

Artisanal and Small-Scale Gold Mining Participation and Its  
Impact on the Livelihood of Rural Households in Tigray  
National Region State, Ethiopia

By

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## Declaration

I, the designated candidate, declare that “*Artisanal and Small-scale Gold Mining Participation and Its Impact on the Livelihood of Rural Households in Tigray Region, Ethiopia*”, is my own original work and this work has not submitted before for any other degree at AAU and other universities for another qualification or at any other higher education institution. All the sources that I have used or quoted have indicated and acknowledged by means of complete references. I would like to confirm that any errors committed, if any, are my own responsibility. Lastly, I hereby submitted the dissertation for examination with all the requirements and have completed the study in terms of the approved application of AAU.

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## ABSTRACT

### *Artisanal and Small-scale Gold Mining Participation and Its Impact on the Livelihood of Rural Households in Tigray National Region State, Ethiopia.*

*Gebreselassie Sebhatleab Gebremichael*

*Addis Ababa University, 2020*

*The purpose of this study is to investigate the impact of artisanal and small-scale gold mining participation on the livelihood of the rural HHs in Tigray National Region State, Ethiopia. The study employed mixed research approaches. Primary data were collected using structured questionnaire from 160 participant and 218 non-participant households, 50 KIIs, 15 FGDs and field observation. Purposive sampling was used to select the study woredas, tabias and members of KIIs and FGDs whereas simple random sampling was applied to draw the survey respondents in the study area. Data were analyzed using multiple techniques. Descriptive analysis and independent sample t-test was used to compare mean difference between participant and non-participant households. The Heckman two stage models was employed to analyze the gold supply to the formal market agents. The food security status of sample households was measured using HFIAS, HFCS, FEI and PSM. On the other hand, Multidimensional Poverty Index (MPI) and PSM were used to analyze the poverty status of households in the study area. STATA version 14 has been used to run the probit and logistic regression outcomes. Finally, Livelihood Vulnerability Index (LVI) was used to assess the vulnerability of livelihood assets in the study area. The results of the study revealed that gold mining is an avenue of generating income for rural households in the study area. The issue of governance in the ASM sector has been found defective. The regression outcome indicates that six variables were found determinant factors affecting gold supply to the formal market and these were distance to the nearest market place, distance to the mining sites, limited access to transportation, poor governance of the ASM sector, and perception of miners and lack of access to credit service. Results from HFIAS, HFCS and FEI indicate that participant households had better food security status than the non-participant households. The results from NNM, KM and RM on the income and food security have shown that households who had been involving in gold mining participation increased their annual income by 23,584.86 ETB and food security by a factor of 0.60. The regression results also demonstrates that sex of household head, livestock ownership, off farm income of the households and lack of credit service were found the determinants of households' food security in the study area. With regard to the poverty status of households, in education and health dimensions, participant and non-participant households were found MPI poor whereas in the third dimension (living standard), the non-participant households were found more MPI poor than their counterparts. Besides, results from NNM, KM and RM also indicate that the total annual income and expenditure of participant households were found higher than the non-participant households in the study area. Finally, results from LVI exhibits that of all the assets, the participant and non-participant households were found extremely vulnerable in terms of natural capital by 0.76 and 0.71 respectively. The study recommends that mining policies, laws and regulations shall be framed based on the local context. Regulating the black market of gold requires extra commitment from the government and hence, there should be effective coordination between federal and regional governments. Miners shall be trained on how to extract miners and protect its adverse effects. There must be a separate tier from federal to local levels that specifically focuses on the ASM sector by allocating human and material resources to improve the overall performance of the sector.*

**Key words:** *governance, gold supply, food security, poverty, vulnerability of livelihood assets*

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## **List of Acronyms**

AEO	African Economic Outlook
AMDC	Africa Mineral Development Center
AMTCCP	Artisanal Mining Transaction Coordinating Core Process
AMV	African Mining Vision
ATE	Average Treatment Effect
ATT	Average Treatment effect on the Treated
ATU	Average Treatment effect on the Untreated
AU-AMV	African Union- African Mining Vision
ASM	Artisanal and Small-scale Mining
ASGS	Artisanal and Small-scale Gold Supply
ASGM	Artisanal and Small-scale Gold Mining
CBE	Commercial Bank of Ethiopia
CSA	Central Statistical Authority
ECA	Economic commission for Africa
EEITI	Ethiopian Extractive Industry Transparency Initiative
EGS	Ethiopian Geological Survey
EHNRI	Ethiopian Health and Nutrition Research Institute
FAD	Food Availability Decline
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agricultural Organization
FCS	Food Consumption Score
FED	Food Entitlement Decline
FEI	Food Energy Intake
ETB	Ethiopian Birr
FGD	Focus Group Discussion
FDRE	Federal Democratic Republic of Ethiopia
DFID	Department For International Development
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
HDI	Human Development Index
HFIAS	Household Food Insecurity Access Scale
IISD	International Institute for Sustainable Development
IMR	Inverse Mill's Ratio
ILO	International Labor Organization
LVI	Livelihood Vulnerability Index
MMSD	Ministry of Mining and Sustainable Development
MoFED	Ministry of Finance and Economic Development
MoMPNG	Ministry of Mines Petroleum and Natural Gas
MPI	Multi-dimensional Poverty Index
NBE	National Bank of Ethiopia

NEMA	National Environment Management Authority
OECD	Organization for Economic Cooperation and Development
PSM	Propensity Score Matching
SLF	Sustainable Livelihood Framework
SNNPR	Southern Nations, Nationalities and Peoples Region
TNRS	Tigray National Regional State
UDED	United Nations Environment and Development
UNDP	United Nations Development Program
UNO	United Nations Organization
USAID	United States Agency for International Development

# Chapter One: Introduction

## 1.1 Background of the study

Ever since human beings began to exploit mineral resources, artisanal mining has been one of the key economic activities which can generate income, provides durable materials for decoration, jewelry and shelter (Hilson, G, 2016). Beginning the dawn of civilization through the early period of the industrial revolution, artisan mining plays a significant role in many developing and developed states (Aizawa, 2016).<sup>1</sup> Despite its benefit to the rural poor, the sector is agonized by backward technology, limited access to market, poor health and occupational safety, informal operation, highly disorganized and its adverse effect on the natural environment is immense (Artisanal Gold Council, 2017; McQuilken & Hilson 2016;Nikhilesh Rodiwal, 2015).<sup>2</sup>

In the early times, valuable minerals had been extracting for decoration, human gifts, bartering (means of exchange) and other social-cultural purposes (Hilson & Hilson 2015; ASM Knowledge Sharing Archives, 2017). Later on, the demand for precious minerals had been drastically increased during the industrial revolution (García et al., 2015). However, until the second half of the 20<sup>th</sup> century, the ASM sector has been marginalized from the main stream policies and international development debates as well.<sup>3</sup> Since 1970s, the sector's contribution to national development and rural livelihoods has been recognized in Africa, Asia, Latin America and elsewhere in the world (Veiga, 2014; Levin, 2014). Technical issues, legal frameworks, social-economic and environmental policies about the ASM sector had been put in to effect to make the sector sustainable and more productive.<sup>4</sup>

The ASM sector has an indispensable contribution to global mineral production, which accounts for 20% of the world's non-fuel mineral production (AMDC, 2014). According to Artisanal and Small-scale Mining Knowledge Sharing Archive website (ASMKSA, 2017), 40.5 million miners are participating in ASM at global level but it is still difficult to ascertain the exact number of people engaged in ASM due to the informal nature of the activity (Seccatore et al., 2014; Levin,

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<sup>1</sup> In 1995, Richard Noetstaller opened the World Bank's International Roundtable on Artisanal Mining with a keynote speech.

<sup>2</sup> OECD (2016), *OECD due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas: Third Edition*, OECD Publishing, <http://www.oecd.org/daf/inv/mne/OECD-Due-Diligence-Guidance-Minerals-Edition3.pdf> (accessed 19.09.2017).

<sup>3</sup> *The general dislike to engage in the ASM sector was that the perception that most ASMs are located in the remote areas where implementing the policies and regulatory mechanisms had been poorly executed. Besides, majority of the ASMs activities had been operating informally and their contribution was seen insignificant.*

<sup>4</sup> EU (2017). *EU 2017/821 of the European parliament and of the Council of 17 May 2017 laying down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high risk areas*. Retrieved from <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2017:130:TOC>

2014; EU, 2017). Different sources indicate, the number of ASMs is drastically growing for three main reasons. Firstly, the price for valuable minerals is rising and especially the rural people are motivated to take part in ASM. Secondly, agriculture is unable to feed its population for various reasons such as climate variability, drought, population pressure and the like (World Gold Council, 2017; World Bank, 2013).

Africa is endowed with verities of mineral resources and the continent accounts for 59% of the world's platinum; 62% of aluminum silicate; 50% of diamonds, and more than 20% of gold (Twenefou, 2009). Gold has been extracted since long but currently, more than 10-15 million artisanal miners are directly involved in gold mining and accounts for 12% of the world annual gold production (World Bank, 2009). In Africa, about 9 million miners are involving in ASM and more than 54 million people depend their livelihood on artisanal mining (Ledwaba & Nhlengetwa, 2016; Persaud et al., 2017). In terms of the number of people engaged in ASM, the leading countries are South Africa, Ghana, DRC and Tanzania (ECA, 2008 and AMV, 2009). In Asia, about 15.7 million miners are operating in the ASM sector and support the livelihood of 76 million people directly or indirectly. China is the leading country which accounts for 57.3% of the total ASM mineral production in Asian (Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017, Basri et al., 2017). In Latin America, 2.7 million miners are taking part in ASM and support about 11.8 million people directly or indirectly (IISD, 2017).

In Ethiopia, gold and precious stones had been extracting since Biblical times referring to the Queen Sheba's gift of gold to the King Solomon of Israel (D'Souza, 2002, Engda, 2011; Gezae, 2010). During the 'Land of Punt', gold had been one of the valuable commodities traded in the commercial expedition via the port of Aulis (Tiruneh, 2012). During the Aksumite period, gold was used for medium of exchange, ornament, gifts, and making coins (Yared, 2013, MoM, 2012; Beyene, 2016). Since the ancient civilization of the Ethiopian state, the socio-economic value of gold has been steadily rising from time to time (Engda, 2011; Gezae, 2010). Even though Ethiopia is endowed with potential mineral resources, the share of the ASM sector to GDP has been insignificant (MoMPNG, 2017; Beyene, 2016).

In the post 1991, mining policies, proclamations and regulations have been enacted to improve the performance of the ASM sector (Beyene, 2016). As a result, the ASM participation has been flourished throughout the country and the contribution of the sector to the livelihood and national

economy improved for some fiscal years (MoMPNG, 2017). Unfortunately, the performance the mining sector has begun to decline since 2015 fiscal year for different reasons such as poor mineral governance, weak regulatory and enforcement mechanisms, illegal gold marketing and lack incentives for miners to supply gold to the formal market agents (NBE and CBE, 2017). Currently, about 1.5 million artisanal and small scale miners are participating in gold, gemstones, tantalum, opal and the leading regions in terms of the estimated number of ASM involvement include Oromiya, SNNPR, Tigray, Benishangul Gumuz, and Amhara regions respectively.<sup>5</sup> In Tigray region, 80,000-120,000 artisanal and small-scale miners are expected to engage in extracting gold in different zones and *woredas* (Office report, 2017/18). However, there is still lack of accurate data on the actual number of artisanal miners at national and regional levels (MoMPNG, 2017). Likewise, it is difficult to have real information on impact of ASM on the livelihood of the rural households' in the study area, Tigray Region.<sup>6</sup> Prior to 1991, the mining sector was highly regulated by the central government but in the post 1991, mineral policies, rules and regulations were enacted. Since then, people have been intensively involving in ASM activities to support their livelihood, especially, in areas where there are limited job opportunities (MoM, 2012).

Nowadays, thousands of miners are participating in ASGM in Tigray region and most of the gold mining activities are concentrated in the north western and central zones of the region. Unlike to the previous times, the socio-economic benefit of ASGM has been recognized by the government and the local people. As a result, many new rural townships began to mushroom stimulated by the ASGM activities near the mining sites (Beyene, 2016; Ali, 2015; Gezae, 2010). Besides, raising the price of gold at local, regional, national and international levels could also be one of the reasons why many people are intensively participating in artisanal gold mining in the study area. Nonetheless, miners are extracting minerals without considering the impact of such activities on the natural environment and with no doubt, ASGM had adverse effect on human and the natural environment unless properly regulated (IIED, 2013).

## **1.2. Statement of the Research Problem**

The artisanal and small scale mining activity has become an avenue for income generation for about 150 million people throughout the world; nonetheless, the sector is being suffered from

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<sup>5</sup>The leading mining regions and the Estimated number of Artisan and small Scale Miners (ASM), particularly gold (is extracted in many parts of the country), gemstones (occurs in many parts of the country), tantalum (is mainly found in Borona, oromiya region) and opal (is mainly situated in Wadela Delanta, Amhara region) and these mineral are being extracted for different purposes.

<sup>6</sup> Tigray National regional State. Office of Energy, Mineral water resources,2017/18)

potential challenges which ultimately hinder its performance and contribution (Artisanal Gold Council, 2017a; Aizawa 2016; Ali, 2015; World Bank, 2013). Studies indicate that the ASM sector is significantly linked to poor mineral governance, lack of awareness on the policy and regulatory frameworks, widespread illegal mineral marketing, lack of technical skills and backward technology and absence of political commitment at various levels to implement the policies and laws (Hilson 2016; Levin, 2014; García *et al.*, 2015). Furthermore, lack access to market information, unsafe mining operation, weak institutional capacity and price fluctuation of minerals, absence of site marketing and insufficient provision of credit service are among the bottlenecks which can hamper the overall performance of the sector (Siegel and Veiga, 2009; AU-African Mining Vision, 2009; Hilson, 2010; World Bank, 2013). Despite its contribution to the livelihood of the rural community and national economy, the ASM sector has obviously an adverse effect on human and natural environment (Hilson, G.2016.) The UNEP (2017) had reported that miners were vulnerable to various mining related risks such as incidents, deaths, and various diseases due to poor occupational safety and limited awareness on the adverse effects of ASM. Besides, soil degradation and loss of the biodiversity are the common phenomenon in the mining sites which ultimately resulted in irreversible effect on the life of human beings (UNEP, 2017).

Hayes (2008) and Siegel and Veiga (2009) argue that the performance of the mining sector mainly depends on good mineral governance (Hilton, 2005a and Hilson, 2010). A study conducted by Wouterse & Taylor (2008) revealed that many of the policy and regulatory frameworks, which are formulated to manage the mining sector have confusing mandates. In his study, Hayes and Wagner (2008) argues that the policy and regulatory frameworks are not in line with the customary conditions of the local people; they lack specificity and are unfit for the purpose of regulating the sector. Moreover, absence of clear guidelines, lack of transparent and accountable governance system of the mining sector resulted in rampant illegal mineral marketing and deteriorating the volume of mineral supply to the formal market agents at local level and this situation has resulted in declining the volume of export and foreign exchange earnings (Beyene, 2016;Weng,2015).

It is obvious that agriculture is the main stay of the Ethiopian economy. Nonetheless, due to climate variability, backward farming, population pressure, land scarcity, fragmentation and ecological degradation, the sector is unable to feed its population and millions are suffering from poverty and food insecurity in the rural areas (MoFED, 2016). Thus, the rural communities are forced to look for alternative strategies to support their livelihood (FAO and WFP, 2010; World Bank, 2014). In

many rural areas of the country, the ASM sector has become an avenue for income generation and supplements the livelihood of the rural people. For this purpose, the current government has adopted policies and regulatory frameworks<sup>7</sup> to govern the sector by incorporating it to GTP I and GTP II. Nonetheless, more than 94% the sector was operating under the informal activity (Beyene, 2016). This is so because the ASM sector is highly plugged to smuggling precious minerals via informal market which ultimately resulted in declining mineral supply to the formal market agents (NBE, 2017).

In his Situation Analysis on ASM, Beyene (2016), the volume of gold marketed through legal channel was found 39%. Recently, the national income earned from gold has been deteriorated drastically. The MoMPNG report (2017/18) indicated that the ministry was planned to generate 600 million dollar in the 2016/17 but only 2.6% (15.81 million dollar) of the plan had been achieved. Similarly, in Tigray Region, it had been planned to supply 1,200kg of gold from artisanal and small scale gold miners to the NBE in the year 2016/17 but the actual performance was found 124kg which was 10.33% of the plan<sup>8</sup>. Therefore, one of the motives to conduct this study is to investigate the major factors which hinder gold supply to the formal marketing system and come up with policy options to minimize the problems related to gold supply in the study area.

Much literature indicates that there are contending views on the role of ASM in ensuring food security of rural households. In this case, there is a knowledge gap on whether the ASM sector ensures food security or not. Globally, more than 150 million people depend their livelihood in ASM activities by generating income and ensure their food security (World Bank, 2005; AMV, 2009). However, Nabaasa (2016) and Hentschel (2002) oppose the above argument justifying that households who engaged in ASM are less food secured than those who engage in agriculture. This is so because the ASM sector is associated with several challenges that tend to nullify the food security of the miners (Nabaasa, 2016; Hentschel, 2002). In Ethiopia in general and study area in particular, almost no research work has been conducted on the nexus between ASM and its impact

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<sup>7</sup>The major proclamations and regulations related to the sector include: Mining Operations Proclamation No. 678/2010 which has been amended under Operations proclamations No.816/2013; Transaction of Precious Minerals Proclamation No. 651/ 2009; Mining Operations Regulations No. 182/ 1994; amended under Regulations No. 27/ 1998; Mining Income Tax Proclamation No. 53/ 1993; amended under Proclamation No. 23/ 1996.

<sup>8</sup>Tigray Regional National state office of Mining and Water resource, 2017/18

on food security. Thus, the study is specifically intended to examine the impact of the ASGM participation on food security of households in the study area.

In the same token, there are contending views on the role ASM and poverty reduction of the miners. For some, ASM is a poverty driven activity and has vital role in reducing poverty of the rural people (World Bank, 2005; Mwaipopo et al, 2004). ASM has a positive association with poverty reduction as it provides the rural poor with additional income to supplement their livelihood (Hilson, 2012; World Bank, 2014). On the contrary, Cordoba (2013) and Wall (2009) disagree with the above arguments for the reason that ASM exacerbates poverty and miners are poor and have remained poor despite working as miners for many years. Research works related to the impact of ASGM on the poverty situation of the miners' are limited and hence, this study is aimed at analyzing the impact of ASM on poverty reduction of households in the study area.

Vulnerability of households to food security, poverty and climate variability have been intensively carried out by several researchers such as Getachew (2018), Alebachew & Aklilu (2012), Birara et al. (2015) and so on. However, research studies on the vulnerability of livelihood assets (human, natural, financial, physical and social) to the effects of ASM have not yet investigated at national level and the study area. Thus, the last specific objective attempts to assess the vulnerability context of livelihood assets to the effects of ASGM in the study area.

To date, very little research works have been undertaken on ASM in Ethiopia and in the study area. Among others, a Situational Analysis on ASM was conducted by Beyene in 2016; Lootable Miners and Insecurity by Gezae Desta, 2010; Artisanal Mining and Its Impact on Environmental Degradation by Hagos, et al in 2009. However, contextually, these research works didn't address the issues of mineral governance of the ASM sector which hindered the performance of the mining sector. They were unable to investigate the major factors affecting gold supply to formal market agents and the reason why the amount of gold had been declining from time to time. The previous studies were also unable to investigate the impact of ASGM on ensuring food security and reducing poverty and they didn't deal with the vulnerability of livelihood assets to the effects of ASGM in the study area. Therefore, this dissertation is expected to fill the above stated research gaps of the ASM sector. Methodologically, the preceding studies were done using qualitative research methods. Thus, this dissertation has tried to fill the methodological gap using both quantitative and qualitative methods of data collection and analysis. In this study, multiple methods and techniques have been applied to measure the key variables related to governance of the mineral sector, mineral

marketing, food security, and poverty and livelihood vulnerability of livelihood assets. To put in nutshell, conducting a comprehensive study in artisanal and small scale gold mining and its impact on the livelihood of rural households is believed to have paramount importance in identifying the bottlenecks related to ASM and come up with sound policy responses to improve the performance the mining sector. Ultimately, this research work is expected to bridge the existing research, methodological and literature gaps as well.

## **1.2. Basic Research Questions of the Study**

The basic research questions of the study are outlined below:

1. What are the socio-economic conditions of the sample households in the study area?
2. Does the existing mineral governance effectively regulate the ASM sector?
3. What are the factors which determine the Artisanal and Small-scale Gold Supply (ASGS) to the formal market agents in the study area?
4. What is the impact of ASGM on food security status of households in the study area?
5. What is the impact of ASGM on the poverty status of households in the study area?
6. What is the adverse effect of the ASGM participation on the livelihood asset of the participant and non-participant households in the study area?

## **1.4. The Objective of the Study**

### **1.4.1. The overall objective of the study**

The main objective of the study was to investigate the impact of ASGM participation on the livelihood of the rural households in Tigray National Region State.

