THE EFFECT OF MINING ACTIVITIES ON SMALLHOLDER AGRICULTURE: THE CASE OF MALE AND FEMALE FARMERS IN THE MPOHOR MINING AREA OF GHANA

BY

EKUA BENTSIWA SLIM ANKOMAH

(10636350)

THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PHILOSOPHY IN ENVIRONMENTAL SCIENCE DEGREE

JULY, 2019

DECLARATION

I hereby declare that this thesis was carried out entirely by me in the Environmental Science Programme, University of Ghana. This thesis has never been presented for the award of a degree in this University or any other institution. All sources of information presented in this thesis have been duly acknowledged.

…… ……

Ekua Bentsiwa Slim Ankomah Date

(Student)

……. …….

Dr. Adelina Maria Mensah Date

(Principal Supervisor)

……. …….

Dr. Ted Yemoh Annang Date

(Co-Supervisor)

DEDICATION

I dedicate this thesis to my mother, Nana Ama Botchey, my dear husband and children, Mr. Dennis Slim Ankomah, Johanna Slim Ankomah and Jayden Slim Ankomah for their love, inspiration and unflinching support throughout my education.

ACKNOWLEDGEMENT

I wish to express my heartfelt gratitude to Almighty God for His protection and guidance throughout my life and education.

My greatest appreciation goes to my supervisors Dr. Adelina M. Mensah and Dr. Ted Y. Annang for their expertise, direction, good guidance, and constructive criticism leading to the successful completion of this research. I also thank all the research fellows of the Institute for Environment and Sanitation Studies for their guidance and criticism during the course of my study.

Special thanks also go to Mr. Emmanuel Ansah and Mr. Prince Owusu of Ecological Laboratory for their technical assistance and support during the laboratory analysis.

My appreciation also goes to Mr. Thomas Tobil, Mpohor District chief cocoa farmer, all the Traditional leaders, chief farmers, and people of Mpohor, Awunakrom, Mpohor Yabiw, Obrayebona, and Adum Banso for their hospitality, participation and contribution towards the successful completion of the research. Also, my appreciation goes to staff of Mpohor District Assembly, Norpalm Ghana Ltd and the Department of Agriculture for providing valuable information during the field study.

Finally, my thanks goes to my entire family, friends and colleagues at IESS M.Phil. Class of 2019, University of Ghana for their prayers, encouragement and inspiration.

God bless you all.

ABSTRACT

The study employed the sustainable livelihood approach to investigate the effect of mining activities on male and female smallholder farmers in the Mpohor District mining area. In addition, livelihood assets of smallholder farmers, heavy metal concentrations in farm soils, the livelihood strategies employed by the smallholder farmers and institutional support to the smallholder farmer in the management of the effect of mining activities were also assessed. Five communities namely; Mpohor, Adum Banso, Obrayebona, Mpohor Yabiw and Awunakrom within the mining area were selected for the study. The data collection tools used to assess the livelihood assets, effect of mining, livelihood strategies and institutional support were household questionnaire surveys, focus group discussion and structured interviews. A total of 206 farmers were administered questionnaires, three focus group discussions were held and six structured interviews were conducted for relevant information. The findings of the study indicated that male smallholder farmers have relative advantage in the acquisition of all livelihood assets (human, social, natural physical and financial assets) than their female counterparts. The study further revealed that, mining has caused more negative effects on the natural, human and physical capital of the male smallholder farmers than the female farmers, but it has equal effect on the socio-economic assets of the male and female smallholder farmers. In the selected farm soils, the concentrations of Pb, As, and Hg measured were within the acceptable limits recommended by WHO/FAO, while the concentration of Cd in all the samples were above the acceptable limit by WHO/FAO. There was also strong positive correlation between As and Hg (r=0.84) and Pb and As (r=0.65). The livelihood strategies employed by the male smallholder farmers were similar to that employed by the female farmers. It included intercropping, selling of raw agriculture produce and wage employment. Formal and informal institutional support identified were the use of law enforcement agencies, compensation and education. The study recommends that mainstreaming gender issues in the

agriculture sector must be done, taking into consideration the natural resources available to smallholder farmers as well as the socio-demographic context and livelihood assets of the female smallholder farmer.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

ASM	Artisanal and Small-Scale Mining
BOPP	Benso Oil Palm Plantation
DFID	Department for International Development
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GGADP	Ghana–German Agricultural Development Project
GGFP	Ghana–German Fertilizer Project
GSR	Golden Star Resources
GSS	Ghana Statistical Service
MoFA	Ministry of Food and Agriculture
MoGCSP	Ministry of Gender, Children and Social Protection
MMP	Minerals and Mining Policy
SAP	Structural Adjustment Program
UNDP	United Nation Development Program
USAID	United States Agency for International Development
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture and mining are among man's oldest endeavors to civilization and have contributed immensely to the earth's land cover change (Down & Stocks, 1978). According to Kenk and Cotic (1983), agriculture is the systematic controlled use of living organisms and the environment to improve on the conditions of humans. However, mining, which involves the excavation of geological materials to extract naturally existing minerals to contribute to the economic and civilizational development of societies is seen as a threat to agriculture (Mackenzie, Lacy, & Koontz, 2006; Crowson, 2009).

The contributions of mining to the global economy has been enormous through international trading and the provision of needs such as energy, construction materials, chemical, pharmaceutical, automotive and electronics (Madeley, 1999; Dubiński, 2013). Mineral endowed countries such as Australia, United States of America, Sweden and Canada have experienced a sustained and substantive economic development and a strong human development index by leveraging their mineral wealth under strong and effective policies and investments (David & Wright, 1997; Amponsah-Tawiah & Dartey-Baah, 2011; McMahon & Moreira, 2014). Some sub-Saharan countries such as Ghana, Botswana and South Africa have achieved and sustained a strong economic growth after reforms in their mining sector that attracted foreign investors (McMahon & Moreira, 2014). However, the same cannot be said about some sub-Saharan mineral endowed countries such as Democratic Republic of Congo, Angola and Mozambique, where political instability and ineffective enforcement of policies has contributed to their underdevelopment and slow growing economies (Sachs & Warner, 1997; Amponsah-Tawiah & Dartey-Baah, 2011; McMahon & Moreira, 2014).

Mining, along with other anthropogenic activities such as petroleum prospecting and poor industrial and domestic waste management, have contributed to the increase in heavy metals concentration in agricultural soils and fresh water sources for irrigation across the world (Chopra, Pathak, & Prasad, 2009; Conceição, Navarro, G, & Silva., 2013). When agricultural lands are exposed to heavy metals such as mercury, cadmium, arsenic and lead, the soils experience deficiencies of vital micronutrients (Jung, 2008; Ezeh & Chukwu, 2011) and increased soil acidification which limits plant growth and induces soil erosion and degradation of aquatic ecosystems (Lin et al., 2005). The use of agrochemicals becomes the next alternative for farmers to improve soil fertility. However, continuous use of these supplements exacerbates the accumulation of the toxic trace elements in the agricultural soils, which results in bioaccumulation and bio-transfer of harmful elements to humans through the food chain (Hesterberg, 1998; de Vries, Römkens, & Schütze, 2007). Thus, contamination of the soil ecosystem with toxic trace elements is a critical environmental problem since they also impact animal and human health (Babatunde, Oyewale, & Steve, 2014).

In mineral endowed countries, the environmental impact of mining is visible but the countries that have seen greater development have managed this impact through the establishment of strong mineral governance and the effective enforcement of laws. The introduction of the Structural Adjustment Program (SAP) by the World Bank and the International Monetary Fund (IMF) in the 1980s resulted in reforms and liberalization in the mining sector in many sub-Saharan African countries (Akabzaa & Darimani, 2001). This led to the influx of export oriented multinational mining companies and the increase in illegal artisanal and small-scale mining activities, engaging in mining activities usually in remote areas which serve as a hub for agriculture (Opoku-Antwi, 2010; Urama, 2013; Hilson, 2016). The activities of the ASM has external costs to the people and environment including depriving people of basic human rights like access to healthy food, clean water and clean environment and a sustainable

livelihood of the many people in agriculture (Crowson, 2009). Globally, approximately 40.5 million people were directly involved in artisanal and small-scale mining (ASM) in 2017, up from 30 million in 2014 (IGF, 2017).

The livelihoods of smallholder agriculture suffered greatly during this period under structural adjustment in the 1980s and 1990s due to some changes such as the depreciation of local currencies, reduced prices for cash crops and the elimination of subsidies on crucial farm inputs such as fertilizers (Hilson, 2016). Thus, research by several scholars on the impact of mining in sub-Saharan Africa have given mixed evidence as to why people leave agriculture to engage in illegal artisanal mining (Banchirigah, 2006; Mihaye, 2013; Urama, 2013; Boateng, Codjoe & Ofori, 2014; Hilson, 2016). In the intertwined economies of farming and mining in rural communities in countries such as Liberia, Mozambique and Mali, smallholder farmers strategically choose mostly to combine engaging in intensive agricultural practices and in other income generating jobs, such as wage employment or migration (Kitula, 2006; Maconachie & Binns, 2007; Hilson, 2016). Generally, smallholder households deploy their human assets, in terms of household numbers and educational status to generate livelihood portfolios (Rakodi, 1995; Hesselberg & Yaro, 2006). However, the patriarchal customs of most rural communities in sub-Saharan Africa, coupled with lack of intensive gender disaggregated data in the agriculture sector, limits the women smallholder farmers from getting access to land, agricultural inputs, extension officers, credit, technology and information, leaving them with minimum options of livelihood activities than their male counterparts (MoFA, 2007; FAO, 2012; MoGCSP, 2015).

1.2 Research Problem

In Ghana, both Agriculture and Mining Sectors continue to contribute immensely to national development after the introduction of SAP in 1983. The variation in climatic factors in different

agro-ecological zones in Ghana support diverse crop growth that contribute to the Gross Domestic Product (GDP) (FAO, 2005). Whereas the country's geological setting provides diverse minerals deposits, such as gold, bauxite, diamonds, and manganese, which are exploited both by legal and illegal means. In 2017, mining contributed 21,901 million Ghana cedis being 11.5 percent to the Gross Domestic Product (GDP) after agriculture, which contributed 35,047 million, or 18.3 percent, to the GDP (GSS, 2018). However, an estimated 80 percent of the total agricultural production which is attributed to smallholder farmers (FAO, 2015), are consistently at risk of losing their livelihoods due to effects of mining activities such as the reduction of farm size and the pollution of agriculture land and irrigation water.

After the introduction of SAP in Ghana, a wealth of scholarly investigations exposed the impacts of mining activities on the environment, society and economy on both local and regional scales (Hilson, 2001; Yelpaala & Ali, 2005; Yirenkyi, 2008; Adjei, Oladejo, & Adetunde, 2012; Boateng et al., 2014; Mensah et al., 2015; Hilson, 2016). These have shown that mining activities are environmentally disruptive and major health risk to the host community and the people who engage in them. Also, a plethora of studies has assessed the livelihood of farmers in areas that have visible mining footprints in relation to toxic trace elements contamination (Smedley, Edmunds, & Pelig-Ba, 1996; Ahmad & Carboo, 2000; Akabzaa, Banoeng-Yakubu, & Seyire, 2005; Crentsil et al., 2013; Dwamema, 2013; Obiri et al., 2016; Acheampong, 2016; Hogarh, Adu-Gyamfi, Nukpezah, Akoto, & Adu-Kumi, 2016; Boadi, Nsor, Antobre, & Acquah., 2016). There are mixed reports on the contribution of mining to increase in concentration of heavy metals in mining communities. While some assessments have shown high concentrations of toxic trace elements in environmental media (Akabzaa et al., 2005; Crentsil et al., 2013), others indicate the presence of toxic trace elements in soils, water and plants with some heavy metals concentrations within the recommended values from WHO and FAO (Ofori, 2015; Mantey, Nyarko, & Owusu-Nimo, 2016). This implies that, the

concentration of toxic trace elements due to mining activities in environmental media cannot be generalized based on the presence of mining activities.

The Government of Ghana's interventions in the agriculture sector in terms of policies and programmes do not benefit all stakeholders in the sector (MoFA, 2007; FAO, 2012). These interventions fail to recognize the multi-factors that influence the wellbeing of the smallholder household, such as gender and assets endowment of the smallholder farmer in a mining environment. The Ministry of Food and Agriculture (2007) in their Food and Agriculture Sector Development Policy (FASDEP II) made emphasis on the gender inequality in the agricultural sector that has undermined the achievements of sustainable agricultural development. The main cause for this inequality is the lack of comprehensive gender disaggregated data and its accessibility to all development planners and policy makers (MoFA, 2007; FAO, 2012).

Programs implemented by the Ministry of Food and Agriculture are unbalanced between men and women. For example, only 20% of extension services reach women (MoFA, 2007). The Planting for Food and Jobs (PFJ), which is a current Government of Ghana programme designed to promote growth in food production and create jobs across the country, requires that interested persons should have at least an acre of land (MoFA, 2017). However, it failed to consider, the gender-based cultural norms, inheritance structures and household responsibilities, which place a limitation on women to have access to land, education and agriculture input (FAO, 2012). The National Gender Policy (2015) and Gender and Agricultural Development Strategy II (2016), which share a common goal of mainstreaming gender equality in developmental intervention, are both faced with the challenges of the dominating masculine customary system in Ghana (MoGCSP, 2015; MoFA 2015).

Thus, holistic approaches such as the sustainable livelihood approach that capture multiple factors including the social differential factors between male and females in a household, are

recommended to understand the multi-dimensional nature of the factors that influence the lives and well-being of individuals, household and communities (Carney, 1998, Rakodi, 1999; DFID, 1999; Krantz, 2001). An assets-based investigation of developmental interventions will reveal realistic factors that influence how the people manage the natural resources in their communities in their bid to achieve a successful livelihood. The sustainable livelihood approach is used in this study to describe livelihoods of male and female smallholder farmers, including their assets (and access to assets), capabilities, social networks and financial status, the risks and opportunities they are faced with by pursing livelihoods in a mining area and the livelihood strategies they employ to achieve a preferred livelihood outcome.

1.3 Research Objectives

The main aim of the study is to assess the effects of mining activities on the livelihoods of men and women smallholder farmers in the Mpohor District in Ghana.

The specific objectives of the study are to:

1. Assess the existing livelihood assets of male and female smallholder farmers.
2. Evaluate the effects of mining activities on the livelihoods of male and female smallholder farmers.
3. Assess heavy metals concentration (mercury, arsenic, lead and cadmium) in soils in selected farms in the Mpohor District.
4. Evaluate livelihood strategies that are employed by male and female smallholder farmers.
5. Evaluate the role of formal and informal institutions in managing the effect of mining activities on smallholder farmers in the district.

1.4 Research Questions

1. What are the existing livelihood assets of male and female smallholder farmers?

2. What are the different effects that mining activities have on the livelihoods of male and female smallholder farmers?
3. What is the condition of soils (pH, electrical conductivity and heavy metals concentration) in the study area?
4. What are the livelihood strategies employed by male and female smallholder farmers in a mining environment?
5. What are the management strategies of formal and informal institutions on the effects of mining activities on smallholder farmers in the district?

1.5 Statement of Hypothesis

Hypothesis 1:

H0: There is no significant relationship between respondent's gender and the effect of mining activities on their livelihoods

HA: There is significant relationship between respondent's gender and the effect of mining activities on their livelihoods

Hypothesis 2:

H0: There is no significant relationship between respondent's gender and an adopted livelihood strategy

HA: There is significant relationship between respondent's gender and an adopted livelihood strategy

1.6 Justification of Study

The effect of mining activities on smallholder agriculture have been observed through the reduction of crop production, heavy metals contamination of food crops and human (Boateng et al., 2014; Bortey-Sam et al., 2015; Aragón & Rud, 2012). However, the enactment of laws

and policies to regulate the health, safety and environmental impact of mining such as the Minerals and Mining Act, 2006 (Act 703) and the National Environmental Policy by the Government of Ghana, have not eradicated the negative effects of mining on the environment (Tershner, 2012; Bansah, Yalley, Dumakor-Dupey, 2016). There are reports that law enforcement on licensed mining operators have been kept to the minimum and relegated to the background to reduce the burden on investors at the cost of the health, safety and environmental protection (Tershner, 2012; Bansah et al., 2016; Businessghana.com, 2017).

According to Mr. Peter Amewu, former minister for lands and natural resources, in his address at the Stakeholders Workshop on How to Control Illegal Mining Activities in Ghana, March, 2017; "the menace of illegal mining, known in local language as 'galemsay', had assumed a dimension that posed a threat to national security". The illegal mining activities have caused deep exposed excavations filled with contaminated water, irresponsible dumping of sewage and solid waste, uncontrolled dust emissions, release of chemicals such as cyanide and mercury, acid mine drainage, river siltation and deforestation (Businessghana.com, 2017). Exploratory studies in the mining areas show that illegal miners are convincing farmers to sell their farms to them (Mantey et al., 2016; Danquah, Fialor & Aidoo, 2017), indicating that lands that were used for farming are now being used for mining. Thus, the need to investigate the effect of mining on smallholder farmers and evaluate the concentration of heavy metals.

According to DFID (1999), identification of the multi-dimensional risks and opportunities that influence the lives and well-being of individuals, household and communities are critical knowledge gaps. A range of empirical research on the impact of mining has been carried out across the country, however, very little attention is given to the mining activities contribution to the increase in the levels of heavy metals in soils and the impact on the smallholder household, taking into consideration the social differentiation factors in males and females (Hilson, 2001; Yirenkyi, 2008; Yeboah, 2008; Adjei et al., 2012). Therefore, formal economic

systems in the agricultural sector, where women are majority stakeholders, often exclude the women opinions, experiences and needs resulting in greater food insecurity for themselves and their families (FAO, 2012; IM4DC, 2014). For example, during the agriculture census in Ghana that took place between April and July 2018 to inform policy makers, information on the household is requested from the head (AgricInGhana Media, 2018), who is usually a man (GSS, 2010). Opinions of women were only recorded in the absence of their male counterparts.

Despite efforts by the government to promote agriculture and improve the livelihood of smallholder farmers, the gender inequality in the agriculture sector is often overlooked. The gender-based cultural norms, inheritance structures and household responsibilities on Ghanaian women place a limitation on women to have access to land, education and agricultural input (FAO, 2012). Male smallholder farmers are at an advantage of engaging in livelihood activities that results in a desirable outcome than their female counterparts. For policy to be more effective, strategies may need to be targeted, as one group may benefit or be impacted more by policy direction, than the other. This study therefore contributes to understanding the implications of mining activities on the available assets and capabilities of the both men and female farmers using Mpohor District as a case study.

1.7 Definition of Terms

1.7.1 Smallholder Farmer

According to Chamberlin (2007), the term smallholder is interchangeably used with small-scale, resource poor and sometimes peasant farmer. However, taking into consideration some common features of smallholder farmers in Ghana and the objectives of this study, the definition of smallholder farmers is given as farmers who own relatively smaller (not more than 2 hectares) farmlands or plots for the cultivation of mainly subsistence crops, depending largely on household or family hands or labour (Morton, 2007; World Bank, 2007).

1.7.2 Livelihood

The British Department for International Development (DFID) in 1999 modified the definition of livelihood by Chambers and Conway (1992) and applied it in their sustainable livelihood approach in poverty reduction especially in developing countries.

For the purpose of this study, the DFID definition of livelihood is adopted which states that "livelihood comprises the capabilities, assets (including both material and social resource), and activities required for a means of living:" (DFID, 1999, p. 1.1).

1.7.3 Livelihood Strategy

The adopted definition of livelihood strategy for this study is given by DFID (1999, p. 2.5) as "the range and combination of activities and choices that people undertake in order to achieve their livelihood goals (including productive activities, investment strategies, and reproductive choices)."

1.7.4 Gender

According to WHO (2002), gender identity is a learned behaviour taught by the society and varies from society to society. People are raised to behave according to certain norms, which include how they should relate to others of the same sex or opposite sex within households, communities and work places. Therefore, in this study, gender is defined as the differences in socially constructed roles and opportunities associated with being a man or a woman and the interactions and social relations between men and women (UNDP, 2007).

1.8 Organization of Thesis

The thesis consists of six chapters. Chapter 1 is the introduction and entails background, problem statement, objectives, research questions, hypothesis, and justification of the study, as

well as the definition of concepts. Chapter 2 consists of the literature review and research conceptual framework followed by Chapter 3, which comprises the materials and methods used for the study. Chapter 4 presents the results obtained from the field research, while Chapter 5 provides the discussions of the results based on the objectives of the study. It discusses the types of assets of respondents, effect of mining activities on the livelihoods of smallholder farmers, chemical properties of soil samples, livelihood strategies adopted by male and female smallholder farmers and the formal and informal institutional roles in managing the effect of mining activities on smallholder farmers. Finally, Chapter 6 presents the conclusions and the recommendations of the research findings.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Agriculture in Ghana

Ghana engaged in agriculture both on commercial and non-commercial basis before attaining independence in 1957. However, policies in the sector were only on export-oriented commodities such as cocoa, coffee and oil palm (Brooks, Croppenstedt & Aggrey-Fynn, 2007). The government's control of the sector was through the establishment of marketing boards such as the "West African Produce Control Board" in 1940 to 1976, to buy cocoa from neighboring countries which have agreed on predetermined prices and the "Ghana Marketing Board" which was commissioned by ordinance in 1947 to regulate market value and production of cocoa but was later dissolved in 1979 for the reconstitution of the Ghana Cocoa Board (Brooks et al., 2007). During those periods, Ghana became the leading producer of cocoa in the world, and the second most prosperous nation in Sub-Saharan Africa after South Africa (Styker, 1991).

Post-independence saw more governmental interventions in the agriculture sector including the control of prices, subsidisation of inputs and credit, allocation of mandatory credit, and intense involvement by the government in the production, distribution and marketing (Brooks et al., 2007). The first president of Ghana, Dr. Kwame Nkrumah, however did not only concentrate on commercial farming systems, he also recognised the contributions of smallholder farmers especially in the production of Ghana's major export crop, cocoa. By 1962, he had established twenty-six (26) co-operative and commercial state farms which focused on rubber, oil palm, cotton, coconuts and fibre plant, and also established district and regional tractor stations to facilitate the renting of tractors to plough farms by smallholder farmers whose main farm equipment were hoes and cutlasses (Wiermers, 2015).

The ideology of small farm first and its potency to create positive growth that can extend to rural poverty alleviation and equity came into international policy after the overthrow of Dr. Kwame Nkrumah (Ellis & Biggs, 2001), thus, policies and programmes implemented by both government and donor agencies were aimed at making Ghana self-reliant on agriculture. The "Operation Feed Yourself" programme, which was initiated by General Acheampong in 1972-1975, was supported by a series of price reforms with the aim to repudiate IMF's support and liberalization of policies (Wiermers, 2015). The Programme ensured that specific production targets were given to stakeholders in the agriculture sector such as the "State Farms Corporation", "Food Distribution Corporation", "Settlement Farms", "National Investment Bank", "Private Farms" and "Educational Institutions" with allocation of government financial resources unmistakably biased towards the agriculture sector. Farmers in smallholder agriculture in the Northern region of Ghana during a study by Wiermers (2015), expressed from memory the abundance of farm inputs, especially fertilizer from the Ministry of Agriculture in the late 1960s to the early 1980s, which facilitated easy farming with appreciable yields. The agriculture sector's contribution to the GDP rose from 51.1 percent in 1960 to 60.7 percent and was attributed to having a labour force of 61.8 percent in 1960 (Jedwab & Osei, 2012).

The economic recovery programme in 1983 brought about the denationalisation of government farms, the removal of controls on prices, and reduction of grants on inputs such as fertilizers in the agriculture sector. Smallholder farmers had the shock to their livelihoods when the subsidy rate on fertilizer imports was completely removed by 1990, after a reduction from 65 percent in 1980 to 45 percent in 1984 (Khor & Hormeku, 2006). During that period, the Ghanaian cedi was revaluated, resulting in inflation to the US dollar, which also forced smallholder farmers to pay very high prices for their inputs. For example; the price of fertilizer per maxi bag rose

from 58 Ghana cedis to 3,600 Ghana cedis and the price of ammonia per bag also increased from 45 Ghana cedis to 2,350 Ghana cedis between 1983 to 1989 (Sarris & Shams, 1991).

Although, agriculture sector's contribution to GDP peaked to about 60 percent after the reformation in 1983, its growth has been constantly declining in the 40 percent margin until 2007, when the contribution of agriculture fell to below 35 percent (Jedwab & Osei, 2012). This was attributed to the fast-growing service sector in the country that raised its share in GDP to over 40 percent becoming the first-time the service sector had contributed the largest percentage to the economy of Ghana. The World Bank (2018a) noted that; "the rise of the Ghana's mineral sector is an emergent sign of Dutch Disease, limiting the growth of the agriculture sector". The Agriculture sector's contribution to real GDP reduced from 30.8% in 2006 to 18.3% in 2017, with the lowest growth of 0.8% in 2011, which was the year of commencement of oil production, resulting in a growth of 14% in GDP (GSS, 2018). The agricultural sector is now the smallest contributor to Ghana's GDP, yet it employs about 44.7 percent of the country's total labour (GSS, 2018).

The five agro-ecological zones in Ghana that are classified by MoFA (2015), as: "Rain Forest, Semi-Deciduous Forest Savannah Transition Zone, Transitional Zone, Coastal Savannah and Northern Savannah (Guinea and Sudan Savannah)" exhibit a regional variation in the distributions of agricultural GDP with significant repercussions for sub-sector-level agricultural growth strategies. Currently, out of a total land area of 238,842.45 sq. km in Ghana, only 64,214.5 sq. km (56.94%) is classified as agriculture land (MoFA, 2015). According to FAO (2015), smallholder farmers accounts for about 80 percent of the total agriculture production in Ghana, which includes women farmers, with the potential to transform into a commercially-viable and sustainable enterprise. Out of a total of 2,503,006 households engage in agriculture, 1,820,431 (75.29%) are known to be rural agriculture households (MoFA, 2015), having an average landholding size of 0.032 sq. km (3.2 Ha) (Chamberlin, 2007). According

to MoFA, 2015, the major agriculture imports in Ghana are wheat, rice, frozen chicken, milk, fish while cocoa, timber and horticulture product are the major agriculture exporting products. Cocoa is the largest crop exports from Ghana, which also accounts for about 20 percent of the world's cocoa export (World Bank, 2018b).

2.2 Gendered Differences in Agriculture

The urgent need for a sustainable global poverty reduction has caused countries, particularly the developing economies to critically improve on their agriculture sector (MoFA, 2015). Agriculture in sub-Sahara Africa is mainly done by smallholder farmers who own about 33 million farms, and contributing to a greater proportion of food production in some sub-Saharan African countries (Wiggins & Keats, 2013). Generally, smallholder agriculture in sub-Saharan African is highly mixed, including farms which are described by Gollin (2014), "as commercial in orientation and those that are rooted in quasi-subsistence livelihoods." However, most crop farms are owned by smallholder farmers having a farm size that are less than 5 hectares (Eastwood, Lipton, & Newell, 2010).

Even though, agriculture has been identified to play a significant role in the reduction of poverty and the growth in national economies, and women are known to pursue a livelihood in smallholder agriculture than the other economic sectors (Gollin, 2014), the sector is not living up to its potential in many countries partly because there is not much differentiation between male and female in relation to policies in agriculture, environmental and other related policies and programmes (FAO, 2011). Farmers are often regarded as men, thus the opinions, needs and contributions of women, who are mostly responsible for the management of household food consumption are misunderstood, underestimated or ignored in the drawing up of policies and programmes (FAO, 2004). For example, women smallholder farmers in Bafoulabé region in Mali, were popularly known for the production of rice, and having an in-depth knowledge

of 30 varieties of local rice by growth cycle, they could even predict the end product of each variety in terms of taste but were not given the opportunity of cultivating the three improved rice varieties introduced in the village. The men, who were least familiar with the local rice varieties, were made the main custodian of the new improved rice varieties (Synnevag, 1997). Apparently, women farmers are often bypassed in recent improvement of agriculture productivity and technology due to their inability to secure credit to access these inputs which have the potential to increase their productivity (FAO, 2004).

According to FAO (2011), globally, women constitute 43 percent of the total labour force in the agriculture sector, working across the sector's value chain as farmers, market sellers, horticulturist and community leaders in charge of natural resources management. According to Howard (2003) and FAO (2011), women accounts for 80 percent of food production in Africa and constitute the majority of agriculture labour force, ranging from 36 percent in Cote d'Ivoire and Niger to over 60 percent in Sierra Leone and Mozambique, but they often engage in subsistence farming with low access to land, agriculture inputs, extension officers, credit, technology and information that leave them more vulnerable to any external shocks and stress on their livelihood than their male counterparts. Agricultural activities in Ghana are predominantly done by rural households (1,775,900 out of 2,203,965) of which 23.3 percent by done by household headed by females (GSS, 2016).

2.3 Overview of Gold Mining in Ghana

Ghana's geological setting teems with varieties of minerals both on large-scale and small-scale with evidence from recent airborne geological survey that confirmed the occurrence of over twenty-eight minerals, including, platinum, uranium, tantalite and rare earth (Ghana Chamber of Mines, 2016). The exploitation of minerals such as gold, diamond, bauxite and manganese are done by large scale mining companies, while kaolin, silica sand and limestone are mostly

produced on small-scale (Akabzaa & Darimani, 2001). However, the mining industry in the country is synonymous to gold because it has always accounted for most of the gross mineral revenue. Historical accounts of gold mining in Ghana, predate the activity to the pre-colonial days (before 1867), where gold was seen in almost all the auriferous Akan states and artisanal placer gold mining was the livelihood of the Asantes, Denkyira, Akyem, Wassa and many other Akan states in the country (Gocking, 2005; Ofosu-Mensah & Ababio, 2011).

The arrival of the Portuguese in 1471, marked the beginning of the influx of European, notably the British, Dutch and Danes to the country to trade in gold. According to the Minerals and Mining Policy (MMP) of Ghana (2014), between 1493 and 1600, with more than 30 gold mining operations in Ghana, the country was credited for 36 percent (8,153,426 fine ounces) of total output of gold in the world. The abundance and richness of Ghana's gold was the precursor of the country being called Gold Coast, under the colonial rule, between 1867 and 1957 (Ofosu-Mensah & Ababio, 2011). During the rule by the British, the mining sector in Ghana was developed in response to the economic and political developments in the Europe, particularly, in Britain (Akabzaa & Darimani, 2001). For example, a bauxite mining concession in Awaso was acquired in 1926, it was until 1940 that mining commenced by the "British Aluminium Company Limited", who acted as representatives for the "British Ministry of Aircraft Production" when other sources of aluminium by allied forces have been cut during World War II (Tsikata, 1997 as quoted in Akabzaa & Darimani, 2001).

After the Independence of Ghana in 1957, "the UN Charter: General Assembly Resolution 1803 (XVII) of 14 December 1962" allowed lasting authority over natural resources in developing countries between the period of 1965 and 1980. Ghana took advantage of its freedom to enact series of statues to regulate land and minerals that resulted in the state ownership of the mineral resources between 1957 and 1983 (MMP, 2014). For example, the Minerals Act, Act 126 (1962) vested "ownership of minerals in the President on behalf of the

Republic and in trust for the people of Ghana". All non-Ghanaian mining companies in the country including "Ashanti Goldfields Corporation (AGC)" and "Consolidated African Selection Trust (CAST)" lost majority of the shares (55%) to the government when the "Mining Operations (Government Participation) Decree, 1972 (NRCD 132)" was enacted (Akabzaa & Darimani, 2001). Thus, during this period, the government development of the mining sector was to protect the employment of the Ghanaians and acquire foreign currency produced by the mines. However, this decision by the government created uncertainty amongst the investors about the safety of their investment. This led to unavailability of foreign exchange to maintain and purchase mine equipment and coupled with unfavorable global gold market conditions, the mining industry became stagnant (MMP, 2014).

In the year 1983, the stagnation of the mineral sector, along with other economic crises forced the Ghanaian government to lunch the Economic Recovery Programme (ERP) with aid from the World Bank. The mineral sector was selected to receive reforms and investment in the bid to revive the economy (MMP, 2014). Several laws were enacted to accomplish the recovery. These included the "Minerals and Mining Law (PNDC Law 153)" enacted in 1986 to "promote and regulate the orderly development of the sector". In 1989, the "Small-Scale Gold Mining Law (PNDC Law 218)" was passed "to regularize and make more efficient small-scale gold mining", the "Mercury Law (PNDC Law 217)" was passed "to regulate the use of mercury by small-scale gold miners" and the "Precious Minerals Marketing Corporation Law (PNDC Law 219)" was passed "to provide official marketing channels for gold produced by small-scale miners". Great successes were achieved from the enactment of the laws as an appreciable increase in gold production in the Country was attained. The small-scale mining industry increased their employment rate by 941.73% from 1984 to 2004 (Opoku-Antwi, 2010).

As at 2016, gold, diamond, bauxite and manganese were being exploited by 14 large-scale mining companies and numerous active artisanal and small-scale mining operations in the country (Ghana Chamber of Mines, 2018). However, the mining industry in the country is synonymous to gold because it accounts for 97.3 percent of gross mineral revenue, while manganese, bauxite and diamond account for only 1.9 percent, 0.7 percent and 0.03 percent respectively (GHEITI, 2018). The country was ranked as the tenth leading producer of gold in 2017 (Reuters, 2018). According to Bank of Ghana (2018), gold exported in 2017 was 4.61 million ounces, an increase of 3.84 million ounces exported in 2016. However, export in manganese, bauxite and diamonds in 2017 were 3 million tonnes, 1.47 million tonnes and 87, 068 carats respectively (Ghana Chamber of Mines, 2018).

There are several techniques employed to remove a mineral of economic value from the earth but they all have the aim of economically and safely removing the mineral with minimum damage to the surrounding environment. In Ghana, the main methods of mining employed by the large-scale mining companies are underground and open pit mining (Ghana Chamber of Mines, 2016), while alluvial mining methods such as *anomabo*, chisel and hammer, dig and wash were used by the artisanal and small-scale companies. Recently the use of 'changfa', 'more blade', and alluvial washing plants have been introduced into the artisanal and small-scale mining industry by the Chinese. Underground 'ghetto' is also used to extract the minerals from deep within the earth crust (Bansah et al., 2016; Mihaye, 2013).

2.4 Impacts of Mining on Smallholder Agriculture

2.4.1 Land Degradation

Land degradation is recognized as one of the most basic and persistent environmental challenges. It involves the long-term loss of ecosystem function and services, caused by disturbances from which the system cannot recover unaided (UNEP, 2016). The continuous

destruction of dry land ecosystems by anthropogenic activities, including unsustainable mining and farming can lead to desertification (UNEP, 2016). The exploitation of mineral resources, irrespective of the scale, requires the removal of vegetation cover which reduces organic matter content, soil nutrients, microbial activity and destabilizes the soil structure. An exposure of the soil surface for a long time leads to the sealing of soil particles. Erosion then becomes inevitable as permeability is reduced and runoff is increased. One third of the world's arable land has been destroyed by erosion over the past 40 years and has been a great constraint in achieving food security and improving livelihoods in Africa, which already has about 45 percent of its land area affected by desertification (UNEP, 2016).

Estimation by UNEP (n.d), placed Africa to be the custodian of 40 percent of the world's mineral resources, whiles having 65 percent of the world's arable land and 10 percent of internal renewable fresh water source. Thus, the launch of SAP in many sub-Saharan countries resulted in the demarcation of farmlands and rangelands to multinational mining companies by governments (Hilson & Banchirigah, 2010). Also, the onset of mining activities is recorded to lead to the hasty emergent of overnight settlements which requires the clearing of vegetation to meet the demand of the rampant urbanization. Space for buildings, wood for construction and fuel, all contribute to deforestation. People who depend on the variability of the land resource are adversely affected as the land continue to deteriorate. The over 2 billion people in the world, who depend on the about 500 million smallholder farmers are at risk on losing their livelihood and food security due to land degradation (Barbut & Alexander, 2016).

In Ghana, Landsat satellite images of the Western Region, which host majority of the country's mining companies indicated that surface mining resulted in 45 percent of farmland being lost to mining activities. This caused an extensive spill-over effects as relocated farmers develop farmland in forests reserves (Schueler, Kuemmerle, & Schröder, 2011). In Tarkwa-Aboso, a

hotspot mining area in the Western region of Ghana, studies done by Preprah, 2002 showed that, 71 percent of arable farmlands have been loss and degraded by surface mining activities. Residents of Prestea, also a mining community in the Western Region of Ghana, led by Human Prestea stakeholder's coalition, took to the streets in January 28, 2014 to register their displeasure against surface mining activities in the community (Ghana news agency, 2013).

