables. Household dependency ratio, household labour size, age of the household head, level of education, agricultural experience, and distance to mining sites are household-specific characteristics that may s influence farmers' labour supply decisions. Farm size, soil fertility, and landholding are also important factors that may influence farmers' involvement in ASM. Participation in ASM may have an impact on farm households' revenue portfolio, as well as their consumption, spendings and food security levels. Small-scale mining, according to Akudugu et al. (2013), is a crucial tool for eradicating poverty and raising the level of national income in underdeveloped countries.

Age of the household head, formal education, household labour size, agricultural experience, and other socioeconomic characteristics influence households' welfare. Household labour size is substantial, which ensures high productivity and increases household welfare. Farm size, soil fertility, and landholding are other farm-specific characteristics hypothesized to affect household welfare. A higher degree of soil fertility lowers agricultural costs and ensures higher yields, which improves welfare. Bank account ownership, credit access, extension service, and access to subsidized fertilizer are all thought to impact welfare. Farmers' finances are bolstered by access to credit and Possession of a bank account, which serves as a stand-in for financial inclusion, and ensures efficient allocation of useful resources.

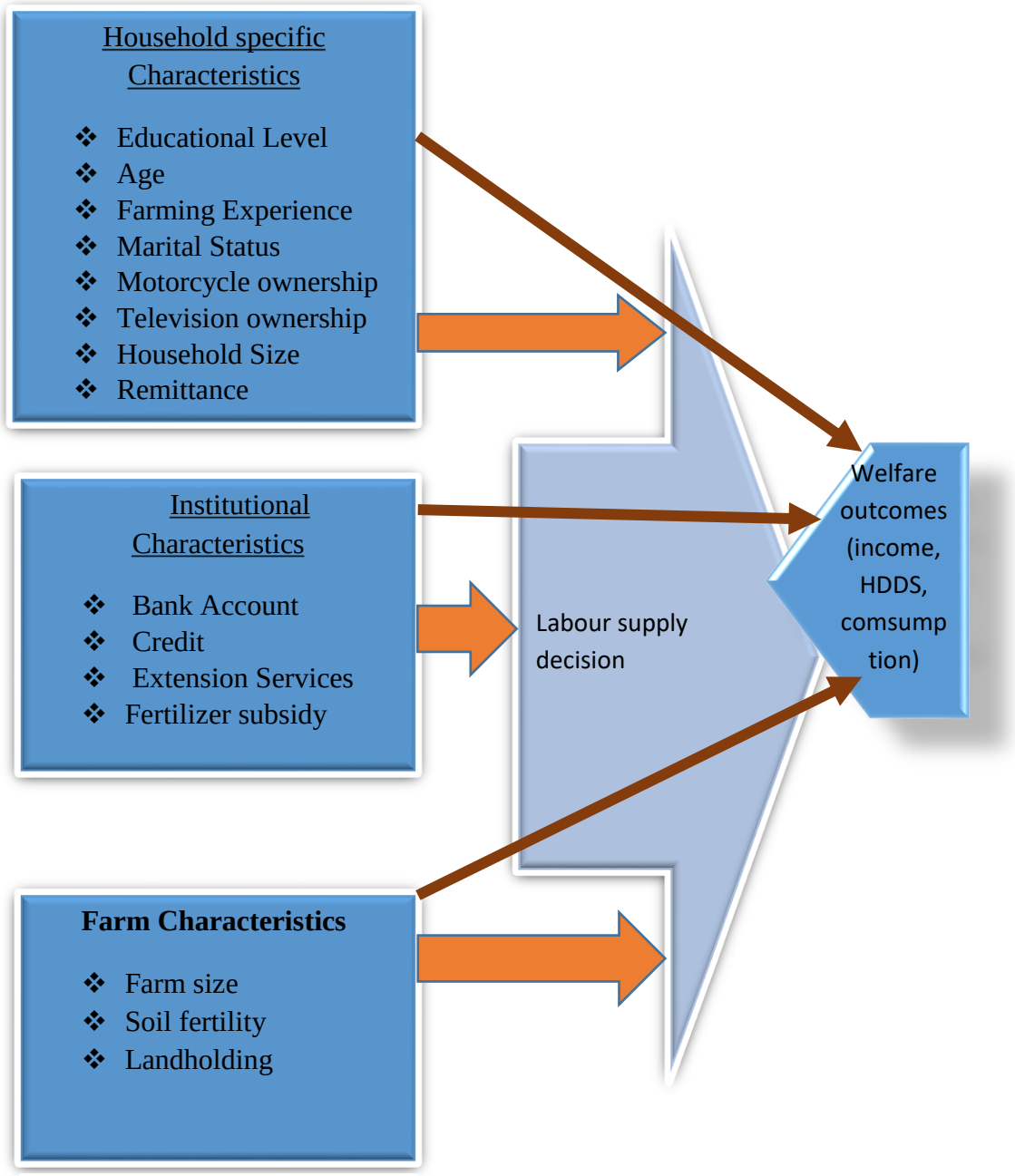

Figure 4: Conceptual Framework

Author's conceptualization

3.7 Theoretical and Analytical Framework

The research is based on the utility maximization theory and the random utility model. By deciding on labour supply to ASM, farmers are assumed to optimize their utility. Farmers are thought to have two options. As a result, a farm will either supply labour to ASM or not. Decisions made by the farmers are guided by the discrete choice model, founded on the random utility theory (McFadden, 1974). According to the Radom utility model, utility is latent and cannot be measured. Various socioeconomic, farm-specific, and institutional factors influence a farmer's decision-making. Gujarati (2006) assumes that the error term in the model is normally, independently, and identically distributed. The utility gained by farmer i as a result of a choice j is stated as :

$$U_{ij} = \beta_{ij} X_{ij} + \varepsilon_{ij} \qquad (1)$$

The utility derived from the supply of labour services is given as:

$$U_{1i} = X_{1i}\beta_1 + \varepsilon_{1i} \qquad (2)$$

The utility derived from non-supply of labour services is given as;

$$U_{0i} = X_{0i}\beta_0 + \varepsilon_{0i} \qquad (3)$$

Where: U_{ij} denotes the utility, an i^{th} farmer derives from the choice of j^{th} alternative, X_{ij} represents a vector of factors that are unique to households, farms, and institutions that influence participation, ε_i is the random error term which is normally, independently and identically distributed.

A farm household choice is based on the fact that the expected satisfaction derived from participation $E\ (U_1)$ is better than expected satisfaction from non-participation (U_0) . Thus $E\ (U_1)\ >\ E\ (U_0)$

The conditional probability is expressed as:

$$P(U=1|X)= P[E\ (U_1) >\ E\ (U_0)] \quad (4)$$

$$P(U=1|X)= P[(X_i\beta_i + \varepsilon_i) > (X_i\beta_i + \varepsilon_0)] \quad (5)$$

$$P(U = 1|X) = P[(X_i\beta_1 + \varepsilon_1) - (X_i\beta_0 + \varepsilon_0) > 0|X] \quad (6)$$

$$[P\ (U = 1|X)\ =\ PX_i(\beta_1 - \beta_0) + (\varepsilon_1 - \varepsilon_0) > 0|X] \quad (7)$$

$$P\ (U = 1|X)\ =\ P[(\beta^* X_i + \varepsilon^*) > 0|X] \quad (8)$$

$$P(U = 1|X) = F(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n) \quad (9)$$

Where P denotes the probability function, β^* is a vector parameter which must be determined, $\varepsilon^* = \varepsilon_1 - \varepsilon_0$ represents the random error term.

3.8 Empirical framework of econometric models

Almost every household in the research area is a small-scale farmer, and some of them also do ASM as a non-farm source of income. To evaluate the influence of ASM on household welfare, Farm household welfare outcomes need to be compared, thus, farmers who supply labour services to ASM (SS) and non-suppliers of labour services to ASM (non-SS). Household income and consumption expenditures, as well as food security, were evaluated as well-being outcomes. Two assumptions were taken into account. Households are considered as economic units that make consumption and

production decisions (Dagunga et al., 2020). Further, the indirect effects of ASM on welfare development, as a result of demand for local products and services, are uniformly distributed across all economic agents in mining areas. Therefore, the surge in food prices brought about by small-scale mining can benefit both SS and non-SS people by expanding their food production and launching businesses.

Based on the objectives, econometric models were employed to achieve the various objectives. Stata 14 was used to do the analysis. The probit model was used to determine the significant factors affecting the provision of labour services to ASM. Additionally, the impacts of ASM on farm households' welfare were estimated using the Endogenous Switching Regression Model (ESRM).

3.8.1 Determinants of provision of labour services of farmers: Probit model

Engagement in ASM is binary. Thus, either a farm household is involved in ASM or otherwise. If a household head provides labour to ASM, his value is represented as 1, otherwise it is 0. The probit model's dependent variable is a dummy that indicates whether or not a farm household offers labour services to ASM. Therefore, a farm household chooses to take part in ASM if the projected benefit of doing so outweighs not taking part. The observed dependent variable is **Y** and Y^* is the unobserved latent variable. The expected utility Y* is therefore not observed, but participation decision (Y) is observed. The participation decision is assumed to be a dichotomous choice; thus, the dependent variable If Y*>0, then Y takes a value of 1; otherwise, then Y takes a value of 0. Thus, the unobserved latent variable is observed through participation. Following the underlying latent variable approach, Consequently, a probit model was

used to estimate the factor that determines the provision of labor services. Mathematically, the standard probit model is specified as:

$$Y = \begin{Bmatrix} 1\ if\ Y_i^* > 0 \\ 0\ if\ otherwise \end{Bmatrix} \quad (10)$$

Where: $Y_i^* = X\beta + e$ (11)

X is a vector of independent variables, β is the unknown parameters and e is the random error term.

The probability that Y=1 is given as:

$$P(Y = 1) = P(Y_i^* > 0) \quad (12)$$

$$P(Y = 1) = P(X\beta + e > 0) \quad (13)$$

$$P(Y = 1) = P(e > -X\beta) \quad (14)$$

$$P(Y = 1) = 1 - P(e < -X\beta) \quad (15)$$

$$P(Y = 1) = 1 - F(-X\beta)p \quad (16)$$

F is the cumulative distribution function of the error term (e).

As in the case of Probit F is symmetric about 0 therefore:

$$P(Y = 1) = F(X\beta) = \varphi(X_i\beta_i) \quad (17)$$

In order to estimates the parameters β_i, maximum likelihood estimation method was used. Maximum likelihood method was used because it is the approach used when estimating non-linear parameters.

The general likelihood function is expressed as:

$$L\left(\beta/_y\right) = \prod[F(x'\beta)]^{y_i}[1 - F(x'\beta)]^{(1-y_i)} \quad (18)$$

In order to linearize it, take log of both sides

$$\ln L\left(\beta/_{y}\right) = \sum_{i=1}^{n} y_i lnF(x'\beta) + (1 - y_i)\ln(1 - F(x'\beta)) \qquad (19)$$

3.8.2 Effects of provision of labour services to ASM on farm households' welfare.

In order to investigate the effect of farmers' participation in ASM on welfare, Farmers are supposed to be rational individuals who will decide to participate if the anticipated gain is larger. Furthermore, when evaluating the effects of ASM on welfare, attributing the difference in welfare to ASM is incorrect because other socioeconomic variables could account for the difference. Because the data is cross-sectional and there are no counterfactuals; to assess the impact of ASM participation in ASM on welfare, the Endogenous Switching Regression Model (ESR) was used. Also, the ESR can detect and correct selection bias. Selection bias is an econometric problem in which unobserved factors affect the error terms of both the selection and outcome equations. Furthermore, unlike PSM and OLS, the ESR is capable to simultaneously estimating the two equations (outcome and selection equation). The primary purpose of the PSM is to achieve a balance in the observed covariate distribution between adopters and non-adopters (Abdulai et al. 2014). The ESR is a generalized version of Heckman's selection technique. Unlike Heckman's selection method, the ESR divides SS and non-SS welfare outcomes based on the assumption that factors influencing the welfare differ. In the ESR technique, the farmers are split into two groups: SS and non-SS, to help identify the variations in responses (Abdulai et al. 2014).