### **1.4.2. The specific objectives**

The detailed objectives of the dissertation are:

1. To analyze the socio-economic situations of the households in the study area
2. To assess the governance aspects of artisanal and small scale gold mining in the study area
3. To investigate the determinants of ASGS to the formal market agents in the study area
4. To examine the impact of ASGM on food security status of households in the study area
5. To analyze the impact of ASGM on the poverty situation of households in the study area
6. To compare and contrast the adverse effects of ASGM on livelihood assets of the participant and non-participant households in the study area.

## **1.5. Significance of the study**

This dissertation is expected to have paramount importance in bridging the empirical or research gaps, methodological and knowledge gaps of the ASM sector. The ASM sector has been overlooked by researchers, policy makers and governments until recently and hence, there are empirical or research gaps in the sector. Of course, little research works have been undertaken but they lack multiple research methods to address the challenges pertaining to the ASM sector. Besides, there is a practical knowledge gap between what is perceived about the ASM and practically existed at the grass-root level. Therefore, this study is expected to narrow the stated gaps and findings of the study could serve for policy input as well as further research activities.

In light of the scarcity of reference materials pertaining to the Ethiopian mining sector, the study is expected to encourage researchers and draw their attention for further research of the government and policy makers to investigate and address issues that hinder the performance of the sector. Besides, the findings would be useful for government offices, stakeholders, development agencies and NGOs. The findings of the study are able to provide pertinent information for policy intervention on the potential issues such as governance, marketing, food security, poverty and vulnerability of livelihood assets to ultimately improve the livelihood of the rural households. Besides, the findings could also be used by the federal and regional governments to review the existing ASM legal and regulatory frameworks in its local context.

## **1.6. Scope/Delimitation of the Study**

The Artisanal and Small-scale Mining (ASM) encompasses the mining activities of different valuable miners such as gold, diamond, tantalum, gemstone and the like. This dissertation is delimited itself to Artisanal and Small-scale Gold Mining (ASGM) participation. Thematically, this dissertation has analyzed ASGM and its impact on the livelihood of the rural households and aims to identify the potential challenges related to it. Geographically, the study is delimited to some purposively selected *woredas* where the prevalence of ASGM participation is high in the region. Hence, it emphasized on three *woredas* and fifteen *tabias*/rural kebeles of the region because dealing the ASGM at national level was found beyond the capacity of the candidate as the work desires huge resource, energy and time. The study also delimited itself to households who had been participating in ASGM and are dwellers in the selected *tabias*<sup>9</sup> or rural kebeles. Since

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<sup>9</sup> Local administration which is lower than *woreda* and consisting many *Kushets* (villages) under it, according to the TNRS arrangement.

the study has focused on the impact of ASGM on the livelihood of rural households, migrant miners were not included because they are highly movable from place to place.

### **1.7. Limitation of the study**

There have been many constraints in course of conducting this dissertation. Topographically, the selected *woredas* are located at lowland areas where temperature ranges from 30-40C<sup>0</sup>, especially; January to June, ASM operations are difficult. Hence, data collection process was found so hard. Gathering information from households, FGD, KII wasn't found as anticipated. Officials who were selected for KII were reluctant to give information and most of them ask permission from their immediate supervisor for interview which prolonged the interview schedule. Forming a focused group discussion was not as such easy for different reasons. Members of the FGD were afraid of being caught by local administrators. The unlicensed miners were unwilling to form FGD and give information as most of them operate informally. Generally, both legal and illegal miners were reluctant to give information about the amount of money they earn and were afraid of being exposed to media outlet. The illegal miners were hesitant for interview because they were worried of being taxed and asked if they have license to operate and consequently being arrested. Moreover, physical access to some of the ASGM sites was difficult and appeared to be dangerous. By its nature, the ASM activity is mostly located at remote areas and sometimes there are no access to car transport and the candidate was using motor cycles for field visit and data collection activities and hence, lack of access to transport was one of the limitations that the candidate faced. The budget allocated to undertake the study was not as expected and hence, one of the severe challenges faced by the candidate was financial constraints.

### **1.8. Structure of the dissertation**

This dissertation is organized into eleven chapters. The first chapter discusses the background of the study, statement of research problem, research objectives, research questions, and significance of the study and so on. It explained the existing research gaps, knowledge and methodological gaps. Chapter two focuses on the theoretical, empirical and conceptual frameworks of the subject matter of ASGM. Chapter three presents the physical settings of the study area and methodology of the study. It thoroughly discusses methods and techniques employed to collect and analyze both the qualitative and quantitative data. Chapter four describes the socio-economic condition of sample households in the study area. Chapter five examines the overall governance practices of ASGM and key challenges which hamper the performance of the ASGM sector in the study area. Chapter

six analyses the determinants of ASGS to the formal market agents at local levels. Chapter seven discusses on the impact of ASGM participation on food security status of households. Chapter eight emphasizes on analyzing the multidimensional poverty situation of households in the study area. Chapter nine presents and devotes the vulnerability context of livelihood assets to the effects of ASGM and finally, concludes on the key points and recommendations are forwarded to address the bottlenecks in the ASM sector.

### **1.9. Operational Definition of Key Terms**

*Artisan and small scale gold supply to the formal market agents:* in the context of this study refers to the marketing process whereby artisanal and small-scale miners supply gold to the formal market agents such as local banks, licensed agents at local levels.

*Artisan and Small Mining(ASM):* is a kind mining operation carried out by individuals or cooperatives which are mostly of manual nature, low technology, labor intensive, no mechanization and may be legal/formal or illegal/informal (Proc.678/2010;Hilson,2010).

*Participant households:* in the context this study, households who were non-migrants but participating in either legal/formal or illegal/informal gold mining in the study area.

*Non-participant households:* in the context this study, households who were non-migrants and not participating in ASGM in the study area.

*Food security:* refers to a condition whereby people have access to adequate and healthy food that satisfies their dietary requirements for an energetic and healthy lifetime (FAO, 2007).

*Household:* in the Ethiopian context, a households consists of a person or group of persons who live together in the same housing unit and have common cooking arrangements (CSA, 2007).

*Food insecurity:* limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways (WFP, 2008).

*Governance:* in the context of this study, governance refers to structures and regulatory frameworks which have been designed to ensure the rule of law, participation, effectiveness, transparency and accountability, responsiveness and inclusiveness of the sector (UNDP, 2009).

*Head of household:* in this context, refers to a person who is able to administer the household and make decisions on matters that affect all or members of the household (CSA, 2007).

*Livelihood:* comprises livelihood assets (human, financial, natural, physical and social), capabilities, a set of economic activities, self-employment, and wage employment by using one's endowments to generate adequate resources to make a living (Chambers and Conway 1991).

*Mining*: refers to any activity directed at extracting minerals from a mineral deposit on or in the earth, water, any residue deposit or residue stockpile by any method, any operation incidental thereto, such as storage, treatment, processing ,transportation and disposal (Proc. 678/2010).

*Propensity score matching*: is a method of evaluating the impact of certain program intervention by asking the question ‘what would have happened to those receiving the intervention if they had not received the program? It shows the counter factual relationship between the two groups.

*Vulnerability*: in this context, vulnerability is the susceptibility of livelihood assets as a result of artisanal and small-scale gold mining participation.

*Multidimensional poverty*: measures deprivations experienced by poor people in their daily lives such as poor health, lack of education, inadequate living standards and so on.

### **1.10. Ethical Considerations**

Ethical guidelines had been employed during data collection processes which include informed consent of participants who were asked to give their consent. In all cases, consent had been obtained from potential respondents prior to administration of the survey. Confidentiality has been another issue of research ethics and all information to be collected from participants has been held in strict confidence to protect participants from any harm related to their interview. Interviews have been recorded from the key informants and kept confidentially. An actual name of participants has not been used in any aspects of this research, instead, pseudo names have been used for better protection of the key informants; and potentially sensitive issues, such as political or personal nature have been cautiously approached and guided by discussion with enumerators and co-researchers during the data collection process.

## CHAPTER TWO

### REVIEW OF RELATED LITERATURE

#### 2.1. Theoretical Review of the Study

This part focuses on the theoretical concepts and approaches that have been used in the study based on the review of the available literature. These theories serve as bases upon which the study has been conducted. The selection of these theories depended on their appropriateness, ease of application, and their explanatory power of the phenomenon under study. The study reviewed the sustainable livelihood framework and other theoretical explanations such as theory of informal sector, tragedy of commons, source curse, and so on to examine the impact of ASGM on the livelihood of the rural households in the study area.

##### 2.1.1. Concepts and definition of artisanal and small-scale mining

It is difficult to provide a full-fledged definition of Artisanal and Small scale Mining (ASM) as it depends on the context of its operation (Aizawa, 2016). In the end of 20<sup>th</sup> century, many experts and researchers had been trying to devise universal definitions of ASM but no agreement has been reached (Mwaipopo et al, 2004). According to Siegel and Veiga (2009), countries have different definitions for ASM based on different criteria.<sup>10</sup> Moreover, scholars have been trying to define the ASM sector in terms of capital investment, number of workers employed, volume of production, depth of the extraction and level of mechanization used (Hentschel *et al.*, 2003; Hilson 2010). The World Bank (2013) had tried to define ASM as poverty driven and labor-intensive activity, low barrier to entry, and have no mechanized production system. Dreschler (2002) defined ASM activity as a rudimentary operation of extracting minerals using locally available manual equipment. Hinton (2010) in his view defined ASM as an activity which applies outdated methods of extracting minerals from the earth's surface. According to ECA and African Union (2008), there is no commonly agreed definition of ASM and hence, countries have their own criteria in defining ASM based on their specific context.<sup>11</sup>

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<sup>10</sup>Stage of mechanization (Brazil, Burkina Faso Ghana and Sri Lanka); size of concession(Ghana, Zambia and Zimbabwe); depth of working (Colombia, Senegal and Ethiopia); capital investment (Argentina, Mexico, South Africa, Pakistan and Thailand); levels of employment (Chile); levels of production(Philippines and Senegal).

<sup>11</sup>Brazil(Level of mechanization, mode of occurrence); Burkina Faso (Level of mechanization); Chile Legal(structure, production levels); Cote d.Ivory (Level of mechanization); Ethiopia(Annual production, level of mechanization); Ghana(Capital investment, number of participants);

The ASM has different names in different countries and hence, researchers have described the ASM sector differently as it varies from country to country, from region to region (Hilson, 2010).<sup>12</sup> Some researchers argue, the ASM sector is a dirty, dangerous, disruptive occupation and hence, it should be discouraged (Hentschel *et al*, 2002; Nabaasa, 2016). Contrarily, others claim the sector is an essential economic activity which can smooth the livelihood of the rural households (World Bank, 2013; Hilson, 2016). In many continents, such as Africa, Asia and most Latin American, artisanal and small scale mining has become a cornerstone of economic activities and associated with rural livelihood (Telmer, 2009).

In Ethiopia, mining policies and regulatory frameworks have been endorsed to enhance the performance of the mining sector. In most cases, artisanal mining and small scale mining are used interchangeably because both of them are labor intensive and use low level technology. Proc. No. 678/2010 article 2(18) and 2(35) stipulate that:

*“Artisanal mining means a mining operation carried out by individuals or cooperatives which are mostly of manual nature and that do not involve the engagement of employed workers. However, small scale mining means any mining operation of which the annual run-off mine ore does not exceed 100,000m<sup>3</sup> for placer operation and 75,000 tons for primary deposit mining gold, platinum, silver and other precious minerals.”<sup>13</sup>*

The above quotation signifies that ‘artisanal mining’ stands for mining activities which are carried out manually whereas ‘artisanal and small-scale mining’ implies a bit advance and extensive. Anyways, the study considers both artisanal and small scale mining operations which are being taken place in the study area. ASM is an activity largely practiced in rural areas by people who may not necessarily have education, skills and modern equipment (IISD, 2017). The local people can easily be legal miners by having a license which doesn’t require start-up capital, technical competence, skills and experience (MoM, 2012; Proc678/ 2010).

Artisanal and small-scale mining is an activity which encompasses both legal and illegal miners who (Hilson, 2016). Legal miners are licensed to operate mineral extracting activities and have the duty to pay royalty whereas illegal miners are unlicensed to operate but involved in mining activities and may not pay royalty to the government (Hinton, 2005; Hentschel et al., 2002;

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*Guinea(Type of minerals); Mexico(Production levels and value); Philippines (Level of mechanization, capital investment); Suriname(Mode of occurrence, level of mechanization); Senegal(Depth of work, crude production levels); South Africa( Capital investment).*

<sup>12</sup>*Ninjas in Mongolia, Zama-Zama in South Africa, Pork-knockers in Guyana, Pirquineros in Latin America, Pocket Miners in the Phillipines, Galamsey in Ghana, Panners in Zimbabwe, Nyonga/Ubeshi in Tanzania, Warare in Ethiopia, Diggers in Sierra Leone, Cresseurs in DR Congo, Orpailleurs in many Francophone Africa and Garimperios[wild cat] in Southern Lusaphone countries (D’ Souza, 2009:1). And Gurandils’ of Indonesia means ‘people who leap from cliff to cliff’ or ‘people who dig holes like rats’*

<sup>13</sup>*This Proclamation may be cited as the "Mining Operations Proclamation No. 678/2010".*

D'Sourz, 2002). In Ethiopia, licensed miners are those miners who have registered as legal miner according to the mining law (Pro.816/2013). However, the informal mining operations do not fully comply with the policies, legislation and regulations (Barreto, 2011). Whereas illegal mining are those miners who are unregistered in accordance with the mining law (Proc.No.816/2013) and hence, they are extracting precious mineral informally and unable to pay royalty to the government.

### **2.1.2. Governance and natural resource management**

Governance is a composite system of interactions among structures, traditions, functions, and processes (UNDP, 2002).It encompasses traditions and institutions by which authority is exercised and it involves the capacity of the government to effectively formulate and implement sound policies (Kaufmann et al., 2005). Governance is the process of decision making and decisions are implemented or not and it aims at protecting the natural resource by implementing the principles of governance such as participation, rule of law, transparency, accountability, equity, effectiveness and so on (UDED,2009). It is the corner stone for sound natural resource management through the application of its core principles to ensure sustainable of resource management (Patti, et al., 2011).

Ineffective management of mineral resources can often lead to overexploitation and eventually the degradation of resource and eventually, resulted in irreversible consequences up on the life of human beings (UNEP, 2017). Elite capture of resource revenues can prevent the benefits generated by natural resource wealth from reaching poor people. Insecure and biased property rights regimes can foster social and economic exclusion and generate conflict. All of these processes undermine poor people's livelihoods and increase their poverty and marginality. Matioli (2011) says the importance of natural resources to the economy and combating poverty cannot be overstated. Thus, natural resources management including water, land and agriculture, forestry, sound environmental management and wildlife conservation are the key to sustainably preserving and improving the livelihoods of millions of rural household (Hilson,2010). The local governance capacities are essential and shall not be overlooked. For this purpose, the government shall enforce the mining policies and regulatory frameworks to promote good governance in mineral resources. Thus, the importance of local governance capacities cannot be overemphasized (EU, 2017).

#### **2.1.2.1.Mineral governance and artisanal and small-scale mining**

Kalindekafe (2013) argues that artisanal mining can create economic benefit, urban development, infrastructure development, improves livelihood of the rural community and wealth creation

through time. Thus, good mineral governance is a prerequisite for enhancing the institutional capacities to increase efficiency and reduce the negative effect ASM (UNEP, 2017). The management of scarce resources is the key governance challenge facing human beings today and hence, people must understand the consequences of mismanaging mineral resources (Kalindekafe, 2013). Cordoba (2013) argues that ASM is a complex activity and shall be given attention to enhance human development since it is at the heart of any conservation effort. Further, the behavior of miners shall be shaped up to the standards of environmental protection and ultimately linked to stimulate socio-economic benefits of the local people. In order to make the standards workable, miners shall be aware of their rights and obligations (Kalindekafe, 2013; Raghunandan, 2010).

The UNEP (2017) found out that there was a need to look at sustainability in mineral resource development from a holistic perspective and hence, sustainability in ASM shall encompass social, environmental and economic dimension. The ASM sector is a diversified sector which exposed to poor governance, informal operations and illegal marketing activities. The local people are able to supplement their livelihood from the mining sector. However, in order to improve the quality of life of the miners, the policies and regulations shall be framed to enhance ASM and ultimately, the living standards of the local population could be improved (Kalindekafe, 2013; UNEP, 2017).

### **2.1.3. Concepts and definitions of mineral marketing**

The term 'market' has different meanings depending on its context. Bain and Howells (1988), define 'markets' is an arrangement in which things are exchanged. A market consists of buyers and sellers with facilities to communicate with each other and many not need specific place (Crammer and Jensen, 1997). Marketing is the process of planning and executing the consumption pricing, promotion and distribution of idea, goods and services to create exchange that satisfy individual and organizational goals (Lemma Desalegn, 2002). Marketing system involves both the physical distribution of economic input and products and the mechanism of process or coordinating production and distribution (Andargachew, 1990). The marketing channel begins from the point of product origin to consumer with purpose of moving products to their final destination (kotler and Armstrong, 2003). Marketing channel is the set of interdependence among organizations or individuals along with the chain and transfer of products from producer to consumer (Lemma Desalegn, 2002).

### **2.1.3.1 Marketing approaches**

There are three essential marketing approaches in most market interaction. Functional approach deals with marketing the process getting product from the producer and distributed to the consumer (Crammers and Jensen, 1997). The institutional approach focuses on the study of the various institutions, which perform the marketing activities (Ibid: pp.45). The commodity approach focuses on what is being done to the product after its transfer from its original production place to the consumer (Kohls and Uhl, 1985). The development of stable and reliable marketing system is an important element in commercialization and specialization of product in any specific sector. To study how markets are functioning, many researchers used the approach known as Structure-Conduct-Performance approach (Kotler and Armstrong, 2003).

In the context of ASM, small-scale miners are often more dependent on the prices fixed by local buyers and intermediaries than global market prices and are less vulnerable to international commodity price fluctuations (Siwale & Siwale 2017). Miners usually need to sell their mineral products quickly with low prices to resolve their immediate problems and they are exploited to intermediaries, brokers and black market hoping to get fair price due to lack of effective protection from the government (Artisanal Gold Council, 2017). Various factors can be a cause for the inefficiencies of mineral marketing system. These are technical barriers such as lack of market information, government programs and policies (ICMM, 2012). In Ethiopia, miners are being affected by low market price and most of are not in a position to take advantage of seasonal price differences because of limited income to cover their financial commitments (Beyene, 2016).

### **2.1.3.2. Factors affecting ASGS to the legal market in Ethiopia**

The contribution of ASM to the national economy had been insignificant in previous regimes since mining was highly controlled by the central government (Engda, 2011; MoM, 2012). However, right after the 1991, millions of miners are participating in extraction various minerals and benefited from the sector. Accordingly, the mining sector had accounted for 5.8% and 5.5% foreign exchange earnings in 2007/8 and 2008/2009 fiscal years respectively (MoFED, 2010). It should be noted that 65% of the foreign exchange earnings came from ASM (Beyene, 2016). Nonetheless, in the last four years, the volume of gold supply has been declining drastically from time to time for different reasons. Therefore, the major factors affecting the artisanal and small-scale gold supply to the legal market are reviewed below.

Distance to the nearest market center and mining sites are some of the factors affecting gold supply to the formal market. The more the distant of the market center, the lesser their interest to the formal market to sell their gold product (Hilson, 2010). Besides, most mining sites are mainly located in the remote areas and hence, households refrain from participating in ASM (Beyene, 2016). A study conducted by Hentschel, T. et al (2002) indicated that the further miners' residence from mining sites, miners have the lesser motive to participate in ASM. Limited access to means of transportation from the mining sites to the market centers is another factor affecting gold supply to the formal market (Hinton, J., 2006). Access to market information plays a key role in market participation of miners to supply gold to the formal market. Put differently, miners usually tend to sell their gold products to black market because they lack of access to reliable source market information about their gold product (Perks, R. (2011). Moreover, price fluctuation of gold influenced gold supply to the formal market.

Artisanal and small scale gold supply has also been influenced by lack of good governance because the activity is located in the remote areas and such situation created poor regulatory mechanism which eventually resulted in smuggling of mineral resources (Seccatore, et al, 2014). Thus, gold produced by artisanal miners easily exposed to the informal market (Elfadil, 2015). Other factors such as lack of commitment from the government to regulate the marketing issues of gold and misperception of miners towards the formal market would result in widespread illegal mineral marketing (Levin, 2014). Many states have implemented incentive schemes to motivate artisanal gold miners to increase mineral supply and foreign exchange earnings. In Zimbabwe, the government incentivizes 5% for small scale miners who deliver their mineral product to the formal market and eventually, the share of small miners increased from 40 percent to about 50 percent. (Janet Shoko, 2014). Ethiopia pays 5% premium on international gold prices and also implemented payments based on 30 days pick price for gold supplied to the NBE. However, these initiatives have been found less effective to bring the desired outcome (NBE, 2017).