2.4.2 Chemical Pollution of Agriculture Land

According to WHO (2018), in 2012, about 12.6 million people lost their lives due to living or working in a polluted environment. Mining activities generates of large quantities wastes rock materials laden with toxic trace elements that cause widespread contamination of the ecosystem. A high intake of some of the toxic trace elements, even those which are classified as essential for normal human growth (micronutrients such as iron, zinc, copper and manganese) can have toxic effects on human health (Fashola, Ngole-Jeme, & Babalola, 2016). Heavy metals that can be described as toxic trace elements like arsenic, lead and, mercury can cause deleterious effect in minute quantities (Cobbina, Duwiejuah, Quansah, Obiri, & Bakobie, 2015).

Heavy metals such as mercury, arsenic and cadmium naturally exist in sediments, water bodies and soils through the chemical weathering of rocks, but human actions such as mining, industrial and domestic waste discharge can increase their concentration, and cause the increase in chemical concentration of terrestrial and aquatic media resulting in the loss of the ecosystem's ability to support plant life and perform other ecological services (Das, Das, & Dhundasi, 2008; Anim, Ahialey, Duodu, Ackah, & Bentil., 2011; Anim-Gyampo, Kumi, & Zango, 2013). The toxicity of these trace elements in humans is determined by the chemical species as well as gender, route of exposure, douse, nutritional status and genetics of exposed individuals (Tchounwou, Yedjou, Patlolla, & Sutton, 2012).

Investigations by Hayford, Amin, Osae, & Kutu (2008) into the concentration of toxic elements in samples of cassava, plantain and soil in the Tarkwa mining area, in the Western region of Ghana showed that, the levels of arsenic and mercury in cassava, plantain and soil were higher than the recommended values from FAO and WHO for food and soil. By using agriculture production function on household level in some communities in Ghana, Aragon and Rud (2012), estimated that agriculture productivity has been reduced by almost 40 percent due to pollution by mining companies and not by input availability.

Waste materials that consist of sulphide bearing minerals like pyrite, gets oxidized and allows the generation of excess acid beyond the natural buffering capacity of host rocks, soil and water resources. This acidification can be further aided by the Thiobacillus ferroxidans bacteria which leaches more trace metals from the waste materials contributing to high deleterious effects on both terrestrial and aquatic ecosystems (Rozkowski & Rozkowski, 1994).

A change in biotic and abiotic component of a plant's environment can influence its productivities. One such effect is known as physiological disorder. According to Guerena (2006), plants depicts disease-like symptoms when affected by physiological disorders. Even though, by altering the environmental conditions, the physiological disorder can be prevented, a low yield is inevitable when the plant shows symptoms of nutrient deficiency (Guerena, 2006; Jarvis & McKeen, 1991). For example, physiological disorders in fruits such as 'bitter pit' (apple), 'monkey fruit' (apple) and 'hen and chicken' (grapes) are caused by nutrients imbalances (Khan & Ali, 2018).

2.4.3 Chemical Pollution of Irrigation Water Resources

Contaminated water is difficult, expensive, and often impossible to rid it of pollutants. Through the hydrologic cycle, contaminants naturally get deposited into both surface and underground water. However, anthropogenic activities such as mining alleviate the level of contaminants in

the environments and increases the process by which these contaminants get into the water sources. As surface water gets turbid by the deposition of suspended particles, it also dissolves soluble toxic elements which makes the water unsuitable for use. The contaminants also get leached into the groundwater sources during precipitation.

Investigations of heavy metal concentration in sediments, water and fish from the Ankobra and Tano Rivers in the Western region of Ghana by Awuah (2016), revealed that, the concentration of arsenic and mercury levels in both Tano and Ankobra were above the WHO recommended levels for pristine freshwater ecosystems and may therefore pose a threat to aquatic wildlife and human health. The basins of both rivers are noted for mining operations since the 15th century (Akabzaa & Darimani, 2001) and prior investigations by Baah (2002), had revealed higher concentration of lead, zinc and mercury in the Ankobra and Tano river basin, with higher mercury levels detected in human blood.

High values of iron, arsenic and manganese as compared to values by the Ghana Standards Authority (2009) limits for drinking water was detected in the Birim River by Asmah (2011) during his investigation into the chemical water quality assessment of the upper catchment of the Birim River. The river is a major source of water for domestic uses and had been abstracted by the Ghana Water Company for treatment and distribution to consumers within and around the catchment of the river. However, the river has experience rapid deterioration due to the operation of illegal ASM activities which liberate toxic metals from the underlying bedrock.

2.4.4 Land Use Conflicts

Land use conflicts between mining and agriculture has been experienced in rural communities all over the world. These conflicts usually results from the farmers' perceptions that mining is utilising lands that traditionally belongs to them, without any offer of alternate livelihood from the miners (IM4DC, 2014). In communities that have informal land tenure systems, some

farmers get evicted unjustly when they fail to prove their ownership of farmlands. The pollution of water bodies by mining activities is also the cause of social conflicts between mining and agriculture, especially in areas with limited fresh water sources. There is also the struggle between illegal small-scale miners, who are sometimes also farmers that have diversified their income, and the large-scale mining companies over the use of land. In this case, the security agencies are usually employed by the multinational companies and government to brutalise the weaker, lesser beneficiaries - the farmers (Tockman, 2001)

The Daily Guide (2018) reported on the incident that occurred at Newmont Ghana Akyem mine, located in Birim North District of the Eastern Region of Ghana. Where seven farmers sustained injuries after police had fired rubber bullets and tear gas to disperse them during a protest against the mines on 16th October, 2018, due to the failure of the mines to compensate them properly. In Latin America, a rally cry by smallholder farmers *"Si a la vida, no a la mina"* (Yes to life, no to the mine) is common on the streets of many rural communities where minerals, oil and gas extraction has exploded to feed the Chinese economy (Slack, 2013).

2.4.5. Influence on Livelihood Strategy

Smallholder farmers in mining communities adapt the three clusters of livelihood strategies namely "agricultural intensification, livelihood diversification and migration" as suggested by Scoones (1998), in the sustainable livelihood framework in their pursuit for a desirable livelihood outcome. Several studies in sub-Saharan Africa have revealed the widespread of diversified portfolios that includes all the three livelihood strategies in the intertwined economies of farming and mining (Kitula, 2006; Maconachie & Binns, 2007; Hilson, 2016). The reduction of arable farmlands and the influx of migrants due to mining activities in rural communities serves as a driver for agriculture intensification in which farmers produce more to meet the demand for food at the same time increasing the prices of food stuffs (Danquah et

al., 2017). The rural-rural population movements, which has been well established as a short term means by which poor households and individuals adopt to shocks and stress on their livelihood (McDowell & De Haan, 1997; Davies, 1996) also contribute to increase in population in mining communities.

Scholarly research gives evidence that, ASM serve as a non-farm livelihood activity for smallholder farmers over a calendar year (Maponga & Ngorima, 2003; Hilson & Garforth, 2012). Hilson, 2016 explored how seasonality influences the balance between farming and mining in sub-Saharan Africa, particularly in Ghana, Malawi, Mali, Sierra Leone, Liberia, Mozambique and Zimbabwe. Farmers in rural communities in these countries endowed with economic minerals such as gold, diamonds and gemstones, branch out into mining to earn extra income, which has contributed to the survival of many households in rural sub-Saharan Africa since the onset of SAP. Thus, capital and labour are the two major inputs exchanged between mining and agriculture over time. Farmers engage in ASM during non-harvesting seasons while the funds from mining is used to construct new houses, invest in good education for their wards and other business which serves as an effective short-term buffer against poverty. Some families use the monies to intensify agriculture, making them less dependent on ASM. For example, a study by Maconachie & Binns (2007), revealed that male farmers in the Eastern Province of Sierra Leone, during the dry season (January and March) engaged in ASM of diamonds while the females ensure to the preparation of the upland farm for cultivation.

Also, the corporate social responsibility of large-scale gold mining companies, gives them the opportunity to initiate alternate livelihood programmes (ALP) for displaced communities to reduce economic dependence on the mining companies (Doso Jnr, Cieem, Ayensu-Ntim, Twumasi-Ankrah, & Twum Barimah, 2015). An example is The Golden Star Oil Palm Plantation (GSOPP), initiative by Golden Star Resources (GSR) in 2007. The aim of the

initiative was to address environmental, food access and community concerns. Degraded lands that was used for mine waste disposal were reclaimed for oil palm plantation, while traditional authorities provided additional lands. The initiative also serves as a means of employment and the rehabilitation of degraded lands with the intention of reducing illegal ASM in the community. GSR provided the initial funding for GSOPP with a dollar per ounce of gold produced (GSR, 2013).

The Sustainable Community Empowerment and Economic Development (SEED) Programme and Hand-in-Hand Sustainable Alternative Livelihood Programme are also examples of alternate livelihood programmes initiatives by Goldfields Ghana Limited (GFGL) and Anglogold Ashanti (AGA) respectively in partnership with Opportunities Industrialization Centres International (OICI) in 2005. The SEED programme was established in 16 stakeholder towns which were affected by the company's operations (GFGL, 2010). It included oil palm plantation and fish farming projects. Oil palm seedlings amounting to over 17,000 were given to over 263 farmers in stakeholder communities for cultivation and a total of 8 fish ponds were constructed and stocked with tilapia and catfish (GFGL, 2010).

2.4.6. Impact on Human Health

The WHO (2019), Health Impact Assessment (HIA) identified three main determinants of health, namely: socio-economic environment, the physical environment and the person's individual characteristics and behaviours. In rural communities where mining activities occur, smallholder farmers and the whole populace are likely to experience a change in their physical environment and their income, which will have a spillover effect on other aspect of their lives such as health, educational level and relationship with friends and family. Also, the moonlike landscapes created by miners after they exhaust their mineral of interest becomes a death trap for unsuspecting wildlife and humans, whereas some excavations get filled with water which

serves as breeding grounds for mosquitoes leading to the diseases such as malaria, Guinea worm disease, Typhoid, and Dysentery. The WHO (2018) reported the over 200,000 deaths of children under five (5) years from malaria.

Furthermore, the rampant urbanisation of mining communities as a consequence of the influx of migrants also affects the socio-cultural and economic lives of the local people. Drug abuse, prostitution and arm robbery are some of the social vices that some of the migrants resolve to when their quest to gain employment in the mines fails (Adu-Yeboah, & Obiri-Yeboah, 2008). An increase in sexually transmitted diseases is common in mining communities. According to Akabzaa & Darimani (2001), resident sexual workers in Tarkwa, a mining community in Ghana, render their services to illegal miners or junior workers employed by large-scale mining companies, while mobile sex workers target the expatriate and high-ranking officials of large-scale mining companies. Records of HIV status of the people in the Wassa West District, where Tarkwa is located showed an increase from six reported cases in 1992 to one hundred reported cases in 1996 (Akabzaa & Darimani, 2001).

The generation of dust particles and gaseous pollutants such as sulphide dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO), by earth moving machinery used in mining are the major causes of air pollution in local communities that hosts mining activities (Aryee, 2001). Reduction of ores surface area to make the mineral of interest accessible, heaping of ore and waste rock samples and the general site clearing are the activities that contribute to the generation of dust in the environment (Baird, 1995). Above tolerable limits, these particles cause respiratory tract infections and other dust related disease. Small-scale miners are particularly at risk of inhaling mercury fumes as they roast their ore during amalgamation. Apart from second-hand smoke, in 2017, WHO reported that, respiratory infections, such as pneumonia was responsible for the death of over 570 000 children who were exposed to indoor and outdoor air pollution.

2.5 Selected Trace Elements

2.5.1 Arsenic (As)

Arsenic naturally exist in the earth crust but is listed by WHO (2018) as a chemical of deleterious health impact. Arsenic is a silver-grey brittle metalloid which has an atomic number of 33 and an atomic weight 74.9 g/mol. The chemical is present in certain diets such as shellfish, poultry and dairy products, and is also used in the manufacturing of glass, textiles and wood preservatives (WHO, 2018). The toxic effect of arsenic is influenced particularly by its state of oxidation and species. In general, inorganic compounds of arsenic such as those found in groundwater are known to be more toxic than most organic forms of arsenic (NIEHS, 2014). Immediate acute symptoms of arsenic poisoning are vomiting, abdominal pain and diarrhoea, while contamination of arsenic through the long-term exposure of arsenic via drinking water and food can result in skin cancer and skin lesions (WHO, 2018).

2.5.2 Cadmium (Cd)

Cadmium is a soft white metal with atomic number 48. It has a density of 8.64 g/cm^3 and an atomic weight of 112.40 (WHO, 2004). Chemically, it has similar properties as zinc and occurs naturally with zinc and lead in sulphide ore, but is rarely found as a pure metal in nature. (ATSDR, 2012). The chemical is mostly used in rechargeable nickel batteries, pigments, plastics as well as in the manufacturing of control rods for nuclear reactors. However, the major route of cadmium exposure by humans is through contaminated food (ATSDR, 2012). Cadmium contaminated soils produces plants that have indications of lacking essential nutrients with symptoms like browning of root tips, chlorosis, growth inhibition, and finally death (Wójcik & Tukiendorf, 2004). Cadmium primarily accumulates in the kidney and has a half-life in humans of 10–35 years which leads disruption of calcium metabolism and the formation of kidney stones (WHO, 2008).

2.5.3 Lead (Pb)

Lead is a bluish or silvery-grey metallic element with an atomic number of 82, a specific gravity of 11.34 g/cm^3 and atomic weight of 207.19 g/mol (ATSDR, 2007). Lead is primarily used in the manufacturing of lead batteries, but also in soldering materials and production of x-ray machines and acid resistant materials used in the building industry. Thus, the source of lead contamination in the environment is primarily from these production industry and also from smoke and dust emissions of coal and gas-fired power stations. The main exposure by humans is through the inhalation of contaminated aerosols (ATSDR, 2007).

Plants grown in lead contaminated soils experience severe effect on morphology, growth and photosynthesis (Sharma & Dubey, 2005). For humans, high exposure to lead affects the kidney, cardiovascular and haematological systems with severe effect on developing nervous system in children, who happens to be more exposed to lead contamination through their hand to mouth activities (ATSDR, 2007). The effects on children include lower intelligence quotient, decreased hearing acuity, delayed speech and language development, and poor attention span (US-EPA, 2002). High lead exposure in men and women has been recorded to cause decreased sperm count and spontaneous abortions respectively, with severe damage to brain and kidney in both sexes (ATSDR, 1999).

2.5.4 Mercury (Hg)

Mercury is one of the predominant naturally occurring toxic heavy metal in the environment, having an atomic number of 80, and an atomic weight 200.59 g/mol, Naturally, the three forms of mercury that exist; metallic or elemental, inorganic and organic have their own profile of toxicity (ATSDR. 1999). A combination of elemental mercury and other elements such as chlorine, sulphur, and oxygen forms inorganic mercury compounds, whereas a combination of the elemental mercury with carbon forms the organic mercury compounds. Methyl mercury

(MeHg) and elemental mercury (Hg^0) are the two most highly absorbed species of mercury. Mercury is used in thermometers, thermostats, and dental amalgam because of its physical and chemical properties such as low boiling point and easy vaporization. The exposure path of mercury in humans are through the inhalation of contaminated aerosols and food (ATSDR, 1999).

All forms of mercury are toxic and their effects include neurotoxicity, gastrointestinal toxicity, and nephrotoxicity, with renal toxicity, vomiting, high blood pressure and skin rashes being some examples of effects of mercury vapour exposure. (Tchounwou et al., 2012).

2.6 Management of Environmental and Socio-economic Impacts of Mining

2.6.1 Management by Higher Level Formal Institutions

After the introduction of SAP, the government of Ghana has taken a regulatory role and increasingly has privatized the mining sector (MMP, 2014). A wide range of governmental and non-governmental agencies are involved in the institutional framework for mining governance, making the framework more complex. The presidency, parliament, central government ministries, departments and agencies are placed at the central level, while, at the local state level, there are Metropolitan, Municipal and District Assemblies and traditional institutions being supported by civic or non-profit organisations (MMP, 2014). The environmental and socio-economic impact faced by the communities and the general citizenry of the country are managed by these institutions aided by environmental regulations on mining, (MMP, 2014; GHEITI, 2018). However, the lack of collaboration and overlapping mandates given to these institutions, serve as a limitation for an effective regulation of the effects of mining on local communities (Akaabzaa & Darimini, 2009; Danquah et al., 2017)

A study by Danquah et al. (2017) in the Amansie West district of Ghana, about the role of institution in managing the effects of mining on rural livelihoods, showed that, the respondents

perceived only 3 institutions, out of the 13 stakeholder institutions in the district to be effective in providing the needed support they have been mandated to the rural households. The three institutions, COCOBOD, Care International and the Millennium Development Authority (MDA), embarked on education, including the rights of farmers against illegal mining land take over, demonstration of new production technology and also were involved in the provision of planting materials and alternate livelihoods in the district.

In Peru, apprehensions about the safety of several livelihoods due to the destruction of the environment by mining activities has caused a lot of social conflicts (Bebbington et al., 2008a). Several national and local institutional innovations that has been implemented since 2004 to enhanced the quality of environment and improve livelihoods. Notable amongst the innovations are the prevention of municipalities by Ministry of Economy and Finance from using resources from tax transfer meant for physical infrastructure development for capacity building; the participatory water monitoring programme, which allows scientists and stakeholders to monitor water resources being used my mining companies against technical water indicators; and the participatory ecological zoning, which incorporate the assessments of land cover change with that of experts assessments (Bebbington & Bury, 2009). Although, the innovations were created as a results of social conflicts, and some are still incomplete, mining companies have been given the opportunities to amicable resolve tensions in their catchment areas.

In Australia, the social effects of mining activities on host communities are the responsibility of the state government. Even though, both the local government and the state government are faced with the challenge of rapid expansion in the minerals sector, the stringent regulatory approach, regional planning initiatives and an effective multi-sector collaborative bodies is helping resolve the many challenges of the locals in mining communities (Barclay et al., 2012).

In India, the Council of Scientific and Industrial Research (CSIR) and Central Institute of Mining and Fuel Research (CIMFR), embarked on several projects to tackle the environmental degradation caused by mining activities. As reported by Singh & Singh (2016), for the removal of heavy metals in soils, different species of aromatic grass such as Cymbopogon winterianus, Citronella and khus grass (Vetiveria zizanoides) are planted on contaminated soils; for the reduction of dust, a haul road dust collecting system have been developed to collect the dust and convert it to fuel briquettes; for the reduction of noise, a scientific control blasting technique have been introduced in several opencast and underground mines; whereas, bio reclamation of mined out areas has been carried out for employment generation and other economic benefits of local communities, especially farmers.

2.6.2 Livelihood Strategies Adopted by Smallholder Farmers

The external cost of mining activities in rural communities are borne by the members of the communities. Smallholder farmers are key recipients of undesirable effects from mining activities as they share a common resource base, land and water with mining operators. Large plots of farmland are demarcated for licensed mining operators, whereas illegal small-scale mining operators move from place to place, exploiting mineral resources at any reasonable size of land (Akabzaa & Darimani, 2001). Therefore, farmers in rural mining communities adopt certain livelihood strategies to cope with shocks and stresses on their livelihood.

According to GSS (2014), smallholder agriculture in the Mpohor District includes the keeping of livestock such as chicken, goats and sheep and fish farming, which a mainly consumed by the households, to reduce the financial burden on acquiring food. In a study on the effects of mining on rural livelihood using the Northern region of Ghana as a case study, Ontoyin & Agyemang (2014), identified land reclamation; control of animal movements or tethering and

engaging in illegal artisanal small-scale mining as livelihood strategies employed by smallholder farmers.

Similarly, livelihood strategy studies done in Tanzania and Malawi showed that, smallholder farmers engage in intercropping, particularly, the growing of food crops such as potatoes maize and as well as the rearing of livestock as an agriculture based (on-farm) livelihood activities to sustain the household and generate income (Kadigi, Mdoe, & Ashimogo., 2007; Ellis, Kutengule, & Nyasulu, 2003). Ellis et al. (2003), also noted that, in some communities in Malawi, the high-income earning farmers have a social obligation of employing their poor counterparts. In so doing, poor farmers are who have limited or no economic assets, offer to work as labourers (off-farm) in other peoples' farms for payment in either cash or kind. This practice limits their productive time on their own farms, reducing the yield of their own produce.

Literature also suggest that smallholder farmers engage in other activities which are not agriculture based (non-farm) to generate income for a desirable livelihood outcome (Muica, Turnock, & Urucu, 2001; Hilson, 2016). Aside engaging in illegal mining activities, wage employment as well as informal economic activities, such as petty trading, food processing, bakery, driving and the repair of motor vehicles and motorcycles are some of the livelihood activities engaged by smallholder farmers in their pursuit for a positive livelihood outcome (GSS, 2014). Migration by some household members is also used as a strategy by some smallholder farmers. This enables the migrants to explore other income earning activities and in turn send remittances back home to contribute to the well-being of the remaining household members (Tolossa, 2010).

2.7 Conceptual Framework for the Study

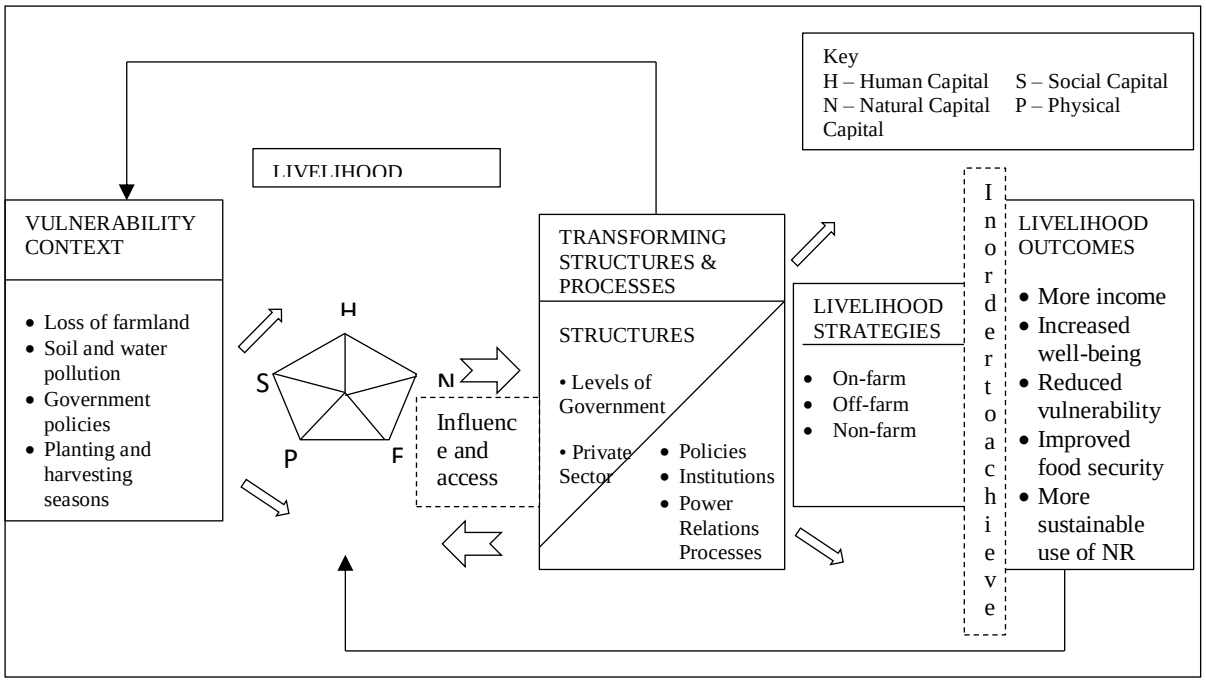
The Sustainable Livelihood Approach (SLA) theory using the DFID Livelihood Model (DFID, 1999) was adopted as the framework for this study. The DFID Livelihood framework is appropriate for the study due to the ease of application, as it offers the opportunity to evaluate the livelihoods of men and women which is constantly being affected by varying dynamic factors and forces, including "vulnerability context", "gender and power dynamics", "transforming structures and process". The analysis is gendered centered and begins with an assessment of the livelihood assets of males and females in the same vulnerability context, the effects of mining activities on their livelihood assets and their choice of their livelihood strategies (Figure 2.1).

The vulnerability context is the external environment that provides factors which have direct impact on peoples' assets status in their pursuit of a desired livelihood outcome (DFID, 1999). Land and water are identified as the main natural asset that farmers exploit for their living. However, the smallholder farmers are operating in an environment characterised by shocks from mining activities, such as loss of farmland and chemical pollution of agriculture soil and irrigation water; under trends in governance (in terms of policies) and seasonality in products and prices (planting and harvesting seasons).

Therefore, smallholder farmers engage in various livelihood strategies, both agricultural (on-farm and off-farm) and non-agricultural (non-farm) using their available assets in the prevailing vulnerability context. The natural resources, such as land and water for irrigation are identified as the natural capitals from which smallholder farmer obtain their livelihood, with support from using their human capital such as good health, education, and skills. The social resources (social capital) for the farmers, developed through their "networks and connectedness" and available infrastructure (physical capital) such as adequate clean water and electricity supply, and secure shelter all support the farmers in pursuit of a sustainable livelihood. The smallholder

farmer is able to achieve a desirable livelihood outcome, well-being or income which all contribute to the financial resources that will be available in obtaining other livelihood assets. However, forces and factors such as government agencies, policies and power relations as well as formal and informal institutions in the community influence the acquisition and usage of the assets available for the smallholder farmers to achieve a desirable outcome (either more income, improve food security and reduce vulnerability).

Figure 2. 1 Conceptual Framework



Source: Modified from DFID, 1999

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

3.1.1 Selection of Study Location

The Mpohor mining area, located in the Western Region of Ghana, hosts one large-scale mine, Golden Star (Wassa) Limited., ninety active (90) small-scale illegal mining activities as at 2016 and countless abandoned mine sites (Mantey et al., 2016). In Ghana, the Western Region has the highest number of registered large-scale gold mining companies and ASMs, and produces the highest tonnes of gold (GCM, 2014). Mpohor is the capital of the Mpohor District of Ghana, which used to be part of the Mpohor Wassa East District. In 2012, by the Legislative Instrument (L.I) 2019, the Mpohor District was separated from the Mpohor Wassa East District along with other 45 Metropolitan, Municipal and District Assemblies (MMDA) (GSS, 2014). As shown in Figure 3.1, the District is geographically positioned at the south-eastern part of the Western Region of Ghana between Latitudes 4.5° N and 5.2°N and Longitudes 1.9°W and 2.25° W covering a land area of about 524.533 km^2. To the west of the District is the Ahanta West District, to the east is the Wassa East District. The Mpohor District is bounded to the north by Tarkwa-Nsueam Municipal and to the south by Shama District. Mpohor is located at about 19 km from the Takoradi-Agona Nkwanta main road.

Gold mining in the Mpohor town dates to the 1400s, as it is reported to have been the source of some of the gold sold to the Portuguese explorers in the late 1400s. It was in the late 1800s that the Europeans showed direct interest in gold exploitation in the area because of the district's proximity to the major port in Sekondi-Takoradi (GSR, 2007). During the gold boom between the late 1800s and early 1900s, almost the whole Mpohor area was licensed to local gold mining operators. Currently, the area hosts the Hwini-Butre concession of Golden Star Wassa Limited, which is 40 km^2, while covering an illegal mining footprint of 24.67 km^2

(Mantey et al., 2016). According to GSS (2014), the area also has an agrarian economy with cocoa and oil palm as the major cash crop.

A total of five communities (Mpohor, Awunakrom, Mpohor Yabiw, Obrayebona and Adum Banso) were selected for the study. Aside the Mpohor Township which was the main study area, three rural communities surrounding the Mpohor Township, Awunakrom, Obrayebona, and Mpohor Yabiw were also purposively selected because of their proximity to the Mpohor Township which has generated an avenue for illegal mining activities. Residents of these three communities are also involved in smallholding farming of cocoa and oil palm. Awunakrom is also catchment community of GSR and have experienced a lot of illegal mining activities, thus presenting a significant setting to access adverse effects of mining of smallholder livelihood. The proximities of four of the communities to each other was also considered as a factor in the research design to reduce costs. Additionally, the homogeneity of livelihood activities served as a criterion for the selection of the study communities.

Adum Banso was selected as a study community because it host several illegal gold mining operations that is affecting the livelihoods of residents while exploratory studies have revealed that iron ore is being prospected in the community (GSS, 2014; Mantey et al, 2016).

3.1.2 Drainage and Topography

Mpohor and its environs falls within the catchment areas of Butre River to the west and the Hwini River to the east, however, there are several streams that runs in the communities. The area is characterized by dendritic drainage pattern, with a long period of erosion resulting in extensive land surface that is undisturbed by crustal movement (GSR, 2007). The bottoms of the broad valleys between the two main rivers (Hwini and Butre) are about 10mASL, gaining a gradual elevation to the north at about 20mASL. In the southern part are rolling hills that

have a modest relief of 20mASL to 30mASL, with a maximum elevation of 110mASL to 120mASL. The maximum relief in the range is about 50m to 60m (GSR, 2007; GSS, 2014).

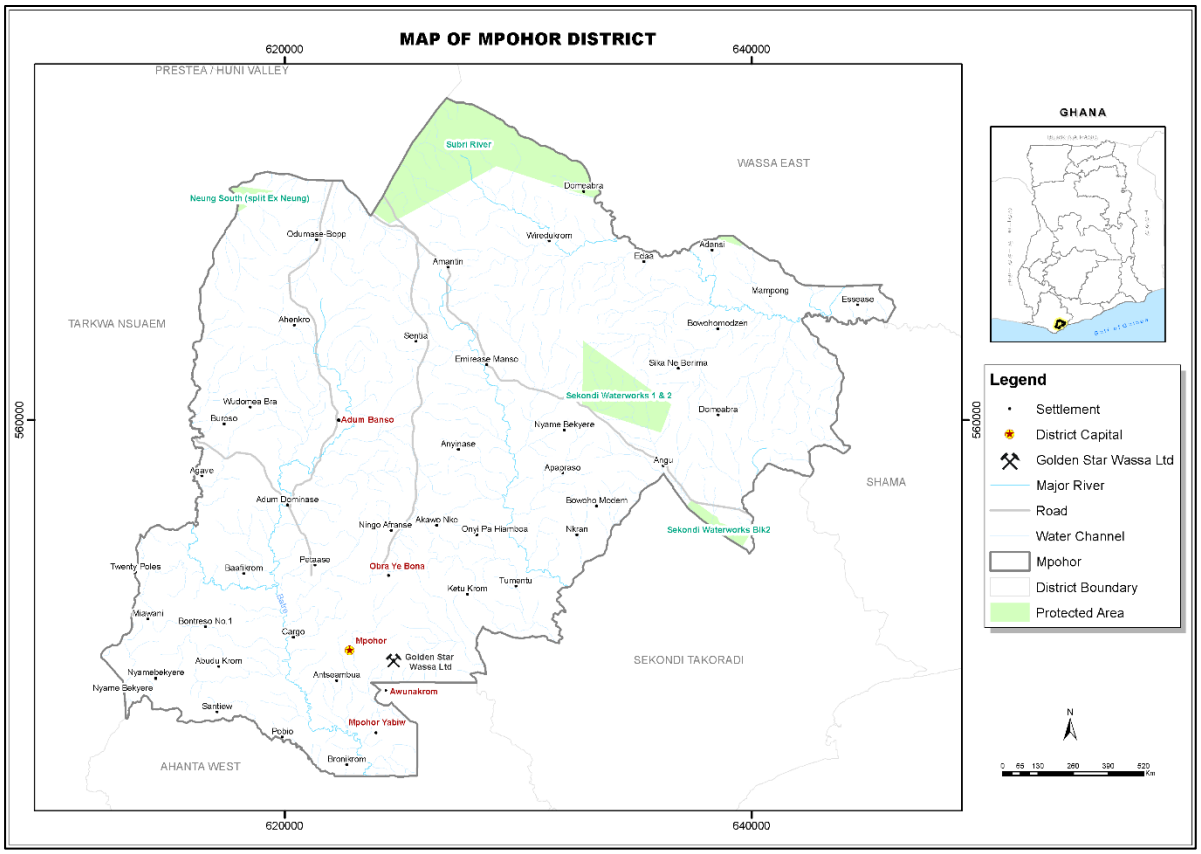


Figure 3. 1 Map of Study Area

Source: CERGIS- University of Ghana

3.1.3 Climate and Vegetation

The Mpohor District falls within the tropical climate zone of Ghana. The annual rainfall experienced in the area has a relatively high mean of about 1500mm, but is also very variable, ranging between 1300mm and 2000mm. The rainy seasons are two, falling between late March to late June and from September to early November, while the dry season occur between November and January. The daily temperature range is about 30°C to 35°C (GSR, 2007; GSS, 2010). The Harmattan season, which is noticeably the shortest, driest and coolest period occurs

in December, January or February with an average daily temperature between 25°C and 28°C. (GSR, 2007).

The vegetation is mainly tropical rainforest interspersed with shrubs. The predominant cash crops are oil palm and cocoa, and major staple food crops produced in the District include cassava, maize, cowpea, rice, cocoyam, sweet potatoes, yam and plantain. Local vegetables such as pepper, garden-eggs, okro and tomatoes and other exotic types like cabbage, are grown on a comparatively smaller scale (GSS, 2014).

3.1.3 Geology and Soils

The Mpohor District mining area lies in the southern part of the Ashanti Greenstone Belt, which has on its' eastern and western corridor, interbedded volcano clastic and a band of highly metamorphosed volcanic respectively (GSR, 2007). There are evidence of a range of intrusive rock types and morphologies such as porphyritic Dixcove granite complexes, the Lower Birimian, the Tarkwaian, and Cape Coast granite. However, majority of soils consists of Cape Coast granitic soils. The rock types are aged from 2.2 Ga to 2.15 Ga. Large deposits of gold, traces of iron and kaolin are found in the district (GSR, 2007; DMTDP, 2012 as quoted in GSS, 2014). Gold mineralization in the Mpohor complex is hosted in narrow discontinuous quartz veins within diorite and granodiorite intrusive rocks (GSR, 2007).

3.1.4 Economic Activities

Farming is the dominant economic activity in the Mpohor District (GSS, 2014). Over 64 percent of the population are engaged in agriculture with cocoa and oil palm being the predominant cash crop. Both commercial and subsistence agricultural activities are practised (GSS, 2014). Norpalm Ghana Limited and Benso Oil Palm Plantation (BOPP) cultivate and produce palm oil on a large-scale with plantation sizes of about 4000 hectares and 5000

hectares respectively, whiles Ayiem Oil Mills, which also produces palm oil buys palm nuts from many small private plantations (GSR, 2007).

The settler farming communities are mostly responsible for the cultivation of cocoa on small to medium farm sizes, and usually intercrop with stable food crops and vegetables. The subsistence agriculture is practised by the rural households and townspeople who have relatively small farm sizes for household consumption and selling of surplus in nearby markets. The subsistence farmers grow mostly food crops such as plantain, yam, cassava, and horticulture crops (fruits and vegetables) (GSR, 2007). Aside crop farming, tree planting, livestock rearing and fish farming are the agriculture-based activities done by households in the district. According to GSS (2014), the use of traditional methods of farming put a limitation on the output per yield of crops, especially cocoa. Also, present in most part of the district are several micro enterprises for micro-scaled agro-processing enterprises.

Mining is done on a large-scale by Golden Star (Wassa) Limited in Mpohor, whereas ASM operations exist in areas like Mpohor, Manso, Adum Banso and several other rural communities resulting in the pollution of soil and water bodies in the district (GSS, 2014).

3.2 Research Method

Data collections employed in the study included both primary and secondary methods (mixed method approach). This method gaves the researcher the advantage of complementing each methodology for more valid and reliable findings (Creswell, 2010). The concurrent embedded design of mixed methods was used to collect primary quantitative data and the secondary qualitative data that gives supportive information to the primary data simultaneously with the aim to save time and cost (Kothari, 2004; Creswell, 2010).

For the Quantitative primary data, structured open and closed ended questionnaires were administered to assess the existing assets and livelihoods of the smallholder farmers, evaluate the perception of smallholder farmers on the effect of mining activities on their livelihoods and identify livelihood strategies employed by the smallholder farmers to cope with the effects of mining activities. Also, the chemical parameters (pH and EC) and heavy metals (Cd, As, Pd and Hg) concentrations in soil samples from selected farms in the study area were measured to evaluate possible contamination from the mining activities.

Focus group discussions, structured interviews, and observational methods were used as secondary field data collection instrument. These instrument were used to obtain qualitative data on the management of environmental pollution by mining activities from relevant formal and informal institutions (Norpalm Ghana Limited, Mpohor District Assembly, Department of Agriculture, and Traditional Leaders) and to ascertain general insight of the effects of mining activities on the study communities.

Secondary data were sourced through desktop review of existing scholarly works which included academic materials and articles from peer review journals and books on relevant topics.

A pilot study was conducted in December, 2018, using four respondents to determine the reliability and validity of the data collection instrument. One interview and three questionnaires were administered. The necessary corrections were made based on the pilot study before the field study.