A probit model is the initial step of the ESR model. As a result, when the projected benefit derived from ASM is larger than the utility derived from not involvement, a

farm household decides to participate in ASM. The participation decision was modelled as follows using the underlying latent variable variable.

$$Y = \begin{Bmatrix} 1\ if\ Y^* > 0 \\ 0\ if\ otherwise \end{Bmatrix}$$

$Y^* = X\beta + \varepsilon$

Given that a farm household would either choose to be an SS or non-SS, the welfare outcomes of the two classifications are expressed below.

Regime 1 (SS) j=0: $Y_{jSS} = X'\beta_{jSS} + \varepsilon_{jSS}$ (20)

Regime 2 (non-SS) j=1: $Y_{jNS} = X'\beta_{jNS} + \varepsilon_{jNS}$ (21)

Y_{jSS} and Y_{jNS} are the expected welfare outcomes for the SS and the non-SS respectively, X' is a vector of independent variables, β_{jss} and β_{jns} are parameters to be estimated for the SS and non-SS respectively and ε_{jss} and ε_{jns} are the random error terms for the SS and the non-SS respectively.

Note, the selection problems occur when the error term ε of the selection equation interact with the error terms of the outcome equation ε_{jSS} and ε_{jNS} (Huang et al., 1991). As a result, unobserved Farmer managerial skills and abilities, for example, affect both participation decisions and welfare outcomes, biasing the computed parameter. The following covariance matrix and mean vector zero are believed to be properties of the trivariate normal distribution that applies to the error terms:

$$cov(\varepsilon, \varepsilon_{jss}, \varepsilon_{jns}) = \begin{bmatrix} \sigma^2_{\varepsilon_{jns}} & \sigma_{\varepsilon_{jns}\ \varepsilon_{jss}} & \sigma_{\varepsilon_{jns}\varepsilon} \\ \sigma_{\varepsilon_{jss}\ \varepsilon_{jns}} & \sigma^2_{\varepsilon_{jss}} & \sigma_{\varepsilon_{jss}\varepsilon} \\ \sigma_{\varepsilon\varepsilon_{jns}} & \sigma_{\varepsilon\varepsilon_{jss}} & \sigma^2_{\varepsilon} \end{bmatrix} \quad (22)$$

In the presence of selection bias, the expected value of the error terms in the outcome equation are non-zero conditional on participation. Thus, to get solution to the above problem the expression for $E\left({}^{\varepsilon_{jss}}/_{Y=1}\right)$ and $E\left({}^{\varepsilon_{jns}}/_{Y=0}\right)$ need to be found.

$$E\left({}^{\varepsilon_{jss}}/_{Y=1}\right) = E\left({}^{\varepsilon_{jss}}/_{(\varepsilon > -X\beta)}\right) = \sigma_{\varepsilon_{jss}\varepsilon}\frac{\emptyset(X_i\beta_i)}{\varphi(X_i\beta_i)} = \sigma_{\varepsilon_{jss}\varepsilon}\gamma_{jss} \quad (23)$$

$$E\left({}^{\varepsilon_{jns}}/_{Y=0}\right) = E\left({}^{\varepsilon_{jns}}/_{(\varepsilon \leq -X\beta)}\right) = \sigma_{\varepsilon_{jss}\varepsilon}\frac{-\emptyset(X_i\beta_i)}{1-\varphi(X_i\beta_i)} = \sigma_{\varepsilon_{jns}\varepsilon}\gamma_{jns} \quad (24)$$

Where φ and $\emptyset$ are cumulative and probability density distribution function of The standard normal distribution, respectively.by substitution, the equations, (20) and (21) can be expressed as (Maddala, 1983):

Regime 1 (SS) j=0: $Y_{jSS} = X'\beta_{jSS} + \sigma_{\varepsilon_{jss}\varepsilon}\gamma_{jss}$ (25)

Regime 2 (non-SS) j=1: $Y_{jNS} = X'\beta_{jNS} + \sigma_{\varepsilon_{jns}\varepsilon}\gamma_{jns}$ (26)

OLS estimates of the equation (20) and (21) will lead bias estimate of the parameters, as $\sigma_{\varepsilon_{jss}\varepsilon}\gamma_{jss}$ and $\sigma_{\varepsilon_{jns}\varepsilon}\gamma_{jns}$ would be omitted. This is only true if selection bias is present and $\sigma_{\varepsilon_{jss}\varepsilon}$ and $\sigma_{\varepsilon_{jns}\varepsilon}$

Takes non-zero value.

Empirically, the expected welfare outcome for the SS is represented as:

$$Y_{1ss} = \beta_{ss0} + \beta_{ss1}\text{age} + \beta_{ss2}prop_{economicactive} + \beta_{ss3}\text{Motorbike} + \beta_{ss4}TV + \beta_{ss5}Edu.level + \beta_{ss6}Distancetosite + \beta_{ss7}extension\ visits + \beta_{ss8}bankaccount + \beta_{ss9}cashcrop + \beta_{ss10}remittance + \beta_{ss11}\text{Fertilizer} + \beta_{ss12}\text{credit} + \beta_{ss13}\text{farmexperience} + \beta_{ss14}\text{Location} + \text{landownership}_{ss15} + \text{farmsize}_{\text{ss16}} + \sigma_{\varepsilon_{1ss}\varepsilon}\gamma_{1ss}$$

For the non-SS, the expected welfare outcome can be empirically expressed as :

$$Y_{0ss} = \beta_{ns0} + \beta_{ns1}\text{age} + \beta_{ns2}prop_{economicactive} + \beta_{ns3}\text{Motorbike} + \beta_{ns4}TV + \beta_{ns5}Edu.level + \beta_{ns6}Distancetosite + \beta_{ns7}extension\ visits + \beta_{ns8}bankaccount + \beta_{ns9}cashcrop + \beta_{ns10}remittance + \beta_{ns11}\text{Fertilizer} + \beta_{ns12}\text{credit} + \beta_{ns13}\text{farmexperience} + \beta_{ns14}\text{Location} + \text{landownership}_{ns15} + \text{farmsize}_{\text{ns16}} + \sigma_{\varepsilon_{0ns}\varepsilon}\gamma_{0ns}$$

Where: β is the unknown parameter to be determined, Y_j is the expected welfare (i.e HDDS, consumption expenditure and income) outcome.

The effect of ASM on household's welfare is of particular importance in this study. The expected welfare of SS was compared to the counterfactual case in which the farmer did not participate in ASM using an ESR. A hypothetical household expected welfare outcome is determined after accounting for endogeneity, i.e., the alternative choice. In

order to calculate conditional expectations and counterfactual hypothetical cases, the following methods are used (Maddala, 1983):

$$E\left(Y_{jss}/Y=1\right)=X_1'\beta_{jss}+\sigma_{\varepsilon_{jss}\varepsilon}\gamma_{jss} \quad \text{SS} \quad (27)$$

$$E\left(Y_{jns}/Y=0\right)=X_0'\beta_{jns}+\sigma_{\varepsilon_{jns}\varepsilon}\gamma_{jns} \quad \text{non-SS} \quad (28)$$

$$E\left(Y_{jns}/Y=1\right)=X_1'\beta_{jns}+\sigma_{\varepsilon_{jns}\varepsilon}\gamma_{jss} \quad \text{SS counterfactual} \quad (29)$$

$$E\left(Y_{jss}/Y=0\right)=X_0'\beta_{jss}+\sigma_{\varepsilon_{jss}\varepsilon}\gamma_{jns} \quad \text{Non-SS counterfactual} \quad (30)$$

Average Treatment Effect on the Treated (ATT) it is the change in welfare of a household due to participation in ASM. It is the difference in household welfare between a participant farmer and the counterfactual. Thus, it is the extra welfare benefit an SS household enjoys due to participation in ASM and it is expressed as follows:

$$E\left(Y_{jss}/Y=1\right)-E\left(Y_{jns}/Y=1\right)=\left(X_1'\beta_{jss}+\sigma_{\varepsilon_{jss}\varepsilon}\gamma_{jss}\right)-\left(X_1'\beta_{jns}+\sigma_{\varepsilon_{jns}\varepsilon}\gamma_{jss}\right) \quad (31)$$

$$=X_1'(\beta_{jss}-\beta_{jns})-\gamma_{jss}(\sigma_{\varepsilon_{jss}\varepsilon}+\sigma_{\varepsilon_{jns}\varepsilon}) \quad (32)$$

In this analysis, we are interested in the difference between the expected welfare with and without participation in ASM of the SS.

Also, Average Treatment Effect on the Untreated (ATU) is the change in welfare of a non-SS household if it were to participate. Thus, it is the extra benefit a non-SS housewhold would have enjoyed if it were to participate in ASM. It is mathematically specified as:

$$E\left({}^{Y_{jSS}}/_{Y=0}\right) - E\left({}^{Y_{jnS}}/_{Y=0}\right) = \left(X_0'\beta_{jSS} + \sigma_{\varepsilon_{jss}\varepsilon}\gamma_{jns}\right) - \left(X_0'\beta_{jnS} + \sigma_{\varepsilon_{jns}\varepsilon}\gamma_{jns}\right) \quad (33)$$

$$= X_0'\left(\beta_{jss} - \beta_{jns}\right) - \gamma_{jns}\left(\sigma_{\varepsilon_{jss}\varepsilon} + \sigma_{\varepsilon_{jns}\varepsilon}\right) \quad (34)$$

3.9 A priori expectation of variables used in the models

Age of household head: Farm labour force age range and livelihood activities are more affected by the age of respondents . Younger smallholder farmers' livelihood portfolios are increasingly diverse. According to GSS (2014), the most productive years of a person's life are between the ages of 26 and 35. Furthermore, when compared to females of the same age, males are more likely to be given farmland ownership by family heads. Consequently, female smallholder farmers are unable to acquire land titles, which they could use for income generation.

Remittance: Some smallholder farm households use migration of some household members as a tactic to improve household welfare. Consequently, migrants can earn additional income and, in turn, send remittances back home to support their families (Tolossa, 2010).

Household size: Human capital (household size) can contribute to agricultural preparation for sowing, as well as be a source of labour. However, for smallholder farm household, the bigger household sizes have both bad and good repercussions. A bigger household size (more than 5 people, UN, 2017) can diminish the family's share of farmland and food production. Nevertheless, large household size can also contribute to economic activities and caring for the elderly and disabled.

Farming experience: An increase in experience in farming can help farmers maximize their assets and achieve satisfying welfare outcomes by optimizing their natural resources.

Level of education: According to Department for International Development (DFID) (1999), education is crucial in the fight against poverty. People with higher education have access to information, knowledge, and cognitive abilities that can be used to integrate different desirable livelihood choices to build a long-term portfolio (Oxenham et al., 2002).

Table 4: Description of variable and a priori expectation of determinants of supply of labour to ASM by farmers

Variable	***Description***	***Measurement***	***A priori expectation***
Age	Respondents' age	Years	-
Soil fertility	Fertility level of farmland for cultivation	Low Medium High	-
Years in Farming	How many years respondent has been farming	Number of years	+/-
Years in school	How many years respondents has spent in school	Number of Years	+/-
Household Size	Number of people Eating form on cooking pot	Number of people	+/-
Total farmsize	Total farm size in acres	Acres	-
Bank account	Whether a farmer owns bank account	1 if yes 0 if otherwise	+/-
Ownership of television	Whether a respondent owns television	1 if yes 0 if otherwise	+/-
Agriculture extension visit	Whether a household received agriculture extension visit	1 if yes 0 if otherwise	-
Access to Electricity	Whether a household have access to electricity supply	1 if yes 0 if otherwise	+/-
Land ownership	Ownership status of land used for forming	1 if owned 0 if rented	+/-
Access Subsidized fertilizer	Whether a farmer obtained subsidized fertilizer	1 yes 0 no	-
Distance to mining site	Distance from resident to mining sites	Km	-

Table 5: Description of variables and a priori expectation of determinants of HDDS

Variable	***Description***	***Measurement***	***A priori expectation***
Age	Respondents' age	Years	-/+
Soil fertility	Fertility level of farmland for cultivation	Low Medium High	+
Years in Farming	How many years respondent has been farming	Number of years	+
Years in school	How many years respondents has spent in school	Number of Years	+
Proportion of active labor force	Number of people between the ages of 15-64 divide by HHsize	Number of people	+
Total farmsize	Total farm size in acres	Acres	+
Bank account	Whether a respondent owns bank account	1 if yes 0 if otherwise	+/-
Ownership of television	Whether a respondent owns television	1 if yes 0 if otherwise	+
Agriculture extension visit	Whether a household received agriculture extension visit	1 if yes 0 if otherwise	-/+
Access to Electricity	Whether a household have access to Electricity supply	1 if yes 0 if otherwise	+/-
Land ownership	Ownership status of land used for forming	1 if owned 0 if rented	+/-
Access Subsidized fertilizer	Whether a farmer obtained subsidized fertilizer	1 yes 0 no	+
Distance to mining site	Distance from resident to mining sites	Km	+

Table 6: Description of variable and a priori expectations of determinants of Household consumption expenditure.