Reports show that illicit trade of gold in Ethiopia has been aggravating from time to time due to rampant contraband activities and hence, the volume of gold supply to the legal market agents has become deteriorating (Beyene, 2016). A research work done by Fabian Stähr and Philip Schütte (2016) in Ecuador indicated that 15-20 tons of gold was produced annually. Out of this, 6-8 tons of gold was marketed illegally every year. In Sudan, more than \$4.5 billion worth of artisanal gold was smuggled between 2010 and 2014 to the United Arab Emirates (Steinmüller, 2017). Similarly,

in DRC, 20-30 tons of gold is extracted annually by Congolese artisanal miners each year, but only about 12-18 tons are officially exported while the remaining portion is traded in the black market (Kira Zalan, 2017). Beyene (2016) has estimated that Ethiopia lost around 9 tons of gold every year due to illicit trade and the sector is exported to black market. Miners have a misperception that the benefit obtained from the illegal market is higher than the benefit obtained from the legal market. A study conducted by Hilson (2010) indicated that miners sell gold in black market as price is fixed by a bank which is lower than the price of illegal market.

License is another key variable that affects the supply of gold to the formal market. It is difficult to regulate the illegal miners to supply their product to the formal market unless they are licensed (Steinmüller, 2017). In Ghana, 70% of gold had been undertaken by illegal gold miners and gold traders (Hilson, 2010). In Ethiopia, 94% of the gold miners are engaged in illegal gold mining and are not licensed (Beyene, 2016). Many ASM have very limited access to credit service for different reasons and hence affects the limits the supply of gold to the formal market (NBE and CBE, 2017).

#### **2.1.4. ASGM participation and food security status of households**

##### **2.1.4.1. Concepts and definitions**

The term food security was first used in the World Food Conference in 1974 due to the food crises and major famines in the world. Up until the mid-1970s, food security had been assumed as adequacy of food supply at global, national and local levels (Maxwell *et al*, 2006). Evidences show that during the last two decades, food production has been increasing in the world but such large amount of food at global level didn't give guarantee to food security at national level (FAO, 2007). Likewise, availability of enough food at national level didn't necessarily ensure household food security. Despite food production has been increasing from time to time, food insecurity, malnutrition and hunger and much more serious problems would remain the main agenda in the globe today (Barrett, 2002). International organizations, researchers and scholars tried to define food security but still the term remains blurred. However, food security is commonly defined as:

*“Physical access to food by everyone at every time to adequate food for healthy lifetime (World Bank, 1986). According to FAO (1996), food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. WFP (2009) defined food security as “a condition that exists when all people, at all times, and are free from hunger. Food security is defined as “a condition where people have adequate food to satisfy their n nutritional needs to alive active, healthy and active lifespan” (World Food Summit, 1996, USAID, 2008).*

Food insecurity, on the other hand, denotes the lack of food security, and it varies from famine to erratic hunger and to undefined food supply (Maxwell *et al*, 2006). It can be chronic and transitory. Chronic food insecurity means that a household runs a continually high risk of inability to meet the food needs of the household members (Ibid: pp.23). It is a persistently inadequate diet caused by the continual inability of households to acquire enough food needed for healthy and active life, either through market purchases or through own production (FAO, 2007). In contrast, transitory food insecurity is a temporary decline in the household's access to needed food due to factors such as instability in food prices, decline in products or incomes (Devereux, et al, 2006). A household is said to be food insecure when its consumption falls to less than 80% of the daily minimum recommended allowance of caloric intake for an individual to be active and healthy (UNDP, 1992). According to FAO (2007), four main dimensions of food security can be identified. Food availability tries to address the quantity side of food security and can be influenced by food productivity, food trade and levels of food stock where food is available. Food Access concerned with adequate supply of food at the national, international and household level (IFPRI, 2008). Food utilization is understood as sufficient energy and nutrient intake by individuals or a household. Food stability focuses on the three dimensions over time. Despite food intake is sufficient, he or she may not have an adequate access to food on a regular basis and hence, he or she is food insecure (WFP, 2008).

#### **2.1.4.2.Theoretical approaches of food security**

**The Food Availability Decline (FAD):** had been a dominant theoretical approach for food crises since the 18<sup>th</sup> century until the year 1980. Sen (1980) defined FAD as “*the availability decline per capita of food for consuming unit*”. The core argument is that any factor which disrupts food production can cause famine. Food availability decline for an extended period by definition constitutes of famine (Degafa, 2002). Thus, hunger and famine do not necessarily evolve from lack of food supplies in the market but lack of resources to produce or purchase them.

**The Food Entitlement Decline (FED):** focuses on famine analysis from supply side to the demand side (Devereux and Maxwell, 2003). The core argument of this approach is the mere presence of food in the market does not entitle a person to consume it and thus starvation can occur. For example, the Bengal famine of 1943, the Ethiopian famine of 1973 and 1984, and the

Bangladesh famine of 1974 occurred due to lack of entitlement rather than due to lack of availability short fall (Gebrehiwot, 2012).

#### **2.1.4.3. Measurements and indicators of food security**

Measuring food security has paramount importance for governments, researchers and policy makers as it is linked to wellbeing and social security. It is also essential to identify households or individuals whether they are food insecure or not, assess the severity of food shortfall and characterize the nature of food insecurity (Nigussie et al., 2012). Rapid, accurate, cross-contextual indicators of food security have been developed over the past decade and have been applied in different contexts. There are various measurements of food security and some of them are:

**Food Energy Intake (FEI) approaches** is an alternative measurement of food security of households or individuals (EHNRI and FAO, 1995-97). The FEI approach has also been used by researchers to identify food secure or insecure households in a society by finding the food energy intake at which an adult attains (Ravallion and Bidani, 1994). In the identification of the food secure and insecure of households, the study employed food energy intake approach (FEI) to quantitatively measure the food security of the sample households in the selected *woredas*. This could be calculated as daily calorie requirement per adult equivalent per day. According to the EHNRI, 2200 kcal adult equivalent per day per person was set as minimum acceptable weighted average.

**Household food insecurity access scale (HFIAS):** has been developed by FANTA in 1997 to capture households' behavior of signifying insufficient quality, quantity and anxiety over insecure access (Maxwell et al., 2013). HFIAS had been applied based on the assumption that food insecurity can be measurable using past experience and described to categorize households by level of food insecurity (FANTA, 2006). It's assume that food insecurity situation is computed and quantified using survey and summarized in a scale developed by world food program (WFP, 2008). HFIAS approach constitutes a direct measure of food access at the household level and has generally used either for 12 months, 6 months, or 30 days recall periods (Coates, 2007).

**The food consumption score (FCS):** has been used by the World Food Program (WFP 2009) to capture the number of different food groups that people eat and the frequency with which they eat them in seven days, and involve weighting the food groups (IFPRI 2006, Coates et al. 2007). This study employed FCS to analyze food security status of households in the study area. The FCS has

applied the 7 days recall period with frequency information and weighted categorical cut-offs (FANTA 2006, FAO and WFP, 2010).

### **2.1.5. ASGM and multidimensional poverty status of households**

The understanding poverty has become very complex task for governments, policy makers and researchers. Development can be realized if poverty is reduced or eradicated and hence, the world is striving to eradicate extreme poverty by 2030.<sup>14</sup> There is no consensus on both the meaning and measurement of poverty and hence, researchers, policy makers and practitioners defined poverty differently (Laderchi et al., 2006). Some defined poverty as deprivation of income and others defined it as deprivations of not only income but also other basic necessities such as shelter, health, water and so on (Alkire and Santos, 2010). The concept of poverty, its measurement is also changing through time and nowadays one can find a number of dimensions in the concept of poverty (UNDP, 2004). Thus, poverty can be measured using objective and subjective techniques.

#### **2.1.5.1. Measuring the poverty status of households**

Various techniques can be used to measure the long and short run poverty situation of individuals or households. In dealing with poverty, income approach, consumption expenditure approach and multiple deprivation approach can be applied depending the topic under investigation.

**Income approach:** In this approach, the income of the households or individual determines if the household or individual to be poor or non-poor providing that poverty was defined as lack of adequate income to meet minimum basic needs (Townsend, 2006). The poor can be identified from the non-poor using international poverty line (1.25 Dollar) and Purchasing Power parity (PPP) conversion factor (UNDP, 2006). Thus, once the poverty line is set, people below the poverty line are leveled as poor but above the line non-poor.

**Consumption expenditure approach:** poverty is viewed as lack of subsistence and nutritional needs for physical efficiency or material needs for physical survival and efficiency. In this case, the food consumption bundle just adequate to meet the required food energy requirements shall be determined based on national standard kilocalorie (Lopez (2008).

**Multiple deprivations approach:** Historically, poverty has been commonly measured using income or consumption approach but recently multiple measurements are used to analyses poverty.

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<sup>14</sup>In United Nations Development Program International Poverty Center (2006). *Poverty in focus: what is poverty? Concepts and measures.*

As a result, different techniques and methods have been developed after Sen's seminal work on poverty, famines, entitlements, and deprivations (Sen, 1981). Among others, MPI has been developed by Oxford Poverty and Human Development Initiative (OPHI) as a measurement of acute global poverty (Alkire 2010; UNDP, 2010). MPI is an index was designed to measure acute poverty situation of households or individuals using major dimensions (education, health and living standards) and about 10 indicators (Alkire and Santos, 2016). MPI combines the incidence of poverty (H) which is described as the proportion of people who experience multiple deprivations, and the intensity (A) of their deprivation (Alkire & Santos, 2010). The incidence (H) of poverty is vital sources of information but knowing the incidence poverty is not adequate to have full-fledged information unless the depth and severity of poverty is known (Alkire, and Foster, 2011). Therefore, MPI has been used to assess the effects of ASGM on poverty situation of the households in the study area using.

#### **2.1.6. Propensity score matching (PSM) technique**

Any impact valuations of a program intervention is evaluated using different estimation methods to measure the impact of counterfactual. Propensity Score Matching (PSM) technique has gained popularity in recent years for its potential to remove substantial amount of bias from non-experimental data (Ahmed, 2015). PSM is advantageous as it summarizes all the differences by computing the treatment effects. It also summarizes the conditional probability of participation given pre-treatment characteristics (Rosenbaum and Rubin, 1983). There are certain processes to be followed while using PSM. The first step in estimating the treatment effect is to estimate the propensity score. In order to obtain p-scores, any standard probability model can be employed such as probit, logit, multi-nominal logit. However, which choice model is appropriate depends on the nature of the program being evaluated. Since the tendency to participate is unidentified, the first task in matching can be to estimate this p-scores (Rajeev *et al.*, 2007).

##### **2.1.6.1. Opting for of matching algorithm of respondents**

There is the best matching algorithm and the methods differ from each other with regard to the outcomes of the control groups while estimating the counterfactual outcome of the treated, the algorithms provide reliable estimates of the ATT beneath the common support region (Caliendo and Kopeinig, 2008). Besides, when there is substantial overlap in the distribution of the propensity

score between the comparison and treatment groups, most of the matching algorithms yield similar results (Dehejia and Wahba, 2002).

**Nearest Neighbor Matching (NNM):** It is the simplest and straightforward matching algorithm. In NNM, a household from a comparison group can be chosen as a matching unit for a treated household that was closest in terms of p-score (Caliendo and Kopeinig, 2008). The NNM can be done with or without replacement options. In the case of the NNM with replacement, a comparison household can be matched to more than one treatment households. On the other hand, in the case of NNM without replacement, a comparison household can be applied only once. In fact, corresponding the groups with no replacement rises bias but increases precision of the estimations of the impact (Dehejia and Wahba, 2002).

**Caliper matching:** is applied in case the closest neighbor is far away. Caliper matching means that a household from the assessment group is chosen as a matching companion for treatment groups that ranges within a given p-score range (Caliendo and Kopeinig, 2008). However, the problem with caliper matching was the difficulty to know the tolerance level.

**Kernel matching:** in this matching, all treated units can be corresponded with a weighted average of the entirely control groups with weights of reversely proportional to the remoteness between the propensity scores of the treated and untreated groups (Becker and Ichino, 2002). What makes it different from caliper matching is those who were included are weighted according to their proximity with respect to the p-score and hence, kernel matching with 0.25 band width is most commonly used. This matching uses the normal distribution where the weight attached to a comparator is proportional to the frequency of the distribution for the difference in scores observed (Bryson *et al.*, 2002). According to Caliendo and Kopeinig (2008), the proper imposition of the common support condition is of major importance for kernel matching method.

### **2.1.7. Theories of artisanal small-scale mining**

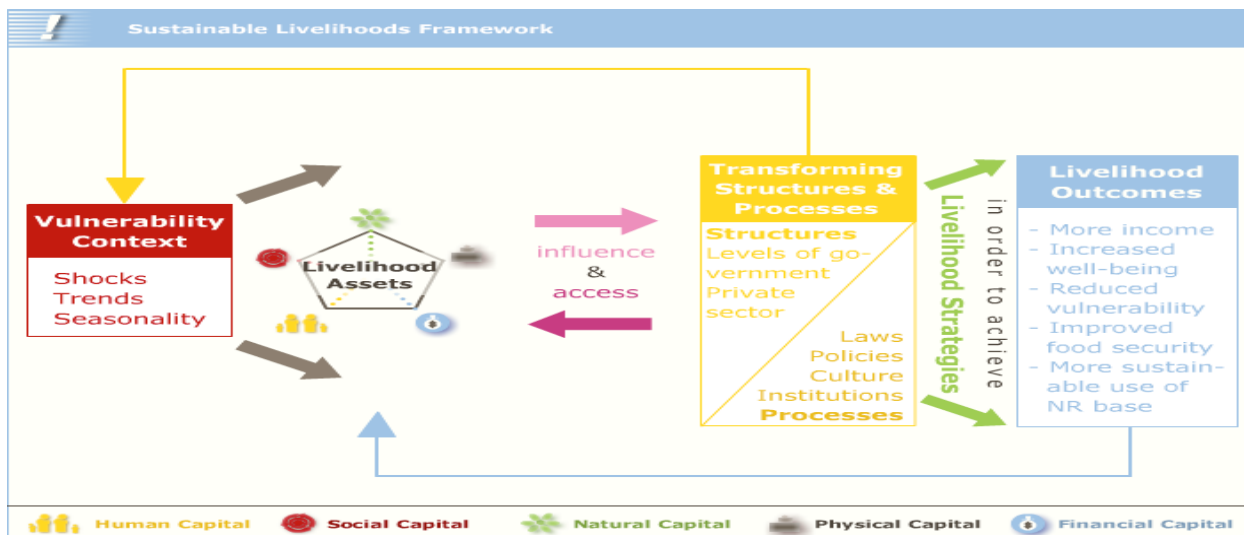
This sub-topic focuses on various theoretical explanations that have been employed in this study based on the review of the available literature. These theoretical explanations serve as lens to view the topic under study. Thus, DFID's Sustainable Livelihood Framework (SLF) to examine the effects of small-scale gold mining operations on the livelihoods of the rural households in Tigary Region. Besides, other theoretical perspectives have been used to explain how various factors and processes constrain or enhance the rural households to make a living in sustainable manner. These

include the theory of the informal sector; the tragedy of commons, the theory of resource curse, and the Dutch disease theories which are related to the mining sector have been discussed below.

### 2.1.7.1. The sustainable livelihood Frameworks (SLF)

The SLF was used by several international development agencies such as UNDP, the DFID, CARE International and other mainstream of development planning. The UNDP viewed SLF as the overall Sustainable Human Development mandate (1997) and the mandate includes poverty eradication, employment and sustainable livelihoods, gender protection and regeneration of the environment, and governance (UNPD, 1997). On the other hand, the CARE organizational focuses its program on helping the poorest and most vulnerable, either through regular development program or through relief work (Krantz, 2001). The DFID adopted the SLF from the publication of the 1997 was aimed at the elimination of poverty in poorer countries.

Figure 2. 1 Sustainable Livelihood Framework



Data Source: DFID (2000)

In order to offer a better understanding of the relationship between ASM and livelihoods, SLF has been adopted to guide this study. Various livelihood studies have adopted and applied SLF in various development studies (UNDP, 2004). This framework came into being due to global debates on sustainable livelihood and poverty reduction (Chambers and Conway 1992). The SLF was chosen by the UK government to alleviate poverty and promote sustainable livelihoods in poorer countries (Scones, 1998). Thus, the core principles underpinning in the SLF include poverty-focused, people-centered, responsive, multi-level, partnership, sustainable and dynamic

development activities (Chambers and Conway 1992). An important part of the analysis is thus to find out people's access to different types of assets (physical, human, financial, natural, and social) and their ability to put the assets for productive use (Kollmair et al., 2002). The framework also offers a way of assessing how organizations, policies, institutions, cultural norms shape livelihoods, both by determining who gains access to which type of asset, and livelihood strategies are important for the people (Carney, 1998). According to Chambers and Conway (1992), the SLF has five main components and these include:

**1) Livelihood assets:** are resources that people use for constructing their livelihood and livelihood strategies and outcomes of households are dependent on livelihood assets (Chambers & Conway, 1991; Scoones, 1998). The livelihood assets include: (i) Human assets (skills, knowledge, size, availability and ability of manpower). Human assets are useful not only in its own but also in its contribution in the mobilization of other assets to achieve positive livelihood outcomes (Rakodi, 2002); (ii) Physical assets consist of equipment and tools, domestic goods, housing, livestock and infrastructure which are usually essential for sustainable livelihoods and are either owned or rented; (iii) Natural assets include the natural resource stocks (land, soil, water, air, trees, forests, e.t.c) and are vital for rural livelihoods. Rural households depend directly or indirectly on the natural resources (Rakodi, 2002); (iv) Social assets include the social resources such as social networks and interconnectedness, relatives, friendships, neighborhoods, partnership and collaboration and membership of formal and informal associations for their livelihood outcomes (DFID, 1999); (v) Financial assets include financial resources such as financial stocks and transfers which are essential in the adoption of livelihood strategies and achieve livelihood outcomes (DFID, 1999).

**2) Vulnerability context:** The vulnerability context of SLF implies that the trends, seasonality and shocks of individuals, households and communities. Vulnerability context can be explained as both external and internal aspects (Chambers and Conway, 1991; DFID, 1999). For instance, households can be exposed to risks, shocks and stress and they have little capacity to recover quickly (Rakodi, 2002). Such stresses and shocks are external aspects of vulnerability. The poor can be vulnerable to continuous and seasonal shortages (Chambers and Conway, 1991). Thus, vulnerability context of SLF has a direct impact upon livelihoods of households (DFID, 1999).

**3) The transforming structures and processes:** Policies affect fiscal or economic trends directly or indirectly and have a direct impact on the livelihood outcomes through the provision of

infrastructure to reduce vulnerability (Ellis, 2000). Institutions are rules of the game within structures such as norms, values and rules that shape behavior and social norms and beliefs and power relations (DFID, 1999). Processes in the framework refer to the processes of change in policies, institutions and organizations which determine the interaction between individuals and organizations. Structures are both private and public which set and implement policy and legislation that affect the livelihood of individuals (DFID, 1999). The institutions, policies, and customs of the transforming structure and processes in the framework enhance or hinder people's access to various assets such as natural capital, financial capital and the like (Ibid:pp.33).

**4) Livelihood strategies:** Livelihood strategies can be reactive and proactive livelihood strategies that lead to the desired outcomes. These are coping and adaptive strategies of households. Coping strategies are a short-term response to shocks and adaptive strategies are long-term change as a result of a stress and shock (Scoones, 1998; Krantz, 2001). Diverse livelihood strategies can reduce the vulnerability of households and require different combinations of financial, human, social, physical and natural resources (Ellis, 2000).

**5) Livelihood outcomes:** The livelihood outcomes can be achieved as a result of livelihood strategies and are linked to livelihood assets (Ashley and Carney, 1999). The poor need to increase their livelihood assets, improve food security, income, and well-being and livelihood security by reducing vulnerability. The outcomes are either positive or negative achievements. Positive achievement would lead to the development of asset and livelihood activities whereas negative outcomes leads to the depletion of asset and increase vulnerability (Ellis, 2000).

#### **2.1.7.2.The theory of the informal sector**

This theory presents various theoretical underpinnings as to how the informal economy is linked to the formal regulatory framework. It is estimated that more than 66% of the world's labor force is found in the so-called informal economy (World Bank, 2009). The main characteristics of employment in the informal economy include low wages, poor education, high rates of poverty and long working hours. Businesses in the informal economy are often small scale, production of goods and services is labor-intensive and skills required for the business activities are usually gained outside formal education (Hilson, 2010). The informal economy consists of individuals who are unregistered and most informal workers operate outside the legal framework with costs rather than benefits, lacking secure work, workers' benefits, social protection and representation or voice (Chen, 2012). The ILO estimates the size of the sector to be 41 % of the gross national

income in sub-Saharan Africa, ranging from 30% in South Africa to 60% in Nigeria, Tanzania and Zimbabwe. Approximately, 40% of Côte d'Ivoire's gross national income originates from the informal economy (Hoadley M. and Limpitlaw D., (2004). It is estimated that 93 percent of the jobs created in sub-Saharan Africa during the 1990s were in the informal economy (Chen, 2005). This indicates that the informal economy significantly contributes to the national economy and creates job opportunity to the marginalized people.