3.2.1 Questionnaire Survey

The pilot study carried out in December, 2018 informed the structuring of an open and close ended questionnaire (Appendix A) to achieve the objectives of the study. It was self-

administered by the researcher and assistants to a sample of farmers in the five communities. To obtain a high response rate from the farmers, taking into consideration the low literacy levels of the farmers, the questions were asked in the local language to enable the famers understand and respond accordingly. The questionnaire had two parts. Part 1 covers the socio-demographic data of the respondents, and Part 2 had five sub-units: It covers the livelihood assets and the perception of the smallholder farmers on the effect of mining activities on their (i) natural capital; (ii) financial capital; (iii) human capital; (iv) physical capital, and (v) social capital. A table of livelihood activities that farmers employ to cope with the effects of mining activities on their livelihoods was developed, based on the pilot study and desktop studies, which allowed the farmers to rank the livelihood activities they employ to achieve desirable livelihood outcome.

3.2.2 Focus Group Discussions and Structured Interviews

A focus group discussion was organized in three different communities to acquire general information from both male and female smallholder farmers about their perceptions on the effect of mining activities on their livelihoods. The group discussions were held with participants from Awunakrom, Obrayebona and Mpohor Yabiw. The discussions consisted of a mixed group of seven to twelve participants of male and female farmers in the community with the researcher as the facilitator. Nine participants from Awunakrom, consisting of three males and six females took part in the discussions. A total of twelve participants (seven males and five females), and seven participants (five males and two females) took part in the discussions from Obrayebona and Mpohor Yabiw, respectively.

The discussions focused on perception of the effects of mining activities on the livelihood of the smallholder farmers in the communities. Due to the peaceful environment and the presence of the chief farmers, the participants freely shared their opinions and experiences.

The study also employed the use of structured interviews, which consisted of a set of questions that probed for specific issues based on the experiences and viewpoints of the respondents and enabled the researcher to establish a general direction for the conversation to achieve the objectives to the study. The structured, open-ended interview technique was used to investigate the management and effectiveness of formal and informal institutions to address the effects of mining activities on smallholder farmers in the district. Face-to-face interviews with notes taking and voice recording were the two interview approaches used to achieve the objectives of the study. The face-to-face interview with notes taking was used with staff of Norpalm Ghana Limited, District Assembly and District Agriculture offices, Traditional Leaders of Awunakrom and Mpohor Yabiw, whiles the voice recording was employed with the Traditional Leader of Obrayebona with his permission.

3.2.2 Sampling Method

A multistage sampling approach was used in the study. The purposive sampling was used to select the study communities, while the simple random sampling method was employed for collecting data from farmers. The homogeneity of the farmers, that is, the fact that they face the same weather conditions, have common natural resource base (Land and water) condition and a common livelihood assets, market and socioeconomic characteristics, permitted the use of the simple random sampling (Saunders, 2000).

A sample size of 395 was calculated using formula Yamane (1967):

$$n = \frac{N}{1+Ne2}$$

Where n = sample size, N = population size of farmers (26,097 based on 2010 Population and Housing Census for the District) and e = level of precision (0.05).

However, two hundred and six (206) questionnaires were administered in five communities in the Mpohor District consisting of 103 males and 103 females due to time constraints. Most

farmers leave for the farm at dawn and return on midday leaving the researcher few hours within the day to administer the questionnaires. Moreover, some farmers reside in their farm huts which is inaccessible to the researcher. While the sample size may not be representative of the larger population, the questionnaire survey was complemented by focus group discussions and interviews of different institutions, making it consistent with the generally accepted standards for the use of statistical inference. Moreover, the high response rate from the farmers, coupled with the detailed nature of the research instruments and methods, and statistical analysis employed diffuses concerns about distorted findings.

Purposive sampling was used to sample staff and leaders of formal and informal institutions. The informants were selected based on their in-depth knowledge about the subject matter under consideration. All three informants from the formal institutions, who were proficient and well-informed with the phenomenon of interest and were available and willing to participate were males. The three informants from the informal institutions were also males because they are traditional rulers responsible for the welfare of the people in their communities. The customs in the study communities do not allow females to be traditional rulers. Table 3.1 summarizes the actual sample sizes from the various communities.

Table 3. 1 Distribution of Respondents and Research Instruments used in the Study

Target Population	**Sample Size**		**Total**	**Research Instrument**
	Male	**Female**		
Smallholder Farmers	103	103	206	Questionnaire
Smallholder Farmers	15	13	31	Focus Group Discussion
Formal Institutions	3		3	Structured Interview
Informal Institutions	3		3	Structured Interview

Source: Field Data, 2019

3.2.3 Direct Observation

For further clarification and validation of concerns brought up by the respondents, the researcher used personal observations. Notes and pictures were taken on the field to help the researcher properly understand some of the issues raised, since the perceptions of respondents about certain issues may not be attributed to mining. Water pollution, flooding, dust pollution and the infrastructures constructed by the mining company that do not provide direct services to the community were observed. The method also helped the researcher to distinguish between some of the experiences of the farmers which is not directly being caused by mining operations such as dust pollution. Apparently, the large-scale mining company constructed a haul road to make operations between its three mining sites effective, but the road is also serving as access road for some travelers to other villages in the districts. Drivers tend to drive at high speed on the dry haul road that generates dust blown into nearby farms. Even though, the mining operation tries to minimize the dust by regularly sprinkling water, it quickly dries up.

3.2.4 Determination of Chemical Properties of Soil Samples

The soil samples were tested to determine the pH, EC and heavy metals (Cd, As, Pb and Hg) concentration in soils in the Mpohor District. The judgmental sampling technique was used in selecting the farmlands that are in proximity to mining activities and accessible by the researcher to provide insight into what chemicals may be present in relation to mining activities in the district. One farm each from Mpohor, Awunakrom and Mpohor Yabiw, that are near the only large-scale mining industry in the district, Golden Star (Wassa) Ltd and less than a kilometer to illegal mining activities were selected for the soil sampling.

Soil samples were collected from the three selected farmlands (1 acre each) at a depth of 0-15 cm. A total of nine composite samples were obtained from three farmlands in the study communities. Three composite soil samples were collected from the farmlands in Awunakrom

and Mpohor Yabiw but one repeat sample was also collected at Awunakrom to check for precision and two composite samples were collected in Mpohor. All composite samples had three (3) sub-samples. One sample was also collected as a control in a farmland which is not close to mining activities.

The soil samples were collected with a stainless steel spade into a plastic bucket and stirred thoroughly to obtain a homogenous mixture. The uniform composite soil samples were packed into transparent zipped lock plastic bags, labeled and transported to the laboratory for analysis. The soil sample locations were picked by using a Geographic Positioning System (GPS) as presented in Table 3.2.

Table 3. 2 GPS coordinates for Soil Sampling Location

Community	Latitude "N"	Longitude "W"	Sample ID
Mpohor	4.965084	-1.888077	MP001 MP002
Awunakrom	4.962808	-1.874238	AW001 AW002 AW003 AW004
Mpohor Yabiw	4.956113	-1.878776	MY001 MY002 MY003

Source: Field Data, 2019

3.2.4.1 Soil Sample Digestion and Determination of Heavy Metals

After collecting the soils, samples were sent to the laboratory for initial treatment and preservation until further analysis. The soil samples were first, air dried at a temperature of 21-27 °C for 5 days. The samples were pulverized using porcelain pestle and mortar, and sieved with a 2 mm sieve to obtain fine sand fraction for various analytical determination.

A 1.0 g of soil sample was measured into a digestion tube and digested with 10 mL of Ternary mixture (20mL of $HCLO_4$; 500mL of HNO_3; 50mL of H_2SO_4) and was placed on a hot plate at 95˚C for 30 minutes under a fume hood. After cooling, the digested samples was filtered into a 100 mL volumetric flask using Whatman No. 42 filter paper and made up to the mark with distilled water (McLaughlin, Zarcinas, Stevens, & Cook, 2000).

After digestion, the digested samples were made up to 100 mL with double distilled water and the analytical bank was made ready for each sample. A series of calibration solutions (standards) having known volumes of analyte elements were also prepared and used to calibrate the PINAAcle 900T Perkin Elmer Atomic Absorption Spectrophotometer. Blanks were atomized and the standards and calibration of graphs were plotted, showing response from the ASS. The calculation of the concentrations were carried out, based on the absorbance obtained using the Beer Lambert law. Responses of the standard were used to create accurate performance of the machine and accurate concentration values of elements. Light was created from a hollow cathode lamp at wavelength characteristic to each analyte. An atomizer was used to atomize each analyte to generate free atoms from the samples. Air acetylene gas, as a source of energy, was used for the production of free atoms for cadmium (Cd), lead (Pb) and argon-acetylene gas for mercury (Hg) and arsenic (As).

The sample, in an aerosol form, was introduced into the flame and the burner aligned in the optical path to let the light beam pass through the flame where the light was absorbed. The light was then focused into a monochromator which then separates the specific analytical wavelength of the light produced by the hollow cathode lamp from the non-analytical. The sensitive light identified then measures the light and translates the response into the analytical measurements. Calculations of concentration of heavy metals were done using:

$$FinalConc.\left(\frac{mg}{kg}\right) = \frac{Conc.(analyticalmeasurement) \times Vol.ofextract}{Sampleweight(grams)}$$

3.2.4.2 Determination of Soil pH and Electrical Conductivity

In order to determine the pH and electrical conductivity of soils, 20 grams of soil sampled were weighed into a beaker and 20 mL of distilled water added to obtain a soil to water solution ratio of 1:1. The mixture was stirred several times for 30 minutes and left to stand for one hour for the suspended soil particles to settle. The pH meter was first calibrated with standard buffer solution of pH 4.0 and pH 7.0. The electrode was then immersed into the solution and the pH and the electrical conductivity reading were taken. The electrode was rinsed with distilled water after each sample measurement (Tan, 2005).

3.3 Techniques of Data Analysis

The Statistical Package for Social Sciences (SPSS Version, 24) and Microsoft Excel (2013) software were used for the quantitative data analysis. Data obtained from the questionnaires for the smallholder farmers to establish their livelihood assets and the effects of mining on their livelihood were thoroughly examined to identify any errors and omissions. The open-ended questions were assigned numbers to enable the researcher categorize the responses. The now coded open-ended questions and already coded questions were cleaned and defined in the SPSS. Thus, the variables obtained in the quantitative study were explained and discussed using descriptive statistics such as frequencies and percentages and presented in tables and graphs. In addition, a chi-square test was employed to test the proposed hypotheses.

Also, the Pearson product-moment correlation coefficient was calculated to measure the strength of the linear relationship between the livelihood strategies employed by the male and female smallholder farmers. The Multinomial Logistics Regression was used to predict the

choice of livelihood strategy employed by the stallholder farmers, given their available assets. Pearson product-moment correlation coefficient was again used to establish the degree of relationship between the chemical properties of the soil samples.

For the qualitative data analysis, data from the focus group was presented as stated to avoid misquoting of ideas while information from the key informants on institutional management of the effects of mining on smallholder farmers were sorted manually and coded according to the topics examined in this study before they were categorized into the various themes obtained in the study (law enforcement, compensation and education).

3.5 Ethical Considerations

An ethical clearance was taken from the University of Ghana Ethics Committee of the College of Basic and Applied Science (Appendix B) before the main administration of the questionnaires between the months of December, 2018 and April 2019. Introductory letters were obtained from the Institute of Environment and Sanitation Studies, which enabled the researcher to seek necessary permission from both formal and informal institutions at the community level for data collection and recruitment of field assistants. The researcher also took steps to ensure adherence to the highest ethical standards for conducting researches involving living persons. No respondent was coerced into participating in the research. In this light all participants were adequately informed in the language they understand, the purpose of the study and their express consent was obtained to participate in the study. They were also made aware of the possibility for them to withdraw from the study at any point if they felt uncomfortable giving out sensitive personal information. Questionnaires were therefore, designed in such a way that, responses given did not allow tracing back information to specific persons. The coding of questionnaires only served as markers of tracking for the researcher to facilitate analysis and cross-referencing. Additionally, to maintain confidentiality of

information gathered and anonymity of respondents, biographical information obtained from respondents cannot be traced back to respondents, as they were not be personalized.

3.6 Limitation to the Study

The study experienced several limitations. Resources, in terms of time and money were the major limitations. The researcher lodged in Takoradi, which is the closest city to the communities due to her inability to secure proper accommodation in the study area, this increased the transportation cost to the study area. Also, due to the inaccessibility of farmers during most part of the day, estimated period for data collection had to be extended incurring more cost to the research budget.

Furthermore, lack of co-operation from the respondents also posed a major problem. But for the integrity of the Chief Cocoa Farmer of the district, who has a master's degree and understands the need for research, most of the farmers would not have agreed to participate in the study due to their feeling of neglect by the government, having participated in several researches in the district. Some of the farmers were also engaged in illegal small-scale mining to generate additional income, based on that, they declined to be interviewed because of the sensitive nature of illegal mining in the country at this period. They believed the researcher maybe an undercover journalist. In some communities, the researcher had to negotiate for a no picture deal, before shown to certain farms that were being affected by mining activities. This was so because, the communities were not truthful in their denial of involvement in any illegal mining activities but were being faced with water pollution by the activities of the licensed large-scale mining company. The District Agriculture Office, which gave detailed experiences of the effects of mining activities on farmers, was unable to produce evidence because they lack resources, in the form of transportation and staff.

CHAPTER FOUR

RESULTS

4.1 Livelihood Assets of Smallholder Farmers

The study employed the sustainable livelihood approach to reveal the available assets (human, social, natural, physical and financial) of the male and female smallholder famers, in pursuit of a positive livelihood outcome in a mining environment.

4.1.1 Human Assets and Livelihoods

4.1.1.1 Demographic and Social Profile of Respondents

The socio-demographic and social characteristics of respondents (Table 4.1) assessed in the study highlight indicators of respondent's ethnicity, marital status, age, size of household, years of farming experience and educational background. These indicators inform the respondents' access to, and use of natural, human, social, physical and financial assets in the pursuit of managing the effects of mining on their livelihoods.

Ethnicity of Respondents:

From the study, 68.9% of male respondents and 59.2% of female respondents were natives, while 31.1% of male respondents and 40.8% of female respondents were migrants (Table 4.1).

Age of Respondents:

The categories of age were grouped into six, ranging from 18 – 25, 26 – 35, 36 – 45, 46 – 55, and 56 – 65 and above 65 (Table 4.1). Majority (61%) of the smallholder agriculture labour force were above the age of 46. This was confirmed by the District Department of Agriculture that the majority of the agriculture labour force in the district was above 50 years. However, 67% of the female respondents were above the age of 46 years while the ages of the male respondents were fairly distributed among the age categories in the study.

Field data showed that 24.3% of the male respondents were between the ages of 26 – 35 years because of the ban on illegal mining in the country during the time of field study, which used to be a major income earning activities for males within that age category. Also, the number of female respondents above the age of 65 years is low (6.8%) as older women farmers (> 65 years) do not engage in farming as compared to the male farmers. Others too were married to older men who had died, leaving them with no access to their farm land.

Marital Status of Respondents:

From the responses, 14.6% of male respondents are single, 82.5% are married, 1.9% are divorced and 1% are widowers. Only 2.9% of the female respondents are single, 70.1% are married, 9.7% are divorced and 16.5% are widows (Figure 4.1). During the study, the men revealed that they preferred to re-marry after separating or after the death of their spouse as compared to the women. One male informant mentioned that, "*As for me, I cannot live without a woman. Currently, I am married to two women and I will replace any of them who decides to go that very day."* (Male participant in a FGD). On the other hand, one female participant who is between the age range of 36 to 45 years with four children had vowed never to remarry after the death of her husband.

The study showed that, 85% of the male respondents were heads of household while, only 32% of females were heads of household. Out of the 32% female heads of household, 46% were widows, 24% were divorced and 30% are married women. The married women are de facto heads of household due to the absence of spouses, who tend to stay away from home for more than 50% of the time within the year. This affects the ability of the women to cope effectively in times of shock or stress on their livelihood.

Household Size of Respondents:

As shown in Table 4.1, 46.6% of the male respondents had household size between 1 to 5 members, 41.7% had 6 to 10 members and 8.7% had household members who are more than 11. Whereas, 42.7% of the female respondents had household size between 1 to 5 members, 47.6% had 6 to 10 members and 9.7% had house members of more than 11.

Years of Farming Experience:

Field studies showed that majority of respondents have more than 20 years of experience in farming. Table 4.1 shows that 44.7% of male respondents and 46.6% of female respondents have over 20 years of farming experience. While 17.5% male and 9.7% female respondents have between 1 to 5 years' experience in farming.

Educational Status:

The study showed that the level of education of women was lower than that of men; 43.7% of female respondents had no formal education as compared to 6.8% of male respondents, 8.7% and 1.9% of male respondents had graduate and post graduate education respectively, while none of the female respondents had been educated to this level (Table 4.1). Most parents cannot afford to educate all their children up to a higher level so they prioritize the male child's education to the female child.

Table 4. 1 Demographic and Social Profile of Respondents

Demographic Profile	Male (n=103)		Female (n=103)	
	Frequency	Percent	Frequency	Percent
Ethnicity				
Natives	71	68.9	61	59.2
Migrants	32	31.1	42	40.8
Age Group				
18-25	7	6.8	6	5.8
26-35	25	24.3	11	10.7
36-45	14	13.6	17	16.5
46-55	18	17.5	25	24.3
56-65	21	20.4	37	35.9
>65	18	17.5	7	6.8
Marital Status				
Single	15	14.6	3	2.9
Married	85	82.5	73	70.9
Divorced	2	1.9	10	9.7
Widowed	1	1.0	17	16.5
Household Size				
1_5	48	46.6	44	42.7
5_10	43	41.7	49	47.6
>11	9	8.7	10	9.7
None	3	2.9		0
Years of Farming Experience				
1_5	18	17.5	10	9.7
6_10	23	22.3	22	21.4
11_20	16	15.5	23	22.3
>20	46	44.7	48	46.6
Level of Education				
None	7	6.8	45	43.7
Primary	23	22.3	37	35.9
JHS/Middle Sch.	47	45.6	16	15.5
SHS/ Voc./Tech.	15	14.6	5	4.9
Tertiary	9	8.7	0	0.0
Post graduate	2	1.9	0	0.0

Source: Computation from field data, 2019

4.1.1.2 Other Income Generating Skills

The study assessed other jobs that the respondents engage in to earn an income. This was used as an indicator for attained skills of respondents. Sixty two percent of male and 71.8% of female respondents are not engaged in any other livelihood activity (Table 4.2). However, 6% of the male respondents are engaged in formal jobs but none of the female respondents are engaged in any formal job, whereas 32% of the male and 28% of the female respondents were engaged in informal jobs. Driving was the dominant informal activity engaged by the male respondents (12%) followed by trading which was dominant for the female respondents (21%) (Appendix C). From the interviews, it was revealed that before the ban on illegal mining operations in the Ghana, the respondents who were engaged in other informal jobs had higher income as compared to what they earn now. This was due to the influx of migrants, who were engaged in the illegal mining operations. Some of the farmers were themselves engaged in the illegal mining operations, and now have to depend only on their farm as a source of livelihood.

Table 4. 2 Other Income Generating Activities Engaged by Respondents

Job Type	Male		Female	
	Frequency	Percent	Frequency	Percent
None	64	62.1	74	71.8
Formal Jobs	6	5.8	0.0	0.0
Informal Jobs	33	32.0	29	28.0
Total	103	100	103	100

Source: Computation from field data, 2019

4.1.1.3 Access to Information Valuable to livelihood

Investigations during the field survey revealed that, information valuable to the livelihood of the farmers is mainly obtained from the District Department of Agriculture. Even though personnel from the district office occasionally visit communities to educate them, majority of information is passed from the agriculture office to farmers who are part of the Farmers'

Association through their chief farmer. However, majority of the respondents have not joined the Farmers' Association. A total of 36.9% (31.1% and 5.8%) of male and 19.4% (17.5% and 1.9%) of female respondents have joined the Farmers' Association (Table 4.3). Thus, most of the farmers depend on traditional knowledge, what is commonly known or inherited knowledge. Some also depend on their friends who are members of the Farmers' Association for information.

Table 4. 3 Types of Associations Joined by Respondents

Association Types	Male		Female	
	Frequency	Percent	Frequency	Percent
Farmers' Association	32	31.1	18	17.5
Farmers' Association and Other Associations	6	5.8	2	1.9
Other Associations only	11	10.7	30	29.1
Not Joined	54	52.4	53	51.5
Total	103	100	103	100

Source: Computation from field data, 2019

4.1.2 Social Assets and Livelihoods

The vertical (patron/client) and the horizontal (between individuals with shared interests) networks and connectedness of respondents was assessed for their social capital. Therefore, the number of people the smallholder farmers engaged as farm labourers (both male and female labourers) and the more formalised associations they have joined were investigated.

4.1.2.1 Patron-Client Relationship

Table 4.4 shows that majority of the respondents employ male labourers than female labourers. Overall, 40% of the respondents do not employ male labourers as compared to 75% of respondents who do not employ female labourers. Thus, 69% of male and 50.5% of female

respondents employ male labourers while 39.8% of male respondents and 10.7% of female respondents employ female labourers.

Table 4. 4 Number of Labourers Employed

No. of Labourers Employed	Male (n=103)		Female (n=103)	
	Frequency	Percent	Frequency	Percent
Male Labourers Employed				
1-3	31	30.1	35	34.0
4-6	32	31.1	15	14.6
7-10	8	7.8	2	1.9
None	32	31.1	51	49.5
Female Labourers Employed				
1-3	29	28.2	10	9.7
4-6	10	9.7	1	1.0
7-10	2	1.9	0	0.0
None	62	60.2	92	89.3

Source: Computation from field data, 2019

4.1.2.2 Community Based Organizations

Apart from Mpohor Yabiw, all the other four communities had at least one community based organisation in their community. For example, the Farmers' Association is found in all the four communities. Other associations such as Blasting Ladies, *Nyamebekyere, Mensuro, Mboa, Akwantufuo, Fahoadzeyewoho*, One Love One Nation and the Royal Youth club are in Mpohor township; Kia Drivers and Loaders, Four Junction, Soccer City, *Abrabopa* and *Egyabakuw* are in Adum Banso township; and *Milotsoviwofe, Habowbow, Borborbor, Vadaha, Agbobi & Akpalo* are in Awunakrom township. Aside the Farmers' Association that gives farm input and information valuable to the smallholder farmer's livelihood from government agencies and departments, all the other associations are self-help groups that give social and financial support to their members.

However, majority of the respondents have not joined the different associations. The study shows that 52.4% of male and 51.5% of female respondents have not joined any association, while 47.6% of male and 48.5% of female respondents have joined a group in their communities (Table 4.5).

Table 4. 5 Community Based Organizations

Joined CBO	Male		Female	
	Frequency	Percent	Frequency	Percent
No	54	52.4	53	51.5
Yes	49	47.6	50	48.5
Total	103	100	103	100

Source: Computation from field data, 2019

4.1.3 Natural Assets of Respondents

For smallholder farmers, natural assets are very important since they derive all or part of their livelihoods from natural resource-based activities. The study assessed smallholder farmers who have access to farmland, thus the type of land acquisition and sources of irrigation water was investigated.

4.1.3.1 Mode of Land Acquisition

Land acquisition in the study area is predominantly through inheritance because most of the smallholder farmers in the district are natives of the land. The traditional leader of one of the indigenous communities (Mpohor Yabiw), demarcates land for natives who are interested in farming but do not have access to any family land as their inheritance. The settler farming communities are also ruled by royal families who were the first occupants of the land and have the right to demarcate part of the land to their family members. This has contributed to some migrants inheriting their farmlands.

Figure 4.1 shows that 65% and 59% of male and female respondents, respectively, acquired their farmland by inheritance. Nineteen percent of male and 29% of female respondents work on rented lands, which are lands that have been released to them by either the community leader or a land owner, who receives either half (*Abunu*) or one-third (*Abusa*) of produce after harvest. However, 16% of male and 12% of female respondents have purchased their farmland.

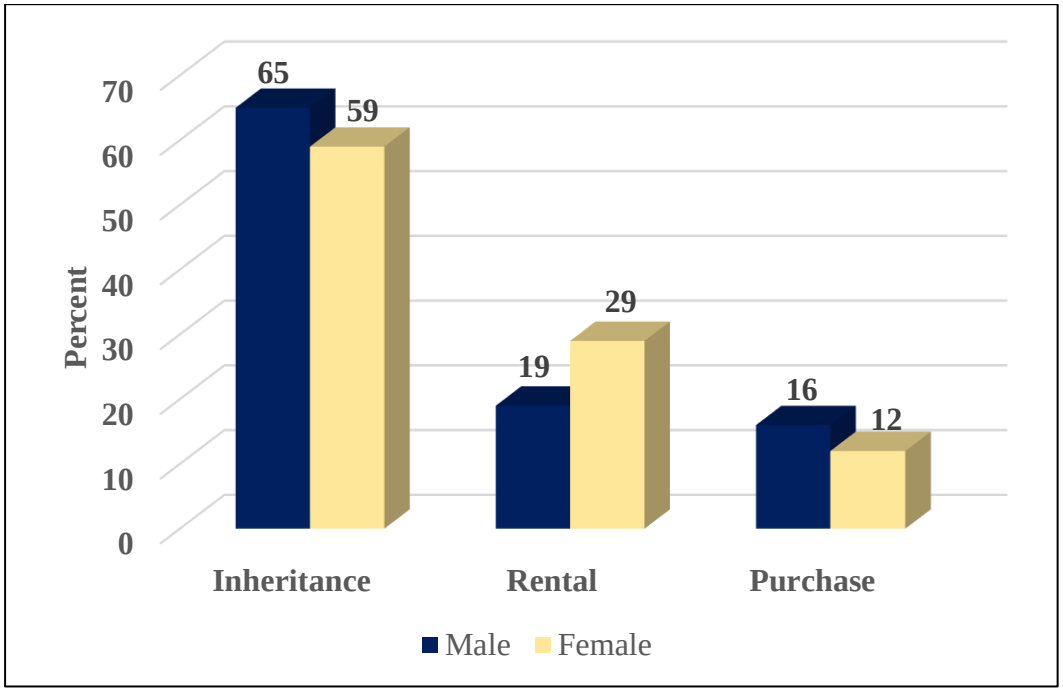


Figure 4. 1 Mode of Farmland Acquisition

Source: Computation from field data, 2019

4.1.3.2 Farmland Sizes

Most (31.1%) respondents have access to more than six (6) acres of land, very few (6.3%) had farmland sizes which is less than one (1 acre) (Figure 4.2). Half of the male respondents (50%) had farmland sizes greater than 6 acres as compared to 13% of female respondents, while most female respondents (38%) have land sizes between 2 – 3 acres. The lowest proportion of both male (5%) and female (8%) respondents, have farmland size less than 1 acre.

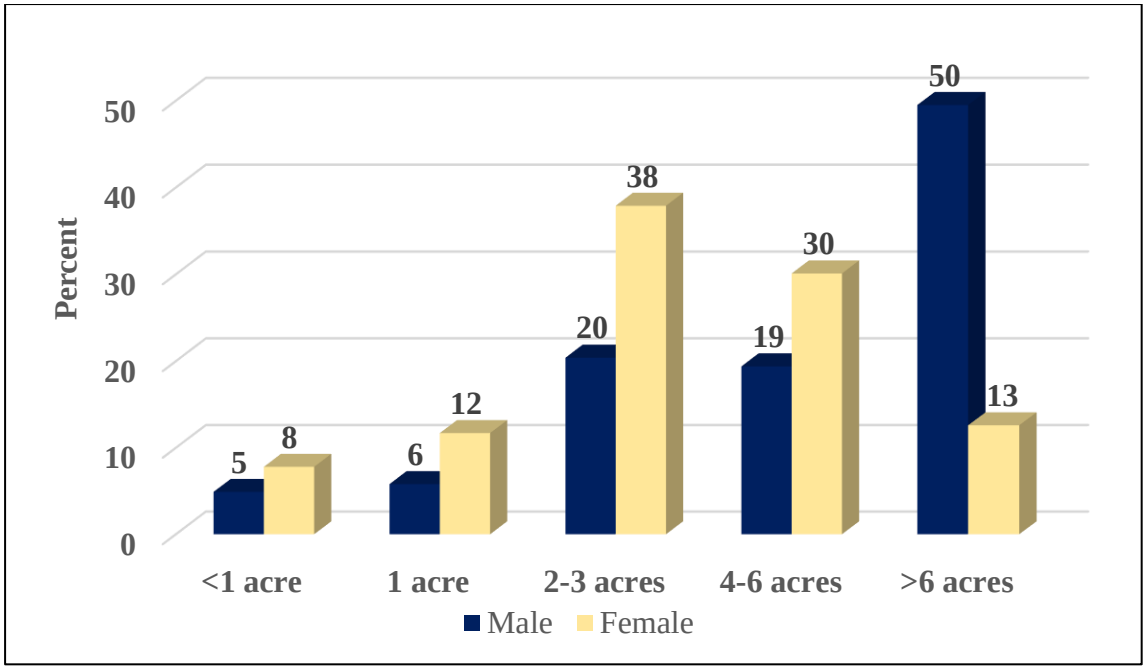


Figure 4. 2 Farm Land Size of Respondents

Source: Field Data, 2019

4.1.3.3 Cultivated Crop Types

Due to the large land sizes available to the male respondents, majority (70%) of the male respondents have grown cash crops, i.e., oil palm (32%) and cocoa (38%) (Figure 4.3). Forty seven percent of the female respondents grow cash crop, i.e., oil palm (20%) and cocoa (27%). Twenty six percent of the male and 45% of the female respondents grow food crop such as cassava, plantain, cocoyam and maize while 4% of the male and 8% of the female respondents grow horticulture crops which represent fruits (dominant are oranges, pawpaw and sugarcane) and vegetables (dominants are lettuce, cabbages, tomatoes and okro).

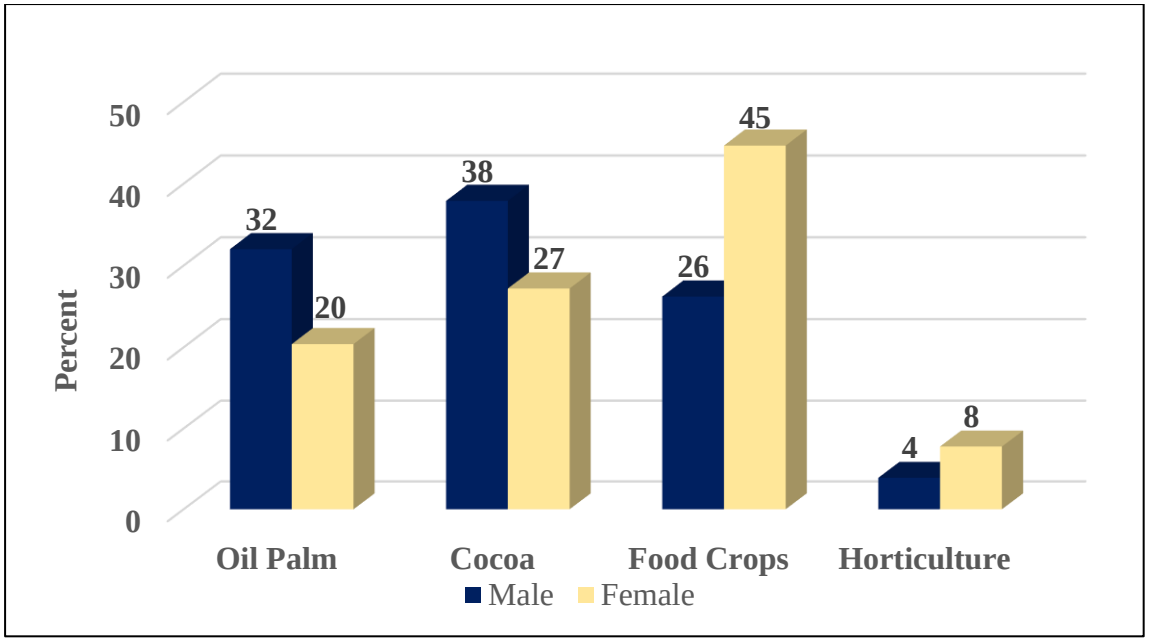


Figure 4. 3 Crop Types Grown by Respondents

Source: Computation from field data, 2019

4.1.3.4 Main Sources of Irrigation Water

Due to the nature of the cash crops (cocoa and oil palm) grown in the district, 50% of male and 67% of female respondents depend mainly on surface water (Figure 4.4). This is because at the early stages of the cash crops, especially cocoa, most farmers intercrop with food crops such as plantain, cocoyam and cassava while others also demarcate part of their land to grow vegetables. Rainfall, as another source of water, is used by 44.7 % of male and 31.1% of female respondents. Very few farmers (6% of male and 2% of female) who depend on streams that dries up during the dry seasons have dug wells (groundwater) in their farms.

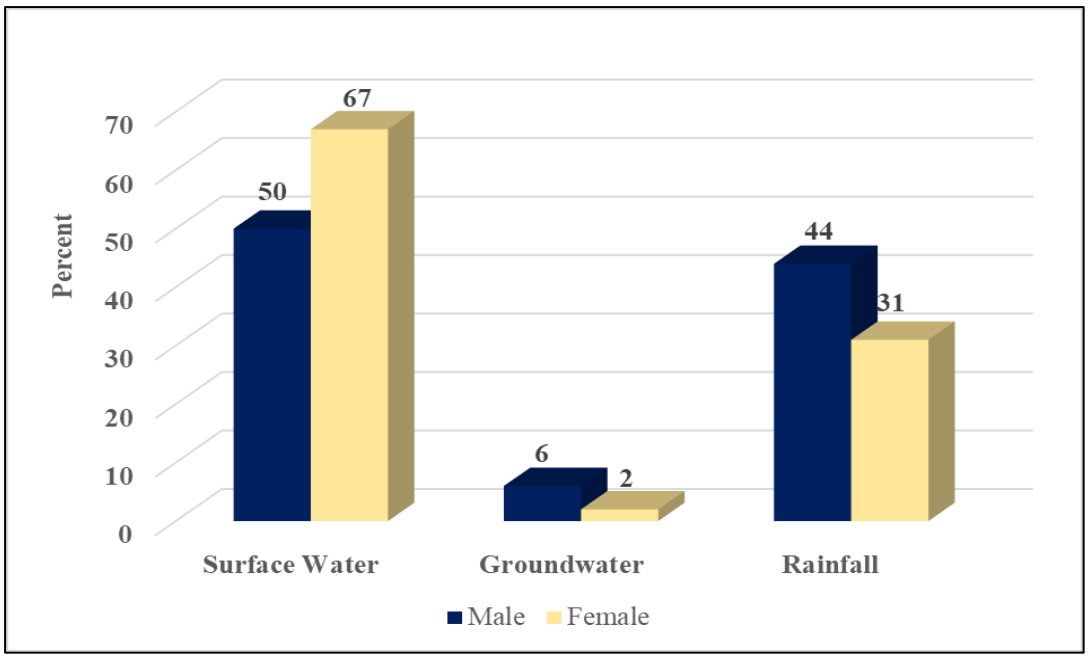


Figure 4. 4 Respondents Sources of Irrigation Water

Source: Computation from field data, 2019

4.1.4 Physical Assets of Study Communities and Respondents

None of the communities have paved roads in good condition. Mpohor Yabiw, Obrayebona and Awuanakrom do not have access to pipe borne water and Mpohor Yabiw does not also have access to electricity. Only Mpohor and Adum Banso had public market and formal credit providers. Therefore, for homogeneity, the type of shelter ownership and main drinking water source of respondents in all the study communities were assessed.

4.1.4.1 Ownership Types of Dwelling Unit of Respondents

From observation, the construction materials (such as clay, bamboo, straw and roofing sheets) used for the construction of houses are inexpensive (Plate 4.1; 4.2; 4.3). This enabled majority of male and female smallholder farmers to build their personal houses. Seventy one percent of the male and 57% of the female respondents live in their personal houses (Figure 4. 5). Fourteen

percent of the male and 19% of the female respondents are living in rented houses, while 15% of the males and 24% of the females stay in their family houses.