Variable	***Description***	***Measurement***	***A priori expectation***
Age	Respondents' age	Years	-
Soil fertility	Fertility level of farmland for cultivation	Low Medium High	+
Years in Farming	How many years respondent has been farming	Number of years	+
Years in school	How many years respondents has spent in school	Number of Years	+
Proportion of active labor force	Number of people between the ages of 15-64 divide by HHsize	Number of people	+
Total farmsize	Total farm size in acres	Acres	+
Bank account	Whether a respondent owns bank account	1 if yes 0 if otherwise	+/-
Ownership of television	Whether a respondent owns television	1 if yes 0 if otherwise	+
Agriculture extension visit	Whether a household received agriculture extension visit	1 if yes 0 if otherwise	-/+
Access to Electricity	Whether a household have access to electricity supply	1 if yes 0 if otherwise	+/-
Land ownership	Ownership status of land used for forming	1 if owned 0 if rented	+/-
Access Subsidized fertilizer	Whether a farmer obtained subsidized fertilizer	1 yes 0 no	+
Distance to mining site	Distance from resident to mining sites	Km	+

Table 7: Description of variable and a priori expectation of determinants of household income.

Variable	***Description***	***Measurement***	***A priori expectation***
Age	Respondents' age	Years	-
Soil fertility	Fertility level of farmland for cultivation	Low Medium High	+
Years in Farming	How many years respondent has been farming	Number of years	+
Years in school	How many years respondents has spent in school	Number of Years	+
Proportion of active labor force	Number of people between the ages of 15-64 divide by HHsize	Number of people	+
Total farmsize	Total farm size in acres	Acres	+
Bank account	Whether a farmer owns bank account	1 if yes 0 if otherwise	+/-
Ownership of television	Whether a farmer owns television	1 if yes 0 if otherwise	+
Agriculture extension visit	Whether a farmers received agriculture extension visit	1 if yes 0 if otherwise	-/+
Access to Electricity	Whether farmers have access to Electricity supply	1 if yes 0 if otherwise	+/-
Land ownership	Ownership status of land used for forming	1 if owned 0 if rented	+/-
Access Subsidized fertilizer	Whether a farmer obtained subsidized fertilizer	1 yes 0 no	+
Distance to mining site	Distance from resident to mining sites	Km	+

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the work's findings and results. In the chapter, sampling farm households from a few chosen ASM villages in northern Ghana are described in terms of their socioeconomic traits. Factors affecting household's welfare (i.e. Food security, income and consumption expenditure) in the study area are adequately discussed. The factors determining the farmers' decision to provide labour services for ASM activities and the effects of participation in ASM on farm households' welfare are discussed.

4.2 Descriptive statistics of respondents

Various socioeconomic and demographic traits of the sampled households are covered in this section. Thus, the section discussed the mean difference of the various socioeconomic factors of the farm households with respect to SS and non-SS. The mean differences were tested using Stata's t-test of unequal variance command. In Tables 8 and 9, the t-test results are displayed. The results of the t-test for discrete variables are shown in Table 9, while those for continuous variables are shown in Table 8.

Level of formal education

Barrett et et.(2012) argued that human capital is critical to obtaining and sustaining high labour productivity. In Table 8, the average number of years of education for SS household heads is five (5) years, compared to three (3) years for non-SS. At 1% level, the difference in the mean ages is statistically significant. The larger the SS's standard deviation, the more variation in the SS's level of education. In addition to having more

assets and access to better infrastructure, educated people are more likely to have secondary incomes that are not dependent on agriculture for survival (Smith et al., 2017). Also, Farmers with higher levels of education are more likely to be exposed to cutting-edge agronomic techniques and technology (Erenstein et al., 2017).

Age of respondent

The difference in average age of household heads between SS and non-SS was found to be statistically significant at 1%. Consequently, the SS have an average age of 38 years, but the non-SS have an average age of 52 years. Farmers in Northern Ghana were found to be 38 years old on average, which is similar to the SS's average age, according to Dagunga et al., (2020). Also, Anang and Dagunga (2023) intimated that the average age of farmers in northern is 36 years. The larger standard deviation for the SS suggests that there is a higher variation in the ages of the SS as compared to that of their contemporaries. In the research area, the SS are significantly younger than the non-SS. This could be related to the fact that ASM operations are labour intensive and necessitate the use of young, energetic men and women to carry them out. This is confirmed by Worlanyo et al. (2021), who asserted that farmers who participate in mining are relatively younger than their counterparts who do not engage in mining.

Table 8: Inferential statistics of suppliers and non-suppliers of labour

(continuous variables)

Variables	SS		Non-SS		t-test
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	
Age of HH head (years)	38.14	14.02	51.93	12.93	7.0940***
per capita Consumption expenditure (GHc)	2353.0210	1719.9180	922.2552	549.9598	7.3568***
Household Dietary Diversity Score	7.8700	1.4600	6.0400	2.1300	7.2270***
per capita income (GHC)	3028.5750	283.1997	868.2240	737.5720	7.4147***
Proportion of economic active labour (econ_active/HHsize)	0.5656	0.2191	0.5302	0.1779	1.2191
Farm size (acres)	5.8900	2.5900	7.0300	3.9300	2.3000**
Distance to site (km)	1.5000	1.3100	4.1400	2.6900	9.1500***
Education (years)	4.9405	6.0626	2.5172	5.0346	2.9917***
Assert (household endowment) GHC	17493.1300	8042.57800	11911.6500	9893.71200	4.3935***
Farming experience (years)	17.5714	9.1220	29.5690	12.7921	7.7423***
Household size	8.5833	6.4101	12.4310	6.3359	4.2102***
Household depend ratio	1.0156	0.0809	1.1489	0.9186	1.1343

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively.**

Source: analysis from field survey data (2023).

Household size and household dependency ratio

Typical of a farm houehold, the average household size of the SS is about 9 members and the non-SS is about 12 members. Since both farming and ASM are highly manual activities household will require large household size to complement their agriculture and ASM activities. Mabe et al. (2021) discovered that the average household size in mining communities in Ghana is about 7.8 members. This is consist with Suleman et al. (2017) who indicated that the average farm household size in northern Ghana is around 6 to 10 members. The household dependency ratio mesures the number of non-working household members depending on economically active household members for survival. From Table 8, the average household dependency ratio for the SS and the non-SS are almost equal. Thus, for both the SS and the non-SS, each economically active household member is taking care one household dependent.

Per capita consumption expenditure

One of the most popular denominators used to estimate household living standards is consumption spending. Unlike income, which is typically acquired in spurts, consumption is consistent over time. An estimation of consumption over a year can be derived from consumption during a short interval, such as a week or a month. Consistent with previous literature Ehiakpor, et al. (2019), During the previous year, household expenditures covering 12 months were calculated for consumption expenditures. The expenditure on non-food items (health, education, and utility) during each month is included along with the consumption of home-produced food, purchased food, and gift food. As a result, consumption is more closely linked to present living standards than

income. According to Table 8, the average consumption per capita expenditure of the SS is GHC 2353.02, whereas the non-SS spending is GHC922.26. As a result, the SS have higher per capita consumption spendings than the non-SS. At 1% level, the difference in consumption spending is significant. The difference in consumption expenditure could be due to the fact that the SS receive additional income from ASM, which will strengthen their income portfolio. From macroeconomics perspective, as income increases there is the likelihood that marginal propensity to consume will also increase. This is confirmed by Akudugu et al. (2012), who found that in term of consumption expenditures, on the average, small-scale miners have higher consumption as compared to their counterparts who do not involve in small-scale mining. Meanwhile, the t-test analysis of the differences in consumption expenditure between the SS and the non-SS have inherent biases which need to be dealt with before categorical conclusion can be made. Therefore, the need for ESR analysis.

Proportion of economic active labour force

From Table 8, the SS have relatively higher proportion of economic active labour force as compared to the non-SS. However, the difference is not statistically significant. According to Ali and Erenstein (2017), large households are likely to commit surplus labour to businesses outside of agriculture to increase their incomes. Meanwhile, this study found otherwise as there was no significant different between the average proportion of labour force between the SS and the non-SS.

Household Dietary Diversity Score (HDDS)

There is a 1% significant difference between the mean of SS and non-SS in terms of HDDS, which is a measure of household food security. According to Table 8, the SS have an average HDDS of 7.9, which is higher than the non-average SS's HDDS of 6.0. The non-SS have a greater standard deviation than their SS counterparts, indicating that their HDDS are more variable. The difference in mean could be associated to the fact that the SS receive direct or indirect economic benafits from ASM which in effect will improve their welfare. Thus, it could be said that households who provide labour services for ASM activities have better welfare as compared to their counterparts who do not supply. However, we cannot conclude on authority, we need further analysis to establish that.

Household per capita income

One of the most prevalent denominators used to determine individual and households wellbeing is income. By increasing earning levels (Barrett, 2020), food insecurity can be eliminated. As shown in Table 8, there is a 1% significant difference between the SS and non-SS average household per capita income. As a result, the SS have an average per capita income of GHC 3028.58, which is higher than the non-SS, who have an average per capita income of GHC 868.22. This disparity arises from the fact that those who provide labour to ASM are more likely to earn additional revenue, which will help the households to diversify their income portfolio. The SS standard deviation is larger than the non-SS standard deviation, indicating that the SS income is highly volatile.

Meanwhile, the higher per capita income for SS than non-SS cannot be concluded due to the biases prevalence in ordinary t-test analysis.

Distance to ASM sites

Farmers' labor supply decisions are likely to be influenced by their proximity to mining sites. Farm households located near mining sites are more inclined to give labour to ASM because they are aware of the economic benefits associated to it. Table 8 shows that at the 1% level, there is a substantial difference between the average distance to mining sites of the SS and the non-SS. As a result, the SS have a shorter average distance to the mining site, which is 1.5 km, compared to the non-SS, who have a 4.14 km average distance to the mining site. As a result, many of the farm households which involved in ASM are located near the mining sites.

Farm size

AS evinced in Table 8, Average farm size differs significantly by 5% between the SS and non-SS. The average farm size for the SS is 5.89 acres, which appears to be incongruent with Ehiakpor et al. (2019), that farms in the Upper East region are typically around four acres in size, nevertheless, the non-SS average farm size is 7.03 acres. The non-SS have a bigger standard deviation than the SS, indicating that the non-SS have a wider range of farm sizes. This disparity can be explained by the fact that farm households who perform ASM activities farm for household consumption rather than to make a living, as opposed to their full-time counterparts (ie. Faming for household consumption and commercial purposes.

Farming experience

Table 8 shows that the non-SS farmers have more farming experience than SS farmers on average. The average farming experience of the SS was determined to be 18 years, whereas that of the non-SS was found to be 30 years. At the 1% level of significance, the SS and non-SS farming experiences were found to be statistically different. This means that in the study area, the average farming experience of the SS is statistically lower than that of the non-SS. The non-SS have more variations in their level of farming experience than the SS, according to the standard deviations.