Scholars have been debating on the nature and function of the informal sector. In the debate on the informal economy, the dualist school of thought makes a distinction between the formal and informal economy, of which the latter is comprised subsidiary activities that provides a safety net for the poor. The dualists argue that informal operators are excluded from the formal economy (Chen, 2012). The structuralism school of thought, on the other hand, argues that the informal and formal economies are intrinsically linked because informal enterprises and wages are subordinate to capitalist development. In this case, it is the structure of the capitalist world economy that explains the existence of the informal economy (Chen, 2012). The legalist school of thought focuses on the relationship between people in the informal economy and the formal regulatory framework. They believe that government deregulation leads to increased informal economy, especially in developing countries (Chen 2012; De Soto, 2000). De Soto (2000) argued that the informal sector is an extra-legal activity and many engage in this sector in order to avoid the costs, time and effort of formal registration.

In the Ethiopian, theoretical underpinnings of the legalist school of thought can be applied to the ASM sector as many miners are participating in the informal mining activities. The classical theory school of thought argues that people with limited capital tend to engage in the informal sector. Campbell (2006) argues that an informal sector arises from the capital-limited nature of the economy where capital is in short supply, rudimentary technology, labor intensive and low productivity (Clausen et al., 2011).

#### **2.1.7.3. The theory of tragedy of the commons**

This theory argues that miners extract minerals from the common-pool resource for their private economic interest but the consequences are shouldered by the entire society (Agyemang, *et al.*, 2012; Janssen, *et al.*, 2010). Due to the low barriers to entry in terms of capital needs and required skills, people can extract the common pool resources for their private advantage (Siegel and Veiga,

2010). In addition, the mining sites are left open and exposed for soil degradation because miners are moving from place to place without recovering the damaged environment (Bryceson and Jønsson, 2010).

In Ethiopia, resources are being depleted by miners for the sake of gold mining. They simply consider their private advantage without weighting the adverse effects on the local community. Common resources have been eroding and damaged because of mining activities which resulted in degrading the natural resource of the country (Hagos, *eta al*, 2014).

#### **2.1.7.4.Theory of resource curse**

According to the resource curse theory, countries with immense natural resources tend to register lower economic development. Paradoxically, despite the mineral potential they have, they are unable show economic and social progress, instead, they involve under perpetual conflicts. (Ricardo, *et al*, 2016). The '*Greed*' and '*Grievance*' is the way of explaining the concept of resource curse argument. This concept elucidates that the greedy behavior and grievance of certain groups can cause for civil war to control the mineral resources (Jose, *et al*, 2012). The case of the long-standing armed conflict in the Democratic Republic of Congo can be best example of resource curses (Kira Zalan, 2017). In Ethiopia, the greedy and grievance (resource curse hypothesis) is to some extent applied in ASM. For instance, a study conducted by Gezae Desta (2010) revealed that there had been small scale conflicts related to artisanal gold mining in Asgede Tsimbla *woreda*. In Shakiso, there have small scale conflicts between the local people and large scale gold mining (Engda, 2011). Above all, the act of wide spread smuggling of precious minerals has been the reflection of greedy behavior that harmed the majority of the people.

## **2.2. Empirical Review of the Study**

### **2.2.1. Global perspectives of artisanal small-scale mining**

Artisanal small-Scale mining contributes significantly to global mineral production in the world. According to the ILO (1999), ASM accounts for between 15 and 20 percent of the world's non-fuel mineral production. It contributes up to 12 percent to the annual gold production. ASM forms an important source of livelihood in many mineral rich countries. It is an important employment generating sector. The sector employs 13 to 20 million people from over 50 countries (World Bank, 2005) but it is difficult to ascertain the exact number of people in sector due to a host of factors. Some of these factors are; lack of official statistics, the informal nature of the sector, the number

of seasonal workers (Hentschel, *et al*, 2002). The sector traditionally employs larger numbers of women and children whose parents work in the sector are usually engaged in the sector. It is however widespread in developing countries as shown in the figure below.

Artisanal and small-scale mining takes place throughout the world, but is particularly widespread in developing countries in Africa, Asia, Oceania, and Central and South America (Hilson, 2001; Hinton, 2005). Globally, many countries are known for artisanal and Small-scale mining (Herschel, *et al*, 2002).<sup>15</sup> Various types of minerals are extracted in the ASM sector. Some of the minerals mined are; gold, diamond, bauxite, iron ore, marble, limestone, silver, tin, zinc, construction materials and various types of gems such as emeralds and garnets (Hinton,2005). These minerals are mined on different scales in the various ASM countries. For instance, over 40 and 20 different minerals are mined in India and China respectively (Hilson, 2010). In Ghana and Ecuador for instance, gold constitutes two thirds of production while it constitutes 90 percent in the Philippines and almost 100 percent in Peru. The volume of minerals produced by the sector varies between countries and between operations within countries (Hentschel, *et al*, 2002).

### **2.2.2. African perspective of artisanal and small-scale mining**

The Africa continent harbors the largest concentration of minerals and presently is the world's largest producer of mineral commodities (ECA and African Union, 2008). The key challenge of ASM in Africa is lack of systematic geological mapping which could unveil its vast mineral resources endowments (ICMM, 2010). The countries of Europe are heavily or fully reliant on imports with regard to many minerals which African states are endowed with (AMV, 2009).

According to World Gold Council (2011) the global average annual production of gold over the past few decades has been approximately 2,400 metric tons. African countries account for 20% of that volume 480 metric tons. The continent's largest producer is South Africa, averaging close to 250 metric tons per annum which is over half of the continent's production and about 10% of the global production in the same year. In fact, it is the only African country featuring among the top

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<sup>15</sup>These include: China, India, Burkina Faso, Ghana, Malawi, Mali, Ethiopia, Mozambique, South Africa, Tanzania, Zambia, Zimbabwe, Indonesia, Philippines, Bolivia, Brazil, Ecuador and Peru (International Finance Corporation, 2008). Other relevant ASM countries are Central African Republic, Congo, Guinea, Kenya, Madagascar, Namibia, Nigeria, Niger, Sierra Leone, Uganda in Africa, Laos, Malaysia, Myanmar, Thailand and Viet Nam in Asia and Chile, Colombia, Dominican Republic, French Guyana, Guyana, Mexico, Nicaragua, Surinam and Venezuela in Latin America and the Caribbean

10 gold producers in the world. The leading gold-producing African countries are Ghana, Mali, Tanzania, Guinea, Nigeria, and Ethiopia, etc. In total, more than 34 African countries producing gold and other precious minerals (US Geological Survey, 2011).

Table 2. 1 Africa as a protagonist in Mineral Resources

Minerals	African reserve	Rank	African Production	Rank
Gold	55+%	1	18%	1
Diamond	60+%	1	54%	1
Manganese	82%	1	28%	2
Platinum	88%	1	78%	1
Chrome	95%	1	51%	1
Vanadium	44%	1	40%	1
Cobalt	42%	1	18%	1

*Source: Department of Mineral and Energy, Republic of South Africa (2005)*

The continent of Africa also ranks first in the global production of a number of mineral resources such as gold, platinum, vanadium, cobalt, diamonds and chrome. In 2002, Africa's share of world production of bauxite and phosphate ore was about 11 per cent and 30 per cent, respectively. This figure did not change much by 2008 (Africa Mining Vision, 2050). The leading producer of gold is South Africa followed by Ghana, and Morocco accounts for 60 percent of Africa's production of phosphate ore. The large deposits of mineral resources in Africa indicate that it has a huge potential and Africa could enhance its economies (Twerefou, 2009).

Indeed, some countries have achieved better performance of the ASM sector in terms of production and governance practices. Among others, countries which have relatively success story of ASM include Tanzania, South Africa and Ghana. In 1997, Tanzania adopted a new mining policy to improve the mining sector. The Tanzanian government has formally recognized and reinforcing the provision of extension services and related supports (Mwaipopo, *et al*, 2004). The new policy also focused on regularizing and improving the ASM sector to address environmental impact, creating conducive mineral marketing and alleviates poverty (Phillips, 2001). Moreover, the new mining policy contributes to address the challenges of the sector through providing affordable technologies, simple licensing procedures; enforcing mining laws and policies of the sector (Mutagwaba, 2000). As a result, large proportion of ASM miners are operating legally in Tanzania unlike to ASM in Ethiopia with less than 5 percent of them are operating legally.

Another African state which has better experience in making the ASM sector effective is the Republic of South Africa. In 1995, South Africa adopted Mineral Policy Process Steering Committee (MPPSC) and approved by the Cabinet in 1998 to address problems associated to the ASM sector. In South Africa, the sector has been recognized as a source of national economy and people's livelihood. Strategies have been developed to make the sector productive and these include land and mining rights, financial services, access to improved technologies, access to market information, building institutional capacity, focusing on health and safety of the miners, effective legal and regulatory framework to protect the environment (Drechsler, 2001). Thus, many donor agencies reported that in South Africa, the ASM sector has shown progresses in gold production performance and governance practices of the sector (World, 2014, AMV, 2009).

Ghana is a West African state which has better experience in governing the ASM sector by involving all interested stakeholders in the process of production (Heemskerk, 2005). Stakeholders' participation encourages the involvement of local people in artisanal mining process (ECA, 2004). Ghana has also introduced decentralized governance to manage the ASM sector as it has paramount importance to mobilize the administrative efficiency and increases local peoples' to participate in decision making (EEITI, 2015). The country has introduced system of accountability and transparency that enables miners to evaluate and monitor the ASM sector so that politicians and local officials could be responsive to the people (Hilson, 2010). Most of the time, good policies, laws and regulations are nothing if they lack capacity, resource and political will (MMSD, 2002). Thus, the Ghanaian government focuses on capacity building to improve human capital, operational capabilities to better facilitate the artisanal mining to be more productive. Thus, the country has strengthened the institutional set up of the ASM with the necessary resources and techniques as a key means of monitoring and enforcing the regulations (Hinton, 2005). In Ghana, awareness creation programs was put in place to minimize the challenges of ASM. Nonetheless, most of them were not put in to effect (Hilson, 2010).

## **2.3.Review of Artisanal Small-Scale Mining Sector in Ethiopia**

### **2.3.1. Overview of artisanal small-scale mining**

Artisanal mining has been practiced since the ancient civilization of the Ethiopian state and especially, during the commercial expeditions to the region of the 'Land of Punt'. The presence of gold in Ethiopia has long been known since long and this was associated to the Queen of Sheba's

gift of gold and gemstones to the King Solomon of Israel (MoM, 2012; D'Souza, 2002). In Ethiopia, gold has traditionally been mined from alluvial deposits for several thousand years back (Gezae, 2010). However, evidences show that the discovery of placer gold in Adola area in 1930s has been the benchmark of ASGM in Ethiopia. Later on, other gold mining such as Legedembi have become the well-known gold mining sites which contribute for foreign exchange earnings, employment, livelihoods (Engda, 2011).

Despite the fact that Ethiopia has a huge potential in mineral resources, the policies and regulatory frameworks of the previous regimes were less supportive in putting the sector productive (MoM, 2012). Thus, during the Imperial regime, the economic advantage of mineral resources was not familiar and hence, even if there were some miners, they had been prohibited via community leaders but informal ASM was operating in the remote and inaccessible areas (EEITI, 2016). In the Derg regime, the service of the community leaders was discontinued and the mining sector was directly controlled by the central government. During this period, there were efforts to introduce improved technology to enhance gold discovery capacity and improve working conditions of artisanal miners but no success has been recorded (Engda, 2011; Yared, 2013). However, the contribution of the mining sector to the national economy is less than 1% of the country's GDP.

ASM has been flourished in Ethiopia due to the newly introduced mining policy in the post 1991. The government has introduced a market oriented economic policy by endorsing proclamation and regulation of the mining sector to encourage private investors and putting the sector within the focus of poverty reduction (MoM,2012;Beyene,2016).Taking the sector's contribution in to account, the government has incorporated the sector in to national development plans.<sup>16</sup> In GTP I, the ASM sector was expected to generate income so that it can create employment opportunities and improve the income of artisanal miners (GTP I, 2010/11-2014/15).<sup>17</sup> In the GTP II, the ASM sector is expected to enhance the implementation capacity of ASM through appropriate policy, regulatory frameworks, increasing export revenues; improving the marketing system of the sector, generating national income, fighting poverty (GTP II, 2016/17-2019/20).<sup>18</sup> As a result, the volume of gold produced by the ASGM has increased from 1000kg of 2002 E.C to 7000kgs in 2007 E.C

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<sup>16</sup> *Growth and Transformation Plan(GTP,2011-2016)*

<sup>17</sup>*The Growth and Transformation Plan (GTP) for 2010/11-2014/15.*

<sup>18</sup> *Growth and Transformation Plan (2015/16 – 2016/20)*

(MoFED, 2016). However, in the last four years, the volume gold produced and supplied to the National Bank of Ethiopia has been drastically declining (NBE, 2017; MoMPNG, 2017).

### **2.3.2. Artisanal and small-scale gold mining in Tigray Region**

There is no adequate literature about the origin of artisanal gold mining in Tigray region. Prior to 1990s, gold mining in the study area was unknown but few farmers were using gold for bartering and other purpose (Gezae, 2010). In the post 1990s, artisanal gold mining activities have been a common practice for many rural communities in Tigray Region in general and study area in particular following the endorsement of mining policies, rules and regulations. Since 1990, miners have been encouraged to operate artisanal gold mining in the study area (MoM, 2012; Gezae, 2010). In Tigray Region, intensive ASGM operations have been taken place in the eastern, south eastern, central, north western and western zones.<sup>19</sup> The ASGM sector has been generating income for the unemployed people, supports the livelihood of the rural poor and at the same time it can bring foreign currency (EEITI, 2016). Nonetheless, the sector is characterized by backward and rudimentary activity. Miners are poorly equipped, they are unskilled and perform their mining activities manually and have no proper care on impacts of the environment (Hagos, *et al*, 2016).

### **2.3.3. The policy and legal framework, institutional set up of ASM in Ethiopia**

#### **2.3.3.1. The policy and legal framework**

Ethiopia was under the socialist economy and hence, private investors in the mineral sector were neither welcoming nor and encouraging. Instead, the government itself was given the right to explore and extract verities of mineral resources in the country (Engda, 2011). However, the EPRDF led government took power in 1991 and hence, it introduced free market oriented economic policy and stimulating the mining sector by endorsing different proclamations to encourage the private investors on the mining sector (EEITI, 2016). No sooner the federal government has introduced decentralization program which empowers the local governments with powers, rights and duties to implement the policies, laws and regulations at lower tiers of the government (Mihret, A., 2007). In order to make the ASM sector productive, many proclamations were issued due to the growing demand for metallic and industrial minerals and create conducive

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<sup>19</sup> *Tigray National Regional State: information obtained from the Mining and Energy Bureau, 2017/18.*

environment for the private investment in Ethiopia.<sup>20</sup>The proclamations had been amended to make them favorable for those who invest in the mining sector though there has been very poor implementation of the policies and regulations at grass-root level (Beyene, 2016).

Thus, the ASM sector has been suffering from informal mining and marketing of minerals. This is so because most mining sites are located in the remote area where monitoring and supervision is inaccessible and difficult (World Bank, 2005). As a result, the performance the sector and its contribution to the national economy and livelihood of the rural households are found inefficient (Nabaasa, 2016). In order to make the sector productive and effective, miners need to have legal permission to operate their mining activities. Mining license has paramount importance for miners to be secured and supported to use technology, get access to credit, and extension services, they shall be legally entitled for ASM (Hilso, 2010; Hilton, 2006).

The MoMPNG has introduced a licensing system to regulate and formalize the illegal mining activities across the country (MOMPNG, 2017). This situation helps the government controls the informal use of mineral resource, generate income, support the livelihoods of the rural households, and reduce environmental impact (MoM, 2012; Beyene, 2016; EEITI, 2016). Proclamation No 816/2013 stipulates that artisanal miners should be dissolved if their license expires; either it is to be transformed either into small scale mining or shifted to any other business. Right after two years of operation, artisanal miners should be transformed into ‘small-scale mining’ or it would abandon mining and shift to other business (Proc. No 816/2013). Therefore, the current system has a serious deficiency as both licensed and unlicensed artisan miners are participating with no limit in time and boundary. Thus, vast majority of miners and mineral traders are operating informally (MoMPNG, 2017; Beyene, 2016)). Of course, the regulations (816/2013) has reduced the period of validity of artisan mining cooperative hoping to encourage miners as an economic stepping stone to a more profitable business (Beyene, 2016).

### **2.3.3.2. Institutional set up of ASM in Ethiopia**

Institutional set up of the ASM sector has paramount importance in assessing the effective implementation of the policies and regulations of the sector (World Bank, 2013). The MoMPNG, regional states, zonal, woreda mines and energy bureaus are responsible for the implementation of

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<sup>20</sup>*Mining Operations Proclamation No. 678/ 2010; Mining Operations Regulations No. 182/ 1994; amended under Regulations No. 27/ 1998; Mining Income Tax Proclamation No. 53/ 1993; amended under Proclamation No. 23/ 1996; Transaction of Precious Minerals Proclamation No. 651/ 2009.*

the policies and regulations of the mining sector (MoMPNG, 2017). Under the newly introduced district level decentralization in 2001, most service delivery activities have devolved to district level. The district level decentralization program was aimed at streamlining of the institutional framework for effective service delivery (Mihret, 2007). This program was designed to facilitate an effective planning and administrative structure that is expected to promote participatory decision making in local levels; raising the capacity of local authorities. The federal government is responsible for national level policy making and administrative structures whereas the administrative mandate of local government resides at district level (Ibid.pp.34).

Thus, as per proclamation no.816/2013, the Ministry of Mining has been responsible for mineral sector development and governance in accordance with the policies, proclamations and regulations which have been endorsed at different times. The Ministry can have overall responsibility for the oversight, coordination, and monitoring and evaluation of project activities (MoMPNG, 2017). The Federal and Regional governments can issue licenses and miners should necessarily be organized as cooperatives. However, the current system has a serious deficiency as many artisan miners are not operating legally, and important provisions such as environmental laws and regulation, and royalty laws have been poorly enforced at local levels.<sup>21</sup>

#### **2.3.4. Geological settings of artisanal and small-scale mining in Ethiopia**

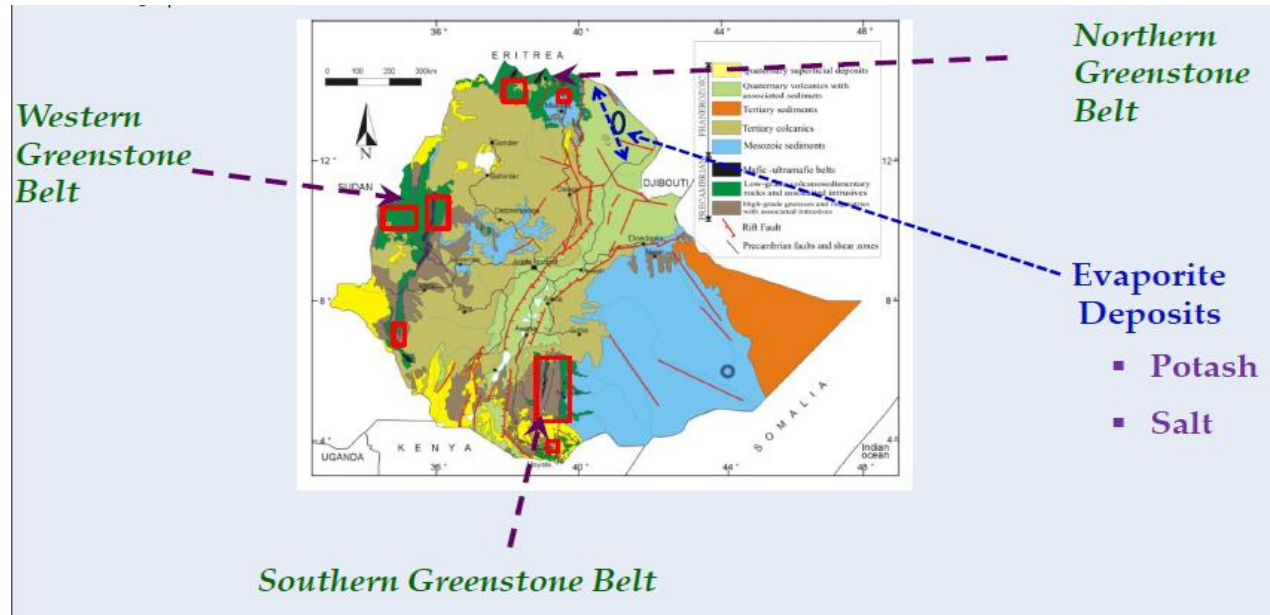
Ethiopia is endowed with potential mineral resources and the geology of the country ranges from the oldest Precambrian rock to recent volcanic and sedimentary formation. The ASGM activities are mostly concentrated in the Precambrian (oldest basement rock) located in the Northern Greenstone Belt (where the study is located), Western Greenstone Belt and Southern Greenstone Belt (EGS, 2010). The oldest basement rock hosts most of the metallic mineral deposits such as gold, tantalum, base metals, industrial minerals, gemstones, decorative and dimension stones such as marble, granite and other colored stones (MoM, 2009). The Paleozoic–Mesozoic sedimentary rocks also host construction materials such as limestone, sand stone, gypsum and other metallic ores like malachite and manganese minerals. The recent age (Cenozoic-volcanic rock) host most industrial minerals such as potash, rock salt, soda ash, diatomite, opal and numerous types of construction and cement raw materials (Ibid:pp.2). The Ethiopian Geological Survey of (EGS,

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<sup>21</sup>*Despite the formulation of policies and endorsement of laws and regulations, the ASM sector remains unmanaged sector where widespread contrabands activities are observed. The existing policy and regulatory mechanisms are defective and unable regulate the mining sector effectually. Hence, there is a need to reconsider the existing rules and regulations (Data obtained from KI at one of the study woredas, 2017/18).*

2010) has been established under the proclamation No.194/2010. Miners are engaged in extracting highly valuable minerals that can generate foreign exchange income and some of these are gold, gemstones, tantalite, salts, sandstone, limestone, gypsum, etc. (EGS, 2010).