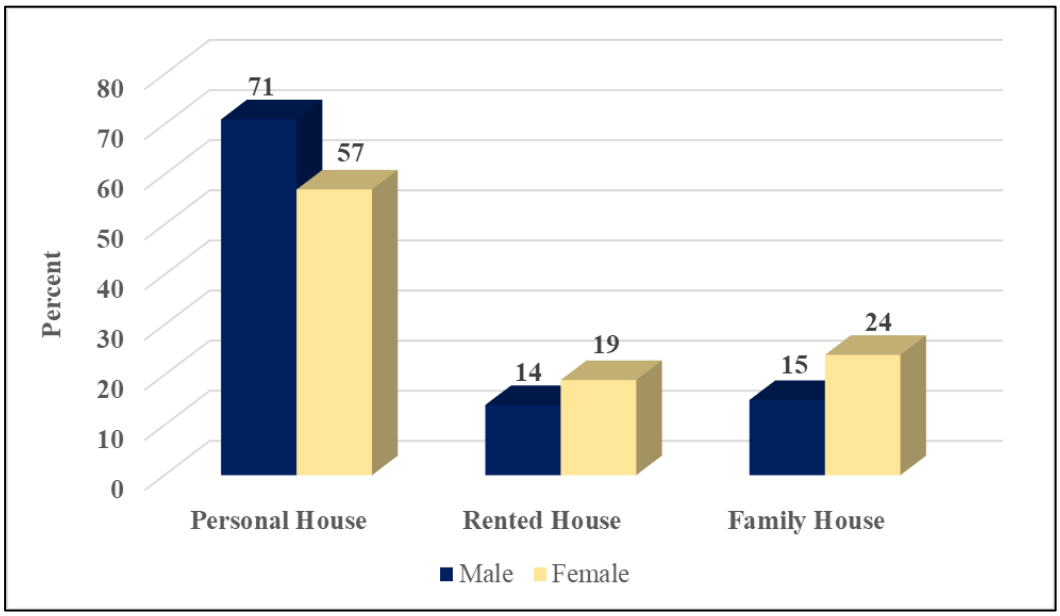


Figure 4. 5 Ownership Types of Dwelling Unit of Respondents

Source: Computation from field data, 2019

Plate 4. 1 Types of Dwelling Units in Awunakrom

Source: Photographed by Author during Field Survey, 2019

Plate 4. 2 Types of Dwelling Units in Obrayebona

Source: Photographed by Author during Field Survey, 2019

Plate 4. 3 Types of Dwelling Units in Mpohor Yabiw

Source: Photographed by Author during Field Survey, 2019

4.1.4.2 Main Drinking Water Sources

Figure 4.6 shows the main types of drinking water resources for the respondents. Groundwater was the main (53.5%) source of drinking water for respondents. Majority of male (62%) and female (45%) depend on the borehole or hand dug well for their source of drinking water. As at the time of data collection, respondents in the district capital (Mpohor) complained of having their taps (which is regulated by the Ghana Water Company) not flowing for about six months. Before that, only 2% of respondents from the Mpohor community could afford to pay their water bills, thus, most of them had their taps disconnected due to their inability to pay their water bills. Twenty six percent of the male respondents use commercially sold water as compared to 4% of female respondents. Eighteen percent of male and 20% of female respondents depend on surface water (river or stream) and 11% of male and 14% of female respondents use pipe borne water.

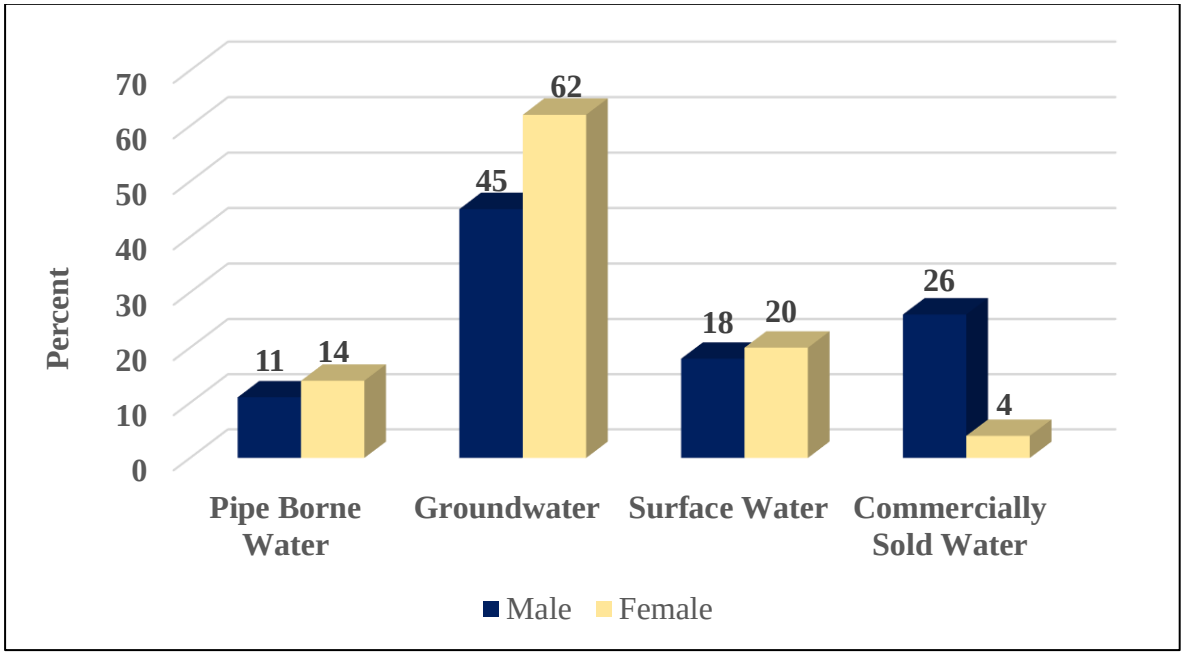


Figure 4. 6 Drinking Water Source of Respondents

Source: Computation from field data, 2019

4.1.5 Financial Assets of Respondents

Financial assets assessed in the study included the cash inflow, assets that can be liquidated and access to credit.

4.1.5.1 Estimated Monthly Income

Table 4.6 shows that the male respondents have an advantage in personal financial assets (in terms of monthly income and personal vehicle) over the female respondents. Most of the crops grown are seasonal crops which influences income generated at different times of the year. Majority (74%) of female respondents estimated their income to be between 100 – 500 Ghana cedis, whereas 46% of male estimated their income to between 600 – 1000 Ghana cedis. However, 5% of male respondents estimated their monthly income to be above 1500 Ghana cedis.

Majority of farmers seek the help of farm labourers and pay them daily between 30 to 40 Ghana cedis per acre for weeding (male labourers) and 20 to 25 Ghana cedis per acre for harvesting (female labourers) during planting and harvesting seasons, respectively. Occasionally, female labourers are employed to fetch water when applying fertilizers and pesticides which earns them at least 10 cedis per day. All these costs are borne by the smallholder farmers at the time that their produce is not ready for the market.

Majority (60%) of the respondents grow cash crops (Cocoa and oil palm) over varying acres of land. For example, at the time of field study, cocoa was sold at 475 Ghana cedis per bag of 64 kg. Cocoa farmers revealed that the quantity of produce is not only dependant on the sizes of farmland but on the quality of farmland. Although most of them use N.P.K Cocoa Nti fertilizer, they cannot afford to apply it at the required amount. Other farmers have also lost part of their land to flooding which they believe is due to mining activities in the community. Thus, the cocoa yield is substantially lower than what farmers expect from their farms. From

the study, cocoa farmers with 1 acre or less, produce at most one maxi bag (64 kg) of cocoa beans (0.16 tonnes per ha), which is below the recommended 1.562 tonnes per hectare by the Ministry of Food and Agriculture. Those with 2 to 3 acres produce between one and three maxi bags of cocoa beans and those with 4 to 6 acres also get between one to seven bags of cocoa beans. Farmers with 6 or more acres of farmland harvest five to 40 maxi bags of cocoa beans. The largest harvest was 40 maxi bags per 10 acres of land (0.70 tonnes per ha). The farmers revealed that they do not always get enough money to apply the necessary chemicals needed for maximum production, thus the harvest of cocoa per land greatly varies per seasons based on their input and also the gradual decreasing of farmland due to the flooding believed to be caused by mining activities. Some farmers also perceive that their cocoa trees wilted due to dust pollution caused by blasting of rock materials, and the use of heavy duty machinery by mining operators on dusty roads in the communities.

Field investigations revealed that personnel from the produce buying company of the Ghana Cocoa Board is stationed in the cocoa farming communities, which makes it easy for cocoa farmers to sell their produce. Oil palm producers also sell the produce to three oil palm buying companies in the Western Region of Ghana; Norpalm Plantation, BOPP and B. Bovid Company. However, taking into consideration proximity to the companies and prices offered, the majority of respondents sell their oil palm fruits to B. Bovid Company. Respondents who grow food and horticulture crops sell mostly in the capital of the District, Mpohor, and also in Takoradi. Two respondents, who have sugarcane plantations in addition to cocoa farms, sell their produce to a company in Accra.

Majority of male respondents (64%) and female respondents (74%) depend solely on farming for their cash inflow, with an equal number of male and female respondents, 23% getting between 100 – 500 Ghana cedis from other sources of income.

Due to their low-income levels, only 36% of male and 13% of female respondents have been able to purchase a vehicle that can easily be sold when the need arises.

Table 4. 6 Monthly Income of Respondents

Financial Assets	Male (n=103)		Female (n=103)	
	Frequency	Percent	Frequency	Percent
Monthly Income from Farm				
100-500	43	41.7	76	73.8
600-1000	47	45.6	19	18.4
1000-1500	8	7.8	8	7.8
>1500	5	4.9	0	0.0
Monthly Income from Other Jobs				
100-500	24	23.3	24	23.3
600-1000	12	11.7	5	4.9
1000-1500	2	1.9	0	0.0
>1500	1	1.0	0	0.0
None	64	62.1	74	71.8
Personal Means of Transport				
No	66	64.1	90	87.4
Yes	37	35.9	13	12.6

Source: Computation from field data, 2019

4.1.5.2 Access to Financial Credit Providers

None of the respondents have access to the formal credit service providers in the district, identified by GSS (2014) as Lower Pra Rural Bank, Adum Banso Area Susu and Loans support Scheme and Phandy Micro Finance in Mpohor. From the survey, the interest rates and collateral requirements from the formal credit providers present a limitation to the smallholder farmers to access credit. The informal financial service providers were rather identified as the main source of financial support for the smallholder farmers but minority of respondents, 16.5% of male and 31% of female respondents (refer to Table 4.3) have joined these associations to have access to financial support.

4.2 Perceived Effects of Mining Activities on the Livelihood of Smallholder Farmers

Mining activities have contributed to the development of many rural communities that serve as hosts. However, these communities are affected by land degradation, water pollution, loss of good health and socio-economic burdens from migrants engaging in the mining activities. The study assessed smallholder farmers' perceptions of the negative and positive effects of mining activities on their livelihoods.

4.2.1 Effects on Farmland

In response to the question: "What are the challenges that male and female smallholder farmers are facing in the district due to mining activities that you have identified?" A Traditional Leader in a mining catchment community answered:

"All our lands were taken from us, and all our inheritance is gone. Some of us who were fortunate to have gotten parts of our lands back have been told not to grow cash crop. Our children cannot inherit cassava and maize. Mining activities has no respect for a person, whether male or female, the difference is how we manage the effects. Most of the men took their money and migrated to other towns, but most of the women stayed back to make the most use of what they can produce. They are keeping the community alive."

One female participant in FDG from a non-catchment community lamented that: "*I have 4 acres of cocoa farm that I used to harvest about 8 bags of cocoa beans during the major season but since the construction of the road on the river by the big mining company, the river floods unto my farm. I now harvest at most, two bags of cocoa no matter the amount of fertiliser I apply. My land size keeps decreasing and the surviving cocoa trees are looking very unhealthy."*

When asked, "Has surface mining affected crop production in the district and in what ways?" The Deputy District Agriculture Officer had this to say:

"*Wetlands that were used for maize and rice production in the wet season and oil palm in the dry season has been taken over by illegal miners, who engage in dig and wash mining technique to pollute the soil. Most of the young men who were engaged in farming are now doing illegal mining, which has reduced the agriculture labour. There is water scarcity due to pollution of irrigation water and food contamination from mine chemicals."*

Although he could not provide a quantitative measure of the effect of mining on crop production, he asserted that crop production has reduced and there are differences in crop appearance.

To validate the responses from the interviews, the smallholder farmers were assessed on their perception of effects of mining activities on their farmland. Table 4.5 shows that majority of male and female respondents have not been affected by mining activities. However, 24% of male and 29% of female respondents had lost their farmland and 15% of male and 8% of female respondents perceived that their farmland had been degraded by waste materials eroded from mine sites that cause low crop yields. Two percent of male respondents who have lost their farmlands, allocated part of their farmland for illegal mining activities to earn extra income.

A chi square test was performed to test the hypothesis on the perception of male and female smallholder farmers on effect of mining activities on their farmlands. Computation from field data shows that, the p-value is 0.27 (Table 4.7), which is greater than the conventionally accepted significance level (0.05). Since $p>0.05$, we accept the null hypothesis that "There is no significant relationship between respondent's gender and the perceived effect of mining activities on farmlands."

Table 4. 7 Effect of Mining Activities on Farmland

Gender	Mining Effects on Farmland			Total
	Loss of farmland	Land Degradation	Not Affected	
Male	24	15	64	103
Female	29	8	66	103
Total	53	23	130	206
Chi square value calculated: 2.6	Probability value: 0.27		df: 2	

Source: Computation from field data, 2019

4.2.2 Effects on Irrigation Water

One of the Traditional Leaders when asked, "What are the challenges that smallholder farmers are facing in the district due to mining activities that you have identified?" replied:

"Our most precious asset, which is the river that supplies water for irrigation and drinking for both humans and animals, has been destroyed by mining activities. The large-scale mining company told us that they will construct our road for us, not knowing they will destroy our water in return. And we cannot even drive on that road. They used boulders to construct the road which has blocked our river, at one side, the river is overflowing its banks, destroying peoples' farms while at the other side, the river cannot flow, depriving us of water to irrigate our farms and drink. All of us, both male and female are suffering."

The road that was constructed serves as a dam on the river (Plate 4.4), causing the destruction of farmlands and surviving crops, while other farmers have lost their source of irrigation water

Plate 4. 4 River Dammed by a Road

Source: Photographed by Author during Field Survey, 2019

A: River overflowing its bounds due to it being dammed by the road

B: The constructed road that is serving as a dam

C: Low flow of river at the other side of the road (dam)

Another Traditional Leader explained;

"Sometimes our river gets different colour and an odour, so farmers nearby that river have to look for other sources of water to irrigate their farms. We all perceive that the large-scale mining company discharges its domestic waste into our river. This really make men and women helpless since that is the main source of drinking water for the community and irrigation water for famers nearby."

In assessing the perception of effects of mining activities on irrigation water sources, 22% of male and 13% of female respondents perceived that mining activities have reduced the quality of their irrigation water. They have noticed some changes in the water such as the change in the colour of water from clear to brownish or muddy, salty or acidic taste, and the overgrowth of algae which reportedly gives the water a bad smell. Respondents indicated that they have not received any form of compensation and now have to walk long distances to fetch water or use public vehicles to transport water from their homes to irrigate their farms.

A chi square test was performed to test the hypothesis on the perception of smallholder farmers on the effect of mining activities on irrigation. Computation from field data shows that the p-value is 0.13 (Table 4.8), which is greater than the conventionally accepted significance level (0.05). Since $p>0.05$, we accept the null hypothesis that "There is no significant relationship between respondent's gender and the perception of the effect of mining activities on their irrigation water."

Table 4. 8 Effect of Mining Activities on Irrigation Water

Gender	Mining Effects on Irrigation Water		Total
	No	Yes	
Male	80	23	103
Female	90	13	103
Total	170	36	206
Chi square value calculated: 3.37 Probability value: 0.13			df: 1

Source: Computation from field data, 2019

4.2.3 Effect on Infrastructure

The most important negative effect of mining activities on the infrastructure of respondents is shown in Figure 4.7. From the field data, 29% of male and 42% of female respondents have not had their infrastructure being negatively affected by mining activities. From the 71% of males and 58% of females that perceive negative effect of mining activities on their infrastructure, 49% of male and 47% of female respondents have perceived their source of drinking water to be polluted which has affected their health and burdened the members of their household to walk for long distance in search of potable water. Thirty percent of male and 50% of female respondents have experienced cracks in their houses due to the vibration from explosives used in breaking down rock materials, while 11% of male respondents have had conflicts with their land owners and 10% of male and 3% of female respondents have had the access road to their farms destroyed by mining activities (Figure 4.7).

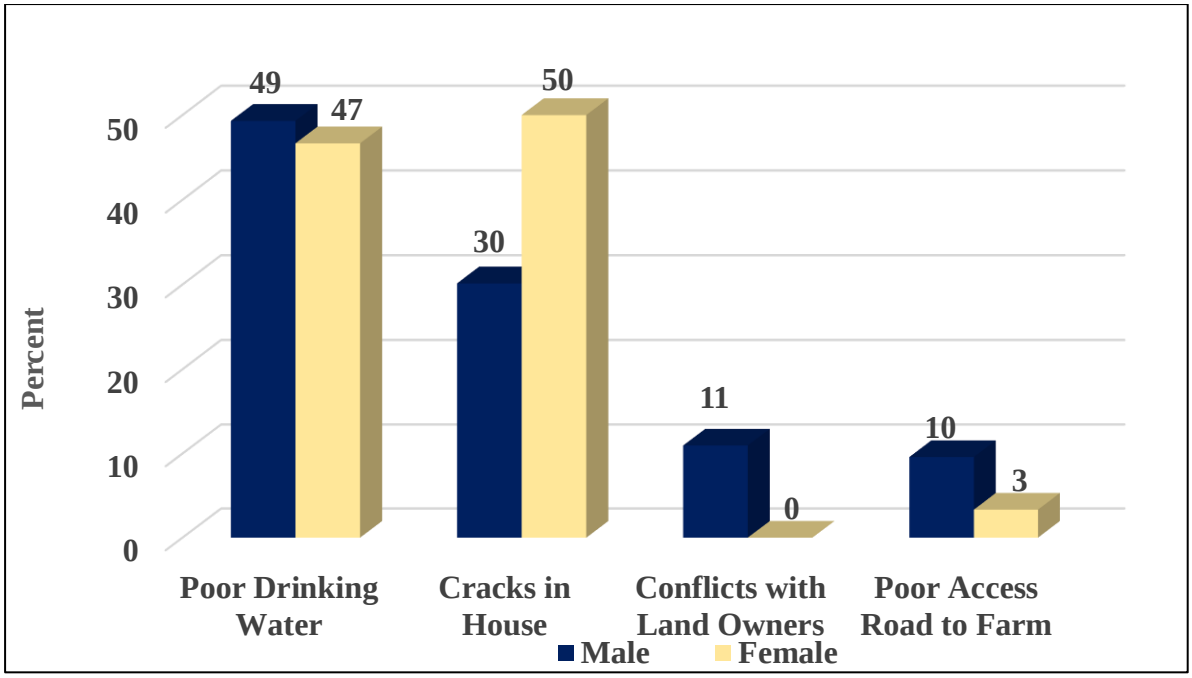


Figure 4. 7 Negative Effects of Mining on Infrastructure of Respondents

Source: Computation from field data, 2019

In terms of provision of infrastructure by mining companies in the district, interviews with key informants, the use of observation and review of literature uncovered that, the catchment communities of the large-scale mining companies have benefited most from mining operations in terms of infrastructural developments. The people of Awunakrom are beneficiaries of a market, early childhood development centre, 300-seat community centre, and a water closet toilet facility with a centralized biogas digester. However, with the exception of the community centre (Plate 4.5), and boreholes situated in the community, the other infrastructures have never been used after they were commissioned by the mining company. According to the respondents, they were not consulted in locating the infrastructure, which is less than a kilometre from the community. They prefer to sell along the road. While all the respondents in Awunakrom make use of the community centre for social functions and other meetings, 83% of the respondents depend on the boreholes that have been provided by the mining company as their source of drinking water, the remaining 17% depend on commercially sold sachet water.

The Mpohor community have also benefited in terms of boreholes, toilet facility with a centralized biogas digester provided by the large-scale mining company and a generator set for the local clinic provided through contributions by the illegal miners. However, due to the location and constant breakdown of the borehole, none of the respondents benefit from the service that the borehole provides; potable water supply. The respondents in Mpohor who depend on borehole for drinking, fetch from boreholes and hand dug wells that are privately owned by residents. This implies that, some of the infrastructure that have been provided by the mining company is not providing the required services (Plate 4.6).

Obrayebona and Mpohor Yabiw are two communities whose main source of drinking water, rivers, are perceived to have been polluted by mining activities in recent times but they have not been beneficiaries of an alternate source of drinking water from the mining companies. The two communities now depend on one borehole each provided by the District Assembly.

The study assessed the number of smallholder farmers that have access to any infrastructure provided by both large-scale and illegal small-scale mining companies which is serving its intended purpose. Figure 4.8 shows that more females have benefited from the physical infrastructure than their male counterparts. Field studies indicated that, a total of 79% of male and 72% of females have not benefited from the infrastructure provided by mining activities. However, from the 21% of male and 28% of female respondents that have access to infrastructure provided by mining activities, 33% of male and 11% of female had access road to their farms, 14% and 7% of male and female respondents respectively had access to only drinking water, while 38% of male and 21% of female respondents have access to only social amenities and 15% of male respondents and 61% of female respondents have had access to both social amenities and drinking water (Figure 4.8).

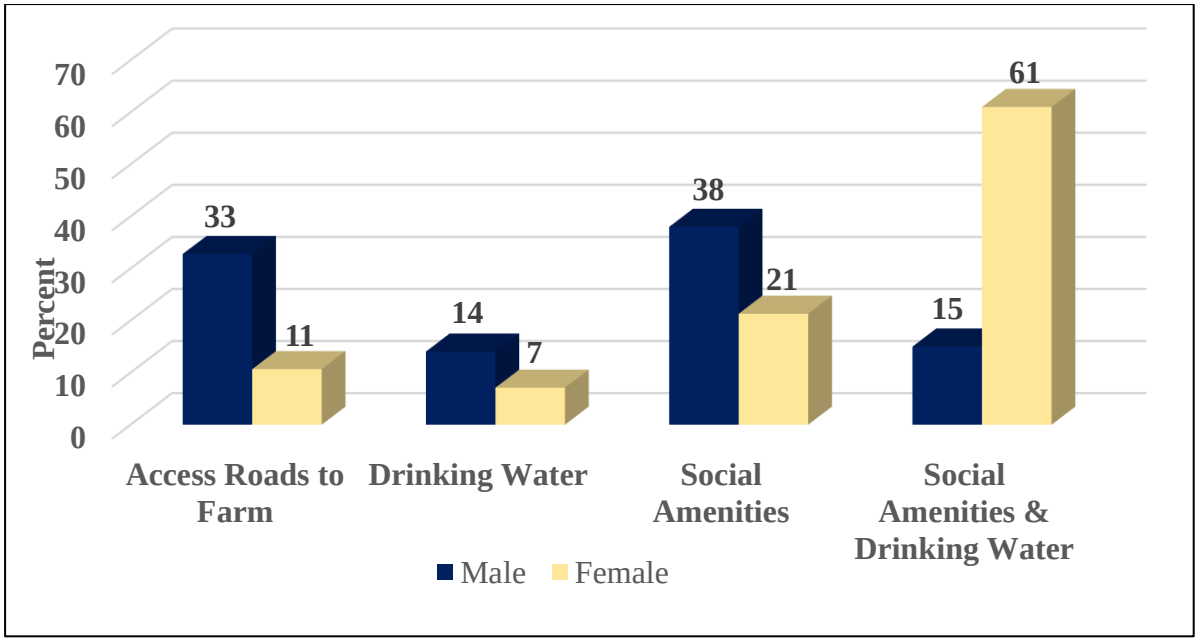


Figure 4. 8 Types of Physical Infrastructure Accessible by Respondents

Source: Computation from field data, 2019

Plate 4. 5 Focus Group Discussion at Awunakrom Community Centre

Source: Photographed by Author during Field Survey, 2019

Plate 4. 6 Abandoned Infrastructure Provided by a Mining Company

Source: Photographed by Author during Field Survey, 2019

A chi square test was performed to test the hypothesis on the perception of smallholder farmers on the effect of mining activities on their physical infrastructure. Computation from field data shows that the p-value is 0.08 (Table 4.9), which is greater than the conventionally accepted significance level (0.05). Thus, we accept the null hypothesis that, "There is no significant relationship between respondent's gender and the effect of mining activities on their physical infrastructure."

Table 4. 9 Effects of Mining Activities on Infrastructure

Gender	**Mining Effects on Infrastructure**		**Total**
	No	**Yes**	
Male	29	74	103
Female	41	62	103
Total	70	136	206
Chi square value calculated: 3.1 Probability value: 0.08 df: 1			

Source: Computation from field data, 2019

4.2.4 Effects on Health

According to majority of respondents (47% of the males and 64% of the females), they have not had any health effect caused by mining activities. Figure 4.9 shows that stomach upset, malaria and respiratory diseases were the common illnesses attributed to mining activities in the study area. The study revealed that, from the 53% of male and 36% of female respondents that perceived that their health have been affected by mining activities, 25% of male and 41% of female respondents have had malaria, which were perceived to be due to the uncovered mine pits in the communities that had been filled with water which is serving as breeding grounds for mosquitoes. Thirty-five percent of male and 11% of female respondents had suffered from respiratory diseases attributed to air pollution from blasting of rock materials during mining. Although, the farmers could not tell the exact type of respiratory diseases that they experienced, chest pains and cough were the common symptoms they experienced. Forty percent of male and 49% of female respondents unknowingly drank polluted water, which upset their stomachs.

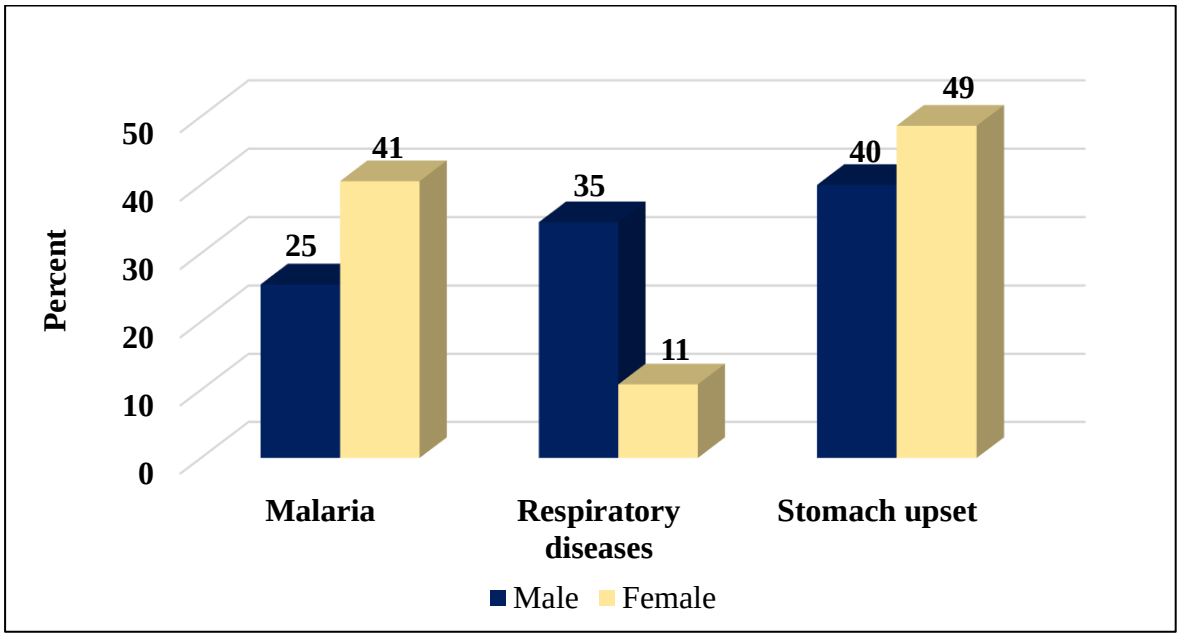


Figure 4. 9 Types of Sickness of Respondents Caused by Mining Activities

Source: Field Data, 2019

A chi square test was performed to test the hypothesis on the perception of smallholder farmers on the effect of mining activities on their health. Computation from field data shows that the p-value is 0.01 (Table 4.10), which is less than the conventionally accepted significance level (0.05). Thus, we reject the null hypothesis and accept the alternate hypothesis that, "There is a significant relationship between respondents' gender and perceived effect of mining activities on their health." The chi-square statistics is significant at 0.05 level (Table 4.10).

Table 4. 10 Effect of Mining Activities on Health

Gender	Mining Effects on Health		Total
	No	Yes	
Male	48	55	103
Female	66	37	103
Total	114	92	206
Chi square value calculated: 6.36 Probability value: 0.01 df: 1			

Source: Computation from field data, 2019

The District Coordinating Director in his response to the question on the difficulties they face in the management of mining impact on the community stated that:

"Teenage pregnancy is one of our major challenges we face. Most of these girls are not old enough to carry babies, and this affects their health. They cannot afford proper healthcare services. The menace also affects the education of the youth in the district but fortunately the current government believes in investing in humans."

4.2.5 Effects on Socio-economic Assets

Respondents indicated that their finances are dependent on mining activities in the district. All the farmers, including those who grow cash crops, also grow at least one food crop that is sold for cash and the rest used in the house. The presence of mining activities means a lot of buyers

for their produce that will generate more income for them. Moreover, some of the male respondents were also engaged in illegal mining operations.

For the male and female respondents who engage in informal businesses, mining activities increase their sales. During the time of study, respondents reported that the rate and amount of money into the smallholder households had greatly reduced because, most of the illegal migrant miners had left the communities due to the ban on illegal mining.

One lady who had a grocery store had this to say: *"Every morning, the young men will always pass here to get items for breakfast and lunch and when they close from work, they come by for supper items. Because of them I started cooking food to sell at my store and business was good. Now, I have closed up my store. The people in the community can all get food produce from their farms and prepare food for themselves*." (FDG)

Another cocoa farmer said: "*I grow mostly cash crops and have a ready market during harvest, but before harvesting, we depend on my wife's drinking spot. The farmers cannot afford to drink expensive liquor, it is the miners who were sustaining the business and my family. They are gone now and we depend on sales from Coke and Fanta that the farmers drink."*(FDG)

Interestingly, the fetish priest, who claim to have supernatural means of locating gold also said his business has gone down due to the ban on illegal mining. This is because, most of the young men who engage in illegal gold mining would go for direction from him to locate the mineral resource.

To confirm their assertion, the personnel from the cocoa product buying company stated that "*The farmers always come to me for loans using their unharvested cocoa beans. I know them personally, and know how much each of them are likely to receive after harvesting so I give them what is appropriate so I don't have to suffer. This leaves them with no money when they harvest, and they have to go borrowing elsewhere*."

However, the respondents' frequency in participation of social events such as weddings, funerals and education sessions were used to assess the effects of mining activities on their social capital. All the respondents participated in at least one social event. However, none of them said the frequency at which they participated have been affected by mining activities. The smallholder farmers live a simple life and had always chosen to attend events that are very important to them.

For the 48% of respondents that have joined associations for both financial and social support, the benefits of being part of the group makes them committed. The 52% of respondents that have not joined any association claimed they have no interest or time to partake in the activities of any group.

One lady who had joined three groups said, *"I have joined three groups because they all offer different things. One group contribute big monies for members who need it. The two other groups are dance groups, I like dancing and mining or no mining, I will follow them everywhere to dance. We get invited to different events, the more groups you join, the more places you get to go."*

However, in contrast to what she said, one male respondent had this to say: *"I have never been interested in social events or joining associations. Unless the event is being organised by a close relative or it is educational, I will not even think of attending, so mining does in no way affect my attending any events*."

4.3 Chemical Properties in Soil Samples

Respondents were asked to identify which natural resource they perceived to have been greatly polluted in the district. Majority (56%) responded that land had been greatly polluted by mining activities while 44% responded that water had been destroyed. Chemical parameters (pH,

electrical conductivity, cadmium, arsenic, lead and mercury) were analysed in soil samples from the study communities.

4.3.1 Hydrogen ions (pH)

The mean pH values of soil samples from Mpohor, Mpohor Yabiw and Awunakrom were 5.20, 5.10 and 5.23, respectively (Figure 4.10). The pH values ranged from a minimum of 4.9 in soil samples from Mpohor Yabiw to a maximum of 5.4 in soil samples from Mpohor and Awunakrom (Appendix D).

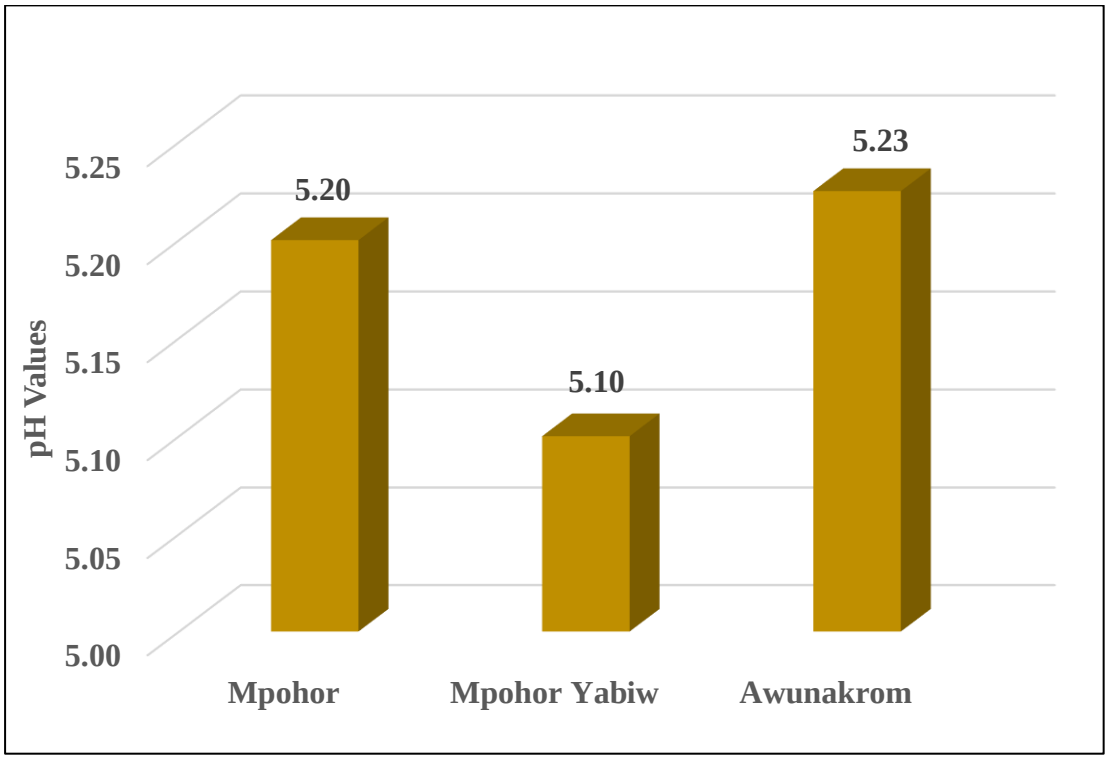


Figure 4. 10 Mean pH of Soil Samples

Source: Computation from Field Data, 2019

4.3.2 Electrical Conductivity

The mean electrical conductivity of soil samples from Mpohor, Mpohor Yabiw and Awunakrom were 421.50µS/cm, 310.67µS/cm and 324.75µS/cm, respectively (Figure 4.11).

The mean electrical conductivity values ranged from a minimum of 155 µS/cm to a maximum of 688 µS/cm both in soils samples from Mpohor (Appendix D).

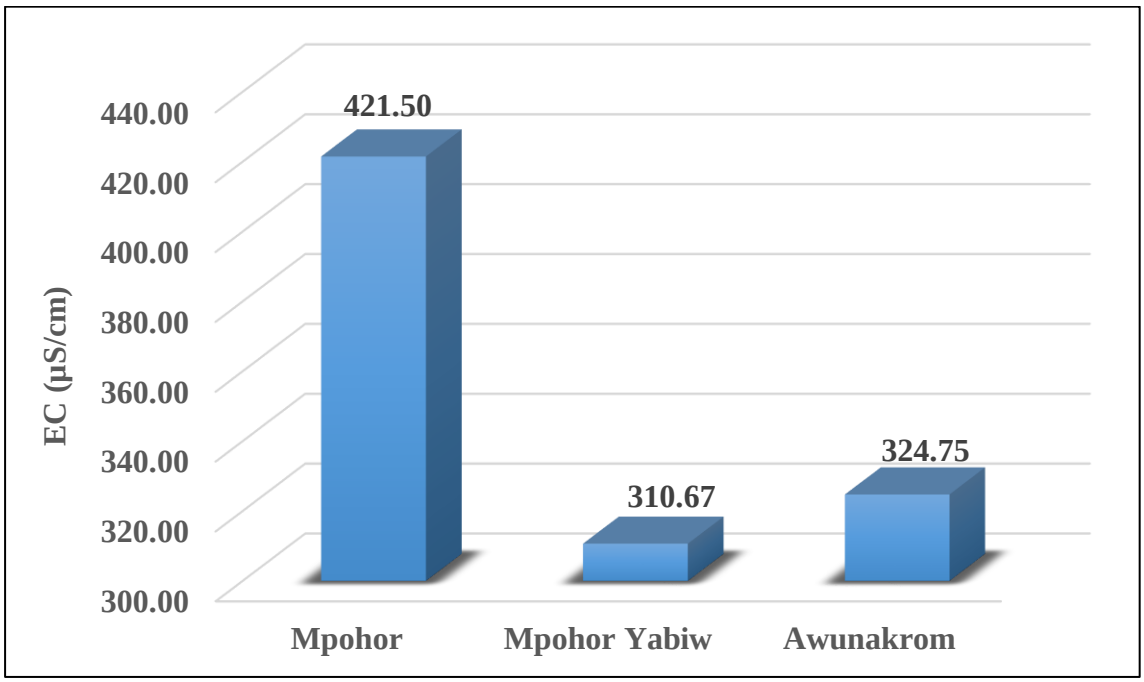


Figure 4. 11 Mean EC of Soil Samples

Source: Computation from Field Data, 2019

4.3.3 Cadmium (Cd)

The mean cadmium concentration in soil samples from Mpohor, Mpohor Yabiw and Awunakrom were 4.70mg/kg, 5.53mg/kg and 6.75mg/kg, respectively (Figure 4.12).