Remittance

From Table 9, it was found that on the average about 20% of the SS receive remittance. However, on the average about 42% of the non-SS receive remittance. Thus, the difference is statistically significant at 1% level. This means that the on the average, The number of the SS who receive remittance in the study area is statistically lower than that of the non-SS. The respondents who receive remittance are financially sound as compared to their counterparts who do not receive. Hence, there will not be any motivation for them to supply labour for ASM activities since the non-SS receive extra income from remittance. This could be the reason why the majority of the respondents who receive remittance do not engage in ASM.

Credit access

In terms of credit, from Table 9, it was found that on the average 7% of the SS have access to credit, however, 16 % of their counterparts have access to credit. This implies

that on the average the number of the non-SS who have access to credit is higher than that of the SS, notwithstanding, the difference is of not statistical significance.

Cash crop

From Table 9 it was found that on the average about 30% of the SS farm cash crop whiles about 50% of non-SS farm cash crop. The proportional difference is significant at 1% level. Thus, majority of the respondents who are not involve ASM activities farm cash crop. This could be associated to the fact that farmers usually farm cash crop in large sizes, thus more hands would be required in the cash crop farm hence there won't be any surplus laborers to be supplied to the non-farming economy.

Access to agriculture extension services

Agriculture extension services is a source of information to the local farmers to boost their farming skills and it also helps the local farmers in the area of new agriculture technology adoption. Dagunga et al.(2018), intimated that extension services serves as source of information for farmers on contemporary agronomic practice which help farmers in adaptive strategies to agricultural risk and uncertainties. From Table 9. It was found that on the average about 14 % of SS have access to agriculture extension services; however, Access to agricultural extension services is available to roughly 48% of non-SS. In contrast, Akudugu (2016) discovered that roughly 57% of Ghanaian smallholders have access to extension services.The average is statistically different at 1% significant level. As a result, in the research area, more non-SS have access to agricultural extension services than the SS. This could be associated to the fact that the respondents who engage in ASM do not get information from extension personnel on

new agronomic practice to increase their yields, thereby they branch into ASM to obtain additional income to invest in agriculture.

Ownership of motor bike

From Table 9, it was revealed that the average proportion of the SS who own motorbike is more than that of the non-SS in the study area. Thus, on the average about 78 % of SS own motor whiles only 50 % of the non-SS own motor bike. The average proportions are statistically different at 1% level of significant. This could mean that the respondents who engage in ASM obtain additional income from non-farm activities which makes their economies more resilient and offer them the opportunity to acquire additional assert.

Marital status

As indicated in Table 9, 95% of the respondents who supplied their labour services for ASM activities were married; however, 35% of the respondents who do not supply labour for ASM activities were not married. This difference is significant at 5% confidence level. Majority of the respondents who supplied labour for ASM activities were married. Children and wives are sources of labour for farm households to complement their non-farm activities. Thus, as ASM is highly labour intensive, a lot of the SS are married because they need large labour force to complement their ASM activities, as wives and children increase households' labour force.

Table 9: Inferential statistics of SS and non-SS(Discrete variables)

Variable	SS		Non-SS		t-test
	Mean	*Std dev.*	*Mean*	*Std. dev.*	
Access to Remittance	0.2000	0.4700	0.4200	0.50000	3.451***
Credit access	0.0700	0.2600	0.0300	0.1600	1.428
Cash crop	0.3000	0.4600	0.5300	0.5000	3.462***
Agricultural extension	0.1400	0.3500	0.3600	0.4800	3.714***
Ownership of motor bike	0.7857	0.412800	0.4741	0.5014	4.8097***
Ownership of TV	0.9167	0.2780	0.3103	0.4646	11.4965***
Ownership bank account	0.1548	0.3638	0.3534	0.4801	3.3285***
Land ownership	0.7857	0.4128	0.5603	0.4985	3.4897***
Region	0.6667	0.4742	0.3793	0.4873	4.1806***
Access to elecetricity	0 .6905	0.4651	0.4828	0.5019	3.0151***
Access to subsidized fertilizer	0.2619	0.4423	0.5000	0.5023	3.5481***

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively**

Source: Analysis from field survey data (2023).

Ownership of Television

Ownership of television is a proxy of households' endowment. household which owns television is assumed to be well endowed than the household which does not own television. From Table 9 it was found that on the average about 91 % of the SS own television whiles about 31% of the non-SS own television. The average proportions are statistically different at 1% significant level. Thus, in the study areas, the average number of the SS who own television is statistically higher than that of the non-SS. This implies that the local farmers who are involve in ASM about 91 % well-endowed are compared to their counterparts who can only manage with 31%.

Ownership of bank account

Ownership of bank account including mobile money subscriber is a proxy of financial inclusion. Olaniyi (2017) evinced that financial inclusion serves as a requisite for agricultural growth, a vital ancillary tool for a more responsive and inclusive socio-economic development and farmers to achieve better and sustained livelihoods in rural arenas. From Table 9, on the average, the proportion of the non-SS who have own bank account is higher than that of the SS. Thus, on the average, it was revealed that about 15% of the SS own bank account whiles about 35 % of the non-SS have bank account. Thus, the means are statistically different at 1% level of significant. This means that on the average, the number of the non-SS who are financial included are more than that of the SS in the study area.

Land ownership

In term of land ownership, from Table 9, it was found that on the average about 78% of the SS own the land used for agriculture production; on the other hand, it is revealed that on the average about 58% of the non-SS own the land for agriculture production. The averages are statistically different at 1% significant level. Thus, on the average, the number of the SS who own land for agriculture production is more than that of the non-SS in the study area.

Regional distribution

Table 9 shows that, on the average, 66% of the sampled SS were from the Savanna region, compared to 48% of the sampled non-SS. The averages are statistically different at 1% significant level. This suggests that the Savanna region's sampled households

primarily participate in ASM. The bulk of sampled households who do not participate in ASM, on the other hand, are from the Upper East region.

Access to Subsidized fertilizer

From Table 9, it was found that on the average about 26% of the SS have access to subsidized fertilizer whiles 50% of the non-SS have access to access to subsidized fertilizer. The averages are statistically different at 1% significant level. Thus, on the average majority of the respondents who are not involve in ASM have access subsidized fertilizer.

Table 10: Determinants of provision of labour service to ASM

Variable	Coef.	dy/dx	Std. Err.
Age (years)	-0.0317	-0.0029	0.0263
Education (years)	-0.0461	-0.0043	0.0540
Distance to site (km)	-0.4975***	-0.0462	0.1397
Farmsize (acres)	-0.0933	-0.0087	0.0769
Remittance	-0.5479	-0.0509	0.5895
Access to agric. Extension	-1.4093**	-0.1308	0.5868
lndOwnership	1.0911*	0.1013	0.6407
Access to credit	0.9967	0.0925	1.3485
prop_econactive	-0.6144	-0.0570	1.3341
Farming experience (years)	-0.0513	-0.0048	0.0372
Sex	-0.8388	-0.0779	0.8315
TV	2.7342**	0.2538	0.6148
On-farm income (GHC)	-0.0001**	0.0000	0.0000
_cons	4.2843**		1.6975
Log likelihood = -60.6527			
Number of obs=200.0000			
LR chi2(14)=150.8100			
Prob > chi2=0.0000			
Pseudo R2=0.5542			

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively.**

Source: Analysis from field survey data (2023).

4.3 Determinants of provision of labour services to ASM

The factors that influence farm households' decisions to provide labour for ASM activities were estimated using the decision choice model (logit model). From Table 10, it was revealed that landholding was postitve and significant at 10% level. Farm households who own land in the research area, in line with the a priori hypothesis, have a higher likelihood of contributing labour services to ASM activities, assuming other parameters remain constant. Farmers are aware that ASM require less technology and

skills, so if one discover that there is a mineral deposit beneath one's own land, he just requires local materials to start mining himself. According to Arthur et al. (2016), 59.5% of farmers are willing to participate in ASM because they realize that mining activities have significantly contributed to the establishment of jobs and revenue.

Table 10 depicts that the farm households which are closer to mining sites have higher chance of involving in ASM as compared to their counterparts which are not located near ASM sites. In relative term, if the distance to mining site increases; the likelihood that a farm household would supply labour to ASM activities decreases. This is because farmers who stay closer to mining sites have more knowledge and are aware of the economic benefits of the ASM activities as compared to their counterparts who stay far away from the mining sites.

In line with a prior hypothesis, respondents who have access to agriculture extension service are less likely to take part in ASM than their peers who do not have this advantage. Agriculture extension services have a critical role in farming as they ensure the transfer of agriculture technology. Thus, farmers are equipped with the skills and the necessary agronomic practices which can be employed by farmers to boost agriculture yields. Therefore, farmers who have access to agriculture extension service may have no incentive to engage in ASM activities as they use the knowledge gain from extension agents to increase yield and improve their welfare. Ehiakpor et al. (2019), identified that agriculture extension services help farmers to mitigate risk associated with agriculture and thereby boost agriculture productivity.

From Table 10, ownership of television which is a proxy of household's endowment was discovered to be favorable and significant at the 5% level. Thus, respondents who own television have higher probability of participating in ASM as compared to their counterparts. This is because farmers who are well endowed have the basic capital and the resource to acquire the basic equipment to engage in ASM. Small-scale miners in Telensi-Nabdan district are generally endowed with more assets than non-small-scale miners, according to Akudugu et al. (2013).

In term of income from on-farm it was identified that households who generate a lot of money from their farm are less likely to provide labour services to ASM activities as compared to their counterparts. Thus, a cedi increases of on-farm income, the likelihood that a household will provide labour service to ASM activity reduces. This is because ASM is poverty driven, so if a farmer has enough money from alternative sources, there will not be any incentive to engage in ASM because of the work hazards associated with ASM. Agricultural practices do not generate profits for smallholder farmers, so they combine them with income generating activities such as ASM (Hilson, 2016).

4.4 Econometric analysis of food security effects of labour supply to ASM activities

Household Dietary Diversity Score (HDDS) was used as proxy for food security. Food security has various components which include (availability, accessibility and utilization) of food items. For the purpose of the study, the accessibility component was measured using HDDS. Due to its flexibility, this method can be used for assessing food security at both the household and intra-household levels (Osman et al., 2018). In order

to calculate HDDS, the number of unique food items consumed during 24 hours was added up. In HDDS, households are able to access a variety of food items based on their economic ability. Estimates of the factors affecting food security were made using the Endogenous Switching Regression model. It was also used to also estimate the impacts of labour supply to ASM on household food security. A falsification test administered by Di Falco (2014) was used to evaluate the instruments' appropriateness. Following the test, television ownership was chosen as the appropriate instrument since it has a considerable effect on labour supply decisions, but not on food security.

4.4.1 Determinants of food security in the regime equations

The estimated determinants of HDDS for each of the regimes is shown in the Table 11. Tambo (2013) claimed that the correlation coefficients (rho), which represent the error components of the selection and outcome equations, demonstrate the presence or absence of selection bias. According to the result, there is no evidence of self-selection because the rhos for SS and non-SS are not statistically significant. As a result, it implies that there was no selectivity bias, that the coefficients represent the genuine effects of the explanatory factors on HDDS, and that OLS could have been used to make the estimates. It is not statistically significant for the Wald Chi-Square (likelihood ratio) test of independent equations. This suggests that the selection and outcome equations for SS and non-SS are not jointly dependent.

There are significant differences between determinants of HDDS for SS and non-SS. For SS, household heads number of years of education and access to remittance were found to significantly influence household food security holding other factors constant.

From the Table 11, number of years of formal education was discovered to have a 10% significant favorable impact on HDDS. Thus, when a respondent number of years of formal education increases by a year, HDDS will increase by 0.04 unit holding other factors constant. Farmers' educational attainment led to greater understanding of the potential benefits of modernizing agriculture through technological inputs, as well as the capacity to read fertilizer package instructions, apply them appropriately and income diversification, all of which would improve household food security (Najafi, 2003). Access to remittance was found to influence HDDS at 5% significant level. From Table 11, the SS who receive remittance have higher HDDS as compared to the SS who do not receive remittance. This is supported by Batista et al. (2019), who found that hunger was lowered in Mozambique's home treatment settings, owing to an increase of remittances arriving at huge. Several empirical research (Acker et al., 2016; Conrad and Mieke, 2016) found that remittances reduced poverty in rural households and served as a buffer against economic shocks in many impoverished households. All of these factors have the same effect as the a priori expectation.