Figure 2. 2 Ethiopian Geological Survey



(Source: MoM, 2012)

### 2.3.5. Modalities of artisan and small-scale mining

Artisanal miners employ different methods of extracting mineral resources from the earth's surface processes (EEITI, 2016). These methods vary according to the type of mineral deposit being extracted and the degree of mechanization adopted by the miners (Gavin, 2002). Most ASM activities are operated using rudimentary methods such as pick and shovel mining, chisels, hand panning (Hagos, et al, 2009). In some cases, water pumps, explosives and washing plants are used during the mining process (Hinton, 2005). In Ethiopia, artisanal miners extract minerals using different techniques depending on the type and source of deposits. Traditionally, placer gold mining has been commonly used along alluvial gold deposits (EEITI, 2016). Although it is exhausted surface mining have been commonly practiced and nowadays, underground mining is increasingly used (Beyene, 2016). The following are some of the typologies of mining operation include open surface mining. It covers vast placer deposits which consist of stream sediment panning and strip mining; this process is carried out by removing top fertile soil and vegetation to reach ore deposits. Open surface mining is the simplest and labor-intensive type of mining often

carried out at family level (Hinton, 2005). Sub-surface mining is another type mining which consists of digging tunnels or shafts into the earth to reach buried gold ore deposits. Although the practice is not common for artisan miners, it is increasingly practiced in the study area (EEITI, 2016). Open-pit mining is the third mode of mining which is commonly used in the rural area and it consists of open pit-shallow depth and open-pit deep hole, which involves discovery of mineral ore from an open pit in the ground. It is very common across all regions and men are mainly engaged in open-pit mining. Its depth goes as deep as 5-25 meters depending the mining sites and type of soil where the minerals are extracted. However, this method of extraction can be dangerous and risky as there are incidences of land slide during extracting process (Hilson, 2010).

### **2.3.6. The nature of artisanal and small-scale mining**

Most ASMs are either formal or informal in nature. The former are miners who have license to extract minerals and hence, they are legal or formal miners while miners who don't have license to extract minerals are known as informal or illegal miners (Hilson, 2010; Hentschel, et al, 2002). Globally, 80 % of ASMs in the world are operating informally or illegally (Mwaipopo et al, 2004). In Ethiopia, about 94% of ASM are operating informally whereas only 6% of them are legally operating across the country (Beyene, 2016). This indicates that number of informal miners in Ethiopia is higher than the figure of the global ASM operation. In Tigray Region, the figure is not different from the national and global figures. In an attempt to formalize the ASM sector, mining cooperatives are given land for the purpose of gold mining (the size varies from as low as 1,500 m<sup>2</sup> to 5,000m<sup>2</sup>) but illegal miners are unwilling to limit themselves in specified land; rather, they want move here and there to search better gold place(KII,2017/18).<sup>22</sup> Miners are digging fertile land, hammering rocks and tunneling deep in the earth in search of gold ore. Besides, miners travel long distances from their residential areas to the mining sites facing harsh climate, tiresome and risky operation (KII, 2017/18). As a result, it is common to see the number of female artisanal miners is smaller than male artisanal miners. Besides, the placer of gold is being depleted and less accessible for them (Beyene, 2016). For most artisan miners (legal or illegal), mining is the backbone of their livelihood in the study area. Out of the total off-farm income of the miners, 74% of the income of the miners comes from ASM (Beyene, 2016) and agricultural and petty trade ranked 2<sup>nd</sup> and 3<sup>rd</sup> respectively (SUDCA, 2013). Social problems exist in many of the mining sites

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<sup>22</sup>Tigray National Regional State: Mining and Energy Bureau, 2017/18. The bureau explained that miners are highly movable from place thinking that they may find better deposited minerals if they wonder here and there across the mining sites.

caused by theft of deposits and cross boundary movements in search of new deposit sites due to the diminishing resource of placer gold (Hagos, *et al*, 2016). Disputes are also prevalent between ASM and large-scale miners in different mining sites of the study area (Gezae, 2010). The root cause of the disputes was the overlapping of the mining sites and the problem of good governance in the mineral sites. In addition, artisanal miners have been mining for many years but the companies came later and contradict over the resources (Engda, 2011).

Socio-economic problems of the ASM sector such as lack access to basic infrastructure facilities, limited access to safe water, electricity and so on are prevailing in most mining communities in Ethiopia (MoM, 2009). In some cases, there are health posts but are not fully functional due to lack of human power and inadequate working facilities (Beyene, 2016). Besides, school enrolment in the mining community because children travel a distance of 5 km to reach a school (SUDCA, 2013). Efforts have been made to connect each *tabia*/rural kebele but still there is lack of regular travel to every destination of the rural kebeles (Hagos, *et al*, 2009).

### **2.3.7. Artisanal and small scale gold marketing in Ethiopia**

The marketing channel of precious minerals consists of both formal and informal channels. As has been depicted in figure 2.3 below, gold is collected by legal buyers at production site that is to be channeled to the NBE for export. However, no success has been recorded to regulate the illegal gold marketing channel (NBE, 2017; Beyene, 2016).

**The formal channel:** The current policy suggests that all dealers and miners should sell gold to the NBE as marked by blue color in the figure while the red color highlights the informal (contraband) gold trade path (MoM, 2015). Gold supplied to the formal market involve tasks undertaken by the NBE at the top and commercial bank branches designated to purchase gold from licensed traders, artisanal gold miners , and cooperatives. However, there is no system that can ensure gold produced by gold miners at each mining site is entirely delivered to the NBE via the delegation of CBE and hence, there is no mechanism that can forbid license holders from participating in illegal transaction (NBE, 2017). The NBE has no adequate branches in the mining sites and gold transactions are formally undertaken by only one center (CBE Shire branch) established and act as an agent of the NBE. The Bank has been responsible to verify the gold purchased by branches at the head office and finally refined and deposited to the country's Foreign Reserve Account (MoM, 2015). In the formal market, the price of gold is largely governed by the international market price with defined quality standards and 5% premium (top up) on the

international gold price. Moreover, the NBE also provided 30 days price selection opportunity as an incentive package to those who supply gold to local bank but the intervention hasn't brought changes on gold supply (NBE, 2017).

**The informal channel:** in the mining sites, gold has been sold to illegal traders and hence, the volume of gold supplied to the local banks has been declining. As there is no product monitoring mechanism, miners and local market agents can sell gold in the black market (contraband) as indicated in fig.2.3 below. Gold has been widely traded to the local illegal market and across boundaries. As a result, the volume of transaction in the formal (legal) channel was estimated 39% of the total gold produced in the year 2014 (Beyene, 2016).

Figure 2. 3 Market channels for artisanal and small-scale gold mining in Ethiopia



(Source: Author's own design, 2017/18)

**ASGM and gold supply to the formal market:** The ASGM sector has many difficulties to increase the volume and sustainable gold market in the study area (Beyene, 2016). The proliferation of illegal gold marketing involvement has become the bottleneck for gold supply to formal market in Ethiopia (MoMPNG, 2017). A number of measures have been taken by the federal and regional governments to address the gold market problem in Ethiopia but none of them has become successful (NBE, 2017). Besides, some policy measures on the gold marketing channels have been applied to increase the volume of gold to be exported and in turn generate foreign currency but the policy measures were found unsuccessful (MoMPNG, 2017).

### 2.3.8. The contribution of ASM to national economy

**ASM and foreign exchange earnings:** The ASM sector has a paramount contribution for the local and national economy in Africa, Asia and Latin American countries (IISD, 2017). Mineral export in average had increased from 30% to 60% and gold export has a lion-share of total exports in these countries (ICMM, 2012). For instance, in Tanzania, about 25% of the export earnings came from ASGM in 1992. About 15% of gold exports in Zimbabwe came from ASM in 1999 (Ibid.pp.67). In Ghana, ASGM contributes about 24% of the GDP in 2012 (Mark L. et al, 2015). Similarly, in Rwanda ASGM sector contributes 19% to export earnings (Luning, S. (2014). According to Mohamed Suliman Ibrahim (2015), 33% the total gold export of the Sudan came from ASM in the period 2012-2014. In Ethiopia, the ASM sector accounts for 10% of the foreign exchange earnings and the ASM takes the lion's share over 65% of the total earnings of the mining sector but the contribution the ASM sector to the GDP is very low (Beyene, 2016; EEITI, 2016; MoM, 2012). However, it is difficult to inspect the contribution of artisan mining to the national economy for various reasons such as underreporting, black market and contraband activities (Beyene, 2016). Regional governments are failed to collect royalties and hence, there is limited information on the amount of gold produced and supplied to the (MoM, 2015).

**ASM and revenue generation:** Many countries are able to achieve the economic advantage of mining while many less developed countries are fail to perform due to structural and other inherent problems prevailing in the sector (ICMM, 2012). A lot of factors negatively influencing the ASM such as illegal gold mining, smuggling of precious minerals, poor governance, and lack of geological data and other are bottlenecks of the ASM sector (EEITI, 2016).

Table 2. 2 Artisanal gold supplied to the NBE and export earnings

Years	Amount of gold purchased by NBE(in kg)	Export of gold (USD, in Millions	Rank
2008/9	426	24.8	8 <sup>th</sup>
2009/10	2,866	126.84	6 <sup>th</sup>
2010/11	7276.30	322.46	3 <sup>rd</sup>
2011/12	8,327.73	419.3	2 <sup>nd</sup>
2012/13	8,386.84	430.6	1 <sup>st</sup>
2013/14	7,559.50	305.33	4 <sup>th</sup>
2014/15	5,548.38	211	5 <sup>th</sup>
2015/16	634.56	42.3	7 <sup>th</sup>
2016/17	150.44	18.67	9 <sup>th</sup>
2017/18	123.56	15.81	10 <sup>th</sup>

(Source: NBE, 2017/18)

Table 2.1 indicates that the amount of gold purchased by the National Bank of Ethiopia from the ASMs increased from 426kg in 2008/2009 to about 8,328 kg in 2011/2012 and hence, the country benefited from the foreign currency earnings (MoM, 2012). However, later on, the amount of gold purchased and exported has been decreased (Beyene, 2016). At national level, Ethiopia has planned to collect 14,000 kg of gold in 2014/2015 from 5 gold producing regions (SNNPE, Oromiya, Bensangul, Tigray and Amhara) but the achievement was far from the planned capacity which was found 5,527.732 kg (39.48%) and since then the foreign exchanging earnings has fallen.

**Employment opportunities:** ASM sector has made significant socio-economic contribution to the local communities and it provides job opportunity and income for over 30 million of the world's poor people and supports the livelihoods 150 million people (IISD, 2017; Hilton, 2005). ASM activity is preferable by rural communities because the sector doesn't require capital, skill, formal educational and the like (Hilson, 2010). The ILO has estimated that 3.0-3.7 million people Africa, 6.7-7.2 million in Asia, 1.4-1.6 million in Latin America and 0.4-0.5 million in developed countries are currently employed in ASM sector (ILO, 1999). In developing countries, people whose livelihoods depend on ASM activities range from 80-100 million. Apart from the direct employment, ASM creates indirect jobs such as goldsmiths, traders and food vendors (Yakovleva, 2006). In Ethiopia, the ASM sector has created at least 1.26 million people and supports the livelihood of over 7.5 million people across the country. Of these miners, 62.5% and 37.5 % are male and women miners respectively (Yared, 2013). Nearly 50,000 artisanal miners have been organized into mining cooperatives and hence, the ASM sector has been a source of employment and livelihood in the rural areas of the country (Beyene, 2016; Gezae, 2010).

**ASM and livelihoods:** Despite the contributing of ASM to the livelihoods of the local community, focus had been given on the adverse effect of the sector until recently (Kemp, 2009). A study conducted by Kolver (2013) on ASM sector revealed that it contributes to support livelihood and poverty alleviation but governments are unable to regulate the negative impact of ASM. Kemp, (2009) conducted a study on the effects of ASM on the livelihoods and the environment of the inhabitants and his study revealed that the sector is suffering by poor governance and informal activity which ultimately resulted in adverse effect on the livelihood of the local community. Another scholar, Kamlongera (2011) studied the livelihood of people before, during and after mining operations. His finding has showed that the sector serves as an alternative source of livelihood for the rural community despite its negative impact. In Ethiopia, the ASM sector

contributes to GDP, employment, income and foreign exchange earnings, food security and poverty reduction so on (Engda, 2011; MoM, 2015; Beyene, 2016).

**ASM and food security:** the ASM sector has both positive and negative implications on residents of mining communities (Yakovleva, 2006). It can reduce poverty in the poor rural by creating employment and generating income of the households (Hentschel et al., 2002). More than 100 million people earn their livelihood from ASM activities worldwide (IISD, 2017). Another study conducted by Okoh, G. A (2013) in Tanzania shows that the ASM communities can ensure food security, reduce poverty and register economic growth. Social infrastructure farcicalities are mostly initiated by ASM. However, ASM operation is the most socio-environmental destructive economic activity in recent years (McQuilken & Hilson, 2016). A study by Nabaasa (2016) revealed that ASM operation resulted in environmental degradation while undertaking alluvial mining activities. Mining sites are left uncovered and become flooded, posing a danger to local residents, especially children, and livestock (Hagos, *et al*, 2009). Wilson et al., (2015) pointed out that food security in most mining communities is being threatened due to conflicts between land owners and small scale miners and between small scale miners and farmers. Telmer (2015) reported that crops are suffering from chemicals and other waste materials near mining sites.

**ASM and poverty reduction:** population pressure is one of the push factors for the rural people to engage in ASM and support their livelihoods (Veiga and Baker, 2004). The World Bank (2013) reported that ASM is a poverty-driven activity in most poor countries where there are limited livelihood alternatives (Hilson, 2010; Shoko, 2005). Veiga and Baker, 2004) argue that ASM is a quest for survival and hence, most rural households engage in ASM to reduce poverty. In most cases, ASM activity is poverty driven during times of economic recession and hardship (Shoko, 2005). ASM has considerable potential to reduce poverty and vulnerability in Tanzania apart from being a source of wealth creation, asset accumulation, investment and employment (Mwaipopo et al., 2004; Hilton, 2005). Hentschel *et al* (2002) added that those people who involved in ASM activities are often driven by poverty and receive income from the sector to support their daily subsistence. However, Nabaasa (2016) has reported that ASM has impoverished the miners by placing in the vicious circle of poverty and food security.

**Effects of ASM on the livelihood assets:** There is direct relationship between ASM and livelihood assets (Balifokus, 2015). As argued by Dreschler (2001) gold panners wash an average of eight million tons of soil per year, and severe soil degradation and pollution of water occurs in the mining

sites. He added that ASM is associated with social, health and safety problems. ASM isn't only created soil erosion and water pollution, deforestation, but also social problems such as alcohol abuse, prostitution, conflicts, child labor abuse and the likes. Thus, the adverse effects of ASM on human health and environment have significant impact on societal welfare (UNEP, 2017). Likewise, lack of safety in ASM sector posed more severe problems than the large-scale mining (Hilson, 2016). In Ethiopia, there is little awareness on the adverse effects of ASM on human health and the natural environment (Hagos, *et al*, 2009). In most cases, restoration measures are not in place by miners to recover the impacts caused by mining. Most mining sites are vulnerable to flooding, soil erosion, and damages agricultural land (UNEP, 2017; Hagos, *et al*, 2009).

**ASM and tenure security the miners:** It is the biggest challenge that miners facing while participating in ASM (Hilson and Potter, 2003). Lack of access to land for mining is a serious challenge for miners in the mining community (Aizawa, 2016). Unless Miners have tenure right, they are unable to improve their technology and productivity (Hilson and Garforth, 2012). Kambani (2003) argues that security of tenure is quite essential for miners to have various alternatives such as collateral to get access loan. This implies that there is a close relationship between security of tenure and investment decisions of the miners (Aizawa, 2016). Miners are expected to be more responsive to the environment if they secure their tenure right. Besides, legal titles would enable miners to use collateral to borrow from lending institutions (Hinson, 2010). In Ethiopia, the root cause of the conflicts in the mining sector is lack of tenure security. Artisanal miners have been mining minerals without having tenure right and later on the mining site may be given for large-scale mining companies and hence, conflict may arise between ASM and large scale miners. Besides, conflict can occur between the permanent settlers and migrants because of lack of tenure security in Ethiopia (Engda, 2011; Gezae, 2010; Beyene, 2016).

### **2.3.9. The major research and methodological gaps of the study**

This study has identified literature, research and methodological gaps which are associated with the ASM sector. The sector has been the major source of livelihood for about 150 million populations throughout the world, 54 million people in Africa (IISD,2017), and 7.5 million people in Ethiopia (Yared,2013) but the sector is suffering from the literature, research and methodological gaps. Though few studies have been conducted on the mining sector, the effect of ASGM on the livelihood of the rural households has not been properly investigated so far. In spite of the existing literature on ASGM, there is a gap between ASGM participation and its effect on

the livelihood of the rural households. Thus, this dissertation is going to add its share in bridging the information gap between the ASGM participation and its effect on the rural households.

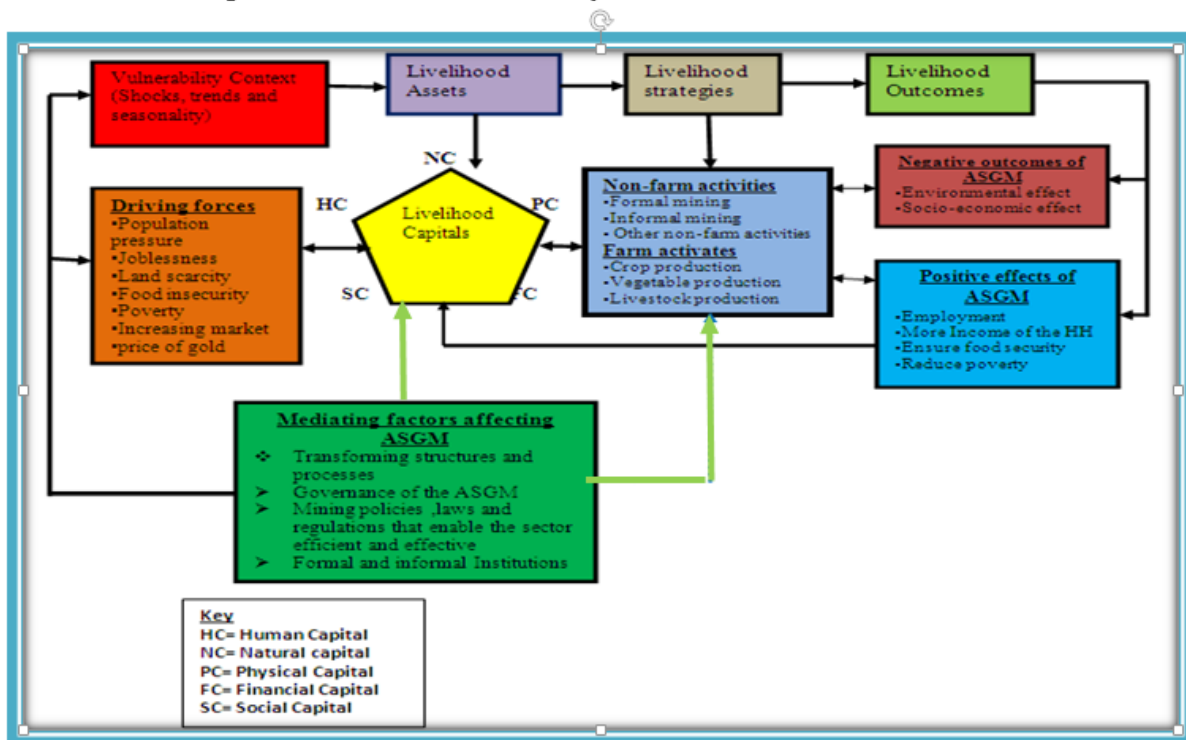
To date, few research works have been conducted in the thematic area of ASM at national and regional levels. Nonetheless, the previous research works were unable to address issues of governance, factors affecting gold supply to the formal markets agents, impact of ASGM on the food security and poverty situation of households and the vulnerability of livelihood assets in the study area. Therefore, none of the previous research works uncover ASGM participation and its impact on the livelihood of the rural households at national or regional levels. Moreover, the previous studies employed qualitative approach but this study has tried to use multiple data analysis techniques to narrow the gaps which have been observed in the previous research works.