The results of cadmium concentrations in the soil samples ranged from 4.3mg/kg in soils from Mpohor to 8.2 mg/kg in soil samples from Awunakrom (Appendix D). Cadmium concentration in all the soil samples (Appendix D) were higher than the recommended cadmium concentration in soils, which is 3 mg/kg (WHO/FAO, 2004).

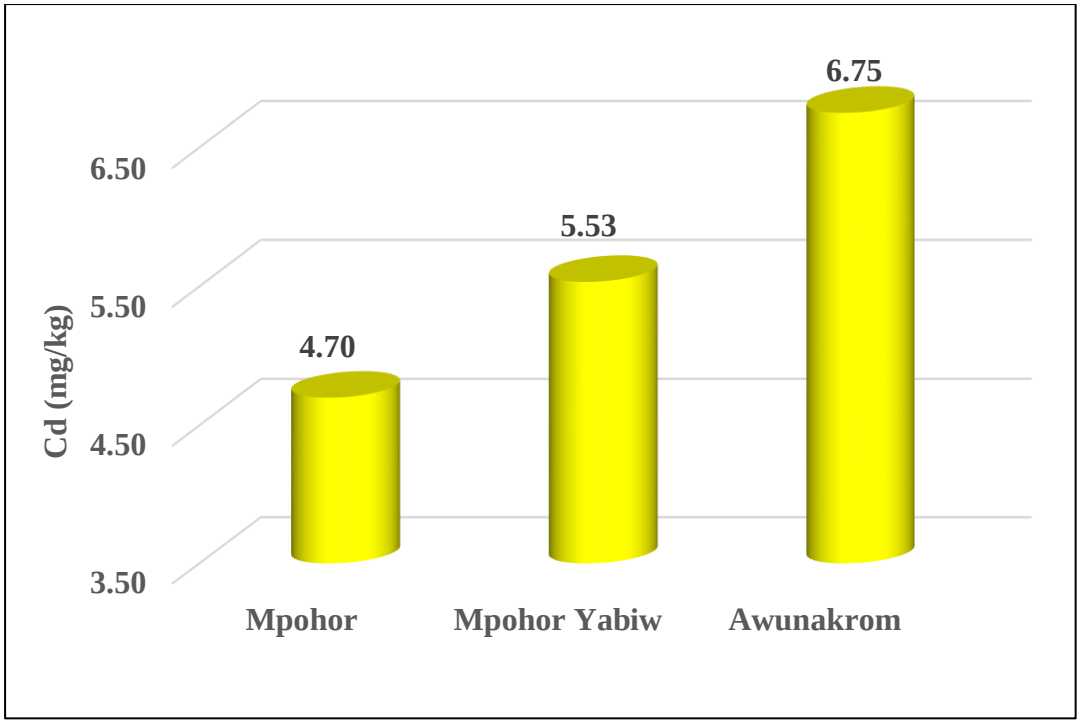


Figure 4. 12 Mean Cd Concentrations of Soil Samples

Source: Computation from Field Data, 2019

4.4.4 Lead (Pb)

The mean lead concentration in soil samples from Mpohor, Mpohor Yabiw and Awunakrom were 24.10mg/kg, 0.43mg/kg and 5.15mg/kg, respectively (Figure 4.13). The maximum mean lead concentration was 24.1 mg/kg in soils from Mpohor (Appendix D). This value is lower than the recommended lead concentration in soils which is 50 mg/kg (WHO/FAO, 2004).

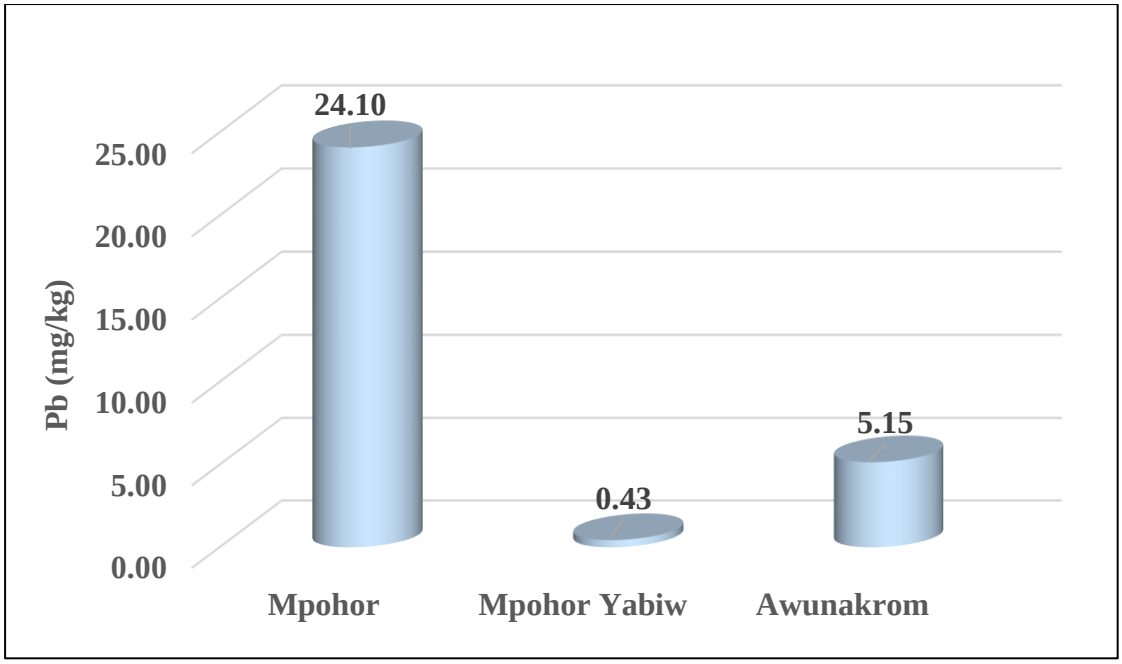


Figure 4. 13 Mean Lead of Soil Samples

Source: Computation from Field Data, 2019

4.3.5 Arsenic (As)

The mean arsenic concentration in soil samples from Mpohor, Mpohor Yabiw and Awunakrom were 1.87mg/kg, 0.97mg/kg and 0.11mg/kg, respectively (Figure 4.14). Arsenic concentrations in the soils ranged from the 0.03mg/kg in soil samples from Awunakrom to 2.41mg/kg in soil samples from Mpohor (Appendix D). The maximum mean arsenic concentration was 1.9 mg/kg in soils from Awunakrom. This is lower than the recommended arsenic concentration in soils, which is 20 mg/kg (WHO/FAO, 2004).

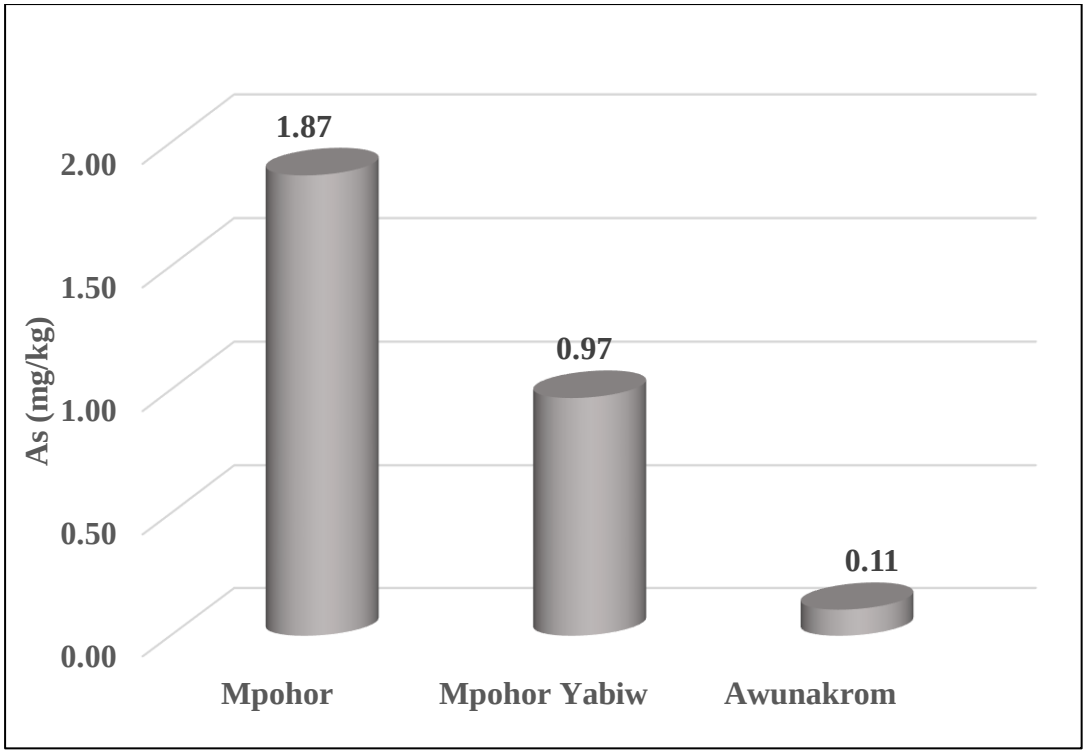


Figure 4. 14 Mean Arsenic Concentration in Soil Samples

Source: Computation from Field Data, 2019

4.3.6 Mercury

The mean mercury concentration in soil samples from Mpohor, Mpohor Yabiw and Awunakrom were 0.136mg/kg, 0.142mg/kg and 0.006mg/kg, respectively (Figure 4.15).

The concentrations of mercury in the soils ranged from the 0.002mg/kg in soil samples from Awunakrom to 0.26g/kg in soils samples from Mpohor (Appendix D). The maximum mean mercury concentration was 0.142 mg/kg in soils from Mpohor Yabiw. This is lower than the recommended mercury concentration in soils, which is 2 mg/kg (WHO/FAO, 2004).

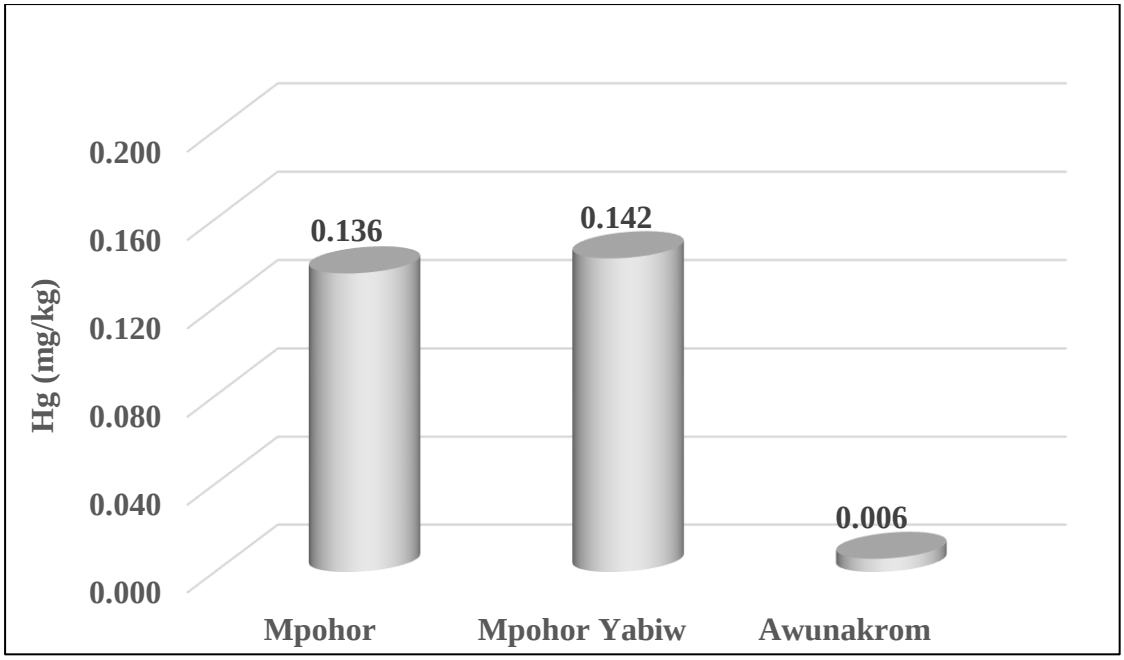


Figure 4. 15 Mean Mercury Concentration of Soil Samples

Source: Computation from Field Data, 2019

4.3.7 Correlation between the Chemical Parameters in the Soil Samples

To investigate the association, between the chemical properties and heavy metal concentrations of the soil samples in the study area, Pearson's Product moment correlation coefficient was used. Significant positive correlation was observed between arsenic and mercury ($r=0.84$; $P<0.01$) and also in lead and Arsenic ($r=0.65$; $P<0.05$). Table 4.11 shows the correlation matrix between the chemical properties and heavy metals concentration in the soil samples. The detailed correlation matrix is shown in Appendix D. pH recorded a negative correlation with EC ($r= -0.052$) but a weak positive correlation with all the heavy metals; Cd ($r=0.016$), Pb ($r=0.0518$); As ($r=0.0119$) and Hg ($r=0.133$). EC recorded a weak positive correlation with Cd ($r= 0.287$) and As ($r= 0.085$), but a weak negative correlation with Pb ($r= -0.181$) and Hg ($r= -0.286$). Cd recorded a weak negative correlation with all the other heavy metals; Pb ($r= -0.329$); As ($r= -0.297$) and Hg ($r= -0.289$). However, Pb recorded positive correlation with Hg ($r= 0.489$).

Table 4. 11 Correlation Matrix for Chemical Parameters of Soil Sampled

	pH	EC	Cd	Pb	As	Hg
pH	1	-0.052	0.016	0.518	0.199	0.331
EC		1	0.287	-0.181	0.085	-0.268
Cd			1	-0.329	-0.297	-0.289
Pb				1	.650*	0.489
As					1	.839**
Hg						1

*. Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

Source: Computation from Field Data, 2019

4.4 Livelihood Strategies Employed by Male and Female Smallholder Farmers

With consideration of the livelihood assets of smallholder farmers in the Mpohor District, several activities were classified under on-farm, off-farm and non-farm strategies. Respondents ranked these activities from 1 as most used, 2 as moderately used and 3 as least used. During the field study, 7% of male and 6% of female respondents did not participate in the ranking of livelihood activities. Multinomial logistic regression was used to predict the livelihood strategy (dependent variable) employed by the smallholder farmers, given their livelihood assets (independent variables).

4.4.1 Ranking of On-Farm Livelihood Strategy

There was a strong positive correlation (r=1) between the ranking of on-farm livelihood strategies by the male and female respondents (Table 4.12 and Table 4.13). Majority of male and female respondents choose to practise intercropping on their farms, which was ranked 1

by both male and female respondents. Crop diversification was ranked 2 by both male and female respondents, while integrating livestock rearing with growing of crops was ranked 3 by both gender as a coping strategy against the effects of mining.

Table 4. 12 Ranking of On-Farm Livelihood Strategies by Males

On-farm Activities	% of Male Respondents Ranking			% Weighting**	Overall Rank
	1	2	3		
Intercropping	52	43	5	247	1
Crop diversification	44	47	9	235	2
Integrating livestock with crop	4	9	87	118	3

*Note:**This is captured as the sum of % respondents ranking x weight of rank (rank1=3, rank2=2, rank3=1)*

Source: Computation from field data, 2019

Table 4. 13 Ranking of On-Farm Livelihood Strategies by Females

On-farm Activities	% of Female Respondents Ranking			% Weighting**	Overall Rank
	1	2	3		
Intercropping	65	28	7	258	1
Crop diversification	28	40	32	196	2
Integrating livestock with crop	7	33	60	147	3

*Note:**This is captured as the sum of % respondents ranking x weight of rank (rank1=3, rank2=2, rank3=1)*

Source: Computation from field data, 2019

Figure 4.16 shows that more females choose to intercrop and rear livestock than their male counterparts, whereas, more males choose to diversify their crops than the females. The detailed descriptive statistics (Appendix E) shows that the least on-farm strategy employed by the farmers is the rearing of livestock.

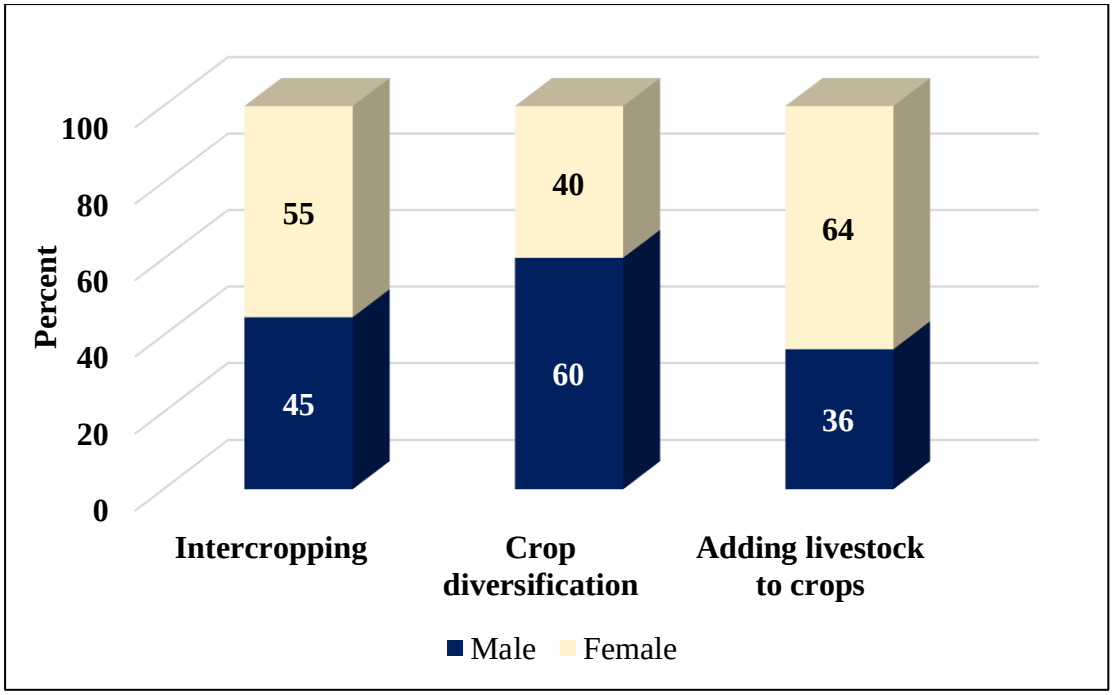


Figure 4. 16 On-Farm Livelihood Strategy by Gender

Source: Computation from field data, 2019

4.4.2 Factors Influencing the Choice of On-Farm Livelihood Activity

Multinomial logistic regression was used to predict a nominal dependent variable (on- farm livelihood strategy) given the independent variables that can influence the choice of livelihood activity. The likelihood ratio chi-square of 56.1, a p-value < 0.05 (Table 4.14) and R^2 (Nagelkerke) of 0.310 (Table 4.15) shows that the model as a whole fits significantly better than an empty model.

Table 4. 14 Model Fitting Information

	Model Fitting Criteria	Likelihood Ratio Tests		
Model	**-2 Log Likelihood**	**Chi-Square**	**df**	**Sig.**
Intercept Only	283.2			
Final	227.1	56.1	26.0	0.001

Source: Computation from field data, 2019

Table 4. 15 Pseudo R-Square

Cox and Snell	0.252
Nagelkerke	0.31
McFadden	0.173

Source: Computation from field data, 2019

The multinomial logit result (Table 4.16) indicates that among the 13 independent variables, the variables origin and organizational support were found to significantly influence choice of on-farm livelihood activity (Appendix F). Origin negatively and significantly affected the probability of choosing intercropping and crop diversification at less than 5% probability level. The odds of a native farmer choosing intercropping and crop diversification rather than adding livestock to crop cultivation is 0.107 and 0.094, respectively less than a migrant farmer. Access to organizational support positively and significantly affected the probability of choosing intercropping at less than 5% probability level. The odds of a farmer who does not have access to organizational support choosing intercropping rather than adding livestock to crop cultivation is 26.97 more than a farmer who has access to organizational support.

Table 4. 16 Parameter Estimates

On-Farm Activity		B	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound
Intercropping	Intercept	3.61	1	0.108			
	Origin	-2.232	1	0.038**	0.107	0.013	0.885
	Organ. Support	3.295	1	0.018**	26.967	1.78	408.632
Crop diversification	Intercept	2.589	1	0.253			
	Origin	-2.36	1	0.028**	0.094	0.011	0.778
	Organ. Support	2.657	1	0.058*	14.254	0.912	222.791

Source: Computation from field data, 2019

** and * stand for significant at 5% and 10% respectively

The reference category is: Adding livestock to crops.

4.4.3 Ranking of Off – Farm Livelihood Strategy

Results from field data showed that, selling of the raw produce from farm was the main off-farm strategies employed by the respondents. As pointed out in Table 4.17 and 4.18, majority of male (86.5%) and female (72.2%) respondents choose to sell the raw produce from their farm and ranked it 1. Processing their farm produce to sell was ranked 2 and while working on other people's farm as labourers was ranked 3 by both male and female respondents.

Table 4. 17 Ranking of Off-Farm Livelihood Strategies by Males

Off-farm Activities	% of Male Respondents Ranking			% Weighting**	Overall Rank
	1	2	3		
Selling of raw agriculture produce	87	9	4	283	1
Processing of produce to sell	10	66	24	186	2
Farm Labourer	3	25	72	131	3

*Note:**This is captured as the sum of % respondents ranking x weight of rank (rank1=3, rank2=2, rank3=1)*

Source: Computation from field data, 2019

Table 4. 18 Ranking of Off-Farm Livelihood Strategies by Females

Off-farm Activities	% of Female Respondents Ranking			% Weighting**	Overall Rank
	1	2	3		
Selling of raw agriculture produce	72	23	5	267	1
Processing of produce to sell	23	55	23	200	2
Farm Labourer	5	23	72	133	3

*Note:**This is captured as the sum of % respondents ranking x weight of rank (rank1=3, rank2=2, rank3=1)*

Source: Computation from field data, 2019

From the field data as shown in Figure 4.17, more of the females, choose to work as farm labourers and process their produce to sell than their male counterparts, whereas more males than females choose to sell their raw produce. The detailed descriptive statistics (Appendix E), shows that the least off-farm strategy employed by the farmers is working as a farm labourer.

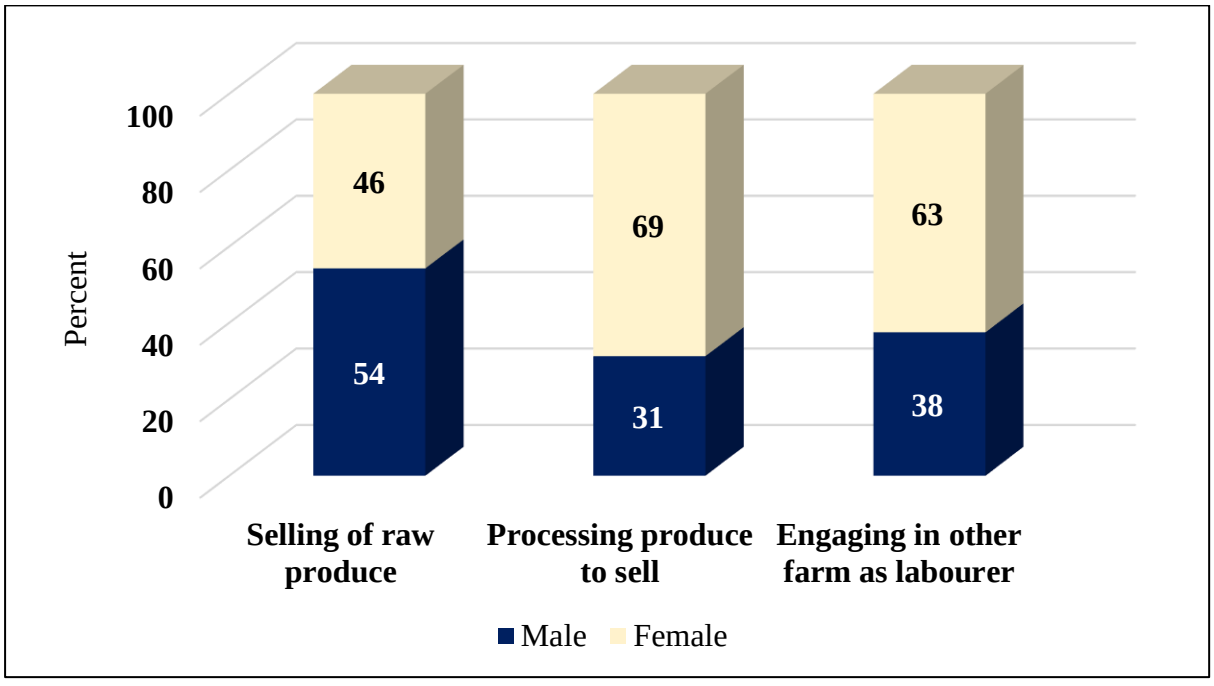


Figure 4. 17 Off-Farm Livelihood Strategy by Gender

Source: Computation from field data, 2019

4.4.4 Factors Influencing the Choice of Off-Farm Livelihood Strategy

Multinomial logistic regression was used to predict a nominal dependent variable (off- farm livelihood strategy) given the independent variables that can influence the choice of livelihood activity. The likelihood ratio chi-square of 122.9 with a p-value < 0.05 (Table 4.19), and R^2 (Nagelkerke) of 0.668 (Table 4.20) shows that the model as a whole fits significantly better than an empty model.

Table 4. 19 Model Fitting Information

	Model Fitting Criteria	Likelihood Ratio Tests		
Model	**-2 Log Likelihood**	**Chi-Square**	**df**	**Sig.**
Intercept Only	220.3			
Final	97.4	122.9	26.0	0.000

Source: Computation from field data, 2019

Table 4. 20 Pseudo R-Square

Cox and Snell	0.473
Nagelkerke	0.668
McFadden	0.52

Source: Computation from field data, 2019

The multinomial logit result (Table 4.21) indicates that among the 13 independent variables, three variables; Association joined, Organisational support, and Crop types were found to significantly influence choice of off-farm livelihood activity (Appendix F). Joining an association negatively and significantly affected the probability of choosing to sell raw produce and process raw produce to sell at less than 1% probability level. The odds of a farmer who has not joined an association choosing sell raw produce and processing raw produce to sell rather than engaging in other farms as a labourer is 2.422_E-39 and 6.553_E-40 respectively, less than a farmer who has joined an association. Access to organizational support positively and

significantly affected the probability of choosing sell raw produce at less than 1% probability level. The odds of a farmer who does not have access to organizational support choosing to sell raw produce rather than engaging in other farms as a labourer is 2.685_E+38 more than a farmer who has access to organizational support. The crop type cultivated by the farmers negatively and significantly affected the probability of processing raw produce to sell at less than 1% probability level. The odds of a farmer who cultivates cash crops in choosing to process raw produce to sell rather than engaging in other farms as a labourer is 0.005 less than a farmer who cultivates non-cash crops.

Table 4. 21 Parameter Estimates

Off-Farm Activity		B	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound
Selling of raw produce	Intercept	148.881	1	0.95			
	Crop type	-3.085	1	0.074*	0.046	0.002	1.352
	Joined Ass.	-88.916	1	0***	2.422_E-39	3.623_E-41	1.62_E-37
	Organ. Support	88.486	1	0***	2.685_E+38	3.394_E+37	2.124E+39
Processing produce to sell	Intercept	146.35	1	0.951			
	Crop type	-5.312	1	0.005***	0.005	0	0.198
	Joined Ass.	-90.224	1	0***	6.553_E-40	9.316E-42	4.609_E-38

Source: Computation from field data, 2019
*** and * stand for significant at 1% and 10% respectively
The reference category is: Engaging in other farm as labourer.

4.4.5 Ranking of Non–Farm Coping Strategy

Field data (Table 4. 22 and Table 4.23) show that, both male and female respondents choose to engage in wage employment and ranked 1. However, the male respondent choose to migrate (ranked 2) rather than taking or remittances (ranked 3) because most of the male respondents

are younger and more educated than the female respondents, which makes them have an advantage of moving to other towns in search for a living while the female respondents choose to take remittances (ranked 2) over migration (ranked 3) because they are mostly responsible in taking care of the family.

Table 4. 22 Ranking of Non-Farm Livelihood Strategies by Males

Non-farm Activities	% of Male Respondents Ranking			% Weighting**	Overall Rank
	1	2	3		
Wage employment	44	38	19	225	1
Migration	29	31	40	190	2
Remittances	27	31	42	186	3

*Note:**This is captured as the sum of % respondents ranking x weight of rank (rank1=3, rank2=2, rank3=1)*

Source: Computation from field data, 2019

Table 4. 23 Ranking of Non-Farm Livelihood Strategies by Females

Non-farm Activities	% of Female Respondents Ranking			% Weighting**	Overall Rank
	1	2	3		
Wage employment	44	38	18	227	1
Migration	10	39	51	160	3
Remittances	45	23	32	214	2

*Note:**This is captured as the sum of % respondents ranking x weight of rank (rank1=3, rank2=2, rank3=1)*

Source: Computation from field data, 2019

Majority of the females choose to earn some income through wage employment and remittances from family and friends than their male counterparts, whereas more of the males will choose to migrate than the females (Figure 4.18). The detailed descriptive statistics (Appendix E) shows that the least non-farm strategy employed by the male farmers is taking remittances, while the least non-farm strategy employed by the female farmers is migration.

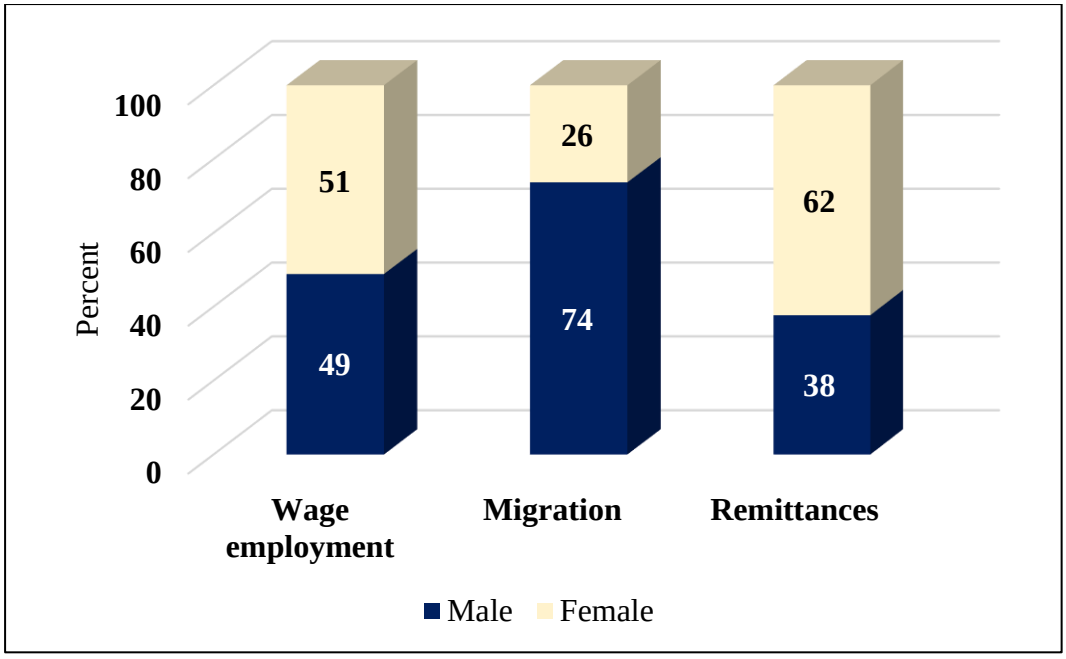


Figure 4. 18 Non-Farm Livelihood Strategy by Gender

Source: Computation from field data, 2019

4.4.6 Factors Influencing the Choice of Non-Farm Livelihood Strategy

Multinomial logistic regression was used to predict a nominal dependent variable (off- farm livelihood strategy) given the variables that can influence the choice of livelihood activity. The likelihood ratio chi-square of 148.8 with a p-value < 0.05 and R^2 (Nagelkerke) of 0.50 (Table 4.25) shows that the model as a whole fits significantly better than an empty model (Table 4.24).

Table 4. 24 Model Fitting Information

	Model Fitting Criteria	Likelihood Ratio Tests		
Model	**-2 Log Likelihood**	**Chi-Square**	**df**	**Sig.**
Intercept Only	369.8			
Final	258.6	111.2	26.0	0.000

Source: Computation from field data, 2019

Table 4. 25 Pseudo R-Square

Cox and Snell	0.438
Nagelkerke	0.499
McFadden	0.275

Source: Computation from field data, 2019

The multinomial logit result in Table 4.26 indicates that among the 13 independent variables, 6 variables, namely Origin, Gender, Marital Status, Dependent on farm only, Organisational support, and Farm income (Appendix F) were found to significantly influence choice of non-farm livelihood activity. Origin positively and significantly affected the probability of choosing wage employment and migration at less than 1% and 5 % probability level respectively. The odds of native farmer in engaging in wage employment and migrating rather than taking remittances is 7.015 and 4.786 respectively more than a migrant farmer. Marital status positively and significantly affected the probability of choosing wage employment and migration at less than 10% and 5 % probability level respectively. The odds of a farmer who is not married in engaging in wage employment and migrating rather than taking remittances is 2.728 and 4.421, respectively, more than an unmarried farmer. Dependant on farm only positively and significantly affected the probability of choosing wage employment and migration at less than 1% probability level. The odds of a farmer who depends solely on farm activity in engaging in wage employment and migrating rather than taking remittances is 15.545 and 6.299, respectively, more than a farmer who has another livelihood aside farming. Income from farm negatively and significantly affected the probability of choosing wage employment and migration at less than 5% probability level. The odds of a farmer who earns less than 500 Ghana cedis in a month from farming in engaging in wage employment and migrating rather than taking remittances is 0.330 and 0.261, respectively, less than a farmer who earns more than 500 Ghana cedis. Also, access to organisational support positively and

significantly affected the probability of choosing migration at less than 10% probability level. The odds of a farmer who does not have access to organisational support in choosing to migrate rather than taking remittances is 3.895 more than a farmer who have access to organizational support.

Table 4. 26 Parameter Estimates

Non-Farm Activity		B	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound
Wage Employment	Intercept	-1.6635	1	0.151			
	Origin	1.9481	1	0.000***	7.015	2.351	20.937
	Marital Status	1.0036	1	0.088*	2.728	0.859	8.661
	Dep. on Farm only	2.7628	1	0.000***	15.845	5.389	46.587
	Farm Income	-1.1094	1	0.028**	0.330	0.123	0.884
Migration	Intercept	-4.2208	1	0.002			
	Gender	1.8825	1	0.014**	6.570	1.457	29.627
	Origin	1.5657	1	0.018**	4.786	1.307	17.530
	Marital Status	1.4864	1	0.035**	4.421	1.113	17.566
	Dep. on Farm only	1.8404	1	0.005***	6.299	1.751	22.665
	Farm Income	-1.3441	1	0.023**	0.261	0.082	0.829
	Organ. Support	1.3597	1	0.087*	3.895	0.823	18.441

Source: Computation from field data, 2019

***, **, and * stand for significant at 1%, 5% and 10% respectively

The reference category is Remittances

4.5 Institutional Support in Managing Effect of Mining Activities

Formal and informal institutions that are in charge of the management of the effects of mining activities on the smallholder farmers in the district were identified through literature review and responses from participants. All the respondents reported receiving support from their

Traditional leaders and the District Department of Agriculture. Some of them reported having received some support from the District Assembly and the Oil Palm Plantations in the district. The main management strategy by both formal and informal institutions was the use of law enforcement, whereas compensation and education were the main support provided to the smallholder farmers who have had their livelihood affected by mining activities.