The factors which have significant effect on HDDS for non-SS are, distance to mining site, cultivation of cash crop, ownership of bank account (including mobile subscriber), access to credit, access to subsidized fertilizer and region. From Table 11, for non-SS, it was found that proximity to mining sites significantly affect HDDS at 1% significant level. Thus, consistence with the a prior, the households who are closer to mining sites are better off in terms of HDDS as compared to their counterparts holding other factors constant. In accordance with a priori hypothesis, respondents who have access to

subsidized fertilizer are better off in terms of HDDS than their competitors who do not. In light of this, the accessibility of subsidized fertilizer is statistically significant at the 1% level. From Table 11, farm households which cultivate cash crop are better off in terms of HDDS as compared to their counterpart. Cash crop was found to be significant at 5% level. This fits with the a priori prediction. The respondents who have access to financing have lower HDDS than their counterparts who do not, which is contrary to the a priori expectation. Credit availability has a detrimental and severe impact on HDDS. This may be explained by the fact that farmers channel credit facilities towards production rather than consumption. Table 11 shows that the region was determined to be statistically significant at the 1% level. Therefore, the Upper East region farm households in the research area are more food secured than their counterparts in the Savanna region. From Table 11, it can be seen that having a bank account, a proxy for financial inclusion, was statistically significant at the 5% level. When compared to their colleagues who have bank accounts, respondents who do not have bank accounts are better in terms of HDDS. This does not match the a priori anticipation.

Table 11: Determinants of HDDS in the regime equations

VARIABLE	SS		non-SS	
	Coef.	Robust Std. Err.	cof.	Robust std. Error.
Age of HH head	-0.0228	0.0214	-0.0078	0.0161
Education level of HH head	0.0423*	0.0251	0.0310	0.0253
Ownership of motor bike	-0.6903	0.6197	0.2979	0.3596
Access to agric. Extension	-0.3859	0.6160	-0.0440	0.3396
Farm size	0.0996	0.0840	0.0317	0.0497
Remittance	0.9702**	0.4581	-0.2709	0.3411
Ownship of bank account	-0.0127	0.4981	-1.3824**	0.5716
Land ownership	-0.5968	0.6833	-0.5008	0.5163
Cultivation of cash crop	0.0783	0.4589	1.0558**	0.4401
Access to credit	0.3181	0.5046	-1.2778***	0.4748
Region	0.3348	0.7423	-3.2798***	0.5630
Household size	0.0463	0.0325	0.0136	0.0359
Farming experience	-0.0178	0.0284	-0.0006	0.0168
Access to subsidized fert.	-0.2104	0.4502	0.8364***	0.3043
Dist. Mining site	0.1135	0.1534	-0.2269***	0.0852
_cons	8.4190***	1.0266	7.9703***	0.8949
/lns1	0.2367	0.0572		
/lns2	0.2757	0.0442		
/r1	-0.1711	0.5774		
/r2	-0.0499	0.2346		
sigma_1	1.2670	0.0724		
sigma_2	1.3174	0.0583		
rho_1	-0.1694	0.5608		
rho_2	-0.0498	0.2340		
Wald test of indep. eqns. :	chi2(1) =	0.09	Prob > chi2 = 0.7585	

Log pseudolikelihood = -396.92218 , Wald chi2(15) = 33.50, Prob > chi2 = 0.0040

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively.**

Source: Analysis from field survey data (2023).

4.4.2 Effect of ASM on household food security

To forecast the observed and hypothetical HDDS, the mispredict command in Stata was used. Based on the findings of Maddala (1983) and Di Falco & Veronesi (2013), who observed that a straightforward comparison of observed mean HDDS values between SS and non-SS is misleading and does not reflect the true effect of involvement. Therefore, ESRM was used to predict observed and counterfactual HDDS. The average treatment effect for the treated (ATT) and average treatment effects for the untreated (ATU) were estimated using the predicted HDDS for the observed and counterfactuals. The t-test was employed to determine whether there is a statistically significant difference between the observed and counterfactual mean of HDDS and the outcomes are shown in Table 12. Note that, ATT is the difference between the average HDDS values that SS actually acquired and the average HDDS that they would have obtained if they had decided not to provide labour to ASM. ATU, on the other hand, is the average difference between the HDDS that non-SS actually received and the HDDS that they would have received if they had provided labour to ASM.

From Table 12 both ATT and ATU for HDDS are significant. ASM's effects on HDDS in every direction support economic theory and a priori predictions. For SS, the ATT is 2.78. This indicates that if farm households who provide labour services to ASM and continue to do so, they will benefit. holding other external factors constant. Thus, if SS decide not to provide their labour, HDDS will decrease from 9.46 to 6.68, which is a change of 41.62 %. As a result, ASM has a gradual impact on the wellbeing of farm

households who provide labour service to ASM. ASM greatly improves food security, alleviates poverty, and provides means of subsistence (Mabe et al., 2021).

Table 12: Effect of farmers' provision of labour to ASM on HDDS (Treatment Effects)

	SUPPLY DECISION		Treatment effects (TE)	% Change in treatment	Transitional heterogeneity (ATT-ATU)
	Supplying	*Not supplying*			
HDDS of SS	9.4568 (1.4708)	6.6776 (1.8746)	2.7792*** (2.5660)	41.6197	2.8078
HDDS of non-SS	8.0722 (0.9584)	5.81522 (1.8910)	2.2570*** (1.7744)	38.8119	

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively. Values in parentheses are standard errors.**

Source: Analysis from field survey data (2023).

Additionally, the projected ATU for non-SS is 2.26 , indicating that farm households' involvement in ASM is advantageous. If a non-SS chooses to work in ASM industry, their HDDS will rise to 8.7, representing an increase in farm households' welfare at about 32.21 percent**.**

4.5 Econometric analysis of effect of labour supply decision of farmers on household per capita consumption expenditure

To study how labour supply decisions affected households' consumption expenditure, Endogenous Switching Regression was utilized. The selection equation, excluding at least one instrument, should contain all of the variables present in the result equations (Lokshin & Sajaia , 2004). A falsification test administered by Di Falco (2014), was used to evaluate the instruments' appropriateness. Following the test, television ownership was chosen as the suitable instrument since it had a significant effect on labour supply decisions but not on household per capita expenditures.

4.5.1 Determinants of per capita consumption expenditure in the regime equations

The ESR estimates of the factors that determine per capita consumption spending for each regime are shown in Table 13. According to Tambo (2013), the rhos are the correlation coefficients between the error terms of the selection and outcome equations, and they serve as an indicator of the existence or absence of selection bias. The results in Table 4.6 indicate that the rhos are not statistically significant, indicating that there is no evidence of self-selection. Accordingly, it suggests that there was no selection bias and that the coefficients represent the actual effects of the explanatory factors on households' consumption spending. Even if selectivity bias was present, it could have been corrected by ESR. The three equations are independent based on the Wald Chi-Square (likelihood ratio) test, which does not show statistical significance. Thus, the three equations could have been estimated separately using PSM, heckman two-stage

or OLS models but the ESRM was employed to allow us to obtain the counterfactuals as well as disintegrate factors that influence the household per capita consumption of both SS and non-SS simultaneously.

There are significant differences between determinants of per capita consumption expenditure of SS and non-SS of ASM. From the Table 13, for SS, household head age, household head level of education, ownership of bank account, agriculture extension services, proportion of economically active household members, farm experience, household size and household dependency ratio are the elements that profoundly influence households' per capita consumption costs.

Age of household significantly influences household per capita consumption expenditure at 5 % level. Thus, as age of a farmer is increased by a year the per capita consumption expenditure decreases by GHC 18.81. Hence, household headed by younger farmers have better welfare as compared to households headed by the aged. This fits with the a priori prediction. Ordinarily, farmers' welfare decreases with age increment because as farmers age increases it is difficult for them to partake in a highly labour-intensive work and also older farmers find it difficult to adopt new agriculture technologies which will result in a low yield and it will translate into poor household welfare. This imply that household which are headed by older farmers who are also SS are limited when it comes to diversifying credit facility portfolios, unlike the younger ones who engage in many non-farms and/or off-farm economic activities to earn extra income to improve their household welfare. This result confirms the empirical studies

by Çağlayan and Astar (2012) to the effect that as age increases the consumption expenditure of rural folks decreases.

Agriculture extension services was found to be negative and significantly influence household per capita consumption expenditure at 10 %. When other things are held constant, farm households who do not have access to agriculture extension services have better household per consumption expenditures than their counterparts who do. This is contrary to the a priori expectation because it is anticipated that farmers would be well educated about new agricultural technology that would boost their yields and thus assist them improve household consumption expenditures. However, this is not the case.

Proportion of Economic active population is significant at 1 %. If the proportion of economic active population increases by a unit the household consumption expenditure will increase by GHC 4654.46, holding other factors constant. This fits with the a priori prediction. This could be attributed to the fact that as the labour size of households increases, it brings about expansion in the farm size of the farm household and also reduce the cost of hiring labour which will then translate into improvement in households well-being. This is in line with research by Abdullah et al. (2019), who indicated that the number of family members who help with farming, the size of the farm, and other criteria are the main predictors of market participation and deciding factors for higher household welfare.

From Table 13, it was observed that ownership of bank account which is a proxy of financial inclusion significantly influence per capita consumption expenditure at 10%. Thus, the farmers that are not financially included have better household per capita consumption as compared to their counterparts. Hence, farm household does not channel financial packages into consumption but rather production. This is mostly true because financially inclusion boost the local economic resources and increase people appetite of saving. This is not consisting with s several empirical studies (Zhang and Mallick, 2019; Adebowale and Lawson 2018; Ugwuanyi, 2012) that financial inclusion has a beneficial and significant impact on people's welfare by boosting spending, lowering income disparity, and reducing poverty.

As indicated in Table 13, inconsistent with the a prior expectations, households who have larger household size have lower per capita consumption expenditure as compared to their colleagues who have smaller household size. Osman et al. (2018), indicated that larger households have low per capita consumption expenditure. Thus, the size of the household could constraints the household to expand their welfare net. The result from Table 13 depicts that households which have higher dependency ratio has higher per capita consumption expenditure as compared to their counterparts who have lower dependency ratio.

Contrarily, the factor which have significant effect on household per capita consumption expenditure of non-SS are, age of the household head, level education of household head, agriculture extension services, land holding, proportion of economic active members, household size and dependency ratio. Age significantly affects per

capita consumption expenditure at 5%. Thus, as household head age increases by a year the per consumption expenditure of the households reduces by GHC 4.63 holding other factors constant. This means that household heads who are aged have better per capita consumption expenditure as compared to youngers household head. Thus, older farmers have a lot of experience in farming, which could result in higher yield and consequently higher per capita consumption expenditure.

Level of education of household head significantly affect per capita consumption expenditure at 1% significant level. It implies that for the non-SS, if education level increases by a year, per capita consumption expenditure will increase by GHC 24.17 holding other factors constant. Thus, household heads who are educated have better per capita consumption expenditure. Education is one of the important instruments of human capita. It equips farmers with skills to adopt new agricultural technology and helps farmers to get employment in the non-farm economy.

Unlike SS, for non-SS Land holding was found to be negative and significantly influence household per capita consumption expenditure. Thus, farm household who own land for agriculture production have lower per capita consumption expenditure as compared to their counterparts. Size of household labour is one of the tool households use to diversify their income by supply the surplus labour to the non-farm economy and by extension improve their wellbeing. However, Table 13 indicates that if the proportion of economic active labour force increases by a unit, per capita consumption expenditure decreases by GHC 758.56 holding other factors constant. This could imply that farm household do not ensure efficient allocation of available labour force to pay for their

marginal products. Hence farmers are at a point whereby increase in labour result in decrease of output which by extension decrease consumption capacity.

Also, Table 13 shows that household size significantly affects household per capita consumption at 1 %. Therefore, if household size increases by a person household per capita consumption decreases by GHC 58.71 holding other factors constant. Thus, households with a bigger size have smaller per capita consumption expenditure as compared to their counterparts. Table 13 indicates that households with lower dependency ratio have better per capita consumption expenditure as compared to their colleagues who have higher dependency ratio.