## 2.4. The conceptual and analytical framework of the study

### 2.4.1. Conceptual framework of the study

The conceptual framework below indicates that the relationships between ASM and livelihood outcomes of the rural households.

**Figure 2. 4 Conceptual framework of the study**



(Source: modified from DFID, 2000)

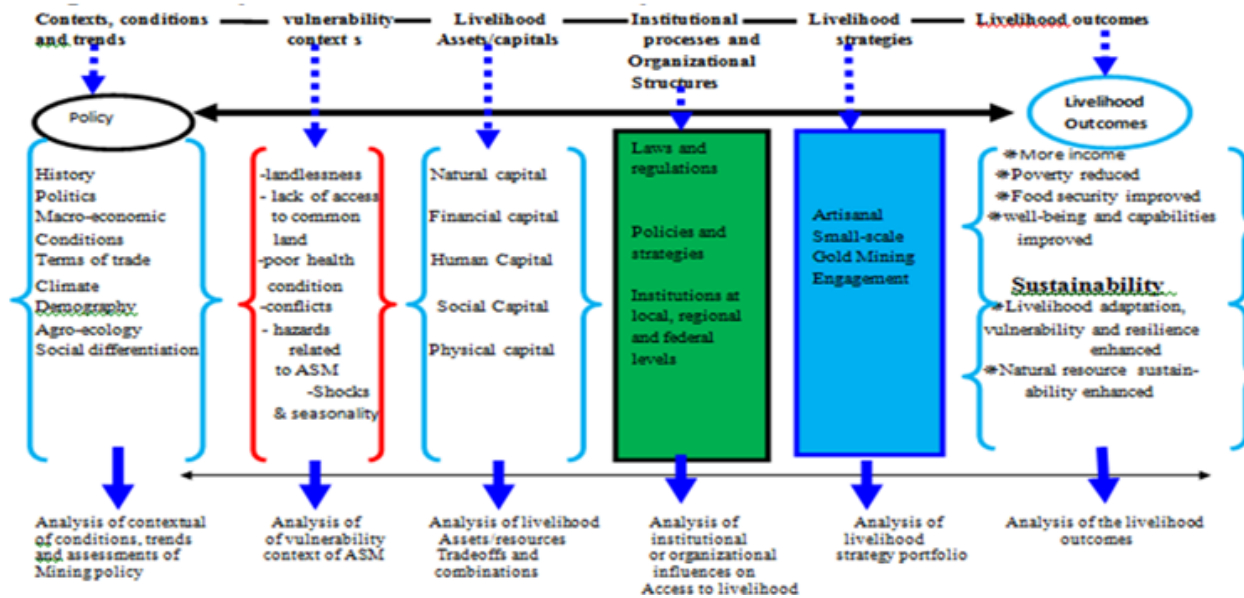
Figure 2.1 depicts the basic premises of this framework are underpinned to show the activities which could change the livelihoods of households by creating capabilities that would ultimately produce livelihood outcomes. The core idea is that the effects of gold mining participation influences households in multiple ways. From a livelihoods' perspective, gold mining affects all the assets as fundamental for the survival of households in the study area.

All the assets or capitals through the institutional systems and processes, formal and informal rules and the overall interaction in the framework are expected to optimize the wellbeing of the households (DFID, 1999). Institutions involve legal frameworks, policies and regulations. Government policies, regulation and laws which play important roles in guiding the ASM sector and influencing how each capital was utilized to enhance livelihoods. The key points of the framework include: (1) livelihood strategies which encompass mining and non-mining income sources that are expected to improve wellbeing of households but focuses on ASM activities; (2) livelihood assets are essential means of creating wellbeing and how the assets influence artisanal gold mining involvement; (3) government structures, institutions, policies, laws, rules and regulation are seen as mediating factors of the overall interplay of the ASGM sector; (4) the vulnerability context of the ASGM sector include population pressure, joblessness, land scarcity, environmental degradation ,land tenure and policies, food insecurity, poverty situation, informal market and poor governance; (v) the livelihood outcome ASGM were discussed in the form of positive and negative outcomes or desirable and undesirable effects; (vi) the coping strategies are also in place to correct the negative outcome of the sector and implications for policy intervention are forwarded in the framework.

#### **2.4.2. Analytical framework of the study**

The SLF was used to analyze the nexus between the effects of ASGM on the livelihood households. The processes and interactions considering the livelihood resources (assets), institutions, livelihood strategies and outcomes. Ellis (2000) suggests that the sustainable livelihood framework was applied to understand the rural development and livelihood strategies.

Figure 2. 4 Analytical framework of the study



Source: adapted from Ellis (2000) and Scoones (2009)

Figure. 2.3 above show that given a particular contexts, there are ASM activities that require the combinations of livelihood assets to reconstruct livelihoods. This in turn would affect livelihood strategies and outcomes to ensuring livelihood security. It is also important to take into account that the process can be change over time. The construction of livelihoods is an ongoing process and the assets, access and activities can change and people have to adapt themselves to the changing conditions. In this framework, the rural household is the social unit to be observed in order to assess people’s livelihood security. The framework was employed to analyze the policy context of ASM, the various shocks experienced by the households, the livelihood assets, and the effect of institutions, livelihood strategies and outcomes as a result of ASGM participation in the study area.

## CHAPTER THREE

### Research Methodology and Description of the Study Area

#### 2.1. Introduction

This chapter presents the description of the study area, the mixed research approaches (quantitative and qualitative), research design, the world views (paradigms) and different techniques have been applied. The sources of primary and secondary data, the sampling techniques, instruments of data collection and methods data analysis have been thoroughly discussed.

#### 3.1. Description of the study area

##### 3.1.1. The Tigray National Region State

The Tigray National Regional State is located in the Northern part of the Federal Democratic Republic Ethiopian and situated between 120 15' and 140 57' North 360 27' East and 390 59' East longitude. It is bordered by Afar National Regional State in the East, Eritrean state in the North, Amhara National Regional State in the South and Sudan in the West. The Tigray National Regional State (TNRS) has an approximate area of 53,386 Square-kilometers and an estimated population of 4,314,456 (about 6% of the country's population) of which 49.2% of the population are males and 50.8% are females. This region has an estimated density of 86.15 people per square kilometer. In the region, there are about 985,654 households with an average of 4.4 persons per household (CSA, 2008). Ethnic composition of the region is Tigrians (96.55%); Irob (0.71%), *Kunama* (0.19%) and other ethnic groups live in the region. Majority of the population (95.6%) are Orthodox Christians, 4.0% Muslim, 0.4% Catholic, and 0.1% Protestant (CSA, 2008). The language widely spoken in the region is Tigrigna and other languages such as *Saho* and *Kunama* are also spoken. Mekelle is the capital city of TNRS.

Administratively, the TNRS is divided into 7 zones and 35 districts/*woredas*.<sup>23</sup> Agro-climatically, the region is classified into *Kola* (low land), *Weina dega* (mid high land) and *Dega* (highland) in which the average temperature ranges from 4°C to 40°C with some exceptions. The rainfall of the region varies from 450mm to 900mm which makes the region usually moisture deficient resulting in recurrent drought. The topography of the region is characterized by mountain plateaus and they

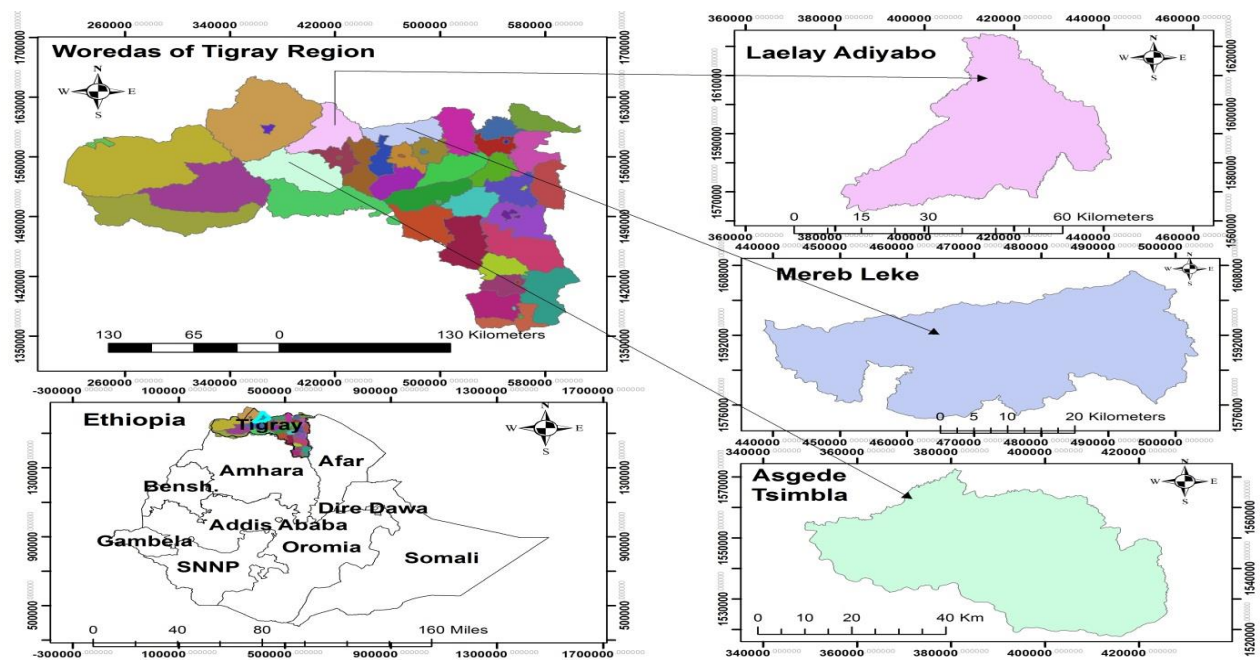
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<sup>23</sup> Census 2007 Tables: Tigray Region, Tables 2.1, 2.5, 3.1, 3.2, 3.4.

vary in altitude from 2000-3000 m.a.s.l (Gebrehiwet, et al, 2011). In the study region, above 80% of the population live in the rural areas and rely on agriculture and *Kiremt* (summer) is the main rainy season. The major types of crops include barely, wheat, *teff*, sorghum, maize, millet, and pulses. In the study area, agriculture is the main source of livelihood backed by off-farm income such as mining, labor trading and petty trade. The average production of the staple crops is less than 7 quintals per family (CSA, 2005; Kidane, 2006).

The TNRS is one of the most drought prone and food insecure regions in Ethiopia. The region has never been food self-sufficient and hence, dependent on relief assistance for many years. According to the socio-economic survey conducted in the region, 16 % of the population revealed to be self-supporting, while the vast majority of 84% couldn't support themselves (REST, 1995). Similar studies show that the region is exposed to persistent drought and climate variability that affect the living condition of the people (Fasil *et al.*, 2007).

**Figure 2. 5. Map of the selected *Woredas***



(Source: TNRS, office of Economic Development, 2017/18)

### 2.1.2. Describing the selection process of the study areas

The study area (*woredas and Tabias*) have been selected for the purpose of assessing the effect of artisanal and small scale gold mining on the livelihood of rural households in the region. In TNRS, there are seven zonal administrations, namely, the Southern Zone, the South-eastern Zone, the Central Zone, the Eastern Zone, the Western Zone, North-western Zone, and Mekelle Zonal

administration. For the purpose of this study, the North-western and Central Zones were selected for the reason that large number of rural households are being engaged in artisanal and small scale gold mining activities (Mining, Energy and Water resource office of TNRS, 2017/18). According to the office, three *woredas* have been ranked from 1<sup>st</sup>-3<sup>rd</sup> based on the number of people who are being participating in ASGM and these are *Asgede Tsimbla*, *Lailay Adyabo* and *Mereb-leke* respectively and five rural kebelles from each study *woreda* was chosen based similar criteria. *These rural kebelles which were incorporated in the study include: Adimehameday,selam,Hitsats,My-berbere,Edagahibret,Adi-hadegti,Zelazle,Tsehayo,Adi-nigsti,Adigedena,Adi-fitaw,Debre-harmaz, Adi-hazo, Terawer and Adi-gebat* were carefully chosen and incorporated in the study. Therefore, the selected *woredas* and *tabias* are believed to show the regional picture of the ASGM sector because majority of the gold miners are located in the study area.<sup>24</sup> For further information, each study *woreda* is described below.

**Asgede Tsimbla *woreda*** is one of the *woredas* in the North Western Zone of TNRS. It is located at 14° 42'to 14°11'North and 37° 34'to 38°19' East. AsgedeTsimbla is bordered by the Tekezé River in south which separates the *woreda* on the south from *Tselemti* and to the west by the Western Zone, then on the northwest by *TahtayAdiyabo*, on the north by *LailayAdiyabo*, on the northeast by *Tahtay Koraro*, and on the east by *Medebay Zana*. The headquarter of *Asgede Tsimbla* is *Indabaguna* and there are other small towns in the *woreda*. The *woreda* has a total area of 2,815.05 km<sup>2</sup> with a density of 48.18 persons per km<sup>2</sup> which is greater than the zonal average which was 40.21 persons per km<sup>2</sup>. According to CSA (2008), a total of 29,677 households were counted in Asigede Tsimbela, with an average of 4.57 persons per household. Asigede Tsimbela has the total population size of 135,561 and the largest ethnic group is Tigraway and majority (97.76%) of them follows Ethiopian Orthodox Christianity while 2.17% of them are Muslim.<sup>25</sup>

According to the CSA (2007), the average land holding of the *woreda* was 1.27 hectare and 88.92% of the land was under cultivation. About 85.61% of the households had owned plot of land, and 16.19% renting, and the rest of them didn't own land. The agro-climate condition of the *woreda* is mainly classified as kola (hot climatic condition) and sub-moist mid high lands. June to September is main rainy season with a total annual rainfall ranges from 250mm to 750mm. The mean annual temperature ranges between 29°C to 41°C with an altitude of 800 to 2300 meter above sea level

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<sup>24</sup> Tigray National Regional State: Mining, Energy and Water Supply Office (2016).

<sup>25</sup> [http://en.wikipedia.org/wiki/Asgede\\_Tsimbla](http://en.wikipedia.org/wiki/Asgede_Tsimbla) accessed on January 2017/18.

(Zenebe et al., 2012). Economically, about 88.15% of the households practice agriculture (crops production and livestock rearing) but due to climatic variability and erratic rainfall, rural households seek other strategies to overcome the challenges related to their livelihoods. Thus, in *Asigede Tsimbela*, artisanal and small scale gold mining activity is an important source of income for rural households by supplying gold for the National Bank of Ethiopia (NBE, 2017). It is an economic activity that has been practiced along alluvial gold deposits in the study area. Usually, miners exploring gold deposits around the catchments or across the mined alluvial gold plain, valleys and small tributaries across the *woreda*. However, exploring and mining activities are carried out using “trial and error” techniques (Hagos, et al, 2009; Gezae, 2010).

**Lailay Adiyabo *woreda*** is another study *woreda* from the North Western Zone of TNRS. It is bordered on the south by *Tahtay Koraro*, on the South-west by *Asigede Tsimbela*, on the North-west by *Tahtay Adiyabo*, on the North-east by the Mareb River which separates it from Eritrea, on the East by the Central Zone, and on the South-east by *Medebay Zana*. The headquarter of *Lailay Adiyabo woreda* is known as *Adi-daero*. The *woreda* has a density of 40.52 with a total of 25,414 households, resulting in an average of 4.48 persons per household. According to the CSA (2007), the number of population in *Lailay Adiyabo woreda* is 119,832. In this *woreda*, 98.9% of the people speak Tigrigna and 96.5% of them practice Ethiopian Orthodox Christianity.<sup>26</sup>

The agro-climate of the *woreda* is classified as *warm semi-arid low lands*; *woidega* and some mountains and hills are classified as *Dega* where temperature is low. The main rainy seasons run from June to August with a total annual rainfall ranges from 686mm to 1200mm. The mean annual temperature ranges between 25c to 38c with an altitude of 800 to 2300 meter above sea level (Zenebe et al., 2012). Agriculture is the dominant economic activity for the majority of the population in the study area. Most households pursue mixed farming (crop production and animal rearing). The average land holding of the *woreda* was 1.16 hectares and 89.39% was under cultivation. With regard to land tenure, 82% of the population own land. Crop production depends on rain-fed and is susceptible to climate changes and erratic rainfall. The dominant cereal crops cultivated include sorghum, maize, *teff*, wheat, barley and the like. Livestock is another source of livelihood in the study area which provides food; serve for farming, and means of transportation for the local population. Nonetheless, like other parts of the country, the outputs of livestock in the study area is poor due to lack of proper nutrition, verities of diseases and limited veterinary

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<sup>26</sup> [http://en.wikipedia.org/wiki/Lailay\\_Adiyabo](http://en.wikipedia.org/wiki/Lailay_Adiyabo), accessed on January 2017/18.

services, and poor breeding systems(CSA,2007). ASGM is another major off-farm activity where by large numbers of licensed and unlicensed miners are being engaged in generating income but the illegal miners are dominating the artisan gold mining operations. However, the government is unable to regulate the sector for different reasons such as lack of adequate budget, lack of skilled man power and logistics to manage the mining sector.<sup>27</sup>

**Mereb-leke woreda** is located in the North-East part of the Central Zone of Tigray Region. It is bordered on the South by *Lailay May-chew woreda*, on the South-west by *Tahtay May-chew*, on the West by the North-western Zone, on the north by the Mereb River (which separates it from Eritrea), on the East by *Enticho*, and on the South-east by *Rural Adwa woreda*. The headquarter of *Mereb-leke woreda* is Rama.<sup>28</sup>

The total population of *Mereb-leke woreda* was 107,218 with the population density of 42.52 in an area of 2,521.70 square kilometers (CSA, 2007). A total of 23,370 households were counted in this *woreda* with an average of 4.59 persons per household. About 96.93% of the residents practice Ethiopian Orthodox Christianity and 99.56% of the people speak Tigrigna as their first language.<sup>29</sup> Agro-ecologically, the altitude of *Mereb-leke woreda* ranges from 350 to 786 meter above sea level, while the minimum annual temperature ranges between 32oC and 44oC. Temperature is very high during the months of February to June. The mean annual rainfall for the area ranges from about 250 to around 860mm. Much of its land is located in the lowlands. The rainy months extend from June–September but the *woreda* receives most of its rainfall from July to August.<sup>30</sup>

Majority of the people practice mixed agriculture as their source of livelihood and supplemented by off-farm income. Land tenure in this *woreda* has been distributed amongst 82.52% owning their land (CSA, 2007). The average the land holding of the *woreda* is 0.85 hectares and 85.92% of the land is under cultivation.<sup>31</sup> Artisan and small-scale gold mining has an immense economic and social contribution in the study *woreda*. Its economic contribution, in terms of income generation for the local people, employment and local economy has played paramount importance in *Mereb-leke woreda*. The local people participate in artisanal gold mining to generate income and support their livelihood. Of course, the amount income obtained from the sector may vary depending on

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<sup>27</sup> *Tigray National Regional State: Mineral, Energy and water supply of Tigray region, (2016).*

<sup>28</sup> <http://en.wikipedia.org/wiki/Merb-leke>), accessed on January 2017/18.

<sup>29</sup> *Census 2007 Tables: Tigray Region Archived 2010-11-14 at the Wayback Machine, Tables 2.1, 2.4, 2.5 and 3.4.*

<sup>30</sup> *The office of agriculture and rural development of Mereb-leke woreda,2017/18*

<sup>31</sup> *CSA of Ethiopia. Agricultural Sample Survey. Report on Area and Production - Tigray Region. Version 1.1 - December 2007.*

the seasons where water is available and suitable for mining activity. Despite the potential economic values of gold, miners are still operating traditionally using manual techniques which ultimately resulted in inefficiency gold production. Besides, most miners engage in the informal mining operation which causes for declining the gold supply and low income tax in the *woreda*.

### **3.2. Research Methodology of the Study**

This section highlights the research paradigm/philosophical foundation of the study, research approaches (qualitative, quantitative and mixed), sampling procedures and types of sampling techniques (probability and purposive sampling techniques), tools/instruments of data collection and various methods/techniques of data analysis processes. This section also explains the purpose and rationale of selecting each technique of data collection and analyzes the impact of ASGM participation on the livelihood of the rural households in the study area. Besides, it discusses ways of addressing the research questions and research objectives of the study.

#### **3.2.1. The research philosophy of the study**

This dissertation is guided by pragmatism research philosophy which has been developed by pragmatic researchers (Gray, 2004). Pragmatism world view recognizes that there are many different ways of interpreting the world (Bryman, 2004). There is no single way of understanding the entire picture of a given issue and hence, multiple realities exist which need multiple approaches and techniques to undertake a scientific research (Saunders, *et al*, 2003). Pragmatism worldview focuses on what practically works to resolve a particular problem. Thus, researchers emphasize on identifying and defining the research problem and then using all approaches available to understand the problem (Creswell, 2007). Pragmatism world view combines both positivism and interpretivism research techniques to address the research problem using multiple techniques of data collection and analysis (Wilson, 2010). Therefore, this study has adopted pragmatism world view to undertake the study. For this purpose, various techniques have been applied to address the stated research questions and research objectives.