4.5.1 Law Enforcement

The Mpohor District Assembly is in charge of all remediate measures concerning environmental pollution, however it does not have the resources to remediate the chemical pollution of soils and water bodies caused by mining activities in the district. The District Assembly, therefore relies on the law enforcement agencies to remove mining operators working without the authorised permit. Before the introduction of "operation vanguard" which comprises of special task force from the Ghana Armed Forces dealing with illegal mining in the country, the District Assembly had constituted its own task force of eight (8) men, who were in charge of stopping illegal mining in the district.

Smallholder farmers who are affected by the destruction of farmland are encouraged to report to the District Assembly for assistance. However, some farmers give out part of their land to the illegal miners and are not able to seek help from the District Assembly when their lands get destroyed. The Norpalm plantation which has also had experience of illegal mining encroachment on its property made use of law enforcement agency to curtail the activities of illegal mining on their lands.

The leaders from the three communities that were interviewed were also smallholder farmers. They all attested to the fact that they do not have the authority and resources to curtail any mining activities affects their communities. They usually lodge their complaints to the Omanhene of the Mpohor Traditional area and the District Assembly and in return get

connected to some the law enforcement agencies (usually, police officers) to help them drive out the illegal mining operators in their communities, who are working without the consent of the land owners.

4.5.2 Compensation

The District Assembly oversees the cash compensation of destroyed farmland by mining operators to the smallholder farmers. This has been effective with regularised mining operators but not much success has been achieved on compensating farmers by illegal miners. Therefore, using funds allocated by the government to foster development in mining communities, infrastructure such as health centres and boreholes have been constructed for rural areas that have been affected by mining activities. Obrayebona has benefited from a borehole and chip compound (health centre), while Mpohor Yabiw have benefited from a borehole from the District Assembly.

Norpalm plantation have also provided potable water by constructing boreholes in communities who have had their water resources polluted by mining activities. *Opoto* and *Awusaeso* are two of the beneficiary communities. The oil palm plantation also presents out grower schemes for oil palm farmers, who in turn stand a chance of receiving technical and financial support.

A leader of one community revealed that, he gives smallholder farmers whose land are destroyed by illegal mining activities, three (3) to four (4) acres of land without any charges so that they can earn a living. For the effects on access roads, it was common for all communities to organise communal labour to fix roads that have been destroyed by mining activities.

4.5.3 Education

The Department of Agriculture (MoFA) provides education to farmers on how to improve the fertility of soils through natural means and by the use of agro-chemicals. Due the hostile

attitudes of illegal miners, personnel from the district agriculture office, who mostly encounter illegal mining operations when on duty in the district are not able to confront them.

Traditional leaders, who usually have formal education and receive informal training in royal households, also contribute to the informal training of smallholder farmers on traditional agricultural systems that have been handed down from generations. Some farmers also acknowledged receiving education from the older generations in their families, while others incorporate the information, they get from friends who are part of the Farmers' Associations in their traditional methods of farming.

CHAPTER FIVE

DISCUSSION

5.1 Assets and Livelihood of Smallholder Farmers

According to DFID (1999), people require a range of assets to enable them engage in activities that will help them achieve a desirable living. Therefore, a precise and realistic apprehension of people's strengths (assets and capital endowments) and the activities they are engaged in is needed to assess how they can formulate coping strategies against shocks and stresses on their livelihood. The assets (or access to assets), capabilities and daily activities of smallholder farmers, including education, skills, social networks and financial status play a major role in the attainment of a sustainable livelihood. Thus, the unavailability and inaccessibility of assets pose a challenge for some African rural areas, which are mostly agrarian, to achieve a positive livelihood outcome (Ellis et al., 2003; Kadigi et al., 2007).

Ghanaian rural household (smallholder farmers) farmlands are traditionally vested in descent groups (Nukunya, 2003). Land, which is their most important asset for their livelihood is mostly attained through their lineages. However, the lack of other equally important livelihood assets in the rural communities, such as good road networks, potable water supply and competitive markets limits the smallholder farmers in their bid to attain a living. Mining companies in rural communities can support in the development of infrastructure (physical assets) but can also contribute to the destruction of land and water bodies (natural capital) through their activities. Therefore, the smallholder farmers, have to depend mostly on their human and social networks in achieving a desirable livelihood outcome (Kadigi et al., 2007; Tolossa, 2010).

5.1.1 Human Assets and Livelihood

The DFID (1999) sustainable framework identifies the human asset as an important livelihood resource that is critical in examining the livelihood of the poor in a society because it is of intrinsic value and is required for the utilisation of any of the other four types of assets. Scholars have pointed out that smallholder farmers rely extensively on their human assets to engage in a combination of livelihood activities (Rakodi, 1995; Owusu, 2001; Ellis et al., 2003; Hesselberg & Yaro, 2006).

The demographic dynamics of households affect local environmental results and resource dependence in people's pursuit to achieve a desirable livelihood outcome (de Sherbinin et al., 2008). Human capital, especially in terms of household size and educational level of members of households, serve as an essential component for households to increase their income and minimize risk. Youthful members of households that have higher education are advantageously positioned across locations and economic sectors to earn extra income for the household (de Sherbinin et al., 2008).

Ethnicity

Carr (2008) observed that both males and females in areas with high population and decreasing forest and crop lands, show higher probability to move to rural areas in search for farmlands to support their livelihood. In the Mpohor mining area there is also a high percentage of both genders migrating, although females were less likely to migrate to urban areas than their male counterparts, contrary to what was reported by Carr (2008). Thus, the higher number of female migrant respondents can be explained by the affinity of some male farmers to marry from other ethnic backgrounds. Also, married women generally assume the duty of household heads due to the absence of their husbands who have migrated to urban areas in search for higher earning income generating jobs. In one settler farming community (Awunakrom), there was very low male representation in the survey due to the out-migration of the men to other towns, which

was attributed to impacts on their livelihood due to governmental intervention on environmental protection. Ghanaian male native smallholder farmers have a higher opportunity of inheriting a farmland than a migrant (Nukunya, 2003). Thus, settler male farmers tend to move to other communities when they lose their farmland than natives who have hope of acquiring other farmlands from their family. A native male is also more likely to inherit a larger plot of land than a native female due to the patriarchal culture, as was observed in the study area.

Age

The age of the respondents plays a major role in determining the age range of the agriculture labour force in the district and the type of livelihood activities they can engage in. Livelihood portfolios of younger smallholder farmers are more diversified. According to GSS (2014), the most productive ages of peoples' lives falls in the 26-35 years age bracket. Moreover, males are often granted ownership to farmlands by family heads compared to females at that age. This limits female smallholder farmers' right to land title, which can be used to acquire other livelihood assets. The low percentage of female respondents above 65 years in the study is contrary to the report by GSS (2016), which indicates that the highest percentage of female labour force in agriculture in Ghana are above 65 years of age.

Marital Status

The marital status of people influences the provision of household needs, as two-parent households are more likely to benefit from pooling their resources together to maintain their households, especially if both have good source of income. Widowed, single and divorced persons may not benefit from this strategy and may have to rely on themselves solely or on other means to support their households (Kpoor, 2015). Higher rates of divorced and widowed females compared to males in the Mpohor District, similar to the national situation (GSS,

2014), has implications for female vulnerability in the mining environment. The ratio of female household heads to male household heads follows the national trend where number of female heads of household are one-third of that of the males (GSS, 2016). Also, the major routes to female household headship in Ghana identified by Ardayfio-Schandorf (1994), as through separation, death of their husbands and divorce were confirmed in this study. Another challenge for the married women due to their ethnicity, i.e., the Akan ethnic group, is that a man is succeeded by his nephew who inherit most of his properties after his death, especially without a will. This affects the access of the spouse to certain livelihood assets such as land and buildings.

Household Size

According to de Sherbinin et al. (2008), household size constitutes an asset (human capital) which can be a source of labour and positively correlates with preparation of farmland for sowing. Thus, male and female respondents in the Mpohor District have equal access to household labour. However, the large household sizes of male and female respondents can have both negative and positive implications for smallholder famers. A larger *(more than 5 person, UN, 2017)* household size can reduce the share of farmland holdings of the family and food production, while also presenting an advantage in terms of labour for economic activities and support for the aged and disabled.

Years of Farming and Education Status and Skills

The majority of male and female smallholder farmers in the Mpohor District have more than 20 years of farming experience, which can contribute to more experience in natural resource management to maximise their assets in attaining a good livelihood outcome. However, the formal educational level of the respondents was very low. According to DFID (1999), education plays a major role in poverty eradication. Educated people have access to

information and possess the knowledge and skills which is useful in combining several desirable livelihood strategies to obtain a sustainable livelihood portfolio (Oxenham, Diallo, H., Katahoire, Petkova-Mwangi, & Sall 2002). Although the majority of males and females were educated to the senior high level, female smallholder farmers were the least educated, which corresponds to national reports of 28% of the females in the district never attending school compared to the males (14%) (GSS, 2014). This disqualifies the female smallholder farmers from engaging in other occupations in the mineral, industrial or service sectors.

The low level of educational status, which acts as a proxy for people's level of understanding, disqualifies them from accessing high income generating jobs for a higher quality of life (Oxenham et al., 2002). The smallholder farmers depend solely on their farm produce, making them vulnerable in the event of shocks and stress on their livelihood. Very few of the male respondents have formal jobs due to their high educational status. The other livelihood activities engaged by the remaining males and all the female respondents are dependent on their natural, human and social capital, evident in the high ranking of off-farm (selling of farm produce) as their livelihood strategy against mining shocks and stress in the district. Men often tend to be more involved in formal employment activities compared to women who usually engage in informal livelihood activities (Owusu, 2001; Tolossa, 2010). In the district, male smallholder farmers were also engaged in artisanal small-scale mining, as seen in rural communities in sub–Saharan Africa (Hilson & Garforth, 2012).

Access to Information

For smallholder farmers to effectively maximise livelihood activities and adapt or mitigate the effects of potential effects of mining activities, access to information that is deemed valuable to their livelihood is very important. The sharing of traditional knowledge as well as modern information, technology and services, plays an important role in smallholder productivity (Schubert, 2012). Membership in the Farmer's Association in the district, provides information

on technological breakthrough in the agricultural sector due to the fulfilment of the sustainable development goals. However, majority of the smallholder farmers are not members of the Farmer's Association because they have no interest in the information and services acquired in the association. Moreover, the leadership of the Association prefer to include limited number of farmers (*about 200*), to enable them effectively distribute the chemicals from the Department of Agriculture. In a related study by Lente (2017), few of the respondents said they receive any information valuable to their livelihood from governmental or non-governmental institutions.

5.1.2 Social Assets and Livelihoods

Relationships built by smallholder farmers with hired labourers and members of their communities serves as a support against livelihood setbacks. The increase in trust and the ability to work together connects people to a wider range of institutions, such as political or civil societies, that support them in addressing the negative impacts of developmental projects in their community, while providing the basis for informal safety nets amongst the poor (DFID, 1999). Moreover, the skills and knowledge acquired through socialization or informal livelihood activities such as being a farm labourer, is an important asset that enables people to pursue their livelihood strategies without the need for a higher level of education (Kpoor, 2015).

Hired labourers support smallholder farmers to achieve their livelihood objectives in terms of land clearing, planting, harvesting and application of fertilisers and pesticides for higher yield and more income (Danso et. al., 2004 & Kpoor, 2015). They also serve as safety nets for the smallholder farmers, i.e., farmers can delegate a trusted labourer to be in charge of all farm activities, from planting to selling of produce without the need for a full disclosure on income and expenses. However, due to scarcity of labour in mining communities, the cost of labour presents a major setback to the smallholder farmer's ability to contract the necessary labour for

higher yield (Danquah et al., 2017). As a result, smallholder farmers, particularly female respondents, who have access to only small farmlands, do not have the financial capacity to fully utilise their natural asset (land). Female farmers, in particular, use male labourers only for robust farm activities such as weeding. Related studies have shown that female-headed household utilise mostly household labour, as they are unable to hire labourers (Baden et al., 1994; Danso et. al, 2004; Kpoor, 2015).

Even though social groups have been identified as an effective tool in influencing governmental policies and programmes (DFID, 1999), smallholder farmers did not show interest in forming strong groups that can be developed into cooperative bodies to champion their common cause in legislation. The Farmers' Association, which has a close link to the Department of Agriculture in the district, is not considered attractive by majority of farmers. Despite the several associations in the Mpohor District, majority of male and female farmers are not associated with any local group. This could minimise their opportunities for improved efficiency in their economic relations, or becoming partakers of developed and shared knowledge in the community (DFIP, 1999). Male and female smallholder farmers who have joined associations are at an advantage of having a sense of wellbeing through identity, honour and belonging and have access to more social support in the event of a shock to their livelihood.

5.1.3 Natural Assets and Livelihoods

Natural assets are particularly critical for rural livelihoods (DFID, 1999). Land and water are the two most important natural assets that form the basic building block for smallholder farmers. In Ghana, studies have shown that communities with abundant land resource have their economy predominately based on agriculture (Abane, 2009; Marchetta, 2011; Kpoor, 2015). However, the relationship between natural resources and mining are so close that,

impacts from mining activities can completely collapse a farming community and affect food production.

Acquisition of farmlands (through inheritance, rental or purchase) by residents for farming activities generates financial assets (income) which can be used to acquire physical assets (e.g. houses) and human assets (education). In addition, the financial assets supports involvement in social functions through which trustworthy relationships are built that serve as a safety net in the event of shocks on their livelihood. Furthermore, majority consume part of the food crops they produce, which enhances their human assets (health). This supports the assertions by Kpoor (2015) that the peoples of Adenkrebi, a farming community in the Greater Accra region of Ghana, draw on natural assets (land) to achieve all the other livelihood assets required for wellbeing.

However, in mining communities, farmers are exposed to the risk of losing all or part of their farmlands to mining operations (Hilson, 2001; Akabzaa & Darimani, 2001 & Schueler, Kuemmerle & Schröder, 2011). Majority of the smallholder farmers, both males and females, have inherited or purchased their farmlands, which makes them less susceptible to the shock of losing their farmlands without compensation. Despite the inadequacy of compensations, as in the case of many farmers hosting mining activities in Ghana (Akabzaa & Darimani, 2001; Yirenkyi, 2008; Mihaye, 2013), these farmers are considered to be more secure than those working on rental lands who may lose their livelihood if the landlord gives out their farmlands to mining operators. More female than male smallholder farmers work on rented farmlands, which makes them more vulnerable to losing their livelihood.

Contrary to findings by other scholars where crop types followed a gendered pattern (Doss (2002 & Kpoor, 2015), the size of farmland was a major determinant of the crop types grown by the smallholder farmers in the Mpohor District. In general, males have farmland sizes

greater than 6 acres and cultivate cash crops, while females have farmland sizes between 2 and 6 acres and cultivate food crops. However, other determinants for the crop types grown by the male smallholder farmers include the competitive ready market (for cocoa) and less labour requirement (for oil palm). Men who cultivate vegetables do so mainly for generating income, whereas the females grow crops that can be sold directly or processed before being sold on the market (such as cassava and maize for cassava and corn dough, respectively, or prepared porridge and/or *banku*, a fermented maize meal) as well as for household consumption. Carr (2008) observed that crops grown by male and female smallholder farmers in the Central Region of Ghana, were based on market sale and household consumption, respectively.

Also, as noted by Andoe (2002), land is not compensated for during a takeover of a farmland by mining operators, only crops are valued and paid for. Cash crops are more expensive than food crops, leaving the male smallholder farmers in a more advantaged position of receiving substantial sums of money for the crops as compensation in the event of losing their land to mining activities. According to personnel from the oil palm plantation, oil palm trees are not easily destroyed by illegal mining activities in the district as compared to other food crops.

In Ghana, surface water in mining communities have been found to be highly polluted and unsafe for crop production and human life (Asante et al., 2007; Obiri et al., 2016). The nature of the crops grown by smallholder farmers in the district also determines the source of irrigation water used. Majority depend on surface water (river or stream) with a high level of dependency that makes them more vulnerable in an event of water scarcity. However, more of the females depend on surface water than the males, which makes them more vulnerable to the pollution of irrigation water by mining activities in the district.

5.1.4 Physical Assets of Study Communities and Respondents

Physical assets are the simplest infrastructure and producer goods, such as electricity and clean water that help individuals to meet their basic needs and be more productive (DFID, 1999). Physical assets provide a wide range of choices and opportunities in income-earning activities and are very critical in examining the livelihood strategies adopted by people in a mining environment. According to DFID (1999), a lack of specific types of infrastructure is seen to be a core dimension of poverty. The opportunity costs associated with poor infrastructure can preclude education, access to health services and income generation. The unavailability of good access roads in the district and lack of open markets in some of the study communities (Obrayebona, Awunakrom and Mpohor Yabiw) poses as a limitation to the smallholder farmers to achieve a sustainable livelihood. In such cases, transportation of farm produce to markets is hindered and lead to post harvest losses, as it exceeds what is needed for household consumption.

Electricity in communities not only provides lighting of houses, but also is important for obtaining valuable information from the television and radio sets, as well as its utilisation in the operation of businesses. However, just as reported by DFID (1999), that insufficient or inappropriate producer goods restrain people's productive ability and therefore the human capital at their disposal, the lack of electricity in one study committee caused the out-migration of many indigenes who were smallholder farmers, affecting food production (especially food crops) in the community.

The majority of residents in the district own their homes, as reported by GSS (2014). This reduces the financial limitations on both male and female smallholder farmers that is caused by monthly or yearly payment of house rent. Low-income earning people in the district are able to own their house due to the type and cost of inexpensive building materials. Houses generally consist of mud brick/earth for an outer wall, metal sheet as the main material for roofing and

cement/concrete for the floor (GSS, 2014). Farmers can also sell their houses if the need to migrate due to shock from mining activities on their livelihood arises.

The dependence on boreholes by respondents as the main source of drinking water shows the low investment of mining royalties in providing potable pipe borne water. Moreover, the siting of few boreholes have been at inconvenient places, and increases the time spent in non-productive activities by the female members' of smallholder household who are in charge of household water supply. The farmers already may be faced with low yield from farms due to mining activities.

5.1.5 Financial Assets of Respondents

According to DFID (1999), the financial assets of the individuals are the most versatile of the five groups of assets because it can be converted into other types of capital or be used for direct achievement of livelihood outcomes. However, it is also the asset that is the least available to the poor, which makes it very necessary for the poor to attain the other types of assets.

The estimated monthly income of respondents' shows that cash inflow and price fluctuations on livelihood strategies of residents in mining communities is dependent on the mining operations. This clearly affect their ability to acquire necessities like food, clothes, schooling and medical care, and also demand for locally produced goods and services within their communities (Bannock Consulting Limited, 2005). However, based on the land sizes, crop types grown and other livelihood activities, the cash inflow for the male respondents was higher than that of the female respondents. Findings by Awumbila & Tsikata (2004) suggest that access to, and benefits from gold mining is gendered and female smallholder farmers, do not benefit directly from mining activities.

The responsibilities that women have to provide for household needs and their lack of access to credit facilities has been cited by other scholars to be the reason for the high numbers of females being members of community-based organizations (Mayoux & Hartl, 2009; Tetteh, Antwi, & Opareh, 2014). Despite this membership, the achievement of diverse livelihood strategies by females is still comparatively lower than males due to the relatively small farmland sizes of women and market price for crop types. In addition, the contributions from these community-based organisations are insufficient to cater for all the needs of members. These contributions are only obtained in times of significant events, such as the loss of a close relative or marriage ceremony, and usually not when a livelihood activity has been negatively affected, such as loss of farmland.

5.2 Effects of Mining Activities on the Livelihood of Smallholder Farmers

With the introduction of SAP in Ghana in 1983, several researchers have explored governmental structures and processes of the Ghanaian economy on macro and micro scales (Hilson, 2001; Amponsah-Tawiah & Dartey-Baah, 2011; Aragon & Rud, 2012). Available literature suggest that the liberalization and subsequent strengthening of the mining sector has generated susceptible conditions which has affected the livelihoods of rural households (Tockman, 2001; Akabzaa and Darimani, 2001; Yelpaala & Ali, 2005; Yaro, 2010). In the Mpohor District mining area, the effect of mining activities on certain variables, considered under different capitals in the sustainable livelihood framework, influence the types of assets utilised for livelihood strategies for successful livelihood outcomes by smallholder farmers.

Effect on Natural Capital

Variables under natural capital include farmland and irrigation water, which are very important resource base for smallholder sustainable livelihoods, but are also the receptacles of the effects of mining activities. In the Mpohor mining area, some smallholder farmers with farmlands in

proximity to mining activities do not perceived that mining has affected their farmlands and irrigation water. However, the operation of the large-scale mining and illegal artisanal small-scale mining has contributed to the loss and degradation of farmlands and also the pollution of some irrigation water. Some farmers in the catchment areas of the large-scale mining operations have shifted from growing cash crops to food crops due to their lands being taken over by mining operations. Other farmers in proximity to illegal small-scale mining had their lands fragmented and degraded by waste materials from the mining operations. These farmers now depend on the application of fertilisers to improve on the soil fertility. Related studies by Tenkorang and Osei-Kufuor (2013) in Tarkwa, Obuasi and Kenyasi (mining communities in Ghana) and Akabzaa and Darimani (2001) in Tarkwa mining community, showed that mining companies take over vast farmlands and deprive rural communities their source of livelihood and increase food insecurity in the communities.

In addition, only lands that were directly taken over by mining operators from the onset of operations were compensated. This means that a number of smallholder farmers did not receive any form of compensation for the destruction of their farmlands by mining operations. Scholarly literature, ranging across economic, geographic and cultural contexts often cites the strained relationship between mining companies and local people (Bebbington et al., 2008b; Garvin, McGee, Smoyer-Tomic & Aubynn., 2009; Kemp, Owen, Gotzmann, & Bond, 2010). A study by Mensah and Okyere (2014) in Obuasi Municipality of Ghana, revealed that mining company and community disputes are centred on unfulfilled promises compensation, resettlement packages, and lack of alternative livelihoods for economically displaced groups. The take-over and destruction of farmlands by mining activities was also reported by Adjei et al., (2012) to be the cause of fear and lack of interest by farmers to engage in farming as a livelihood activity. A research by ECASARD and WoMin (2015), in Ntoroso, Asunafu District in the Brong Ahafo region, revealed that, the women farmers, who were the primary food

producers did not receive any compensation for their farmlands that were taken over by Newmont Ghana Limited (now Newmont Goldcorp). Some of the women had to engage in prostitution to support their families.

The increase in toxic trace elements in water bodies have been the primary objective of researchers examining the effect of mining on water sources (Cobbina et al., 2015, Awuah, 2016; Obiri et. al., 2016). However, mining activities can affect irrigation water of smallholder farmers without necessarily introducing toxic element. Some smallholder farmers in the Mpohor mining area perceive that surface water sources for irrigation and household consumption have been polluted by mining activities. Others have had the reduction of the flow of the river that served as their main source of irrigation water. Without chemical analysis of surface water bodies in Ntotroso (a mining community in Ghana), residents and medical assistants perceived the pollution of rivers in the community has increased the cases of malaria, typhoid and skin rashes (ECASARD and WoMin, 2015).

The effect of mining activities on both farmlands and irrigation water is however independent of gender since natural assets are usually deemed as a public good and accessible to all. Even privately owned land by a male or female can be affected by mining activities if it is located in a mineralised zone.

Effect on Physical Capital

The common negative effects of mining on the physical capital in mining communities in Ghana are conflicts with landowners, cracks in buildings, poor access to roads and pollution of water bodies (Mihaye, 2013). Water pollution and cracks in houses were identified as the main negative effects on physical capital in this study, just as in a similar study done by Kitula (2006) in Tanzania, where water pollution, cracking and collapse of building were identified as the most pressing issues in relation to mining activities in the Geita District.

According to DFID (1999), if infrastructure is not built based on demand from intended users, the intended service from that infrastructure is likely going to be unsustainable due to neglect and lack of maintenance. Residents in the Mphohor mining catchment community have not fully utilised the infrastructure provided by mining companies, which has resulted in its neglect or lack of maintenance. However, as suggested by Molyneux (2002) cited in Kpoor (2015), the preponderance of women in associational groups illustrates the gender difference in usage of certain infrastructure, as more female respondents utilised the community centre (social amenity) for group meetings. This is however not significant, as the effects on mining activities on physical capital is independent of the gender of smallholder farmers.

Effect on Human Capital (Health)

Malaria, stomach upset and respiratory diseases were identified as the common diseases caused by mining operations in the Mpohor mining area. However, water related diseases (malaria and stomach upset) were dominant. This was attributed to the blocking of a river in one of the communities and uncovered pits by illegal mining operations that has led to the increase in breeding grounds for mosquitoes and the pollution of drinking water source. Similar studies by Akabzaa and Darimani (2001), in Tarkwa, a mining community in Ghana, showed that, diseases such as malaria, diarrhoea, upper respiratory diseases, skin diseases and acute conjunctivitis form part of the top ten diseases in the area. In addition, Yelpaala and Ali (2005), in studies in Akwatia, a diamond mining community in Ghana, revealed that health officials confirmed severe water borne diseases in the community over a long period of time due to mining activities. However, this decreased when bottled water was introduced in the community. In the Mpohor District mining area, the effect of mining activities on the health of male smallholder farmers is different from the effects on the health of female smallholder farmers due to the difference in exposure path of both genders to mining pollutants in the environment. More males are exposed to polluted air as they generally do not evacuate from

the communities during blasting of rock materials by mining operations. Furthermore, even though both males and females perceived to have stomach upset caused by the intake of polluted water by mining activities, majority of women drank contaminated water directly from the rivers during their working hours in the farms but the men drank the contaminated water after it has been fetched from rivers and filtered. Therefore, the severity of the stomach upset experienced by the females was higher than men.

Effects on Financial and Social Capital

As suggested by other researchers, the increase in demand for food items by migrant miners, the introduction of alternate livelihood programmes, and the generation of direct and indirect employment by mining activities influence the livelihood activities of residents in mining communities (Awumbila & Tsikata, 2004; Abew & Temeng, 2009; Doso Jnr et al., 2015 & Hilson, 2016). However, the robust nature of mining operation presents a gender bias in mining areas which limits females in accessing opportunities in the local economy due to mining activities in the community (Awumbila & Tsikata, 2004). This makes females more vulnerable to risks, should they lose assets that contribute to their livelihood. Livelihood assets such as small farmland sizes, low valued crop types and low educational status of the female smallholder farmers constrain them from increasing income from their livelihoods as farmers or from other businesses during the boom of mining activities in their communities. Even at a time that the rate of mining activities has reduced due to low productivity, the female smallholder farmers earn very little from their livelihood activities as compared to the male smallholder farmers.

On the contrary, both the male and female smallholder farmers' choice to engage in social activities has not been influenced by mining activities. The farmers have become accustomed to the trends of mine production and have witnessed at least two large scale mine closures in the district that resulted in economic difficulties in their various communities. Farmers are also

aware that illegal mining operators abandon pits and leave the community when they have exhausted the mineral of interest from the pit. Therefore, the smallholder farmers acknowledge the seasonality of their crop production and have adopted strategies to cope with the trends of mine production to avoid being financially incapacitated for social engagements.

5.3 Chemical Properties in Soil Samples

Generally, the pH, EC and heavy metals analysed in soil samples from the Mpohor District mining area indicated that mining has not contributed to the reduction of soil quality. Only the concentration of Cd in all soil samples were higher than the guideline limit of 3 mg/kg (WHO/FAO, 2004). Plants grown in soils with higher concentrations of Cd show visible symptoms of injury, revealed in terms of chlorosis, growth inhibition, browning of root tips, and death in the end (Wójcik & Tukiendorf, 2004). Moreover, cadmium is not known for any essential biological function and accumulates primarily in the kidneys, having a biological half-life of 10–35 years in humans (WHO, 2008). It is important to investigate potential sources of cadmium in agricultural soils in the study area and apply an appropriate measure to manage its effect on crops and humans. The results of heavy metals analysis indicated that the mean concentrations of lead, arsenic and mercury were within the recommended limits by WHO/FAO (2004), contrary to results obtained by Hayford et al., (2008), in his investigation of toxic elements in crop and soil samples, from mining communities around Tarkwa in the Western region of Ghana. Which showed that, the levels of some metals such as mercury and arsenic in crops (cassava, plantain) and soils were higher than the permissible values proposed by the FAO and WHO for crops and soils.

The pH of agricultural soil is an important chemical property that influences the solubility and availability of soil nutrients, minerals and other elements for plant use. The acceptable range of pH for most plant growth is from three to nine (Estefan, Sommer, & Ryan, 2013). Analyses

of soil samples from selected farms in the study area indicated mean pH range, which correspond to the pH values for forest oxysols soils, which are lower than 5.0 at the top soil but increases down the soil profile (Brammer, 1962 as cited in Adjei–Gyapong & Asiamah, 2000). This indicates that the soils are suitable for plant growth and mining activities have not contributed to the low pH in the soils at Mpohor mining area. Some studies have shown effects of mining activities on the soils in Prestea and Bogoso (mining communities in the Western Region of Ghana) where the pH of the soils were recorded as low as 3.96 (Assel, 2006). The acidity of the soils have caused the reduction of plant growth and increased food scarcity.

Electrical conductivity (EC) is an indication of soil salinity, which influences the degree to which the soil is suitable for crop growth, and should be between 0-2000 µS/cm to support plant growth (Estefan et al., 2013). The EC (135 µS/cm to 688 µS/cm) of soils in the Mpohor mining area is suitable for plant growth.

5.4 Livelihood Strategies Employed by Male and Female Smallholder Farmers

According to DFID (1999), knowledge of the factors that forms the basis of people's choice of livelihood strategy is important to identify the positive aspects (such as access to assets) that need to be reinforced, and mitigate the constraint. This will offer opportunities for self-determination and the flexibility to adapt over time. Winters et al (2002) explained that different assets; natural, physical, financial, social and human are allocated to different activities within a household to achieve a common outcome. However, people who are endowed with a wide range of assets are more likely to achieve and maximise positive livelihood outcomes as compared to people who are less endowed in asset, who may be forced into adopting undesirable strategies (DFID, 1999).

The livelihood strategies employed by smallholder farmers against shocks and stress, particularly on food and income security were categorised into on-farm, off-farm and non-farm

options (Reardon, 1997; Ellis et al., 2003). Non-agricultural employment (non-farm activities) is used by rural households, especially smallholder farmers, who are not able to achieve positive livelihood outcomes in agriculture (Ghosh & Bharadwaj, 1992; Gecho, Ayele, Lemma, & Alemu, 2014).

On-Farm Livelihood Strategy

All smallholder farmers ranked on-farm livelihood strategy second, but there was a significant difference in the types of on-farm livelihood activities engaged by males and females. Even though both male and female respondents ranked intercropping (planting of food crops and vegetables on the same plot of land) as most used activity, more females than males intercrop on their farms because they do not have the alternative options of planting different crop types after the harvest or on a different farmland, as the males. Research on rural household livelihood strategies in Tanzania and Malawi showed that intercropping of maize, potatoes and vegetables was a dominant livelihood activity by farmers (Kadigi et al., 2007; Ellis et al., 2003). However, integrating livestock with crop, which was one of the second highest income earning activity by farmers in studies done by Gecho et al., (2014), was the least ranked on-farm livelihood activity. This was because the smallholder farmers did not have the financial ability to acquire and maintain higher earning livestock such as cattle, sheep and goats. Moreover, responses from some of the respondents indicated that the uncovered pits in the communities serve as death traps for such higher earning livestock.

In predicting the choice of on-farm livelihood strategy given their livelihood assets, migrants are more likely to intercrop than natives and engage in crop diversification than rear livestock, because the migrants have limited access to farmlands and so do not have the financial resources to rear highly profitable livestock. Also, farmers that have organisational support have a higher probability of rearing livestock than intercropping because they may have access

to veterinary services from the Department of Agriculture, which was one of the institutions that supports smallholder farmers in the district.

Off-Farm Livelihood Strategy

The selling of raw farm produce (off-farm livelihood activity) was the highest ranked strategy by both male and female in the Mpohor area. For the male smallholder farmers, the competitive market and prices of the types of crops grown (mostly oil palm and cocoa) was the major reason for planting those crops. Moreover, they inherit large plots of land to support their livelihood, whereas women, who are the primary food providers for household consumption, also sell part of their farm produce to generate income to support in the provision of other household necessities such as fish, cloths and educational materials for children. Even those with smaller farm sizes (less than one acre) do not have the facilities to store all their farm produce, and resolve to sell some of their produce.

In predicting the off-farm livelihood strategy using the available assets, farmers who have joined community based organisations and those who do not have support from any organisation are more likely to sell raw produce or process their farm produce to sell instead of engaging in other peoples' farms as labourers. However, farmers who do not cultivate cash crops are more likely to engage as farm labourers rather than process raw produce to sell because they do not generate income from their produce. These are farmers that cultivate food crops and horticulture crops, which are usually sold raw on the markets or consumed at home.

Non-Farm Livelihood Strategy

Non-farm livelihood strategies have been described as a means for farmers to obtain income from other sources aside agriculture, and off-set risks and uncertainties associated with agriculture such as loss of farmland to mining activities (Gecho et al., 2014). However, in the Mpohor area it was the least ranked by male and female smallholder farmers. For females, the

access to different livelihood assets required for certain non-farm livelihood activities constrains the choice of non-farm activities as compared to the males. For example, more females would choose not to migrate to other towns and cities in search for jobs because they do not have the educational status or skills, and consider themselves too old in acquiring higher earning income generating jobs away from their communities.

In predicting the type of non-farm livelihood strategy chosen by farmers based on their available assets, native farmers had a higher probability of choosing to engage in wage employment and migrate than accepting remittances. This is because native farmers have large farm sizes and more financial and social resources to engage in informal livelihood activities both in their community and in other communities.

Farmers who depend solely on their farming livelihood also had a higher probability of choosing to engage in wage employment and migrate than accepting remittances. This is because the type of wage employment engaged by the farmers in the Mpohor mining area and its surrounding communities require minimum or no educational status, such as driving and trading. Also, farmers with lower income (<500 Ghana cedis or <100 USD) generated from their farm are also less likely to engage in wage employment and migrate, but will rather choose to take remittances from friends and family than those who earn higher income.

5.5 Institutional Support in Managing Effect of Mining Activities

Institutions are described by DFID (1999, p. 2.4.2) "as standard operating practices or informal practises that structure relationships and make the behaviour of organisations somewhat predictable". An understanding of the effects that policies, laws and institutions have on the pro-poor will help build or reform existing ones to increase opportunities for the poor in the society. Ironically, policy reforms in Ghana's mining sector that brought about generous incentive packages for mining investors, have failed to harmonise mining and environmental

laws and policies to address the concerns of the local communities (Akaabzaa & Darimani, 2001). Existing literature have emphasized the significant role played by institutions in the determination of the quality of development and natural resource management (Ostrom, 1992). However, in many cases, mineral sector expansion occurs before adequate institutions are put in place (Bebbington & Bury, 2009; UNDP, 2015). Evidence from Latin American countries, such as Argentina, Bolivia, Chile and Peru, shows that the introduction and enforcement of mining environmental regulation can exist with thriving investment environment in mining (UNDP & UN Environment, 2018). However, due to ineffective cross-sectoral linkages among the governmental institutions in the mining sector in Ghana (Akaabzaa & Darimani, 2001), communities are left to their fate when mining activities negatively impact their environment and livelihoods.

Institutional support for smallholder farmers in the Mpohor area for addressing the effects of mining activities is gender blind. Moreover, support from the formal institutions are inadequate, whiles support from the informal institutions are unsustainable. From the study, it is not enough to have a legal and institutional framework in the mineral sector in Ghana, without the involvement of law enforcement agencies such as the military and the police. However, a report by Mihaye (2013), showed that majority of illegal small-scale miners in East Akim Municipal Assembly have not been arrested by the police since their engagement in the activity because they were aware of the constant attacks from the police on them and remain vigilant. This implies that, the option to use the military or police will not completely eradicate the unlicensed mining operations and reduce the effect of their activities on the livelihood of residents in mining communities, including smallholder farmers.

Secondly, while there is expectation that local governments will make available a range of community services and facilities to help manage the effect of mining activities, their influence and resources are still severely limited, making it challenging for them to provide an adequate

services and facilities to meet the needs of their communities. Just as in Australia, where the use of State Agreements and rate pegging, limits the capacity of local governments to fund service provision in mining communities (Barclay et al., 2012), in Ghana, overlapping ministerial obligations limit the local government to fully utilise funds from mineral royalties for economic and social development of communities in mining areas. Aside cash compensation for destroyed crops, economic or infrastructural developments are still inadequate for providing an appropriate range of services to support sustainable livelihood options for the smallholder farmer in the district.

Another issue highlights the marginalization of the pro-poor (in this case, smallholder farmers) in accessing programmes being implemented by the government at the local level. Due to the lack of education and low level of social status, the smallholder farmers, particularly, the female farmers are not connected to people in higher authority that can help them get selected to benefit from governmental programmes. Also, Education from the Department of Agriculture is limited to how to use agriculture processes to maximise crop yield, which is not enough to deal with toxic trace elements that can be introduced or increased in agriculture soils through mining activities or the application of agrochemicals (Hesterberg, 1998).