From Table 13, it was revealed that access to agriculture extension significantly affect per consumption expenditure at 1% level. Consistent with the a priori expectation, households who have access to extension services have better welfare than their counterpart who do not have access to extension services. Access to extension services increases technology adoption and output in agricultural businesses which improve farmers wellbeing (Worlanyo et al. 2022).

Table 13: Determinants of Household per capita consumption expenditure in the regime equations.

variables	SS		non-SS	
	coef.	*robust SE*	*coef.*	*robust SE*
Age	-18.8123**	8.5219	4.6258*	1.8100
Education	53.0428***	18.9001	24.1700**	11.9740
Dist_site	-77.2292	117.4264	-33.1907	20.5141
Farm size	-17.9382	38.6539	15.9818	12.1452
AccRemittance	176.5909	273.7912	13.9720	89.0803
Bank	-524.1532*	311.4620	-309.9830	221.7909
Access to agric. ext.	-743.4538*	441.8639	295.4551***	86.2823
lndOwnership	15.1052	312.6396	-384.8786**	158.7892
Cashcrop	133.0881	320.0819	100.7287	127.1259
access to credit	-586.8587	394.4230	24.3012	163.8337
prop_econactive	4654.4570***	1364.8090	-758.5539*	420.9112
Farm_exp	53.1828***	16.1406	-6.5546	5.0253
Sex	-355.9617	421.3910	-160.4442	186.9063
HHsize	-129.1975***	29.1806	-58.7115***	12.1796
Dep_ratio	482.9245*	288.8494	-151.3686**	66.0236
_cons	676.4909	1091.9640	2227.6200***	395.7298
/lns1	6.9097***	0.0535		
/lns2	5.9607***	0.0154		
/r1	-0.3320	0.4943		
/r2	-0.2738	0.2251		
sigma_1	1001.9830	53.6546		
sigma_2	387.8628	5.9701		
rho_1	-0.3203	0.4436		
rho_2	-0.2672	0.2091		
Wald chi2(15)	= 94.4100			
Prob > chi2	= 0.0000			
Log pseudolikelihood	= -1614.8769			
Number of obs	= 200			
Wald test of indep. eqns. :	chi2(1) = 1.90	Prob > chi2 = 0.1675		

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively.**

Source: analysis from field survey data (2023).

4.5.2 Effect of ASM on households' per capita consumption expenditure

From Table 14, average per capita consumption expenditure for the SS as they continue to provide labour service to ASM is approximately GHC 2047.67 while the average per capita consumption expenditure for SS if they decide to be non-SS stands at GHC 975.99. This shows that SS who remained as SS have higher or better household per capita consumption expenditure than the SS who decide not to supply labour services to ASM. Okoh and Hilson (2011) hinted that ASM represents an essential source of income diversification for many farmers, making it important to immediately improve their lives.

Conversely, if non-SS decide to provide labour service, their household per capita consumption expenditure on average stands at GH₵ 2036.13. While non-SS who continue to be non-SS have their per capita consumption expenditure being GH₵ 970.30. The average treatment effect of the treated (ATT) which is the difference in average per capita consumption expenditure of SS who continue to supply labour service to ASM and that of SS who decide to be non- SS being GH₵ 1091.64, and statistical significance for the difference exists at 1% level. The average treatment effects of the untreated (ATU) is also measured as the difference between the average per capita consumption expenditure of non-SS who choose to provide labour services to ASM and that of non-SS who choose to remain non-SS, which is GH 1065.83. This is corroborated by Akudugu et al. (2012), who discovered a significant difference in welfare outcomes between small-scale miners and non-small-scale miners and came to the conclusion that small-scale mining had a positive impact on small-scale miners'

welfare. Worlanyo et al. (2022), who conducted a more recent study, noted that farmers who engage in small-scale mining earn (GH 189)-$31.68 more annually than those who do not. Additionally, Barreto et al. (2018) reported that gold miners in Kenya receive roughly USD140 per month, which helps to support their way of life in many ways.

Table 14: Effects of participation in ASM on household consumption expenditure.

	Supply decision		**Treatment effects (TE)**	**% Change in treatment**	**Transitional heterogeneity (ATT-ATU)**
	Supplying	*not-Supplying*			
Per capita CE (GHC). SS	2047.6790	975.9907	1071.6380***	109.8000	5.8050
	(1182.0450)	(394.8653)	(1048.6790)		
Per capita CE (GHC). Non-SS	2036.1320	970.2990	1065.8330***	109.8458	
	(1188.2600)	(399.5849)	(1049.37800)		

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively. Values in parentheses are standard errors.**

Source: analysis from field survey data (2023).

4.6 factors influencing household per capita income in the regime equations

From the Table 15, there is significant different between determinant of household per capita income of SS and non-SS. For the SS, age, number of education, Access to credit, region, proportion of economic active members, farming experience, dependency ratio and household size are the significant factors that affect household per capita income. However, for the non-SS, age, farm size, proportion of economic active, distance to mining site, sex, dependency ratio and size of household are factors that are significantly responsible for household per capita income.

From the results, for SS, number of years of education positively affect per capita income at 10% significant level. Thus, if a farmer number of years of education increases by a year household per capita income would increase by GHC 4.20 percent holding other factors constant. This is in line with the a priori expectation**.** Akerele & Adewuyi (2011) asserted that the home head and spouse's formal education would raise household income and, consequently, the wellbeing of household members. Therefore, education increases human capital and labour market involvement through reducing poverty. Education increases a person's likelihood of having more resources and access to better infrastructure, which increases the possibility of finding non-agricultural employment and decreases dependency on agricultural income (Smith et al., 2017). This means, the educated household heads have a better chance of improving his household income via efficient allocation of productive resources.

It was observed that Access to credit is statistically significant at 5%. Thus, households which have access to credit have lower per capita income as against their counterparts

which do not have access to finance. This is not consistent with the a priori expectation. This is so because the credit obtained by farmers is not channeled into the productive sector to expand farmers income envelop but it rather goes into consumption.

From the results, region significantly affect per capita income at 1% level. The SS households which are located in the Savanna region have better per capita income as compared to their counterparts from the Upper East region. This is mostly true because the mining communities in the Savanna region are more developed than those in the Upper West region. Thus, the mining communities in the Savanna region have access to essential social facilities that are expected to have a favorable impact on household income, such as good roads, power, and drinkable water.

Proportion of economic active household members which is the ratio of economic active labour force and household size is positively significant at 1%. Thus, if the proportion of economic active labour increases by a unit, household per capita income will increase by GHC 10003.29 holding other factors constant. Proportion of economic active labour exerts a positive impact on household per capita income suggesting that a rise in the proportion of economically active labour would lead to a rise in the amount of cash resources available to take care of family members. The rise in per capita income (availability of resources) indicates that farmers' living conditions are getting better and better. It is imperative to note that among the selected factors that affect household income, proportion of economic active labour force is the highest contributing factor. This highlights the importance labour force to household welfare.

From Table 15, it was revealed that, age has negative effect on household per capita income. Thus, if a household head age increases by a year per capita income will decrease by GHC 28.23 holding other factors constant. This imply that younger farmers have better household per capita income as compared to the older farmers. Younger farmers are able to invest well on their farms and since they form the active labour force in the communities, the farming activities of weeding, sowing, ploughing, fertilizer application among others are executed timely to derive good yield. Thus, they adopt more labour-intensive technology because of their young exuberance and strength to provide their own labour as compared to older farmers.

Faming experience is measured as number of years the respondent has been engaging in farming. Table 15 indicates that farming experience positively influence household per capita income at 5% level. Thus, if farming experience increases by a year, per capita income will increase by GHC 57.33 holding other factors constant. Farmers that experienced have more knowledge on risk associated with farming, and thus, seek for other technological advancement that could boost output and by extension household income.

Dependency ratio measures the economic burden of the working household members exerted by the non-working household members. It is identified from table 15 that farm households which have higher dependency ratio have better per capita income as compared to those who have lower dependency ratio. This is because households which have higher dependency are aware that they have a lot of dependents to take off so they engage in several income generating activities to boost their income level. From Table

15, it is observed that household size has negative effect on household per capita income and it is significant at 1% level. Thus, if household size increases by a person, household per capita income decreases by GHC 64.48. This is because larger households tend to lower per capita production due to poor allocation of labour. Thus, an increase in size of household decreases standard of living. This is consistent with Tuyen (2015), who discovered that an additional family member corresponds to a drop of roughly 9% in per capita income. According to Nguyen & Nguyen (2019), household size and the percentage of dependents are inversely correlated with per capita income in Vietnam.

From the Table 15, the factors that significantly affect the per capita income of non-SS are age, farm size, proportion of economic active, distance to mining site, sex, dependency ratio and household size. Age of household was revealed in Table 15 to be significant and positively related at 10% level.. Thus, the non-SS who are older have better household per capita income as compared to their counterparts who are younger. This is not in line with a prior expectation. Thus, if age increases by a year, per capita income increases by GHC 11.85 holding other factors constant. Older farmers tend to accept new technologies to increase their production and, consequently, their revenue since they are more experienced and have better understanding of the agricultural business. Dagunga et al. (2020), revealed that age enhances farmers chance to adopt agriculture technologies. According to Mahama & Maharjan (2017) in Ghana, age is a significant determinant of livelihood and diversification.

Moreover, Farm size is significant and positively influenced household per capita income. This suggests that respondents with larger farms are more likely to improve

their household income per capita by GHC 36.06 while holding other parameters constant. Farmers in the study area have a greater possibility of making more money from their agriculture produce because of high incidents of ASM which attract people from other parts of the country. This is consistent with Tuyen (2015), who found that agricultural use in Vietnam—both annual and perennial—increased household income. According to Nguyen & Tran's (2018) research, Vietnam's North Central region's household income is highly influenced by forestland. It is also at odds with Nguyen & Nguyen's (2019) finding that annual farmland decreased household income in Vietnam's central highland.

From Table 15, proximity to mining sites significantly affect household per capita income at 5 % level. Thus, when distance to mining sites increases by a kilometer, household per capita income reduces by GHC 77.40 holding other factors constant. This fits with the a priori prediction. The interpretation of this is that, households which are closer to mining sites are better off in terms of household income as compared to their counterparts. Hence, respondents who stay closer to mining site enjoy some economic benefits (i.e. mining employment, improved road networks, potable water, food crop sales and subsistence (petty) business.) which are beneficial to their per capita income. According to Wilson et al. (2015), mining works as a buffer and shock absorber for nearby populations. Furthermore, according to a recent study by Worlanyo et al. (2022), ASM offers numerous microeconomic livelihoods supports to the local, nearby, and distant people.

The results from Table 15 indicates that male headed households have better per capita income as compared to female. This is because the male respondents are energetic and can engage in a lot of off-farm activities. Also, female farmers are marginalized in terms of access to land and credit for agriculture activities. Therese and Steven (2020) observed that men have power over production resources on farm investment decision, area cultivated and allocation of inputs and improved seed, labour allocation etc.

unlike the SS, household dependency ratio has negative effect on household per capita income. Thus, farm household with higher dependency ratio, has lower per capita income as compared to household with lower dependency ratio. Most likely, dependents do not engage in any income generating activities, however, with a higher consumption level. this could be the reason why household with higher dependency ratio tends to have smaller household per capita income. Nguyen & Nguyen (2019) also identified that; dependency ratio negatively linked to household income per capita in Vietnam. Household size has a negative and significant effect on household per capita income at 1% level. Thus per capita income is higher for smaller household size than bigger ones. Thus, an increase in household size by a member, per capita income is likely to reduce by GHC 64.48 holding other factors constant. larger households are likely to have higher per capita consumption, however with lower per capita food production (Osmana et al., 2018). Proportion of economic active labour force has a negative influence on household per capita income. Thus, inconsistent with a prior expectation, household with a larger labour force tends to have smaller per capita income. This is because the

non-SS households with a large labour force does not ensure efficient allocation of available labour to maintain higher productivity.