#### **3.2.2. Research approaches of the study**

The study has employed a mixed research approaches that combines both quantitative and qualitative method of data collection and analysis. Mixed research approach is the most effective and widely used method of data collection and analysis (Prowse, 2010). This approach is more appropriate for multi-disciplinary fields of study and rigorous explanation of the research problem

and come up with new findings, insights and perspectives (Bryman, 2004). Mixed research approach is preferable by most researchers to substantiate and triangulate the quantitative data with the qualitative one. By applying the principles of triangulation, it can complement the weakness of the quantitative dataset by strengths of qualitative dataset for detailed understanding and generalization of findings (Creswell, 2007). Mixed research approach is used by researchers on the notion that a single data set may not be sufficient to address the research problems and questions of the study (Creswell and Clark, 2007). Therefore, mixed approach is usually employed when multiple methods are applied to answer different research questions and specific research objectives (Cresswell, 2007, Gray, 2004; Bryman, 2004). Taking the above reason in to account, this dissertation has applied mixed research approach to assess the effects of ASGM participation on the livelihood of the rural households in TNRS. In the quantitative part, both descriptive and inferential statistics, regression analysis have been applied to analyze the quantitative data while the qualitative data have been used to supplement and triangulate the quantitative data.

### **3.2.3. Data types and sources**

**Primary data sources:** The primary data for particular study have been collected from household survey, key informants' interview, Focus Group Discussion (FGD), field observations and documents. Large proportion of quantitative data have been collected from sample households using structured questionnaire from the selected '*woredas*' and '*tabias*'/rural kebelles. Qualitative data have also been gathered from the key informants who have been working at federal, regional and local levels. In the key informant interview, top officials of the federal and regional governments, local head officers, experts, development agents, community representatives and other stakeholders related to the sector. In addition, focus group discussion, open and check listed observation were used to collect pertinent information and gain a deeper understanding about the topic under investigation.

**Secondary data sources:** The study has also employed secondary data which are obtained from different sources. According to Gupta (2005), secondary data sources are classified into published and unpublished sources. Published sources such as books, journal articles, published policy documents and published research works used in this research work. Besides, unpublished sources such as office reports of the federal, regional and local governments have also been used to gain deeper understanding about the research problem and come up with policy alternatives of the mining sector. Therefore, the published and unpublished sources have been intensively reviewed

on the ASM sector and the theoretical, empirical and conceptual frameworks of this research work were developed.

#### **3.2.4. Instruments/tools of data collation**

The primary data for this study were collected using various instruments or tools. These include questionnaire, key informant interview, focus group discussions, structured observations and documenting essential sources.

**Questionnaires:** Structured questionnaire was designed to collect survey data on the effect of ASGM participation on the livelihood of rural households in TNRS. The questionnaire had been developed so as to address specific objectives of the study. In each questionnaire, dummy and multiple choices were incorporated to properly answer the research questions. Questionnaires were prepared in English and translated into the local language “Tigrigna” for simplicity and clarity of the research questions to be addressed. The questionnaire was piloted before final use to test their validity and reliability. For this purpose, a total of 15 enumerators and 3 supervisors were hired. The enumerators and supervisors had better educational background and speak local language (Tigrigna) to clarify vague questions in the questionnaire during data collection processes. They had received single day training as to how administer and caution to be taken during the data collection processes. Enumerators and supervisors had been responsible to carefully administer the data collection activity by encouraging the respondents to answer the questions contained in the questionnaire. This has been done by repeatedly reading the questions, choices and reassuring the respondent about the objective and the confidentiality of the data collection process whenever there is a hesitation on the side of the respondents.

**The key informant interview (KII):** The KII is one of the frequently used tools of data collection using in-depth interview and generate deep information on the issue which is being investigated (Creswell, 2007). Besides, this method of data collection allows researchers to explore and understand the problem and come up with proper remedy (Boyce and Neale, 2006). Therefore, the purpose of preparing interview guide for this study was to gather pertinent and thorough qualitative information on the effect of artisanal and small scale gold mining on the livelihoods of rural households in the study area. The interview guide for KII contains open questions to allow the interviewees express their beliefs, perceptions and attitudes about the issue under investigation. The interview guide was prepared in English and translated in local language “Tigrigna” to make the conversation smoothly. The interview guide for KII was piloted before makes use of it.

**Focus group discussions:** The perception, attitude, lived experiences of the discussants on any issue under investigation (Bryman, 2004). FGD is an essential technique of data collection whereby pertinent information can be generated using thorough discussion on the research problem to be examined. This technique requires proper planning and developing guideline as to how the FGD is implement (Creswell, 2007). Hence, this study employed FGD to collect adequate as well as pertinent information on the effects of ASGM on the livelihood of the rural households. Data obtained from FGD has been used to supplement the survey (quantitative) data and increase the validity and reliability of the findings of the study. For this purpose, a total of fifteen (15) FGDs were selected from a total of 15 *tabia*/rural kebelles. The number of discussants in each FGD was made manageable (6-8) and the members of the FGD were purposively selected and grouped to enable the researcher generate additional information to check and triangulate the data obtained from survey respondents. The discussants encompassed *tabia* administrators, community elders, local gold traders, environmental authority and local financial institutions which have been on duty during the data collection process. However, discussants were unwilling to be recorded by tape recorder due to the sensitivity of the topic and fear of media outlet. Hence, all the reflections obtained from each FGD were captured by taking intensive notes, summarizing them carefully and were used during the data analysis process.

**Observation:** is a process of closely observing the physical setting, people's activities and social differences by providing important information that could add knowledge of the subject matter (Kothari.2004). In this study, observation was used to gain a deeper understanding about the ASGM participation and its effect on the physical setting of gold mining activities, the nature of the work, the hardship faced by miners at the mining sites, the livelihood strategies of households, how to make use of household assets, the overall process and the livelihoods the local people. Besides, this method had paramount importance to triangulate information collected by other techniques of data collection. Thus, study employed structured observation using check list so as to record the issues related to gold mining activities in the study sites.

**Documents:** In most cases, researchers explore and identify documents to gather relevant data for the ongoing research work (Creswell, 2009). Hence, information obtained from various documents could have significant support in providing relevant information about the issue under investigation (Kothari, 2004). Relevant documents had been collected form federal, regional and

local government offices which believed to be supportive for this particular study. Eventually, the documents had been verified and validated before make use of them as data sources.

### **3.2.5. Sampling procedures and techniques of the study**

Usually, conducting population census and getting complete information about the entire population is impossible for individual researchers as it is very expensive and time consuming activity (Kothari, 2004). Perhaps, governments may conduct census or complete enumeration of the population for especial purpose such as policy input, development planning and population estimation. Obviously, there is no need to apply sampling technique to draw sample respondents if the population is small (Bryman, 2004). However, sampling technique is frequently used by researchers to gather information and draw inferences about that specific population. Therefore, depending on the nature of the study, an appropriate sample size is needed to make an accurate inference about the population which is being investigated (Creswell, 2007; Kothari, 2004).

**The study population:** the target populations of this study were participant and non-participant households in artisanal and small-scale gold mining activities in the selected *woredas* and *tabias*. The unit of analysis for this particular study is ‘household’ and it comprises a person or group of persons who normally live together in the same housing unit and who have common cooking arrangements (CSA, 2005). In most cases, household level of analysis is preferable in most rural areas because dealing with food security, poverty and other socio-economic condition of the rural population is highly interconnected (FAO, 2007; WFP, 2008). Therefore, this study is intended to analyze the overall effects of artisanal and small-scale gold mining participation on the livelihood of the rural households in the study area.

**The sample frame of the respondents:** contains the list of the study population from which the sample size is drawn (Kothari, 2004). The source list/sample frame of the study was obtained from the governmental offices of the respective study *woredas* and *tabias* where the study is located. Both the participant and non-participant households have been residing in the study *woredas* and *tabia* for at least a year because ASGM in the study area is dominated by migratory miners and this may result in inconsistent information about the issue under investigation.

**Determining the sample size of the study:** is the most important factor that affects the quality of any scientific research (Kothari, 2004). In order to make generalize or inference about the study and avoid sampling errors, a sample size shall be adequate and representative (Creswell, 2007).

However, one of the most frequent problems in statistical analysis is determining the proper sample size of the population. A proper sample size is required in any scientific research be it experimental or non-experimental research to be valid and trustworthy. That is, if the sample size is too small, it cannot yield valid results (Cresswell, 2007). Similarly, too large sample size would result in wasting resources (Gray, 2004). Thus, determining proper sample size has paramount importance for the validity and accuracy of results in any scientific research. For this particular study, Kothari's (2004) formula was used to determine the sample size of the study. For Kothari (2004), the sample size for finite population can be computed as:

$$n = \frac{Z^2 \cdot p \cdot q \cdot N}{e^2(N-1) + Z^2 \cdot p \cdot q}$$

Where, N= total number of households

$p$  = expected proportion. If there is doubt about the value of  $p$ , it is best to error towards 50% (0.5) as it would lead to a larger sample size.

$$q = 1 - p;$$

$z$  = the value of the standard variant at a given confidence level and to be worked out from table showing area under Normal Curve (the confidence level of this study is 95%, then  $Z=1.96$ )

$n$  = size of sample;  $e$ = margin of error

Given the above formula, the sample size of the study has been calculated as:

$N= 25,224$  total number of households (both participant and non-participant households)

$$q= 0.5$$

$$p= 0.5$$

$z= 1.96$  at 0.05 level of margin error of 95% of level of confidence

$$e=0.05; n=?$$

$$n = \frac{Z^2 \cdot p \cdot q \cdot N}{e^2(N - 1) + Z^2 \cdot p \cdot q}$$

$$n= (1.96)^2 (0.5) (0.5) (25224) \div [(0.05)^2 (25224-1) + (1.96)^2 (0.5) (0.5)]$$

$$n= (24224) \div (64.018)$$

$$\mathbf{n= 378}$$

Therefore, as has been shown above, the sample size of the study was found ( $n=378$ ). Out of the total sample respondents, 160 of them were found participants while 218 of them were non-participants in the ASGM activities. The sample households have been selected from the three *woredas/districts* and fifteen *tabias/rural kebelles*.

### 3.2.5.1. Purposive sampling technique

The study has employed purposive sampling to select 3 study *woredas* from North western and central zones of TNRS. According to the office of Energy, Water and Mineral Resources (2017/18), *Asgede Tsimbla, Lailay Adyabo and Mereb-Leke* have been ranked 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> in terms the number people participating in gold mining activities and hence, these *woredas* had been purposively selected. Likewise, from each selected study *woreda*, 5 top ranked *tabias* (rural kebeles) have also been purposively selected using similar criteria. The primary data obtained from the office indicates that the gold mining participation is being undertaken in many parts of the region but the selected *woredas* and *tabias*/rural kebeles have very good track record in gold mining participation and hence, they had been intentionally chosen.

Moreover, the key informants had also been chosen carefully because they were expected to have specific knowledge and expertise on issues related to under study. Purposive sampling involves the process of selecting key persons to gather pertinent information about the issue under investigation (ASGM and its effect on the livelihood of the rural households in the study area). Therefore, officials at federal, regional, *woreda* and *tabia* levels have been purposively chosen as key informants to demonstrate and generate relevant data to elicit the views of persons who had specific knowledge and provide evidence for the purpose of data collection for the study.

Table 3. 1 Key informants at Federal, regional and *wereda* levels

Levels	Target population of the key informants	Total no. of KII
Federal level	<ul style="list-style-type: none"> <li>• Ministry of Mining and Energy (1 person)</li> <li>• Artisanal small-scale mining(ASM) directorate office (1 person)</li> <li>• Directorate office for Market channel/chain of ASM(1person)</li> <li>• Legal service center (1 person )</li> </ul>	4
Regional level	<ul style="list-style-type: none"> <li>• Tigray Mining and Energy Head Officer (1 person)</li> <li>• ASM Core processor (1 person)</li> <li>• Market expert for traditional gold mining (1person)</li> <li>• Mineral expert for ASM ( 1person)</li> </ul>	4
<i>Woreda</i> level	<ul style="list-style-type: none"> <li>• <i>Woreda</i> administrator (3 persons)</li> <li>• <i>Woreda</i> water and mineral chairperson(3 persons)</li> <li>• <i>Woreda</i> Agriculture and natural resource office heads (3 persons)</li> <li>• <i>Woreda</i> food security expert (3persons)</li> </ul>	12
<i>Tabia</i> /rural kebelles level	<ul style="list-style-type: none"> <li>• Rural administrators (5 persons, 1 from each <i>tabia</i>)</li> <li>• Community elders (5 persons, 1 from each <i>tabia</i>)</li> </ul>	15 15
Total No. KII =		50

Source: author's own selection (2016/17).

### 3.2.5.2. Simple random sampling technique

Simple random sampling technique is a sample selection technique which gives equal probability of being selected and to be included in the sample (Kothari, 2004). This sampling technique has been preferred since it is cost effective; reduces sampling bias, easy to apply and doesn't require technical knowledge to draw the sample respondents from the sampling frame (Ibid:pp.60). For a respondent to be equally considered as a sampling unit, he or she must be selected using a random selection (Creswell, 2007; Drayman, 2004). Hence, simple random sampling is used to draw the sample respondents from the sampling frame of the target population. The justification to apply this sampling technique is to increase the quality of the research findings and ensure adequate representation of the study population (Kothari, 2004). The sampling frame for this particular study was obtained from the Agriculture and Rural Development offices of the chosen *woredas* and *tabias* in the study area. Once the sampling frame had been prepared, lottery method was used to draw the sample respondents and the total sample households proportionally taken from selected *woredas* and *tabias* in the study area.

Table 3. 2 Number of sampled households from each *tabia*

Woreda/District	Tabias/rural kebelles	Total HHs*	Sample Size	Number of sample Households **	
				Participant HHs	Non-Participant HHs
Asgede Tsimbla	Adi-mehameday	1876	28	13	15
	Selam	1792	27	10	17
	Hitsats	2087	31	14	17
	My-Berbere	1669	25	12	13
	EdagaHibret	1902	29	10	19
	<b>Sub-total</b>	<b>9326</b>	<b>140</b>	<b>59</b>	<b>81</b>
Laelay Adyabo	Adi-Hadegti	1724	26	12	14
	Zelazle	1860	28	10	18
	Tsehayo	1594	24	09	15
	Adi-Nigsti	1652	25	12	13
	Adi-gedena	1688	24	11	13
	<b>Sub-total</b>	<b>8518</b>	<b>128</b>	<b>54</b>	<b>74</b>
Mereb Leke	Adi-Fitaw	1742	26	12	14
	Debre-harmaz	1587	24	11	13
	Adi- Hazo	1456	22	10	12
	Terawur	1284	19	08	11
	Adi-gebat	1311	19	06	13
	<b>Sub-total</b>	<b>7380</b>	<b>110</b>	<b>47</b>	<b>63</b>
<b>Grand total</b>		<b>25,224</b>	<b>378</b>	<b>160</b>	<b>218</b>

(Source: Survey data, 2018/19)

\*List of household heads from each of the selected *tabias* (2012/13).

\*\*sample size proportionately computed from the given total households of each *tabia*.

Table 3.2 shows that the sample respondents which were proportionately drawn from each study *woreda* and *tabia* and determine the total sample size of the study. First, the number of households in each *tabia* had been identified. Secondly, the sample proportion of each study *tabia* was drawn and finally, the sum of the households who were drawn from each study *tabia* has been the total sample respondents of the study (see table.3.2.)

### **3.2.6. Quality control of the study**

The use of reliability and validity are essential components of any research study to validate or check the accuracy of the findings and replicate by other researchers. In this research work, the issues of validity and reliability have been critically addressed.

#### **3.2.6.1.The validity of the study**

Validity determines whether the research truly measures what is intended to measure the truthfulness of the research results. It is concerned with appropriateness of the indicator to measure the intended subject (Bryman, 2004; Amin, 2005). Creswell (2007) describes validity as the extent to which a method of data collection measures what it is supposed to measure. O’Leary (2010) in book ‘research methods and techniques’ emphasizes that validity considers the relevance of the methods, approaches and techniques employed to address the issues of interest. In this study, pilot study had been conducted to ensure the validity of all questions in the questionnaire to yield the intended results. Hence, the validity of each specific question in the questionnaire was checked. Errors which had been found during pre-testing process were corrected before conducting the actual data collection process in the study area.

#### **3.2.6.2.The reliability of the study**

Reliability is the extent to which results are consistent over time and an accurate representation of the total population under study. If the results of a study are reproduced under a similar methodology, then the research instrument can be considered as reliable (Creswell, 2007). Reliability is related to the consistency of the instruments and the similar data would have been collected each time over repeated observations but it does not ensure accuracy (Bryman, 2004; O’Leary, 2010). For Creswell (2007) there are several devices which are used to check the reliability of instruments such as pre-testing the consistency of the questionnaire and interview guidelines. In this research work, questionnaires had been tested and re-tested to check their

reliability prior to the entire data collection was carried out. As a result, the questionnaires and interview guidelines were proved reliable and consistent.

### **3.2.7. Methods of data analysis**

Data analysis is one of the core elements of any scientific research (Kothari, 2004; Bryman, 2008; Gray, 2004; Creswell, 2007). This study has employed multiple data analysis methods and techniques depending on the nature of the research question to be addressed. It should be noted that each specific objective of the study was analyzed using appropriate data analysis technique which suits best. Accordingly, descriptive and inferential statistics as well as econometric models were used to analyze the quantitative data. Descriptive statistics was applied to provide a summary of numerical data on the demographic and socio-economic characteristics of household using different techniques such as tabulations, graphs, figures, frequencies, percentages and the like. Besides, inferential statistics was used to make inferences about the study population. The study has also employed econometrics model to analyze the relationship between dependent and explanatory variables. Essentially, the study has used both of qualitative and quantitative techniques of data analysis. The quantitative method analyzed the data collected from households' survey while the qualitative technique analyzed the qualitative data gathered from KII, FGDs and field observation and the quantitative data were used to supplement and triangulate the quantitative data analysis. For the regression, STATA version 14 software has been applied to analyze the volume of gold supply to the formal market and factors affecting to gold marketing. Moreover, data collected using audio recording had been transcribed and were embedded in the data analysis

#### **3.2.7.1.Data processing of the study**

Next to the completion of data collection process, data editing, coding, classification and tabulation process are carried out and amenable for analysis (Kothari, 2004). Editing entails both field and central editing which involves a careful scrutiny of the completed questionnaires to assure that the data are accurate, consistent with other facts gathered, uniformly entered, as completed as possible and have been well arranged to facilitate coding and tabulation(Gray,2004;Bryman,2004). Coding refers to assigning digits, letters or both to various responses to make possible easy tabulation of information. The purpose of coding is to classify the responses to a question into meaningful categories, which is essential for tabulation (Gupta, 2005 Creswell, 2007). Classification is also essential process of arranging data in groups or classes on the basis of common characteristics

(Kothari, 2004). After the interviews, each question and its responses shall be checked. After the editing, coding and classification process had been completed, the key variables and their labels were entered into STATA version 14 and each question has been labeled and ready for output. The study consists of six specific objectives and each specific objective has its own techniques and methods of analyzing data. Thus, the following sub-sections tried to elucidate the techniques, methods and models of data analysis.

#### **3.2.7.2.Methods of analyzing the socio-economic condition of households**

The first specific objective of the study aims at describing the current socio-economic condition of ASGM participation in the selected *woredas* and *tabias*/rural kebeles. Descriptive statistics has been applied to summarize the general feature of the ASGM sector in the study area. That is, the survey data on demographic and socio-economic characteristics of household have been summarized using frequencies, figures, percentage, tables and figures.

#### **3.2.7.3.Methods of analyzing the governance practices and policy environment of ASM**

The second specific objective employed both qualitative and quantitative techniques of data analysis. In the qualitative analysis, content analysis technique is used to critically examine the effectiveness of the mining policy; laws and regulatory framework of the ASGM sector whereas in the quantitative analysis, data collected using survey questionnaire from sample respondents have been summarized using descriptive statistical techniques using *linkert scale*, frequencies, percentages, tables and figures. Linkert scale was used to measure the awareness and attitude of respondents towards the policies issues, rules and regulations, and governance practices of the ASGM sector to make the sector productive.

#### **3.2.7.4.Methods of analyzing the determinants of ASGS to the formal market**

In the third specific objective, descriptive, inferential and econometrics model have been applied to analyze factors affecting ASGS to the formal market in the study area. Descriptive statistical techniques such as average/mean, percentages, and standard deviations have been applied to examine the socio-economic characteristics of sample households, institutional and market characteristics of ASGS to the formal market in the study area. Besides, inferential statistics has been employed to make inferences about the population using t-test to compare the group mean between participant and non-participant households. The  $\chi^2$  test to determine the significance level

of the discrete variables. Finally, Heckman two-stage model has been applied to describe the participation decision ASGS to the formal market and income level of the household.