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusions

The resilience of livelihoods against external shocks and stresses is important for the sustainable productivity of natural resources. In addition, availability of a wide range of assets is fundamentally essential for the achievement of a resilient and sustainable livelihood. For the smallholder farmer in a mining environment, critical trends, shocks and seasonality which are beyond the control of the farmer influences the adoption of other non-agricultural activities altogether, with the hope of being supported by local institutions to achieve a positive livelihood outcome. The study provides a quantitative measure of gender differences in the acquisition of livelihood assets (human, social, natural, physical and financial) by smallholder farmers and the effects on mining activities on the livelihoods of smallholder farmers, including the assessment of selected chemical parameters of agriculture soils that can be influenced by mining activities. It also provides the coping strategies adopted by the smallholder farmers and a qualitative measure of institutional support to smallholder farmers to address the effects of mining activities on their livelihood using Mpohor District mining area of Ghana as a case study.

The study highlights the gender differences in the agriculture sector, backed by the patriarchal local customs. It shows that mainstreaming gender issues in the agriculture sector must take into consideration the natural resources available to the smallholder farmer as well as the socio-demographic context of the female smallholder farmer. Whereas, all smallholder farmers are faced with challenges presented by mining activities in their community, the analysis of the social differentiation factors in a smallholder household revealed that women are more vulnerable than men. Generally, the educational status, access to valuable information, crop types grown (especially food crops grown mostly by the females), access to infrastructure and

producer goods such as good paved roads, markets, electricity and potable water supply available for the farmers in the Mpohor mining area makes them vulnerable to shocks and stress from mining activities in the district, however, female smallholder farmers have restricted access to essential livelihood assets such as land and education as compared to their male counterparts.

The effect of mining activities on natural, physical and socio-economic capitals is the same for both male and female smallholder farmers. Assets like land and education, which are major determinants of successful livelihood outcomes, are not equally distributed between males and females, with specific limits on the wellbeing of the female smallholder farmer. Environmental pollution by mining activities can negatively affect both adults and children, males and females, however, the rate and duration of exposure determines the effect it can have on humans. Even though more male smallholder farmers have experienced poor health (human capital) due to mining activities, the sources of pollutants (in air and water) and severity of health effects from mining activities differed from men and women. Whiles the male smallholder farmers had a choice in choosing to be exposed to the pollutants by not evacuating from a blasting zone, the female farmers who were affected by dust pollutants, inhaled the dust from the dusty haul road close to their farms. Also, most of the male farmers had stomach upset drank polluted water after it had been fetched to the house and could have been filtered properly but most of the females were left with minimal or no alternatives because their main source of drinking water in their homes and farms was the river that was perceived to be polluted by mining activities.

There were also observed discrimination in the compensation of private and public goods. Within the communities, lands that were taken over by mining activities were compensated for, whereas, polluted or redirected rivers were not properly addressed even by the regulated mining company. A successful resolution of social conflicts between mining companies and

communities will be achieved if public goods that serve as assets to the livelihoods are protected.

Also, with the current ongoing fight against illegal mining activities in Ghana, the government, in using baseline data for heavy metal concentration of soils in mining communities can implement effective remediation measures. Generally, the pH, EC and heavy metal concentrations of agriculture soils in the Mpohor mining area have not been impacted due to mining activities. Concentrations of heavy metals in the soils were within acceptable limits except for cadmium, which requires a further investigation to know the source and effectively monitored.

In mining communities, variability of assets and coping strategies by smallholder farmers are inextricably linked. Smallholder farmers, particularly, the females, do not have the requisite natural, human and financial capital to engage in on-farm activities such as crop diversification and integrating livestock with crop, nor do they have the human, physical, financial and social capital to engage in higher earning income generating activities which are non-farm activities. Therefore, majority engage in off-farm activities, which includes selling of raw agriculture produce and processing of produce to sell. One main limitation is the human assets of the female smallholder farmer, which prevents her from engaging in meaningful non-farm livelihood activities.

Institutions, backed by strong environmental regulations will curb the destruction of the natural resource livelihood base of the smallholder farmer by mining activities. The study concludes that, both formal and informal institutions work within their resources and authority to manage the effect of mining activities in the communities. However, the lack of adequate financial and human resources in the formal governmental institution and limited authority for informal

institutions limits the reduction of risks and maximisation of opportunities for smallholder farmers in the Mpohor mining area.

6.2 Recommendations

Based on the findings of the study, the following recommendations are made:

Firstly, since livelihoods and well-being of smallholder farmers are strongly tied to the capabilities, assets and activities, the interest of the government should not only be on supporting agricultural productivity, but also encourage smallholder households to provide similar educational opportunities for the girl child as given to the boy child. Also, the government as well as non-governmental agencies should engage in educating the smallholder farmer on savings and investment portfolios and provide avenues, such as savings and loans facilities for the smallholder farmer to acquire long-term assets and skills in alternate livelihoods that will ensure their resilience to changes in their livelihood due to natural occurrences or developmental projects. As done in other rural communities, the existing social groups can incorporate savings of small amounts of monies on a daily or weekly bases (known in the Akan language as *susu*), to help the farmers save for a rainy day.

Secondly, the District Assembly, Departments of Agriculture and Non-governmental organisations should engage with community-based organizations in providing training and education on their rights as smallholder farmers, and opportunities to access governmental programmes to maximise positive livelihood activities. Since women are more engaged in community-based organisations, strengthening these organisations to influence government policies and laws concerning their livelihoods, will minimise their vulnerability in a mining environment. This may make the organisations attractive to majority of farmers in the district.

Thirdly, the District Assembly, which is in charge of all environmental issues at the local level, can develop measures that will include the polluter pays principle on public goods such as water resources in their environmental monitoring programmes. The implementation of these measures on regulated mining companies will help address social unrest in mining communities. Community leaders should be empowered and educated on the ecosystem valuation such as effects on production, preventive expenditure and human capital, to enable them place monetary value on the natural resources that have been destroyed and demand for it.

Fourthly, as an employer, the government, should engage more qualified agricultural extension officers who are knowledgeable in dealing with toxic trace elements and other physiological effects of mining on agriculture lands and crops in mining communities. Some smallholder farmers can be trained and equipped with adequate resources to provide agricultural extension services to farmers. This is key because according to the officials of Department of Agriculture, the office had only two (2) agricultural extension officers for all the operational areas in the district as at the time of field data collection for the study.

Lastly, further research should be conducted on the gendered effects of mining activities on all members pursuing different livelihoods in mining communities to determine the actual fate of livelihoods of men and women in mining areas. Also, an extensive chemical parameterisation of soil and water resources in the district should be conducted to ascertain the effects of mining activities on natural resources.

REFERENCES

Abane, H. (2009). Livelihoods in a forest community in Southern Ghana: Intervening policies and community resistance. *Journal of African Studies and Development, 1*(2), 028-035.

Abew J. K., and Temeng, V. A. (2009). A Review of Alternative Livelihood Projects in Some Mining Communities in Ghana. *European Journal of Scientific Research, 35*(2), 217-228.

Acheampong, E. A. (2016). *Assessing the Impact of an Operating Tailings Storage Facility on Catchment Surface and Groundwater Quality: A Case Study of Adamus Resources Limited (Nzema Gold Mine) in the Ellembele District of the Western Region of Ghana* (Masters' thesis). University of Ghana. Accra, Ghana.

Adjei-Gyapong, T., and Asiamah, R. D. (2000). *The interim Ghana soil classification system and its relation with the World Reference Base for Soil Resources*. Soil Research Institute, Kwadaso, Kumasi.

Adjei, S., Oladejo, N. K., and Adetunde, I. A. (2012). The Impact and Effect of Illegal Mining (galamsey) towards the Socio-economic Development of Mining Communities: A Case Study of Kenyasi in the Brong Ahafo Region. *International Journal of Modern Social Sciences, 1*(1), 38-55.

Adu-Yeboah J.K., and Obiri-Yeboah D. (2008). Practical Social Studies for Senior High Schools. KwaDwoan Publishing. Accra.

Agency for Toxic Substance and Disease Registry (ATSDR). (1999). *Toxicological Profile for Mercury*. U.S. Department of Health and Humans Services, Public Health Service, Centres for Diseases Control, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR). (2007). *Toxicological Profile for Lead*. U.S. Department of Health and Humans Services, Public Health Service, Centres for Diseases Control, Atlanta, GA.

Agency for Toxic Substance and Disease Registry (ATSDR). (2012). *Toxicological Profile for Cadmium*. U.S. Department of Health and Humans Services, Public Health Service, Centres for Diseases Control, Atlanta, GA.

AgricInGhana Media (2018). *Public information: Ghana Census in Agriculture*. Retrieved: 27th September, 2018 from https://agricinghana.com/2018/05/20/public-information-ghana-census-of-agriculture/

Ahmad, K., and Carboo, D. (2000). Speciation of As (III) and As (V) in some Ghanaian gold tailings by a simple distillation method. *Water Air Soil Pollution, 122*, 317–326.

Akabzaa, T. M., Banoeng-Yakubu, B., and Seyire, J. S. (2005). Heavy metal contamination in some mining communities within the Jimi River basin in Ashanti Region, Ghana. *Journal of Ghana Science Association, 7*(1), 36-45.

Akabzaa, T. M., and Dramani, A. (2001). *Impact of Mining Sector Investment in Ghana: A Study of the Tarkwa Mining Region*. A Draft Report Prepared for SAPRI. Retrieved September, 2018, from http://www.saprin.org/ghana/researc/gha

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

Andoe, A. A. C. (2002). Mining and the Environment. Paper presented at the conference "Mining, the Environment and Sustainable Development," 21-22 February, Tarkwa, Ghana.

Anim-Gyampo, M., Kumi, M., and Zango, M. (2013). Heavy Metals Concentrations in some selected Fish Species in Tono Irrigation Reservoir in Navrongo, Ghana. *Journal of Environmental and Earth Science, 3*(1), 109–120.

Anim, K., Ahialey, E. K., Duodu, G. O., Ackah, M., and Bentil, N. O. (2011). Accumulation Profile of Heavy Metals in Fish Samples from Nsawam, Along the Densu River, Ghana. *Research Journal of Environmental and Earth Sciences, 3*(1), 56-60.

Aragon, F. M. and Rud, J. P. (2012). *Mining, Pollution and Agricultural Productivity: Evidence from Ghana*. Discussion Papers dp12-08, Department of Economics, Simon Fraser University.

Ardayfio-Schandorf, E. (1994). *Household headship and female earning in Ghana*. In E. Ardayfio-Schandorf (Ed.), Family and Development in Ghana. Accra: Ghana Universities Press.

Aryee, B. N. A. (2001). Ghana's mining sector: its contribution to the national economy. *Resources Policy 27*(2), 61-75.

Asante, K. A., Agusa, T., Subramanian, A., Ansa-Asare, O. D., Biney, C. A., and Tanabe, S. (2007) Contamination status of arsenic and other trace metals in drinking water and residents from Tarkwa, a historic mining township in Ghana. *Chemosphere 66*:1513–1522.

Asmah, M. H. (2011). Physico-Chemical and Bacteriological Water Quality Assessment of the Upper Catchment of the Birim River. (Masters' thesis). University of Ghana.

Assel, P.G. (2006). Evaluating the usefulness of Acacia auriculiformis in ameliorating surface mine degraded lands. Department of Agroforestry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Awuah, G. (2016). Assessment of heavy metal concentrations in sediment, water and fish from the Ankobra and Tano River basins in Ghana. (Masters' thesis). University of Ghana.

Awumbila, M., and Tsikata, D. (2004). *Migration dynamics and small scale gold mining in northeastern Ghana: implications for sustainable rural livelihoods*. University of Ghana Press. Legon. Accra.

Baah, D. A. (2002). Studies on levels of mercury, lead and zinc in some environmental samples from the Ankobra and Tano River basins in Southwestern Ghana. Retrieve from KNUSTSpace.

Babatunde, O., Oyewale, A., and Steve, P. (2014). Bioavailable Trace Elements in Soils around Nnpc Oil Depot Jos, Nigeria. *Journal of Environmental Science, Toxicology and Food Technology*, *8*(1), 47-56.

Baden, S., Green, C., Otoo-Oyortey, N., and Peasgood, T. (1994). *Background paper on gender issues in Ghana: Report prepared for the West and North Africa department, Department of Overseas Development (DFID)*. Brighton, UK: Institute of Development Studies, University of Sussex, UK. Retrieved from http://www.bridge.ids.ac.uk/reports/re19c.pdf

Baird, C. (1995). *Environmental Chemistry*. W.H. Freeman and Company, New York.

Banchirigah, S. M. (2006). How have Reforms Fuelled the Expansion of Artisanal Mining? Evidence from Sub- Saharan Africa. *Resources Policy*, *31*(3), 165-171.

Bank of Ghana. (2018). *Monetary Policy Summary*. Bank of Ghana. Accra.

Bannock Consulting Limited (2005). *The Impact of Price Fluctuations on Livelihood Strategies in Artisanal and Small-Scale Mining Communities Compared with other Non-Financial Shocks*. Retrieved April 18, 2019, from http://r4d.dfid.gov.uk/pdf/outputs.

Bansah, K. J., Yalley, A. B., Dumakor-Dupey, N. (2016). The hazardous nature of small-scale underground mining in Ghana. *Journal of sustainable mining*, *15*, 8-25.

Barbut, M., and Alexander, S. (2016). Land degradation as a security threat amplifier: The new global frontline. In I. Chabay, M. Frick, & J. Helgeson (Eds.), Land restoration: Reclaiming landscapes for a sustainable future (pp. 3-12). Waltham, MA: Elsevier. https://doi.org/10.1016/B978-0-12-801231-4.00001-X

Barclay, M. A., Everingham, J., Cheshire, L., Brereton, D., Pattenden, C., and Lawrence, G. (2012). *Local government, mining companies and resource development in regional Australia;* Meeting the governance challenge Final Report, CSRM: Brisbane.

Bebbington, A. J., and Bury, J. T. (2009). *Institutional challenges for mining and sustainability in Peru*. Proceedings of the National Academy of Sciences of the United States of America, 106(41), 17296-17301. doi:10.1073/pnas.0906057106

Bebbington, A. J., Bury, J. T., Bebbington, H. D., Lingan, J., Muñoz, J. P., and Scurrah, M. (2008a). Mining and Social Movements: Struggles Over Livelihood and Rural Territorial Development in the Andes. *World Development 36* (12), 2888-2905.

Bebbington, A., L. Hinojosa, D. H. Bebbington, M. L. M.L. Burneo, and X. Warnaars (2008b) Contention and ambiguity: mining and the possibilities of development. *Development and Change 39*(6), 887–914.

Boadi, S., Nsor C. A., Antobre, O. O., and Acquah, E. (2016). An analysis of illegal mining on the Offin shelterbelt forest reserve, Ghana: Implications on community livelihood. *Journal of Sustainable Mining, 15*(3), 115-119.

Boateng, D. O., Codjoe, F. N. Y., and Ofori, J. (2014). Impact of illegal small scale mining (Galamsey) on cocoa production in Atiwa District of Ghana. *International Journal for Advance Agriculuture Research. 2*. 89-99.

Bortey-Sam, N., Nakayama S. M. M., Akoto, O., Ikenaka, Y., Fobil, J.N., Baidoo, E., Mizukawa, H., and Ishizuka M. (2015). Accumulation of Heavy Metals and Metalloid in Foodstuffs from Agricultural Soils around Tarkwa Area in Ghana, and Associated Human Health Risks. *International Journal of Environmental Research and Public Health, 12*(8), 8811-8827.

Brooks, J., Croppenstedt, A., and Aggrey-Fynn, E. (2007). *Distortions to Agricultural Incentives in Ghana. Agricultural Distortions Working Paper 47*. World Bank's Development Research Group.

BusinesGhana, (2017). *Government to tackle illegal mining through collaboration*. Retrieved from https://www.businessghana.com/site/news/general/142838/Government-to-tackle-illegal-mining-through-collaboration

Carney, D. (1998). Implementing the sustainable rural livelihoods approach. In D. Carney (Ed.). *Sustainable rural livelihoods: What contribution can we make?* (pp.3-23). London, England: Department for International Development.

Carr, E. R. (2008). Men's crops and women's crops: The importance of gender to the understanding of agricultural and development outcomes in Ghana's Central Region. *World Development 36*(5), 900–915.

Chamberlin, J. (2007). Defining smallholder agriculture in Ghana: who are smallholders, what do they do and how are they linked with markets? Ghana Strategy Support Program (GSSP) Background Paper No. GSSP 0006. Accra.

Chambers, R., and Conway, G.R. (1992). Sustainable rural livelihoods: Practical concepts for the 21st century. IDS discussion paper no. 296. Brighton: Institute of Development Studies (IDS).

Chopra, A. K., Pathak, C., and Prasad, G. (2009). Scenario of heavy metal contamination in agricultural soil and its management. *Journal of Applied and Natural Science, 1*(1), 99-108.

Cobbina, S., Duwiejuah, A., Quansah, R., Obiri, S., and Bakobie, N. (2015). Comparative Assessment of Heavy Metals in Drinking Water Sources in Two Small-Scale Mining Communities in Northern Ghana. International Journal of Environmental Research and Public Health, 12(9), 10620–10634. http://doi.org/10.3390/ijerph120910620

Conceição, F. T., Navarro, G. R. B., and Silva, A. M. (2013). Anthropogenic influences on Cd, Cr, Cu, Ni, Pb and Zn concentrations in soils and sediments in a watershed with sugar cane crops at São Paulo State, Brazil. *International Journal Environmental Research, 7*(3):551-560.

Crentsil, K. B., Ewusi A., Obiri-Yeboah, S., Asabere, B. S., Mensah, F., Boateng J., and Hans-Jürgen, V. (2013). Distribution of Arsenic and heavy metals from mine tailings dams at

Obuasi Municipality of Ghana. *American Journal of Engineering Research, 02*(05), 61-70.

Creswell, J. W. (2010). *Research design: Qualitative, quantitative, and mixed methods*. (Vol. 3). Thousand Oaks, California: SAGE Publications. Inc.

Crowson, P. (2009). The Resource Curse: A Modern Myth? In J. Richards (Ed), *Mining, Society, and a Sustainable World*. Berlin, Heidelberg: Springer.

Daily Guide, (2018). General News. *7 Shot at Abirim Following Protests Against Newmont*. Retrieved from https://www.modernghana.com/news/891073/7-shot-at-abirim-following-protests-against-newmont.html

Danquah, I. B., Fialor. S. C., and Aidoo, R. (2017). Mining Effects on Rural Livelihoods, Adopted Strategies and the Role of Stakeholder and Regulatory Institutions in Ghana. Evidence of the Amansie West District of Ghana. *American Journal of Rural Development 5*(1), 19-29.

Danso, G., Cofie, O., Annang, L., Obuobie, E., and Keraita, B. (2004). *Gender and urban agriculture: the case of Accra, Ghana*. Paper presented at the Resource Centres on Urban Agriculture and Food Security (RUAF), International Water Management Institute (IWMI) and Urban Harvest Woman Feeding Cities Gender workshop, in Accra, Ghana.

Das, K., Das, S. N., and Dhundasi, S. A. (2008). Nickel, its adverse health effects and oxidative stress. *Indian Journal of Medical Resource*, (128), 412-425.

David, P. A., and Wright, G. (1997). Increasing Returns and the Genesis of American Resource Abundance. *Industrial and Corporate Change 6*: 203-245.

Davies, S. (1996). *Adaptable livelihoods*. London: Macmillan.

de Sherbinin, A., VanWey, L. K., McSweeney, K., Aggarwal, R., Barbieri, A., Henry, S., and Walker, R. (2008). Rural household demographics, livelihoods and the environment. Global *Environmental Change*, *18*(1), 38-53. https://doi.org/10.1016/j.gloenvcha.2007.05.005

de Vries, W., Römkens, P. F. A. M., and Schütze, G. (2007). Critical soil concentrations of cadmium, lead, and mercury in view of health effects on humans and animals. Reviews of Environmental Contamination and Toxicology, 191:91–130.

Department for International Development (DFID) (1999). Sustainable Livelihoods Guidance Sheet. Department for International Development. London, UK.

Doso Jnr, S., Cieem, G., Ayensu-Ntim, A., Twumasi-Ankrah, B., and Twum Barimah, P. T. (2015). Effects of loss of agricultural land due to large-scale gold mining on agriculture in Ghana: The case of the Western Region. *British Journal of Research 2*(6). Pp 196-221.

Doss, C. R. (2002). Men's crops? Women's crops? The gender patterns of cropping in Ghana. *World Development, 30*(11), 1987-2000.

Down, C. G., and Stocks, J. (1978). *Environment impact of mining*. Applied Science Publish Ltd, London.

Dubiński, J. (2013). Sustainable development of mining mineral resources. *Journal of Sustainable Mining, 12*(1), 1-6

Dwamena, O. F. K., (2013). Impact of Gold Mining Activities on the Water Quality of the Lower Pra River. (Masters' thesis). University of Ghana.

Eastwood, R., M. Lipton, and A. Newell (2010). 'Farm size', in P.L.Pingali and R.E. Evenson (eds) Handbook of Agricultural Economics, Elsevier: Amsterdam.

ECASARD and WoMin. (2015). The Impact of Mining on Women Farmers in Ntoroso, Asunafu District, Brong Ahafo. Ghana

Ellis, F., and Biggs, S. (2001). Evolving themes in rural development, 1950s– 2000s. *Development Policy Review, 19*(4), 437–448.

Ellis, F., Kutengule, M., and Nyasulu, A. (2003). "Livelihoods and Rural Poverty Reduction in Malawi," *World Development 31*(19), 1495-1510.

Estefan, G., Sommer, R., and Ryan, J. (2013). Methods of soil, plant and water analysis: A manual for the West Asia and North. In International Centre for Agricultural Research in Dry Areas (ICARDA, 2013). 3rd Edition. 1-244.

Ezeh, H. N. and Chukwu, E. (2011). Scale mining and heavy metals pollution of agricultural soils: The case of Ishiagu mining District, South Eastern Nigeria. *Journal Geology and Mining Research. 3*(4), 87-104.

Food and Agriculture Organization (FAO). (2004). Building on Gender, Agrobiodiversity and Local Knowledge. Fact sheet. Retrieved from http://www.fao.org/docrep/007/y5608e/y5608e00.htm#Contents

Food and Agriculture Organization (FAO). (2005). Fertilizer use by crop in Ghana. First version. Rome. Available from http://www.fao.org/docrep/008/a0013e/a0013e00.htm#Content

Food and Agriculture Organization (FAO). (2011). *The role of women in agriculture*. ESA Working paper no 11-02. Retrieved from http://www.fao.org/publications/sofa/en/.

Food and Agriculture Organization (FAO). (2012). *Gender inequalities in rural employment in Ghana.* An overview report. Accra. Ghana

Food and Agriculture Organization (FAO). (2015). Socio-economic context and role of agriculture. Country fact sheet on food and agriculture policy trends. Accra. Ghana

Fashola, M. O., Ngole-Jeme, V. M., and Babalola, O. O. (2016). Heavy Metal Pollution from Gold Mines: Environmental Effects and Bacterial Strategies for Resistance. *International journal of environmental research and public health, 13*(11), 1047.

Garvin, T., T. K. McGee, K. E. Smoyer-Tomic and Aubynn, E. A. (2009). Community-company relations in gold mining in Ghana. *Journal of Environmental Management 90*, 571–586.

Gecho, Y., Ayele, G., Lemma, T., and Alemu, D. (2014). Rural Household Livelihood Strategies: Options and Determinants in the Case of Wolaita Zone, Southern Ethiopia. Social Sciences. Vol. 3, No. 3, 2014, pp. 92-104. doi: 10.11648/j.ss.20140303.15

Ghana Chamber of Mines. (2014). Performance of the mining industry in 2013. Ghana Chamber of Mines. Retrieved from http://www.ghanachamberofmines.org/

Ghana Chamber of Mines. (2016). *Factoid on the Industry's Performance*. Accra, Ghana. Retrieved from http://ghanachamberofmines.org/wp-content/uploads/2016/11/Factoid-2016.pdf

Ghana Chamber of Mines. (2018). *Performance of the Mining Industry in 2017*. Accra. Ghana. Retrieved from https://ghanachamberofmines.org/media-press/our-publications/

Ghana Extractive Industries Transparency Initiative (GHEITI). (2018). GHEITI Report on the Mining Sector 2016. Ministry of Finance. Accra.

Ghana News Agency. (2013). Seventeen galamsey operators crush to death at Kyekyewere Retrieved September 15, 2018, from http://www.modernghana.com/news.

Ghana Statistical Service. (2010). *Population and housing census: Summary report of final results*. Ghana Statistical Service Publications. Accra

Ghana Statistical Service. (2014). 2010 Population and housing census: Mpohor District Assembly. Accra: Ghana Statistical Service Publications.

Ghana Statistical Service. (2016). *2015 Labour Force Report*. Ghana Statistical Service Publications. Accra

Ghana Statistical Service. (2018). *Provisional 2017 Annual Gross Domestic Product*. Ghana Statistical Service Publications. Accra

Ghosh, J. and Bharadwaj, K. (1992). *'Poverty and Employment in India'*, in H. Bernstein, B. Crow and H. Johnson (eds) Rural Livelihoods: Crises and Responses, Oxford: Oxford University Press and The Open University.

Gocking, R. S. (2005). The History of Ghana. Westport CT: Greenwood Press. Pp 384. ISBN 0313318948.

Gold Fields Ghana Limited (GFGL) (2010). *Sustainability report 2010*. Available from:http://www.goldfields.co.za/pdf/sustainability_reports/sustainability_report_2010.pdf.

Golden Star Resources. (2007). Technical Report First Time Disclosure of Mineral Reserves Hwini-Butre and Benso Properties Southwest Ghana. Denver

Golden Star Resources. (2013). *Corporate Responsibility Report 2013*. Retrieved from: http://www.gsr.com/PDFs/GSRAnnualSustainabilityReport2010.pdf

Gollin, D. (2014). *Smallholder agriculture in Africa: An overview and implications for policy*. IIED Working Paper. IIED, London.

Guerena, M. (2006). *Nematodes: Alternative controls*, NCAT Agriculture. ATTRS-National Sustainable Agriculture Information Service. Fayetteville, USA

Hayford, E. K., Amin, A., Osae, E. K., and Kutu, J. (2008). Impact of Gold Mining on Soil and some Staple Foods Collected from Selected Mining Communities in and around Tarkwa-Prestea Area. *West African Journal of Applied Ecology, 14*, 1-12.

Hesselberg, J., and Yaro, J. A. (2006). An assessment of the extent and causes of food insecurity in northern Ghana using a livelihood vulnerability framework. *GeoJournal 67*(1), 41-55.

Hesterberg, D. (1998). Biogeochemical cycles and processes leading to changes in mobility of chemicals in soil, *Journal of Agriculture, Ecosystem and Environment, 67*(1998), 121-133.

Hilson, G. (2001). *A Contextual Review of the Ghanaian Small-Scale Mining Industry, London*: MMSD. IIED. London.

Hilson, G. (2016). *Artisanal and small-scale mining and agriculture: Exploring their links in rural sub-Saharan Africa*. IIED, London.

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

Hilson, G., and Garforth, C. J. (2012). 'Agricultural Poverty' and the Expansion of Artisanal Mining: Case studies from West Africa. *Population Research and Policy Review, 31*(3), 435-464.

Hogarh, J. N., Adu-Gyamfi, E., Nukpezah, D., Akoto, O., and Adu-Kumi, S. (2016). Contamination from mercury and other heavy metals in a mining district in Ghana: discerning recent trends from sediment core analysis. *Environmental System Research 5*(15)

Howard, P. (2003). *Women and plants, gender relations in biodiversity management and conservation*. London: ZED Books

Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2017). *Global Trends in Artisanal and Small-Scale Mining (ASM): A review of key numbers and issues*. Winnipeg: IISD.

International Mining for Development Centre (IM4DC). (2014). *Mining and Agriculture: Strange bedfellows or a match made in heaven.* Retrieved from www.im4dc.org

Jarvis, W. R. and McKeen, C. D (1991). *Tomato Disease. Agric*. Can. Publ.1479/E. Ottawa-Canada, p. 70.

Jedwab, R and Osei, R. D. (2012). *Structural Change in Ghana 1960-2010*. Country Case Studies Workshop on "Structural Change in Developing Countries", organized by the World Bank.

Jung, M. C. (2008). Heavy metal contamination in soils and factors affecting metal uptake by plants in the vicinity of a Korean Cu-W mine. *Sensors, 8*, 2413-2423.

Kadigi, R. M. J., Mdoe, N. S. Y., and Ashimogo, G. C. (2007). Collective arrangements and social networks: coping strategies of the poor households in the Great Ruaha Catchment in Tanzania. *Physics and Chemistry of the Earth 32*, 1315–1321.

Kenk, E. and Cotic, I. (1983). *Land Capability Classification for Agriculture in British Columbia*. MOE Manual 1. Surveys and Resource Mapping Branch, Ministry of Envirnoment and Soils Branch, Ministry of Agriculture and Food. Kelowna, B.C. 68 pp. ISSN 0821-0640.

Kemp D., Owen, J.R., Gotzmann, N., and Bond, C.J. (2010) Just relations and company–community conflict in mining. *Journal of Business Ethics, 101*, 93–109.

Khan, A. S and Ali, S. (2018). Preharvest Modulation of Postharvest Fruit and Vegetable Quality. *In Preharvest Modulation of Postharvest Fruit and Vegetable Quality. Acadamic Press*. 209-255. ISBN 978-0-12-809807-3

Khor, M., and Hormeku, T. (2006). *The impact of globalisation and liberalisation on agriculture and small farmers in developing countries: the experience of Ghana*. Accra: Third World Network.

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

Kothari, C. R. (2004). *Research Methodolgy; Research method and techniques*. New Delhi. New Age International (P) Ltd. Publishers.

Kpoor, A. (2015). *Livelihood Strategies of Male and Female Headed Households in Greater Accra Region of Ghana*. (PHD thesis). University of Ghana. Accra, Ghana.

Krantz, L. (2001). *The Sustainable Livelihood Approach to Poverty Reduction: An Introduction*. Retrieved from http://www.forestry umn.edu/prod/groups.

Lente, I. (2017). Vulnerability and adaptation of smallholder farmers to changes in agroecosystem services and climate in semi-arid regions: the case of Nandom District of Ghana. (PHD thesis). University of Ghana. Accra, Ghana

Lin, X. C., Tong, L. W., Yan, Y., Nie, C., Chu, C., and Long, J. (2005). Environmental impacts of surface mining on mind lands in the Dabaoshan mine region, Southern China, *Land Degradation and Development, 16*(5), 463-474.

Mackenzie, S., Lacy, H., and Koontz, D. (2006). *Benefits of planned versus unplanned mine closure and strategies for both*. Retrieved: 30th July 2018, from www.mineearth.com.au

Maconachie, R. and Binns, T. (2007). Farming miners' or 'mining farmers'? Diamond mining and rural development in post-conflict Sierra Leone. *Journal of Rural Studies 23* (2007) 367–380.

Madeley, J. (1999). *Big business, poor peoples: The impact of transnational corporations on the world's poor*. London New York: Zed Books.

Mantey, J., Nyarko, K. B., and Owusu-Nimo, F. (2016). Costed and decommissioning strategy operations in 11 selected MDA's of the Western region of Ghana (S-33205-GHA-1). *Final Report for International Growth Centre.*

Maponga, O., and Ngorima, C. F. (2003). Overcoming environmental problems in the gold panning sector through legislation and education: The Zimbabwean experience. *Journal of Cleaner Production 11*(2): 147–157.

Marchetta, M. (2011). *On the move livelihood strategies in Northern Ghana*. CERDI: Etudes et Documents, E 2011.13.

Mayoux, L., and Hartl, M. (2009). *Gender rural microfinance: Reaching and empowering women, guide for practitioners*. International Fund for Agricultural Development (IFAD).

McDowell, C., De Haan, A. (1997). *Migration and sustainable livelihoods: a critical review of the literature*. IDS Working Paper, no. 65. Institute of Development Studies, Brighton.

McLaughlin, M. J., Zarcinas, B. A., Stevens, D. P., and Cook, N. (2000) Soil testing for heavy metals. *Communications in Soil Science and Plant Analysis, 31*:11-14, 1661-1700, DOI:10.1080/00103620009370531

McMahon, G and Moreira, S. (2014). *The Contribution of the Mining Sector to Socioeconomic and Human Development. Extractive industries for development series*; no. 30. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/18660 License: CC BY 3.0 IGO.

Mensah, A. K., Mahiri, I. O., Owusu, O., Mireku, O. D., Wireko, I., and Kissi, E. A. (2015). Environmental Impacts of Mining: A Study of Mining Communities in Ghana. *Applied Ecology and Environmental Sciences, 3*(3), 81-94

Mensah, S. O, and Okyere, S. A. (2014). Mining, Environment and Community Conflicts: A Study of Company-Community Conflicts over Gold Mining in the Obuasi Municipality of Ghana. *Journal of Sustainable Development Studies, 5*(1), 64-99

Mihaye, J. (2013). *Small-scale mining operations and their effects in the East Akim Municipal Assembly*. (Master's Thesis). University of Ghana. Accra

Minerals and Mining Policy of Ghana (MMP). (2014). Ensuring mining contributes to sustainable development. Government of Ghana. Accra

Ministry of Gender, Children and Social Protection (MoGCSP). (2015). *Mainstreaming Gender Equality and Women's Empowerment into Ghana's Development Efforts*. National Gender Policy. Accra

Ministry of Food and Agriculture. (2007). Food and Agricultural Sector Development Policy II, Accra

Ministry of Food and Agriculture. (2015). *Agriculture in Ghana: Facts and Figures*. Accra

Ministry of Food and Agriculture. (2017). *Planting for food and jobs strategic plan for implementation (2017-2020)*. Accra

Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences, 104*(50), 19680-19685.

Muica, N., Turnock, D., and Urucu, V. (2001). Coping strategies in rural areas of the Buzau Sub-Carpathians. *GeoJournal, 50*, 157-172.

National Institute of Environmental Health Sciences (NIEHS). (2014). *Arsenic fact sheet-508*. U.S.A. Retrieved from https://www.niehs.nih.gov/health/materials/arsenic_508.pdf

Nukunya, G. K. (2003). *Tradition and change in Ghana: An introduction to sociology* (2nd edition). Accra: Ghana Universities Press.

Obiri, S., Mattah, P. A. D., Mattah, M. M., Armah, F., Osae, S., Adu-kumi, S., and Yeboah, P. O (2016). Assessing the Environmental and Socio-Economic Impacts of Artisanal Gold Mining on the Livelihoods of Communities in the Tarkwa Nsuaem Municipality in Ghana. *Int. J. Environ. Res. Public Health 13*, 160; doi: 10.3390/ijerph13020160

Ofori, A. (2015). *An assessment of heavy metals content of water, soil and plants in some selected coastal communities near the jubilee oil field in the Western Region of Ghana.* (Masters' thesis), University of Ghana, Accra, Ghana.

Ofosu-Mensah, and Ababio, E. (2011). Historical overview of traditional and modern gold mining in Ghana. *International Research Journal of Library, Information and Archival Studies Vol. 1*(1). 006-022

Ontoyin, J. and Agyemang. I (2014). Environmental and rural livelihoods implications of small-scale gold mining in Talensi-Nabdam Districts in Northern Ghana. *Journal of Geography and Regional Planning. 7*. 7(8). 150 – 159.

Opoku-Antwi, G. L. (2010). *Three essays on small-scale gold mining operationsin Ghana: An integrated approach to benefit-cost analysis* (doctrates thesis), Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Ostrom, E. (1992). Governing the Commons: The Evolution of Institutions for Collective Action, 32 *Nat. Resources J. 415* (1992).

Owusu, F. (2001). Urban impoverishment and multiple modes of livelihood in Ghana. *The Canadian Geographer / Le Geographe canadien, 45*(3), 387-403.

Oxenham, J., Diallo, A. H., Katahoire, A. R., Petkova-Mwangi, A., and Sall, O. (2002). *Skills and literacy training for better livelihoods: A review of approaches and experiences.* African Region Human Development Working Paper Series. Washington DC: World Bank.

Preprah, E. (2002). *The impact of surface gold mining in Tarkwa-Aboso area*. (masters' thesis).Univerrsity of Ghana.

Rakodi, C. (1995). The household strategies of the urban poor: Coping with poverty and recession in Gweru, Zimbabwe. *Habitat International, 19*(4), 447-471.

Rakodi, C. (1999). A capital assets framework for analysing household livelihood strategies: Implications for policy. *Development Policy Review, 17*, 315-42.

Reardon, T. (1997). Using evidence of household income diversification to inform the study of rural non-agricultural labor market in Africa. *World Development, 25*(5), 735-748.