Table 15: Determinants of household per capita income of SS and non-SS in the regime equations

Variables	SS		non-SS	
	Robust Coef.	*Robust SE*	*Robust Coef.*	*Robust SE*
Age	-28.2342*	15.4650	11.8481*	6.3282
Education	41.1977*	24.8124	24.8557	16.4992
Ownership of motor bike	-775.4956	634.0399	180.3303	174.6340
Ownership of television	-788.7175	737.4245	108.6598	126.7963
Farm size	-50.6528	66.8494	36.0638**	16.7570
Remittance	280.6873	450.5531	73.2326	111.3890
Ownership of bank acc.	602.6682	455.9584	449.9712	303.8193
Land ownership	-809.6243	669.4782	-124.7735	134.3311
Cultivation of cash crop	-91.0102	415.3165	128.4151	215.9955
Access to credit	-1157.3750**	501.0530	51.0331	185.1024
Region	2819.8530***	844.9528	75.3736	204.4193
prop_econactive	10003.2900***	2120.7630	-1364.8830**	688.5969
Farming experience	57.3317**	28.2259	-13.6010	8.6237
Access to electricity	374.4611	313.1059	63.3652	147.2808
Access to subsidized fert	-292.1037	424.1197	-131.2409	117.7341
DISTSITE	-81.7018	131.3253	-77.3991**	35.6904
Sex	292.1481	598.9059	213.9708*	115.2613
Dependency ratio	1019.4560**	500.3508	-261.7525**	130.8576
Household size	-88.7666**	42.5187	-64.4785***	13.9573
_cons	-2860.7960	1940.1750	1979.1430***	533.4699
/lns1	7.1583***	0.0604		
/lns2	6.2759***	0.0012		
/r1	-0.3105	0.6156		
/r2	-0.0278	0.1422		
sigma_1	1284.6690	77.6327		
sigma_2	531.5896	0.6422		
rho_1	-0.3009	0.5598		
rho_2	-0.0278	0.1421		
log pseudolikelihood = -1671.8507				
Wald chi2(19) = 210.64				
Prob > chi2 = 0.0000				
Wald test of indep. eqns. : chi2(1) = 0.36 Prob > chi2 = 0.5488				

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively.**

Source: Analysis from field survey data (2023).

4.6.1 Effects of supply of labour service to ASM on household per capita income

From Table 16, the average household per capita income for SS as they continue to participate in ASM is approximately GHC 2910.74 while the average per capita income for SS if they decide to be non-participants stands at GHC 1064.85. This shows that the respondents that provide labour services to ASM and continue to do so have higher or better household per capita income than those who participate in ASM and decide to be non-participants. Summarily, participating in ASM will lead to about 173.09 % increment in household per capita income.

Also, for non -SS who decide to be SS, their per capita income on average stands at GH₵ 2894.90. While non-SS who continue to be non-SS have their per capita income being GH₵ 1059.71.

The Average Treatment effect of the Treated (ATT) which is the difference in average household per capita income of the SS and their counterfactual case is GH₵ 1844.89 and the difference is statistically significant at 1%. The average treatment effect of the untreated (ATU) which is also the difference in average household per capita income of non-SS who decide to be SS and that of non-SS remain non-SS being GH₵ 1835.18. The implication of the ATT and ATU is that the respondents who participate in ASM have better household welfare and thus the difference in household per capita income of SS and non-SS is caused by ASM. This is consistent with other empirical studies (Labonne 2003; Hilton et al. 2012; Akudugu et al. 2012), which found that small-scale mining serves as a significant source of income for people in rural areas. Additionally, Arthur et al. (2016) noted that artisanal and small-scale mining has a significant impact

on revenue generation, and discovered that roughly 59.5% of the respondents who were surveyed agreed that mining activities had a favorable impact on their quality of life. According to Cartier and Burge (2011), ASM plays a significant role in the mining and agricultural industries and supports the livelihoods of several people in northern and eastern Sierra Leone.

Table 16: Effects of supply of labour services to ASM on household per capita income

	Supply decision		**Treatment effects (TE)**	**% Change in treatment**	**Transitional heterogeneity (ATT-ATU)**
	Supplying	*not-Supplying*			
Per capita income (GHC). SS	2910.7380 (1784.2850)	1065.8520 (584.4351)	1844.8860*** (117.6141)	173.09026	-9.7020
Per capita income (GHC). Non-SS	2894.8970 (1791.6800)	1059.7140 (587.4045)	1835.1840 *** (1664.1510)	173.17729	

***NB*: *, ** and ***, denotes 10%, 5% and 1% significant levels respectively. Values in parentheses are standard errors.**

Source: Analysis from field survey data (2023).

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This chapter aims to emphasize the study's important findings in summary form, draw conclusions, and make policy recommendations in that vein.

5.2 Summary of the key findings

The study empirically examines the determinants of farmers supply of labour service to ASM and its effect on welfare in northern Ghana.

The results of the descriptive analysis of the socio-economic factors indicated that, the SS household head have an average age of 38 years whiles that of the non-SS is 51. Thus, both groups are within the age range of active labour force; hence, capable of undertaken any active economic activity. However, the SS household head are extremely younger than the non-SS. Results from the educational level of the respondents revealed that the average educational level of the SS is 5 years whiles the non-SS is 3 years. This implies that the SS are more educated. Unsurprisingly, the analysis unearthed that the SS have better household welfare (i.e. HDDS, household per capita consumption expenditure, household per capita income.) on the average than the non-SS.

The probit model was employed to conduct the analysis with regard to the factors that influence ASM participation. The results from the probit model revealed that ownership of television, distance to mining site, access to agriculture extension service, land

ownership and farm revenue have significant effects on participation decision. It is imperative to note that, the estimates further revealed that the respondents who own television had better chances in participate in ASM. Additionally, it was discovered that respondents who had access to extension services were less likely to participate in ASM. It was found that proximity to mining sites also influence labour supply decision. Thus, the closer a farm household is to mining sites, the greater the chances of participation in ASM.

The study further analyzed the determinants and effects of participation in ASM on household welfare (i.e., HDDS, household per capita consumption expenditure and household per capita income) using Edogenous Switching Regression Model (ESR) model. The stata movestay command was used to estimate the ATT and ATU in the regime equations.

The results revealed that, for the SS, access to remittance and education increase HDDS whiles for the non-SS, cultivation of cash crop and access to subsidized fertilizer were found to improve HDDS. However, ownership bank account, access to credit, region and distance to mining sites were found to reduce HDDS of the non-SS. The study further unearthed that, for the SS, the factors that increase household per capita consumption expenditure are education, farming experience, proportion of active labour, region and household dependency ratio; however, ownership of bank account, extension service, age, distance to mining site decrease household per capita consumption expenditure. Also, it was found that for the non-SS, age, education and agriculture extension visits increase household per capita consumption expenditure

whiles proportion of economic active labour, household size and household dependency ratio reduce per capita consumption expenditure for the non-SS.

In terms of household per capita income, the results indicated that, education, proportion of economic active, farming experience and region were found to boost household per capita income of the SS; however, access to credit, age and household size reduce per capita income of the SS. Nevertheless, age, farm size and sex were found to improve per capita income of the non-SS; however, household size, dependency ratio and distance to mining sites were found to reduce per capita income of the non-SS.

In terms of the effects of supply of labour services to ASM on household welfare, after accounted for endogeneity, mspredict command in stata was used to do the estimates. The results, indicated that, the effect of ASM on all the indicators of welfare justified that ASM profoundly improves household welfare. The average treatment effects indicate that households who supply labour to ASM have better welfare relative to their counterparts who do not. The average treatment effect of the treated (ATT), which accurately reflects the welfare impact of the labour supply service to ASM, provided evidence for the improved welfare of farm household who participate in ASM.

5.3 Conclusion

The study sought to examine the determinants of farmers involvement in ASM and its effects on household welfare. The study revealed that, land ownership, ownership of

televion (i.e endowment), distance to mining site and access to agriculture extension and on- farm income are the major drivers of farmers supply of labour services to ASM.

The empirical results on the determinants of welfare revealed the importance of age, education, farming experience, family labour and agriculture extension services in improving household welfare.

The average treatment effects indicate that farmers' participation in non-farm activities such as ASM tremendously enhances farm household welfare. Thus, participation in ASM leads to incremental effects on household welfare. This discovery is very important from welfare perspectives signifying the crucial role play by ASM in the rural economies.

The results of the study are consistent with several studies. Some of the empirical research previously covered suggests that small-scale mining offers the poor and vulnerable a way out of extreme poverty. But it is crucial to note that participation in ASM, statistically speaking, it is significant factor in explaining the observed variation in welfare results (i. e. HDDS. Per capita consumption expenditure and per capita income) between SS and non-SS in northern Ghana.

5.4 Recommendation

To make it easier for the majority of people to receive an education, the government should increase the availability of universal, high-quality education, through the

ministry of education. This will enlighten people to make informed decisions, which can boost their welfare.

The Ministry of Land and Natural Resources should design and implement the current Small-Scale Sector Framework on behalf of the Ghanaian government. This will go a long way to mitigate the environmental impact of the ASM subsector. This framework should target leveraging on the positive impact of the ASM sector so that the mining communities can benefit fully from the extractive industry.

It is recommended that government should employ and resource the existing extension service personnel and should intensify educating farmers on the best agronomy and agriculture technologies as this allows them to invest confidently in agriculture thereby improving farmers welfare.

Farmers should be sensitized to invest moneys obtained from mining into the sustainable sector such as agriculture to expand their welfare net in the long run.

Household size reduces welfare; thus, farmers should be educated to practice family planning in order to reduce the current average household size to improve household's welfare.

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APPENDICES

Appendix 1: Questionnaire

Research Questionnaire

University for Development Studies

Faculty of Agriculture and Consumer Sciences

Department of Agricultural and Food Economics

Farmers Provision of Labour Services to Artisanal Small-Scale Mining: Determinants and Welfare Effects in Northern Ghana

Serial number……..

Please the name is Ayuba Dauda. I am a Masters student from the University for Development Studies, Tamale. I am here to collect data which will facilitate me in my research work which is aimed at analysing the determinants and welfare effects of provision of labour services to artisanal small-scale mining. I would like to assure you that your responses would be used for academic purposes only and will be treated confidentially.

Date:

……/……./……

RESIDENCE INFORMATION

Name of Region name of district name of community

…… …… ……

Community type: (1) mining [ ] (2) non mining [ ]

Respondent house no:……

Residential status: (1) indigene [ ] (2) settler Ghanaian [ ] (3) settler non Ghanaian [ ]

1.00 Household socioeconomic and demographic characteristics

1.01 Age of respondent…… years

1.02 Status of respondent in household? Household head [ ] household member [ ]

1.03 Sex of respondent: (1) male [ ] (2) female [ ]

1.04 Household composition by sex: (1) number of male….. (2) number of female……

1.05 Marital status of respondent: (1) single [ ] (2) married [ ] (3) widow/widower [ ]

(D) Divorced [ ]

1. 06 Is farming your main occupation? Yes [ ] no [ ]

1.07 Do you engage in off-farm activities/ yes [ ] no [ ]

1.08 If yeas, spercify (a) petty trading (b) salaried worker (c) mining (d) other (others)……..

1.09 Respondent level of education: (1) no education [ ] (2) non formal education [ ] (3) primary [ ] (4) JHS [ ] (5) SHS [ ] (6) tertiary [ ]

1.10 Respondent number of years of schooling……

1.11 Respondent spouse level of education: (a) no education [ ](b) non formal education [ ] (c) primary [ ] (d) JHS [ ] (e) SHS [ ] (f) tertiary [ ]

1.12 Respondent spouse number of years of schooling…….

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

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

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

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

1.17 Household number of aged (age>64): male…….female…….

2.0 Basic social Amenities

B asic social facilities	**Do you have access to the following facilities** **(1)Yes [ ] (2) No [ ]**	**How far is the facility from house? (km)**	**How long does it take to get to the facility**		
			days	**hrs**	**Mins**
at the nearest primary school					
Health worker					
Portable water					
National electricity grid					
Public/privately own toilet (at least pit lactrinre)					
Bank					

3.00 household's income generated activities in past 12 months

Source of Income	Estimated total amount (GH¢)	Frequency
Earns from farms		
Earns from ASM		
Earns from livestock		
Earns from rental income		
Earns from handicraft		
Earns from street vending		
Earning from hawking		

Earning from carpentry/construction		
Earning from small business (shop, brewing, Beer)		
Salary income (full/ part time salary employment)		
Earnings from remittance		
Hunting		
Others:_____		

Note: household's income includes earnings from productive activities and transfers home-produced goods that are either exchanged by barter or consumed directly within the household, and for any income received in-kind.