Reuters, T. (2018). *GFMS Gold Survey 2018*. London

Rozkowski, A. and Rozkowski, J. (1994). *Impact of mine waters on river water quality in the upper Silesian Coal Basin*. Fifth International Mine Congress, Nottingham 18-23 September, Pp.811-821.

Sachs, J. D., and Warner, A. M. (1997). *Natural Resources and Economic Growth*. Harvard Institute for International Development, Discussion Paper.

Sarris, A., and Shams, H. (1991). *Ghana under structural adjustment: The impact on agriculture and the rural poor*. New York University Press.

Saunders, M. et al. (2000): *Research Methods for Business Students*. 2nd ed. Harlow, UK: Prentice Hall.

Schubert, C. (2012). *Knowledge is power for smallholder farmers. Research programme on climate change, agriculture and food security*. Retrieved from https://ccafs.cgiar.org/fr/blog/knowledge-power-smallholder-farmers#.XQuEkohKjIV

Schueler, V., Kuemmerle, T. and Schröder, H. (2011). Impacts of Surface Gold Mining on Land Use Systems in Western Ghana. *AMBIO 40* (5). https://doi.org/10.1007/s13280-011-0141-9

Scoones, I. (1998). *Sustainable rural livelihoods: A framework for analysis*. IDS Working Paper No. 72. Brighton: IDS

Sharma, P. and Dubey, R.S. (2005) Lead Toxicity in Plants. *Brazilian Journal of Plant Physiology, 17*, 1-19.

Singh, P. K., and Singh, S. R. (2016). *Environmental and social impacts of mining and their mitigation*. Conference Paper: National Seminar ESIMM-2016: Kolkata.

Slack, K. (2013). The Growing Battle between Mining and Agriculture. Retrieved from http://inec.usip.org/blog/2013/mar/29/growing-battle-between-mining-and-agriculture

Smedley, P. L., Edmunds, W. M., and Pelig-Ba, K. B. (1996). Mobility of arsenic in groundwater in the Obuasi gold-mining area of Ghana: some implications for human health. *Geological Society, London, Special Publications, 113*(1), 163-181.

Stryker, J. D. (1991). Trade, exchange rate, and agricultural pricing policies in Ghana. World Bank Comparative Studies. The World Bank. Washington DC. ISBN 0-8213-1443-2

Synnevag, G. (1997). Gender differentiated management of crop genetic resources in Bafoulabé District, Kayes region of Mali, a case study. *Gestion de Ressources Génétiques de Plantes en Afrique des Savanes*, Bamako. 85-93.

Tan, K. H. (2005). *Soil Sampling, Preparation, and Analysis*, Second Edition. CRC Press. ISBN 9780849334993

Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K., and Sutton, D. J. (2012). Heavy metal Toxicity and the Environment. *Experientia supplementum, 101*, 133-64.

Tenkorang, E. Y. and Osei-Kufuor, P. (2013). The Impact of Gold Mining on Local Farming Communities in Ghana. *Journal of Global Initiatives*: *Policy, Pedagogy, Perspective, 8*(1), 21-44

Tershner, B. A. (2012). Small-Scale Mining in Ghana: The Government and the Galamsey. *Resources Policy 37*(3): 308-314. DOI: 10.1016/j.resourpol.2012.02.001

Tetteh, E. K., Antwi, K. B., and Opareh, N. O. (2014). Microcredit and women empowerment: evidence from microcredit clients of the upper Manya Krobo rural bank in the eastern region of Ghana. *International Journal of Emerging Trends in Science and Technology*, *1*(6), 875-893.

Tockman, J. (2001). Ghana: IMF, Mining and Logging. Retrieved 11 March, 2019 from http://www.wrm.org.uy/bulletin/54/Ghana.html

Tolossa, D. (2010). Some realities of urban poor and their food security situations: A case study at Berta Gibi and Gemachi Safar in Addis Ababa City, *Ethiopia. Environment and Urbanization, 22*, 179-198.

United Nations. (2017). Population Facts: Household size and composition around the world. Department of Economic and Social Affairs. No. 2017/2

United Nations Development Programme (UNDP) (2007). *Resource Guide on Gender and Climate Change*. Geneva, United Nations Development Program and Global Gender and Climate Alliance.

United Nations Development Programme (UNDP) (2015). *Review of Alignment between the Africa Mining Vision (AMV) and Ghana's Policy/ Legal Frameworks for Solid Minerals.* Retrieved from https://www.gh.undp.org/content/ghana/en/home/library/poverty/review-of-aalignment-between-the-africa-mining-vision

United Nations Development Programme (UNDP) and UN Environment (2018). *Managing mining for sustainable development*. A sourcebook. Bangkok: United Nations Development Programme.

United Nations Environment Programme (UNEP). (2016). *Protect Earth. Restore Land. Engage People*. Report on World Day to Combat Desertification (WDCD). Retrieved

from https://www.unenvironment.org/news-and-stories/story/land-restoration-key-human-well-being

United Nations Environment Programme (UNEP). (n.d). *Our work in Africa*. Retrieved from https://www.unenvironment.org/regions/africa/our-work-africa

Urama K. C. (2013). *Mining and agriculture for development: Exploring the nexus*. Presented at Mining, Agriculture and Development: Bread from stones conference, Perth, 2013. Western Australia: Crawford Fund and the Africa Australia Research Forum.

United States Environmental Protection Agency (US-EPA). (2002). *Lead Compounds*. Technology Transfer Network- Air Toxics Website. Retrieved from http://www.epa.gov/cgi-bin/epaprintonly.cgi

Wiemers, A. (2015). Time of Agric: Rethinking the Failure of Agricultural Programs in 1970s Ghana. *World Development, 66*, 104-117.

Wiggins, S. and Keats, S. (2013). *Leaping and Learning: Linking smallholders to markets in Africa*. Agriculture for Impact, Imperial College and Overseas Development Institute. London

Winters, P., Davis, B., and Corral L. (2002). Assets, activities and income generation in rural Mexico: factoring in social and public capital. *Agricultural Economics (27)*, 139-156.

Wójcik, M. and Tukiendorf, A. (2004). *Plant Growth Regulation*. Kluwer Academic Publishers. 44: 71. https://doi.org/10.1007/s10725-004-1592-9

World Bank. (2007). *World development report 2008*: Agriculture for Development. Washington DC.

World Bank. (2018a). *Third Ghana Economic Update: Agriculture as an engine of growth and jobs creation (English)*. Washington, D.C. World Bank Group.

World Bank (2018b). *Ghana Agriculture Sector Policy Note: Transforming Agriculture for Economic Growth, Job Creation, and Food Security*. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/28394 License: CC BY 3.0 IGO."

World Health Organization. (2002). *WHO Gender Policy*. Geneva

World Health Organization. (2004). *Preventing disease through healthy environments. Exposure to cadmium*: A major public health concern. Geneva

World Health Organization. (2008). *Cadmium. In: Guidelines for drinking-water quality,* 3rd edition incorporating 1st and 2nd addenda. Vol. 1. Recommendations. Geneva, pp. 317-319.

World Health Organization. (2018). *Inheriting a Sustainable World: Atlas on Children's Health and the Environment*. Retrieved from http://www.who.int/news-room/headlines

World Health Organization. (2019). *The Determinants of Health. Health Impact Assessment.* Retrieved from https://www.who.int/hia/evidence/doh/en/index1.html

Yamane, T. (1967*). Statistics: An Introductory Analysis.* 2nd Edition. Harper and Row, New York. pp. 919

Yaro, J. A. (2010). Customary tenure systems under siege: Contemporary access to land in northern Ghana. *Geojournal, 75*(2), 199-241.

Yeboah, J. Y. (2008). *Environmental and Health Impact of Mining on Surrounding Communities: A Case Study of Anglogold Ashanti In Obuasi* (master's thesis), Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Yelpaala, K., and Ali, S. H. (2005). Multiple scales of diamond mining in Akwatia, Ghana: addressing environmental and human development impact. *Resources Policy, 30*(3), 145-155

Yirenkyi, S. (2008). Surface Mining and its Socio-Economic Impacts and Challenges. *The Southern African Institute of Mining and Metallurgy, 1*, 181-202

APPENDICES

APPENDIX A: QUESTIONNAIRE AND INTERVIEW GUIDES

SAMPLE QUESTIONNAIRE FOR FARMERS

THE EFFECT OF MINING ACTIVITIES ON SMALLHOLDER FARMERS: THE CASE OF MALE AND FEMALE FARMERS IN THE MPOHOR MINING AREA

Section A

Section A is designed for smallholder farmers in Mpohor District to assess the effect of mining activities on your livelihood. The questionnaire is divided into two parts. Part 1 is designed access your background data. Part 2 is designed to evaluate your perception of the effect of mining activities on your farm soil and water quality and also to test the general effects of mining activities on your livelihood.

Part 1

Interview Date ……/……/…… Time ……/……/… Serial No …….

Tick (√) or circle where applicable and provide answers to open ended questions.

Personal Data

1. Name of village/community_____
2. Age: 1. 18-25 ( ) 2. 26-35 ( ) 3. 36-45 ( ) 4. 45 and above ( )
3. Gender: 0. Male ( ) 1. Female ( )
4. Origin: 0. Native ( ) 1. Migrant ( )
5. Hometown of migrant: _____
6. Marital Status: 1. Single ( ) 2. Married ( ) 3. Divorced ( ) 4. Separated ( ) 5. Co-habiting ( ) 6. Widowed ( )
7. Are you the head of the household? 0. No ( ) 1. Yes ( )
8. If 'No' who is the head of the household? 1. My husband ( ) 2. My wife ( ) 3. Other __

9. Where is the head of the family permanently residing (> 50% of time)? 1. With me ( )
   2. Another city: Specify _____ 3. Another country _____
10. Do you have dependents? 0. No ( ) 1. Yes ( )
11. If 'Yes' number of Male Adults >18years _____Female Adults>18 years _____
    Male Children < 18 years_____ Females Children <18years_____
12. Type of home: 1. Personal house ( ) 2. Rental ( ) 3. Family house ( ) 4. Other _____
13. Educational Background: 1. None [ ] 2. Primary [ ] 3. JHS/MSLC [ ] 4. SHS/ 'A' Level/ 'O' Level [ ] 5. Technical /Vocational Training [ ] 6. Tertiary: University Graduate [ ]; Technical University (Polytechnic) [ ] or Training Colleges [ ] 7. Post-graduate [ ] 8. Non-formal education [ ]
14. Is farming your main occupation: 0. No [ ] 1. Yes [ ]
15. How long have you been engaged in farming?
    1. 1-5 years 2. 6-10 years 3. 11-20 years 4. >20 years
16. Who makes decisions on the following? Farm _____ Produce _____ Income _____

Part 2

Perception of the Effect of Mining Activities on Farm Soil and Water Quality and the Effect of Mining Activities on Natural Capital

17. Is your farm close to mining activity? (0) No [ ] (1) Yes [ ]
18. If 'Yes', How close is your farm to mining activity (1) <1 km (2) 1-5km (3) 6-10km (4) >10km
19. Has mining activities affected your agricultural land? (0) No [ ] (1) Yes [ ]
20. If 'Yes', how has mining activities affected your agriculture land? (1) Loss of farmland (2) Soil erosion (3) Soil Pollution (4) I can't tell (5) Other _____

21. Apart from yield, what indication do you use to determine the quality of your soil? (Explain how it was before and after)

(1) Colour; explain _____

(2) Smell; explain _____

(3) Taste; explain _____

(4) Microorganisms; explain _____

(5) Other _____

22. Do you use any water to irrigate your farm? (0) No [ ] (1) Yes [ ]

23. If 'Yes', what is the source of irrigation water? (1) River (2) Stream (3) Groundwater (4) Reservoir

24. Do you think mining has changed the quality of your irrigation water? (0)No [ ]

(1) Yes [ ] (2) I don't know [ ]

25. If 'Yes', how has mining changed the quality of your irrigation water in terms of the following?

(1) Colour; explain _____

(2) Smell; explain _____

(3) Taste; explain _____

(4) Other _____

26. Which natural asset do you think has been greatly polluted? (0) Soil [ ] (1)Water [ ]

The Effect of Mining Activities on Financial Capital

27. Who does your farmland belong to? (1) Myself (2) My spouse (3) My maternal family (4) My paternal family (5) A friend (6) Other _____

28. How many acres of land do you cultivate on? (1) <1 acre (2) 1 acre (0.4 Ha) (3) 2-3 acres (0.8-1.2 Ha) (4) 4-6 acres (1.6-2.4 Ha) (5) > 6acres

29. How did you acquire the land for farming? (1) Inheritance (2) From Family head

(3) Abunu & Abusa (4) Purchased (5) Other _____

30. How far is your farm from your house?

(1) Just around my house (2) 2 km from my house (3) 3-4 km (4) 5 km (5) >5 km

31. How do you go to your farm? (1) On foot (2) My personal car/Motto/Bicycle (3) By public transport (4) Other _____

32. What type of crops do you grow? (1) Cocoa (2) Oil Palm (3) Maize (4) Plantain

(5) Cocoyam (6) Cassava (7) Vegetables; Specify _____

(8) Fruits; Specify _____

33. Why do you grow such crops? (1) Inherited (2) Higher earning (3) Low labour

34. What do you do with your products? (1) I sell them (2) I store for house usage

(3) I sell and store some for house usage (4) other _____

35. Where do you sell your products? Specify _____

36. How many maxi bags/tons of the food crops do you produce monthly?

(1) Oil Palm	
(2) Cocoa	
(3) Others	

37. Is this job the main source of income to your household or family? (0) No [ ] (1) Yes[ ]

38. If 'No' what is the other source of income to your household or family? (1) Petty trading

(2) Livestock rearing (3) Professional Job; Specify_____ (4) Other_____

39. Which source of income contribute to >50% to your household? _____

40. Do you engage any labourers on your farms? (0) No [ ] (1) Yes [ ]

41. Do you engage any family members as labourers? (0) No [ ] (1) Yes [ ]

42. Do you pay the labourers and your family members equally? (0) No [ ] (1) Yes [ ]

If 'Yes', proceed to question 45. If 'No', proceed to question 46.

43. How much do you pay them per day/month/annum? *Circle appropriate time*

(1) >100 (2) 100-300 (3) 301-600 (4) 601-900 (5) >900

44. Answer the following questions.

	Number of workers	Status (Temporal/ Permanent)	Type of activity	Earnings
Male Labourers				
Female Labourers				
Male Family Members				
Female Family Members				

45. How do you pay them?

(1) Own source (2) Loan from bank (3) Others _____

46. Has mining activity affected any aspect of your livelihood including agricultural production? (0) No [ ] (1) Yes [ ]

47. If 'Yes', which aspect of your livelihood has it affected? (1) Farmland (2) Produce (3) Labour (4) Earnings (5) Other _____

Affected Livelihood	Before	After
(1) Farmland (in acres)		
(2) Produce (in bags or tons)		
(3) Labour (in number of persons)		
(4) Earnings (in Ghana cedis)		
(5) Other		

The Effect of Mining Activities on Human Capital

48. Has mining activities affected the health conditions of you and your family? (0) No [ ]

    (1) Yes [ ] (2) I don't know [ ]

49. If 'Yes', what type of health condition? (1) Headaches (2) Fever (3) Malaria

    (4) Respiratory diseases (5) Other _____

50. Has mining activity resulted in the death of a family member? (0) No [ ] (1) Yes [ ]

51. Has mining activities affected your alternate livelihood? (0) No [ ] (1) Yes [ ]

52. If 'Yes', in what way? _____

53. Has mining activities contributed to any new skills or knowledge you have acquired?

    (0) No [ ] (1) Yes [ ]

54. What type of skills or knowledge did you acquire? _____

55. Has mining activities affected the workload of family members? (0) No [ ] (1) Yes [ ]

56. If 'Yes', how has is affected the female members of your family?

    _____

    How has it affected the male members of your family?

    _____

The Effect of Mining Activities on Physical Capital

57. Do you encounter any problem in terms of the following due to mining activities?

    Circle all applicable (Note in which ways they encountered each problem)

    (1) Conflicts with land owners (2) High cost of input equipment/chemicals/Seeds

    (3) Poor of access roads to farm (4) Poor drinking water supply (5) Poor electricity supply (6) Cracks in houses due to blasting vibration (7) Loss of accommodation

    (8) Other _____

58. Were you compensated? (0) No [ ] (1) Yes [ ]

59. Who compensated you? (1) Large Scale mines (2) Illegal miners (3) District assembly (4) Family members (5) Other _____

60. How were you compensated? (1) New farmland (2) Money (3) Alternate livelihood (4) New house (5) Other _____

61. Has mining activities provided you with any physical benefits? (0) No [ ] (1) Yes [ ]

62. What kind of benefits have you acquired? *Circle all applicable*

(1) Access roads to farmlands (2) High quality water for irrigation (3) Access to improved farming technology (4) Access to educational facilities (5) Access to health facilities (6) Access to good drinking water (7) Access to good electricity supply (8) Access to other social amenities (9) Other _____

63. What is your source of drinking water? (1) Pipe borne water (2) Borehole/ Hand dug well (3) River/ Stream (4) Commercially sold water (5) Other _____

64. Has mining activity affected the supply of your drinking water? (0) No [ ] (1)Yes [ ]

65. If 'Yes', how?

Drinking Water	Before	After
Supply	(0) Increased (1) Decreased	(0) Increased (1) Decreased
Quality	(1) Taste (2) Smell (3)Colour (4) Microorganisms	(1) Taste (2) Smell (3) Colour (4) Microorganisms

The Effect of Mining Activities on Social Capital

66. Are there any associations in your community? (0) No [ ] (1) Yes [ ]

67. If 'Yes', mention them? _____

68. Are you part of any association? (0) No [ ] (1) Yes [ ]

69. If 'Yes', which association are you part of, if 'No', proceed to question 76?

_____

70. What benefits do you get from the associations? (1) Financial assistance (2) Skills and knowledge (3) Access to government institutions/justice (4) Others _____

71. Why are you not part of any association? _____

72. Has mining activities affected your participation in informal educational activities organized by your associations/other organisation in the community? (0) No [ ] (1) Yes [ ]

73. If 'Yes', in what way? (1) Increased; why _____

(2) Decreased; why _____

74. Has mining activities affected your participation in social organizations/social networking (e.g. funeral, weddings, durbar, outdooring etc.) in the community? (0) No [ ] (1) Yes [ ]

75. If 'Yes', in what way? (0) Decreased; why _____

(1) Increased; why _____

76. Does the District Assembly provide you with any type of support for farming?

(0) No [ ] (1) Yes [ ]

77. What type of support do you get from the District Assembly?

(1) Planting for Food & Jobs (2) Extension services (3) Improved technology

(4) others _____

78. Are you satisfied with the assistance you get from the District Assembly?

(0) No [ ] (1) Yes [ ]

79. If 'Yes', why are you satisfied? _____

80. If 'No', why are you not satisfied? _____

Livelihood Strategies used by Smallholder Farmers to manage the effect of mining activities.

Which of the following livelihood strategies do you employ to manage the effect of mining on your livelihood? Please rank from (1) most used; (2) moderately used and (3) least used

Livelihood Strategy	**Rank**
A. On Farm Strategies	
Intercropping (planting of different crops on the same land)	
Crop diversification (changing of a type of crop after harvesting, e.g. planting of cocoa after harvesting oil palm) or acquiring different lands to plant different crops	
Adding livestock rearing with crops	
B. Off Farm Strategies	
Selling of raw agriculture produce	
Processing of produce to sell (e.g. processing cassava or maize to dough)	
Engaging in agriculture activities on other people's farm (e.g. being a labourer)	
C. Non-Farm Strategies	
Wage employment other than from agriculture (petty trading, carpentry, masonry, teacher, etc.)	
Migration to other towns and cities	
Remittances (e.g. from relatives and friends);Property income (such as houses, stores, land, etc.) or Government grants and transfers (pension)	

INTERVIEW GUIDE FOR FOCUS GROUP DISCUSSION

1. Has there been a significant in the environment due to mining activities?

(Such as reduction of farmland sizes, air and water pollution, high cost of living etc.)

2. How has the changes been like?

(i) Farmland

(ii) Water Bodies

(iii) Others

3. Are there any differences in the effects/challenges that male and female smallholder farmers are facing due to mining activities?

4. What are the challenges?

6. What are the effects of mining activities on these livelihood assets?

i. Human capital

- ✓ Effect on health/death
- ✓ Access to labour
- ✓ Access to valuable information
- ✓ Any other

ii. Natural capital

- ✓ Effect on agricultural land
- ✓ Effect on water resource
- ✓ Effect on air
- ✓ Any other

iii. Physical capital

- ✓ Effect on shelter/personal buildings (storage facilities etc.)
- ✓ Effect on water supply
- ✓ Effect on electricity
- ✓ Effect on infrastructure (schools, roads, drinking water, community centres, etc.)
- ✓ Any other

iv. Social capital

- ✓ Effect on participation in social organization/networking
- ✓ Effect on participation in informal/non-formal educational activities
- ✓ Any other

v. Financial capital

- ✓ Effect on personal belongings & equipment
- ✓ Effect on crops and/or livestock
- ✓ Effect on income earning opportunity
- ✓ Effect on access to credit
- ✓ Any other

7. What are the livelihood strategies employed to safeguard your livelihoods?

8. Are the members of the communities (specifically smallholder farmers) assisted by any institution to help address the effects of mining activities?

9. State the institutions involve

10. What type of services do these institutions provide?

11. Do every member of the community benefit from such services?

12. State the beneficiaries of the support services. (E.g. women only, men only, children, the aged, large scale farmers, small scale farmers, etc.)

INTERVIEW GUIDE FOR FORMAL AND INFORMAL INSTITUTIONS

Interview Date ……/……/…… Time ……/……/……

A) Institutional Background

1. Name of institution: _____
2. Type of institution: (0) Formal (1) Informal
3. Position of interviewee: _____
4. Years of existence in Community: _____

B.) Institutional contribution to addressing the effect of mining activities on agriculture dependants.

5. How does your institution manage any of environmental problems/pollution it encounter during its operation (e.g. waste management, water pollution, air pollution)?
6. How does your institution help in terms management of environmental pollution (soil, air and water pollution) caused by mining activities in the district?
7. What difficulties do you face in the management of mining effects on the environment?
8. What has your institution achieved in the management of mining effects in the district?
9. Are there any effects/challenges that smallholder farmers in the district are facing due to mining that your institution or you have identified?
10. Are there any differences in the challenges male smallholder farmers face from their female counterpart?
11. In what ways is your institution helping to resolve challenges smallholder farmers, particularly those who have been affected by mining operations?
12. In your opinion, are the government interventions on illegal mining effective?

INTERVIEW GUIDE FOR DISTRICT AGRICULTURAL OFFICER

Interview Date …… Time ……

A) Biodata

1. Position of interviewee: _____
2. Gender: 0. Male ( ) 1. Female ( )
3. Level of Education: 1. Primary/JHS [ ] 2. SHS/Vocational/Technical [ ] 3. Tertiary; University [ ]; Polytechnic [ ]/ Training College [ ] 4. Post-graduate [ ]
4. How long have you been working as an Mpohor District Agriculture personnel? _____

The Effect of Mining Activities on Agriculture

5. What is the quality of soils in farm lands in the Mpohor District?
6. What crops grow well in the district?
7. What is the average farm size for farmers in the district?
8. Has surface mining affected food production in the district? In what ways?
9. What is the difference in maxi bags of food production before and after the commencement of mining in the district?
10. In what other ways, aside food production, has mining affected farmers in the community. Both benefits and risks?
11. How is the ministry addressing soil and water pollution and other problems of farmers in the district?
12. In your opinion, can mining and crop production co-exist sustainably in the district? Why?

APPENDIX B: ETHICAL CONSENT LETTER

UNIVERSITY OF GHANA

COLLEGE OF BASIC AND APPLIED SCIENCES

Ethics Committee for Basic and Applied Sciences (ECBAS)

Official Use only Protocol number ECABS 014/18-19

PROTOCOL CONSENT FORM

Section A- BACKGROUND INFORMATION

Title of Study:	The Effect of Mining Activities on Smallholder Agriculture in the Mpohor District of Ghana
Principal Investigator:	Ekua Bentsiwa Slim Ankomah
Certified Protocol Number	ECABS 014/18-19

Section B– CONSENT TO PARTICIPATE IN RESEARCH

You have been selected as one of the persons to help the student investigator in her project which is titled 'The Effect of Mining Activities on Smallholder Farmers in the Mpohor District of Ghana. The purpose of the study is to access the various effects mining has on the livelihood of both male and female smallholder farmers. The data to be collected will be used purely for an academic purpose. You will be interviewed for about 20 to 30 minutes but note that your participation is voluntary. Please if there is any question on the topic that you need clarification, you can ask before we start with the interview.

You will help the researcher achieve the purpose of evaluating the different effects mining has on the livelihood of male and female small holder farmers in the Mpohor District, which will direct policies in the agricultural sector.

You will also acquire knowledge on the level of toxic trace elements in soils of some selected farms which will help farmers' effect remedial measures for healthy crops and high productivity. Biodata, financial and social information will be asked of respondents of which they may want to be kept confidential. You are assured of confidentiality and anonymity as the questionnaires are designed in such a way, biographical information obtained from you will not be traced back to you, as they will not be personalized.

During the course of investigation, research records will be accessible to only the student investigator. After the study, research records will be available to the entire staff and student body of the University of Ghana.

Section C- VOLUNTEER AGREEMENT

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and I am willing to give consent for me, my child/ward to participate in this study. I have not waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

_____

Name of Volunteer

_____

Signature or mark of volunteer Date

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_____

Name of witness

_____ _____

Signature of witness Date

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____

Name of Person who obtained Consent

_____ _____

Signature of Person who obtained Consent Date

APPENDIX C: LIVELIHOODS OF SMALLHOLDER FARMERS

Table 1: Other Income Generating Activities Engaged by Male Respondents

Job Type	Frequency	Percent
None	64	62
Clerical officer	1	1
Cocoa Buyer	1	1
Teacher	3	3
Electrician	1	1
Driver	12	12
Fetish priest	1	1
Galamsey or Illegal Miner	3	3
Lotto Staker	1	1
Mason	1	1
Mobile Money Vendor	1	1
Plantation Worker	3	3
Trader	11	11
Total	103	100

Source: Field Data

Table 2: Other Income Generating Activities Engaged by Female Respondents

Job Type	Frequency	Percent
None	74	72
Forklift Operator	1	1
Galamsey or Illegal Miner	2	2
Hairdresser	3	3
Plantation Worker	1	1
Seamstress	1	1
Trader	21	20
Total	103	100

Source: Field Data

APPENDIX D: CHEMICAL PARAMETERS OF SOIL SAMPLES

Table 1: Results of chemical parameters in soil samples

Sample ID	pH	EC (µS/cm)	Cd (mg/kg)	Pb (mg/kg)	As (mg/kg)	Hg (mg/kg)
MP-001	5	688	5.1	8	1.33	0.01
MP-002	5.4	155	4.3	40.2	2.41	0.26
MY-001	5.3	329	4.5	0.1	1.11	0.19
MY-002	4.9	266	6.2	0.4	0.64	0.06
MY-003	5.1	337	5.9	0.8	1.15	0.18
AW-002	5.4	415	8.2	1.1	0.25	0.01
AW-002	5.1	266	7.2	1.3	0.08	0.01
AW-003	5	224	6.1	2	0.06	0.002
AW-004	5.4	394	5.5	16.2	0.03	0.004

Source: Computation from field data, 2019

Table 2: Correlation matrix for chemical and heavy metals parameters of soil sampled

		pH	EC	Cd	Pb	As	Hg
pH	Pearson Correlation	1	-0.052	0.016	0.518	0.199	0.331
	Sig. (2-tailed)		0.887	0.966	0.125	0.581	0.351
	N	10	10	10	10	10	10
EC	Pearson Correlation	-0.052	1	0.287	-0.181	0.085	-0.268
	Sig. (2-tailed)	0.887		0.421	0.616	0.815	0.454
	N	10	10	10	10	10	10
Cd	Pearson Correlation	0.016	0.287	1	-0.329	-0.297	-0.289
	Sig. (2-tailed)	0.966	0.421		0.353	0.405	0.418
	N	10	10	10	10	10	10
Pb	Pearson Correlation	0.518	-0.181	-0.329	1	.650*	0.489
	Sig. (2-tailed)	0.125	0.616	0.353		0.042	0.151
	N	10	10	10	10	10	10
As	Pearson Correlation	0.199	0.085	-0.297	.650*	1	.839**
	Sig. (2-tailed)	0.581	0.815	0.405	0.042		0.002
	N	10	10	10	10	10	10
Hg	Pearson Correlation	0.331	-0.268	-0.289	0.489	.839**	1
	Sig. (2-tailed)	0.351	0.454	0.418	0.151	0.002	
	N	10	10	10	10	10	10

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Source: Computation from field data, 2019

APPENDIX E: RANKING OF LIVELIHOOD STRATEGIES

On-farm Activities	Male		Female	
	Frequency	Percentage	Frequency	Percentage
None	7	6.8	6	6
Intercropping (planting of different crops on the same land)	50	48.5	63	61
Crop diversification (changing of a type of crop after harvesting, e.g. planting of cocoa after harvesting oil palm) or acquiring different lands to plant different crops	42	40.8	27	26
Integrating livestock with crop	4	3.9	7	7
Total	103	100	103	100

Off-farm Activities	Males		Females	
	Frequency	Percentage	Frequency	Percentage
None	7	6.8	6	6
Selling of raw agriculture produce	83	80.5	70	68
Processing of produce to sell (e.g.processing cassava or maize to dough)	10	9.7	22	21
Engaging in agriculture activities on other people's farm (e.g being a labourer)	3	2.9	5	5
Total	103	100	103	100

Non-farm Activities	Males		Females	
	Frequency	Percentage	Frequency	Percentage
None	7	6.8	6	6
Wage employment other than from agriculture (petty trading, carpentry, masonry, teacher, etc.)	42	40.8	43	42
Migration to other towns and cities	28	27.2	10	10
Remittances (e.g. from relatives and friends);Property income (such as houses, stores, land, etc.) or Government grants and transfers (pension)	26	25.2	44	43
Total	103	100	103	100

Source: Computation from field data, 2019

APPENDIX F: PARAMETER ESTIMATES OF MULTINOMIAL LOGISTICS

On-Farm Activity		B	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound
Intercropping	Intercept	3.61	1	0.108			
	Gender	0.679	1	0.586	1.972	0.171	22.687
	Origin	-2.232	1	0.038**	0.107	0.013	0.885
	Marital Status	1.166	1	0.324	3.209	0.316	32.543
	Household head	-1.116	1	0.279	0.328	0.043	2.471
	Educated	-0.101	1	0.915	0.904	0.14	5.817
	Dep. on Farm only	0.585	1	0.472	1.795	0.365	8.834
	Farm Income	-1.175	1	0.217	0.309	0.048	1.998
	Mining Affected Farm	-0.004	1	0.996	0.996	0.222	4.478
	Farm Size	0.032	1	0.974	1.032	0.153	6.985
	Crop type	-1.105	1	0.302	0.331	0.041	2.7
	Employ Labourers	1.347	1	0.164	3.845	0.576	25.649
	Joined Ass.	-1.034	1	0.415	0.355	0.03	4.275
	Organ. Support	3.295	1	0.018**	26.967	1.78	408.632
Crop diversification	Intercept	2.589	1	0.253			
	Gender	0.904	1	0.47	2.47	0.212	28.763
	Origin	-2.36	1	0.028**	0.094	0.011	0.778
	Marital Status	1.265	1	0.288	3.543	0.344	36.46
	Household head	-0.889	1	0.392	0.411	0.054	3.143
	Educated	-0.623	1	0.522	0.536	0.079	3.621
	Dep. on Farm only	0.787	1	0.332	2.197	0.448	10.765
	Farm Income	-1.017	1	0.29	0.362	0.055	2.377
	Mining Affected Farm	0.863	1	0.266	2.37	0.518	10.836
	Farm Size	0.058	1	0.953	1.059	0.157	7.126
	Crop type	-0.489	1	0.654	0.613	0.072	5.203
	Employ Labourers	0.193	1	0.846	1.213	0.172	8.561
	Joined Ass.	-0.666	1	0.606	0.514	0.041	6.434
	Organ. Support	2.657	1	0.058	14.254	0.912	222.791

Source: Computation from field data, 2019

** and * stand for significant at 5% and 10% respectively

a The reference category is: Adding livestock to crops.

Off-Farm Activity		B	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound
Selling of raw produce	Intercept	148.881	1	0.95			
	Gender	1.092	1	0.642	2.981	0.03	299.878
	Origin	-88.614	1	0.967	3.278E-39	0	.c
	Marital Status	18.729	1	0.996	136140662.4	0	.c
	Household heac	0.574	1	0.75	1.775	0.052	61.008
	Educated	-0.659	1	0.678	0.518	0.023	11.655
	Dep. on Farm o	15.754	1	0.984	6947781.325	0	.c
	Farm Income	-43.172	1	0.957	1.781E-19	0	.c
	Mining						
	Affected Farm	-56.268	1	0.936	3.66E-25	0	.c
	Farm Size	41.167	1	0.959	7.5639E+17	0	.c
	Crop type	-3.085	1	0.074*	0.046	0.002	1.352
	Employ Labour	0.278	1	0.854	1.321	0.069	25.36
	Joined Ass.	-88.916	1	0***	2.422E-39	3.623E-41	1.62E-37
	Organ. Support	88.486	1	0***	2.685E+38	3.394E+37	2.124E+39
Processing produce to sell	Intercept	146.35	1	0.951			
	Gender	2.374	1	0.334	10.74	0.087	1331.411
	Origin	-90.498	1	0.966	4.981E-40	0	.c
	Marital Status	19.1	1	0.995	197198374.3	0	.c
	Household heac	1.683	1	0.381	5.381	0.125	232.161
	Educated	-0.437	1	0.8	0.646	0.022	19.146
	Dep. on Farm o	14.815	1	0.985	2718009.981	0	.c
	Farm Income	-41.646	1	0.959	8.188E-19	0	.c
	Mining						
	Affected Farm	-58.318	1	0.933	4.706E-26	0	.c
	Farm Size	41.87	1	0.959	1.52681E+18	0	.c
	Crop type	-5.312	1	0.005***	0.005	0	0.198
	Employ Labour	-1.16	1	0.481	0.314	0.012	7.892
	Joined Ass.	-90.224	1	0***	6.553E-40	9.316E-42	4.609E-38
	Organ. Support	91.501	1	.	5.473E+39	5.473E+39	5.473E+39

Source: Computation from field data, 2019

*** and * stand for significant at 1% and 10% respectively

a The reference category is: Engaging in other farm as labourer.

c Floating point overflow occurred while computing this statistic.

Non-Farm Activity		B	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound
Wage Employment	Intercept	-1.6635	1	0.151			
	Gender	-0.0999	1	0.881	0.905	0.245	3.337
	Origin	1.9481	1	0.000***	7.015	2.351	20.937
	Marital Status	1.0036	1	0.088*	2.728	0.859	8.661
	Household head	0.5840	1	0.308	1.793	0.583	5.513
	Educated	-0.5025	1	0.337	0.605	0.217	1.687
	Dep. on Farm only	2.7628	1	0.000***	15.845	5.389	46.587
	Farm Income	-1.1094	1	0.028**	0.330	0.123	0.884
	Mining Affected Farm	0.1361	1	0.767	1.146	0.466	2.817
	Farm Size	0.3541	1	0.549	1.425	0.448	4.534
	Crop type	0.7991	1	0.127	2.223	0.797	6.205
	Employ Labourers	0.0804	1	0.874	1.084	0.401	2.929
	Joined Ass.	0.3523	1	0.549	1.422	0.450	4.498
	Organ. Support	-0.8730	1	0.199	0.418	0.110	1.584
Migration	Intercept	-4.2208	1	0.002			
	Gender	1.8825	1	0.014**	6.570	1.457	29.627
	Origin	1.5657	1	0.018**	4.786	1.307	17.530
	Marital Status	1.4864	1	0.035**	4.421	1.113	17.566
	Household head	1.0363	1	0.123	2.819	0.756	10.516
	Educated	-1.3273	1	0.108	0.265	0.053	1.337
	Dep. on Farm only	1.8404	1	0.005***	6.299	1.751	22.665
	Farm Income	-1.3441	1	0.023**	0.261	0.082	0.829
	Mining Affected Farm	-0.7483	1	0.176	0.473	0.160	1.397
	Farm Size	0.4757	1	0.518	1.609	0.380	6.811
	Crop type	1.0417	1	0.103	2.834	0.810	9.910
	Employ Labourers	0.9027	1	0.173	2.466	0.673	9.037
	Joined Ass.	-0.7087	1	0.300	0.492	0.129	1.883
	Organ. Support	1.3597	1	0.087*	3.895	0.823	18.441

Source: Computation from field data, 2019

***, **, and * stand for significant at 1%, 5% and 10% respectively

a. The reference category is: Remittances.