Gift and receipts in kind: unit product quantity unit price

--- --- ---

4.0 household's asset ownership, control and use

Asset	Quantity (a)	Number of years used (b)	Price (GHc) (c)	Depreciation (c*0.1)*b	Total current value(GH¢)
Land (per acre/hectare/plot)					
Car					
Living room furniture					
Radio cassette player					
Generator					

Motor bike					
Bicycle					
Motor king					
Tractor					
Tv					
Mobile phone					
Home theatre					
Water pump					
Cattle					
Donkeys					
Sheep					
Goats					
Guinea fowls					
Chickens					
Rabbits					
Watering can					
Knapp sack sprayer					
Donkey cart					
Other assets					

5.00 Access to agricultural extension and information in 2018/2019 cropping season

5.01 Did you or any member of your household ever receive advice from agrc. extension officer in the 2018/2019 cropping season? (1) Yes [ ] (2) No [ ]

5.02 If yes, how many times did an agric. Extension officer visited/had contact with you in the 2018/19 cropping season?

6.00 Household consumption expenditure

6.01 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
Groundnut									Bowls/Pans/Bags
Beans									Bowls/Pans/Bags

Sorghum									Bowls/Pans/Bags
Millet									Bowls/Pans/Bags
Vegetables									
Tomatoes									Bowls/Pans/Bags
Pepper									Bowls/Pans/Bags
Salt									
Fruits									
Oranges									
Mangoes									
Pawpaw									
Banana									
Shea fruits									
Pineapple									
Meat									
Beef									
Chevon									
Mutton									
Eggs									
Bush meat									
Chicken									
Fish									
Beverages/Drinks									
Tea									
Soft Drink									
Fruit juices									
Alcoholic drinks									

Water									
Fats and oils									
Cooking oil									
Bread									
Pastries									

6.02 How much on average of household income is spent on family education in a year?

GH100-500 [ ] GH500-900 [ ] GH900-1300 [ ] GH1300-1700 [ ] GH1700-2100 [ ] GH2100+ [ ]

6.03 How much of household income is spent on family health care annually?

GH100-500 [ ] GH500-900 [ ] GH900-1300 [ ] GH1300-1700 [ ] GH1700-2100 [ ] GH2100+ [ ]

6.04 How much of household income is spent on utility?

GH100-500 [ ] GH500-900 [ ] GH900-1300 [ ] GH1300-1700 [ ] GH1700-2100 [ ] GH2100+ [ ]

7.0 Land ownership, usage and land rent in the 2018/2019 cropping season

7.1 Ownership status of land used by household for agricultural production for 2018/ 2019 cropping season:

(1) Owned [ ] (2) rented [ ] (3) family land [ ]

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

7.3 What is the fertility level of the land used by household for farming in the 2018/2019 cropping season?

(1) Poor [ ] (2) medium [ ] (3) fertile [ ]

7.4 What is the size of the land the household used for agricultural production in 2018/2019 cropping season? …….acres.

7.6 Do you cultivate cash crop? (1) Yes [ ] (2) No [ ]

7.7 If yes, specify the proportion of the land used: ……. Acre.

8.0 Labour supply for ASM activates

8.01 Do you supply labour service to ASM?

(1) Yes [ ] (2) No [ ]

8.02 Do any member of you household engage in ASM? Yes [ ] no [ ]

If another member please fill the table below:

8.03Labour supply for ASM activities for the past 12 months

ASM activities	1) the status of the household member		(2)age		(3)Level of education (years)		(5)No. of hours worked per day		(6)Wage per day (**GH¢**)		No of days worked		Total mandays (one manday is 8 hrs)	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
panner														
Cook														
Loading														
Sluicing and separation of gold														
Burning of Amalgam (of gold particle with mercury)														
Digging														

Crushing of stone													
Washing													
Drill													
Security man													
Blastman													
Grinding													
Driver													
Others:_____													

9.0 respondent credit accessibility

9.1 Did you or any member of the household obtain credit in 2018/2019 cropping season? (1) Yes [ ] (2) No [ ]

9.2 If yes, specify source. (1) Commercial bank [ ] (2) rural bank/microfinance institutions [ ] (3)credit union [ ] (4) government credit program [ ] (5)NGO credit program [ ] (5)friends and family [ ] (6)Susu/Village Savings and Loan Associations (VSLA) [ ] (7)others [ ]

(If others, please specify) …….

9.3 What was the purpose of the credit? (1) Agricultural activities [ ] (2) ASM activities [ ]

9.4 Did you get the full amount you apply for? (1) Yes [ ] (2) No [ ]

9.5 If no, state the reasons

……

……

……

9.6 What was the total amount you applied for? GH₵ ……

9.7 What was the total amount you received? GH₵ ……

9.8 How much of the credit was used for agricultural purposes? GH₵ ……..

9.9 How much of the credit was used for ASM purposes? GH₵ ……..

10.0 **Household's Food security indicators**

10.1 Household Dietary Diversity Score (HDDS)

In the past 24hrs did your household consume any of the following food group?

Food group	**Question**	**Yesterday**	**Today**
Cereal	Did you or any member of the household eat any foods made from millet, sorgum, maize, rice, wheat, etc.	Yes [ ] No [ ]	Yes [ ] No [ ]
Root and tubers	Did you or any member of the household eat any food made from yam, potatoes, cassava, etc?	Yes [ ] No [ ]	Yes [ ] No [ ]
Vegetables	Did you or any member of the household eat any food made from okro, alefu, , ayoyo, bean leaf, tomatoes, etc?	Yes [ ] No [ ]	Yes [ ] No [ ]

Fruits	Did you or any member of the household eat any food from mango, orange, water melon, etc?	Yes[ ] No [ ]	Yes [ ] No [ ]
Meats, chicken and guinea fowl products	Did you or any member of the household eat beef, pork, lamb, goat, chicken, duck, guinea fowl, etc?	Yes [ ] No [ ]	Yes [ ] No [ ]
Fish and sea food	Did you or any member of the household eat food made from fresh or dried fish, etc?	Yes [ ] No [ ]	Yes [ ] No [ ]
Legume/pulse/nuts	Did you or any member of the household eat any foods made from beans, soybeans, groundnuts, etc?	Yes [ ] No [ ]	Yes [ ] No [ ]
Milk and milk products	Did you or any member of the household eats any cheese, yoghurt, milk, etc?	Yes [ ] No [ ]	Yes [ ] No [ ]
Oil/fats	Did you or any member of the household eat any foods made with shea butter, groundnut oil, palm oil, etc?	Yes [ ] No [ ]	Yes [ ] No [ ]
Sugar/honey	Did you or any member of the household eat any sugar or honey?	Yes [ ] No [ ]	Yes [ ] No [ ]
miscellaneous	Did you or any member of the household eat other foods such as coffee, tea, etc.	Yes [ ] No [ ]	Yes [ ] No [ ]

10.4 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?	Yes [ ] No [ ]
You or others in your household were unable to eat healthy and nutritious food?	Yes [ ] No [ ]

You or others in your household ate only a few kinds of foods?	Yes [ ] No [ ]
You or others in your household ate food you do not like?	Yes [ ] No [ ]
You or others in your household had to skip a meal?	Yes [ ] No [ ]
You or others in your household ate less than you thought you should?	Yes [ ] No [ ]
You or others in your household ran out of food?	Yes [ ] No [ ]
You or others in your household were hungry but did not eat?	Yes [ ] No [ ]
You or others in your household went without eating for a whole day	Yes [ ] No [ ]

11.0 Agricultural policy intervention and others

11.1 Are you a beneficiary of PFJ? (1) Yes [ ] (2) No [ ]

Did you apply subsidized fertilizer on your farms for the 2018/2019 planting season?

(1) Yes [ ] (2) No [ ]

Did you apply subsidized pesticide on your farms for the 2018/19 panting season?

(1) Yes [ ] (2) No [ ]

11.2 Did you use subsidized certified seeds in the 2018/19 planting season? (1)Yes [ ] (2) No [ ]

11.3 Do you have access to irrigation? (1) Yes [ ] (2) No [ ]

11.4 Are you a member of any farm base organization? (1) Yes [ ] (2) No [ ]

11.5 Agricultural and ASM input and product market

Community	District capital	Product market (agri. Products selling market)	ASM product market	Input market
Means of transportation	(1) Foot [ ] (2) Bicycle [ ] (3) Motor cycle [ ] (4) Car [ ] (5) Canoe/engine boat [ ] (6) Other [ ] (specify)……	(1) Foot [ ] (2) Bicycle [ ] (3) Motor cycle [ ] (4) Car [ ] (5) Canoe/engine boat [ ] (6) Other [ ] (specify)…….	(1) Foot [ ] (2) Bicycle [ ] (3) Motor cycle [ ] (4) Car [ ] (5) Canoe/engine boat [ ] (6) Other [ ] (specify)…….	1) Foot [ ] (2) Bicycle [ ] (3) Motor cycle [ ] (4) Car [ ] (5) Canoe/engine boat [ ] (6) Other [ ] (specify)……
Time of travel	.....hrs…..mins	.....hrs…..mins	.....hrs…..mins	.....hrs…..mins
Nature of road	(1) Path [ ] (2) Untarred road [ ] (3) Tarred road [ ]	1) Path [ ] (2) Untarred road [ ] (3) Tarred road [ ]	1) Path [ ] (2) Untarred road [ ] (3) Tarred road [ ]	1) Path [ ] (2) Untarred road[ ] (3) Tarred road [ ]
distance				
motorable	(1) Motorable [ ] (2) Unmotorallable [ ]	(1) Motorable [ ] (2) Unmotorallable [ ]	(1) Motorable [ ] (2) Unmotorallable [ ]	(1) Motorable [ ] (2) Unmotorallable [ ]

12.0 Experiences and ASM activities decisions

12.1 How many years have you been farming? …….

12.2 Number of years ASM activities started within the community ……years

12.3 How many years have you been providing labour services to ASM? ……..

12.4 Season that you provide labour services to ASM: (1) raining season [ ] (2) dry season [ ]

12.5 How far are mining sites from this household? ……km

12.6 How long will it take to walk to mining sites? ……. hrs…..…mins……..seconds

12.7 State five reasons why you provide labour services to ASM:

……

……

……

……

……

……

ENUMERATOR'S SIGNATURE Respondent telephone: …….

……

THANK YOU.

Appendix 2: Matrix of objectives, methods, finding and recommendations

Objectives	Methods	Key finding	Conclusion	Policy recommendations
Objective one	Probit model	Distance to mining site, access to agriculture extension services, on-farm income have significant effects labour provision decision.	Institutional, farm specific and demographic variable influences farmers participation in ASM.	Government should resource the existing extension service personnel and intensify educating farm household on the best agronomy technologies so that they can confidently invest in agriculture.
Objective two	ESRM	Level of formal education of household heads has a favourable effect on household food security. Also, ASM increases household food security at about 41.6%.	ASM significantly increases household food security in northern Ghana.	Government should intensify the availability of universal high-quality education; this would help farmers to efficiently allocate resources which would increase household welfare.
objective three	ESRM	Household size reduces household welfare. Also, ASM increases household welfare.	ASM increases household welfare.	Farm household should be educated to practice family planning in order to reduce the current average household size to improve household welfare.
Objective four	ESRM	Farm size increases farmers' income. Also, ASM significantly increases household income.	The discovery signifies the crucial role played by ASM in rural economies.	Farmers should be sensitized to invest money obtained from ASM in agriculture.

SMALLHOLDER FARMERS' PROVISION OF LABOUR SERVICES TO ARTISANAL SMALL-SCALE MINING: DETERMINANTS AND WELFARE EFFECTS IN NORTHERN GHANA

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