**Econometrics model:** In many cases, dichotomous (yes or no) dependent variable is widely applicable when survey data are available (Gujarati, 2004). One of the dependent variable in this study is a binary variable that takes a value of '0' or '1' and households were give the choices if they participate in ASGS to the formal market agents. However, the independent variables can continuous or categorical. Binary choice models assume that households are faced with a choice between two alternatives. Thus, the choice model is used to determine the probability that a household make a choice (Woodridge, 2002).

ASGS participation to the formal market agent is a dependent variable, which is dichotomous taking on two values, '1' if the household participate in ASGS and '0' otherwise. Estimation of this type of relationship requires the use of qualitative response models. In this regard, the non-linear probability (logit and probit) models are the possible alternatives binary model because these models give guarantee that the estimated probabilities lies between the logical limit of '0' and '1'. The binary outcome models have an S-shaped relationship between the independent variables and the probability of an event that addresses the problem with functional form in the linear probability model (Gujarati, 2004; Woodridge, 2002). The reason is that probit probability model is associated with the *cumulative normal probability function* where the logit model assumes *cumulative logistic probability distribution* and they are very close to each other and hence, different results are not expected if one uses the logit or the probit model. Therefore, the choice between the logit and probit models is related to the availability and flexibility of computer programs, personal preference, experience and other facilities because the substantive results are generally indistinguishable (Maddala, 1992). Thus, given the similarity between the two models, probit model has been preferable for the analysis of the determinants of ASGS participation to the formal market agents in the study area.

**Heckman two-stage procedure:** The purpose of this specific objective was to analyze the determinants of ASGS participation decision and its effects on households' income. The common version of the Heckman procedure is to estimate in two stages. In the first stage, it estimates the selection or participation equation (the probability of participating in ASGS) using binary probit model and derives maximum likelihood estimates with data from both participants and non-participants using the estimation result of LAMBDA and it is a tool for controlling bias due to

sample selection (Heckman, 1979). This approach is chosen as it considers the selection bias that could arise due to unobservable factor (Heckman, 1979, Maddala, 1992).

The second stage involves the IMR as an additional explanatory variable to the household income equation or outcome equation and estimating the equation using OLS model using data only from the participant households. If the coefficient of the ‘selectivity’ term is significant then the hypothesis that the participation equation has been governed by an unobserved selection process or selectivity bias is confirmed. Moreover, with the inclusion of extra term, the coefficient in the second stage ‘selectivity corrected’ equation is unbiased (Wooldridge, 2002). Therefore, it is reasonable to use Heckman’s two stage model for this study since it simultaneously models the decision to participation in ASG supply to the formal market and the effect of participation in ASG supply on the income of households.

**Model specification**

$$Y_i = f(X_1, X_2, X_3, X_4, \dots X_k) \dots \dots \dots (1)$$

The econometric model for the outcome model stated in equation (3) can be specified as:

$$Y_i = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \dots + \beta_k X_k + \lambda + \varepsilon_i \dots \dots \dots (2)$$

Where,  $Y_i$  represents the amount of income from ASGS participation.  $X_1, X_2, X_3, X_4, \dots X_k$  are factors affecting the income of households’ ASGS to the formal market agents. Parameters;  $\alpha_0 + \alpha_1 \alpha_2 + \alpha_3 + \alpha_4 \dots + \beta_k + \lambda + \varepsilon_i$  represent coefficients for the row vectors to be estimated,  $\lambda$  is the inverse mills ratio and  $\varepsilon_i$  is the error term.

In the Heckman two-stage Model, ASGS income equation is specified as:

$$Y_i = X_i \beta + \varepsilon_i \dots \dots \dots (3)$$

Where,  $Y_i$  is the individual household’s income from ASGS to the formal market agents. It is observable for the participants and unobservable for the non-participant households and the reason for employing Heckman sample selection.  $X_i$  is a vector of observable factors that affect the level of income from and  $\varepsilon_i$  is the error term.

Let the selection model for household’s participation in ASGS be explained by the equation given below. Here, the equation indicates that households’ ASGS participation to the formal market agents depends on some value  $P_i^*$  of a latent variable.

$$P_i^* = Z_i \alpha + \mu_i \dots \dots \dots (4)$$

Therefore, the study determines the ASGS participation and its effect on the income of the household from the selection equation and this is stated below.

$$P_i = \begin{cases} 1 & \text{if } P_i^* > 0 \\ 0 & \text{if } P_i^* \leq 0 \end{cases}$$

The decision to participate in ASGS is represented by  $p_i = 1$  and  $p_i = 0$ , otherwise where  $p_i$  is a variable indicates participation in ASGS,  $Z$  is a vector of variables that affect households' decision to participate in ASGS and  $\mu_i$  is the corresponding error term. The outcome equation (for income from ASGS) is discussed below:

$$Y_i = \begin{cases} X_i\beta + \varepsilon_i & \text{if } P_i^* > 0 \\ \text{Unobservable} & \text{if } P_i^* \leq 0 \end{cases}$$

As shown above, problems arise when estimating  $\beta$  if  $\mu_i$  and  $\varepsilon_i$  are correlated and further assuming that the following criteria shall be fulfilled.

$$\mu_i \sim N(0,1)$$

$$\varepsilon_i \sim N(0, \sigma^2)$$

$$\text{Corr}(\mu_i, \varepsilon_i) = \rho$$

Put differently, the error terms ( $\mu_i, \varepsilon_i$ ) are assumed to follow a bivariate normal distribution with mean 0, variances  $\sigma(\text{sigma})\mu$  and  $\sigma(\text{sigma})\varepsilon$  respectively, and correlation coefficient  $\rho(\text{rho})$ . The other assumption is ( $\varepsilon, u$ ) is independent of  $X$  and  $Z$ . That's, the error terms are independent of both sets of explanatory variables. The conditional expected income of individual households who have been participating ASGS is:

$$\begin{aligned} E\left\{\frac{Y_i}{P_i} = 1\right\} &= X_i + E\left(\frac{\varepsilon_i}{P_i} = 1\right) \\ &= X_i\beta + \frac{\rho\phi(Z_i\alpha_i)}{\Phi(Z_i\alpha_i)} \\ &= X_i\beta + \rho\lambda \end{aligned}$$

The term  $\rho\phi(Z_i\alpha_i)/\Phi(Z_i\alpha_i)$  is known as Inverse Mill's Ratio (IMR); usually represented by **lambda** ( $\lambda$ ) and reflects for the selection variable that captures the selection bias. Thus, the two stage choice model was applied to analyze factors affecting the participation decision of ASGS and the effect on the income of the participant households.

## **Definition of variables and working hypotheses**

Participation decision and level of income of participant households can be affected by key variables in the study area. The variables which have been hypothesized to affect participation of ASGS to the formal market agents and level of income had been tested whether they were statistically significant or not using t-statistics and chi-square ( $\chi^2$ ) tests. That is, the t-test had been used to test the significance of the mean value of continuous variables of the two groups of participant and non-participant households. On the other hand, discrete explanatory variables were tested using the chi-square ( $\chi^2$ ) distribution. Therefore, their symbols and measurements have been depicted in table 4.3 below. Accordingly, the key variables which have been expected to influence the participation decision households in ASGS and level of income of participant households are explained below.

**Dependent variables:** The dependent variable for the first stage Heckman model is participation decision and it is a dummy variable taking a value '1' if the household participates in ASGS to the formal market agents and '0' otherwise. For the second stage Heckman model, households' income is a continuous variable measured in Ethiopian Birr (ETB).

**Explanatory/independent variables:** The independent variables which have been hypothesized to affect the participation decision of households in ASGS to the formal market agents and level of income of the households had been assumed to be affected by demographic, socio-economic, institutional and physical factors. Therefore, the key factors which are expected to affect the participation decision of ASGS to the formal market agents and level of income the households in the study area are defined as follows.

### **A) Demographic variables**

**Age of household head (agehhh):** Age of the household head is usually a continuous variable which is measured in years. It is assumed that older people have good experience and better access to resources than younger heads (Kidane et al., 2005) but contrary to the above argument old ages are less expected to travel long distance to sell gold to the formal market due to poor physical fitness. Thus, it is hypothesized that age of the household head can have a negative effect on the ASGS to the formal market and level of income of the households.

**Sex of the Household head (sexhhh):** it is expected to have an impact on ASGS to the formal market agents. Hence, male-headed households are expected to have strong bargaining power

regarding market issues better market than female-headed households (Beyene and Muche, 2010). The variable positively or negatively affects the intensity of ASGS to the formal market and its effect on the income of the household; it is a binary variable which takes the value '1' for male; 0 otherwise (female).

**Family size of the household (fshh):** It is a continuous variable which is measured in terms of adult equivalent. Families with more household members tend to have more active labor in production and marketing. According to Tsegay (2009), family size having positive effect on the households' gross income but large family size requires large amount of consumption that reduce marketed surplus. As gold mining needs group work, the larger the family, the higher the production of gold and increases market supply. Therefore, family size can positively affect the volume of ASGS to the formal market agents and may influence the income level of households.

**Education status of the household head (eduhhh):** It represents the level of formal schooling completed by the household head. On one hand, literate miners are expected to have accumulated knowledge through formal learning which might enable them to pursue better livelihood strategy that leads them to generate better income (Fekadu, 2008). Therefore, it is hypothesized that the education level of household heads can positively affect the ASGS to the formal market and the level of income of the household in the study area.

## **B) Socio-economic variables**

**Perception of miners to price fluctuation (pmpf):** It is a dummy variable it takes '1' for price fluctuation affects gold supply to the formal market and '0' otherwise. It is assumed that declining the gold price negatively affects agricultural supplies. Similarly, declining in the price of gold would result in deteriorating ASGS in the study area. This presumption implies that as the prices of gold decreases, artisanal miners are not motivated to produce more and this could be one of the reasons why ASGS has been dwindling. It is hypothesized that price fluctuation is a key variable affecting ASGS in the study area.

**Incentives to increase gold supply (iningosu):** It is a dummy variable that takes the value '1' if lowering the amount of gold (50gm) motivates miners to supply gold to the formal market (Banks) and '0' otherwise. Providing various incentives to miners would increase the supply of gold to the formal market. Among others, the 5% premium is given to miners when they supply gold to the formal market (Banks). Besides, lowering the number of grams was another incentive for miners

to supply gold to the local banks. It is hypothesized that the variable can positively affect the supply of gold to the local banks in the study area.

**Perception on the benefit of the illegal market (pebeilma):** It is a dummy variable that takes the value of '1' if miners obtain more benefit from the illegal market than the formal market and '0' otherwise. Miners usually tend to illegal gold market because miners perceive the benefit obtained from the illegal market is better than the formal market. It is hypothesized that this variable has a negative impact on ASGS to the formal market.

**Cooperative mining (comi):** it is a dummy variable which takes the value of '1' if the miners have institution or unity among them yes take a value of '1' and '0', otherwise. It is assumed that forming mining cooperatives is expected to increase productive efficiency of gold and enables to get a better market price and bargaining power.

### **C) Institutional variables**

**Access to information (acinfo):** It is a dummy variable, which takes '1' if the miner has access to information and 0 otherwise. Access to market information is included as a dummy variable whether the household received information on the market prices prior to selling. Access to market information is important because it enables miners to make more appropriate decisions on which market to sell to and when to sell the commodity. Miners need complete market information to decide and supply gold to the formal market. Therefore, it is hypothesized that access to market information is positively affect the ASGS to the formal market.

**Governance of ASGM (goas):** refers to the governance aspects of the ASM sector. In many countries, the ASM sector has been suffering from a lack of good governance as mining activities are located in remote areas. It is a dummy variable that takes the value '1' for good governance in artisanal gold mining and '0' otherwise. It is hypothesized that governance can have a positive or negative effect on the ASGS to the formal market in the study area.

**Access to illicit trade of gold (aciltrgo):** it is an illegal gold marketing using informal channels and this variable causes for declining the volume of gold supply to the formal market. Reports from MoMPNG show that the illicit trade of gold in Ethiopia has been worsening since the last four years. As a result, the volume of gold supply to the formal market has been deteriorating (Beyene, 2016). It is hypothesized that this variable can negatively affect the ASGS to the local banks. It takes the value of '1' if there is illicit trade of gold in the study area and '0' otherwise.

**Access to credit service (accrse):** It is a dummy variable, which takes the value of ‘1’ if the participant households had access to credit service and ‘0’ otherwise. Having access to credit service is a key factor for further investment activities. Households who had access to credit services have good opportunity of obtaining mining technology that enables them to produce more and if they produce more, then the supply of gold will increase. Therefore, it is hypothesized that access to credit service determines the amount of gold production because miners are able purchase technologies and it positively affects their gold supply.

#### **D) Physical variables**

**Lack of access to transportation (laactr):** It is a dummy variable, which takes ‘1’ if the household had access to transportation and 0 otherwise. In most cases, mining activities are taken place in remote areas where no or limited access to transportation. It is true that a lack of access to transportation may result in a limited supply of gold to the formal market. Hence, it is hypothesized that the lack of access to transportation can negatively affect the gold supply to the formal market in the study area.

**Distance to the nearest market center (disnmc):** it is a continuous variable which has been measured in km. It is the distance between the mining sites and the nearest market center and expected to determine gold supply to the formal market. It is hypothesized that it can negatively affect ASG supply to the formal market.

**Distance from home to the mining sites (dishomsi):** it is a continuous variable which is measured in km. It refers to the distance between the residences of participant households to the mining sites. Proximity of the households to the mining sites and reach easily can increase productivity of gold. It is expected to determine the household’s market supply of gold to the formal market and it is hypothesized that this variable can negatively affect gold supply.

Table 3. 3 Description of explanatory variables

Variables' code	Description	Measurement	Expected effect
<b>Demographic variables</b>			
agehhh	Age of the HHH	Number(continuous variable)	(-)
sehohe	sex of the HHH	1= male, 0=female	(-)
eduhhh	educational level of the HHH	Categorical variable	(+)
fshh	Family Size of HHH	Number(continuous variable)	(+)
<b>Socio-economic variables</b>			
pmpf	Perception of miners to price fluctuation	1=yes or 0= otherwise	(-)
iningosu	Incentives to increase gold supply	1=yes or 0=otherwise	(+)
pebeilma	Perception of miners on the illegal market	1=yes or 0= otherwise	(-)

mcom	Member cooperative mining	1=yes or 0= otherwise	(+)
<b>Institutional variables</b>			
acinfo	access to information	1=yes or 0= otherwise	(+)
goasgm	governance of ASGM	1=yes or 0= otherwise	(+ or -)
aciltrgo	Illicit trade of gold	1=yes or 0= otherwise	(-)
accrse	Access to credit Service	1=yes ; 0= otherwise	(+)
<b>Physical variables</b>			
laactr	lack of access to transportation	1= yes or 0= otherwise	(-)
dishomsi	distance from home to the mining sites	Km	(-)
disnmc	distance to the nearest market center	Km	(-)
acfoma	access to formal market	1=yes or 0= otherwise	(+ or -)

Source: Author's own construction (2017)

### 3.2.7.5. Methods of data analysis for food security status of households

Food security status of households can be measured using different methods and techniques. In this objective, Household Food Insecurity Access Scale (HFIAS), Food Consumption Score (FCS) and Food Energy Intake (FEI) approach have been used to investigate the food security condition of households in the study area. So as to examine the effect of ASGM on the livelihood of rural households, Propensity Score Matching (PSM) was used. Besides, the descriptive, inferential statistics and econometric model were also applied to assess the food security situation of households in the selected *woredas*. In the descriptive statistics, frequency distribution, charts, mean, maximum and minimum, percentage distribution and standard deviation have been employed to analyze the quantitative data. In the inferential statistics, X<sup>2</sup>-test has been used to identify the relations between discrete variables and independent t-test is also used to associate the mean variances between the treated and untreated groups as per the objective of the research objective. Qualitative data which have been collected from key informant and FGD are used to supplement the survey data during the analysis. Finally, logistic regression has been also applied to determine the factors affecting the food security situation of households in the selected *woredas*.

#### 3.2.7.5.1. Measurements of food security status of households

There are several measurements of food security status of households and this study has applied some of the measures to identify factors affecting the food security condition of households in the study area.

##### A) Household food insecurity access scale (HFIAS)

It had been developed by Food and Nutrition Technical Assistance (FANTA) to measure food insecurity status of households or individuals in 1997(FANTA, 2006). In rural areas, food security situations are changes overtime and hence, 30 days recall period was used to capture food

insecurity situations and understand the households' food security status in the study area. HFIAS comprises 2 related questions; one is called an occurrence question. One is called an occurrence question and contains nine questions to be asked if a typical condition is associated with the practice of food insecurity happened during the preceding 30 days (Maxwell et al., 2013). Every severity question has been followed by the rate of occurrence question that asks how often the condition occurred during the last 30 days. Every occurrence question contains of time frame for remembrance, detailed behavior and the two response options are '0' for no and '1' for yes. Every HFIAS for *frequency-occurrence question* asks how regularly the situation reported in the previous *occurrence question* happened in the prior thirty days. According to FANTA (2006), there are three response options: 1 = rarely, 2 = sometimes, 3 = often. The value of HFIAS score lies between 0 and 27 points. According to Coates et al. (2007), the outcomes of HFIAS are classified in to 4 categories are identified: 1 = Food Secure 2 = Mildly Food Insecure Access 3 = Moderately Food Insecure and 4 = Severely Food Insecure and hence, policy intervention is needed according to the household's severity level.

#### **B) Household food consumption score (HFCS)**

There are many ways to collect and analyze food consumption data using *proxy* indicators and the *proxies* include information on dietary diversity consumed by households and frequency of the diet quality (WFP, 2008). The frequency of weighted HFCS was the score computed using the frequency consumption of various food groups consumed by a household during the 7 days prior to the field survey. Using 7-days food frequency data, all the food items were grouped into specific food groups. Firstly, summing up all the consumption occurrences or frequencies of the food items of the similar group. Secondly, multiplying the amount found for every food group by its weight could create new weighted food group scores. Thirdly, summing up the weighed food group scores and obtain the HFCS. Finally, using the appropriate threshold, decide the food security status of households. The weight for every food item was determined by WFP (2008): Cereals=2; Pulses=3; Vegetable=1; Fruit=1; Meat and Fish = 4; Milk= 4; Sugar=0.5; oil=0.5; Condiments=0.

The first threshold is a score of 21, set as barely minimum but a households scoring below 21 was anticipated not to eat staple and vegetables on a daily base and have poor food consumption. The value 21 comes from an expected daily consumption of staple (frequency  $\times$  weight,  $7 \times 2 = 14$ ) and vegetables ( $7 \times 1 = 7$ ). The second threshold is set at 35. Households' between 21 and 35 are placed at the borderline FCS, while households that score above 35 are placed at the acceptable FCS. The

value 35 has been derived from an expected daily consumption of staple and vegetables complemented by very essential food items which are frequently consume in a household [(staple×weight)+(vegetables×weight)+(oil×weight)+(pulses×weight)=(7×2)+(7×1)+(4×0.5)+(4×3)=35)]. In order to calculate the HFCS, the type of food and the frequencies should be multiplied by the given weights for each food group as shown below.

Table 3. 4 Calculating the Households FSC

$HFCS = \alpha \times f(\text{staple}) + \beta \times f(\text{pulse}) + \gamma \times f(\text{vegetables}) + \gamma \times f(\text{fruit}) + \delta \times f(\text{meat}) + \varepsilon \times f(\text{sugar}) + \delta \times f(\text{dairy}) + \varepsilon \times f(\text{oil})$ . Where HFCS = food consumption score,  $f$  = frequencies of food consumption = number of days for which each food group was consumed during the past 7 days,  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$  and  $\varepsilon$  = weight/nutritional value of each food group. According to WFP (2007), the weights<sup>32</sup> for each symbol  $\alpha = 2$ , for main staples;  $\beta = 3$ , for pulses;  $\gamma = 1$ , for vegetables and fruits;  $\delta = 4$ , for meat and milk;  $\varepsilon = 0.5$ , for sugar and oil.

(Source: WFP, 2008; IFPRI, 2008)

According to (WFP, 2008; IFPRI, 2008), households with poor FCS have a food score of 0-28, households with borderline FCS have a food score of 28.5-42 and households with adequate and acceptable FCS have a food score of above 42.

### C) Food energy intake (FEI) approaches

The FEI approach has also been used by researchers to identify food secure or insecure households in a society by finding the food energy intake at which an adult attains (Ravallion and Bidani, 1994). In the identification of the food secure and insecure of households, the study employed food energy intake approach (FEI) to measure the food security of households in the study area. This could be calculated as daily calorie requirement per adult equivalent per day. According to the FDRE (2001) and MoFED (2002), 2200 kcal (AE) per/day/ person was set as minimum acceptable weighted average.

### D) Determining the food security status households

<sup>32</sup>The weight for every food item was determined by WFP (2007): Cereals=2; Pulses=3; Vegetable=1; Fruit=1; Meat and Fish = 4; Milk= 4; Sugar=0.5; oil=0.5; Condiments=0

Researchers prefer consumption expenditure to measure household food security status to income because it is less vulnerable to seasonal variations and captures the welfare of the household (Maxwell et al., 2013). Consumption is also less exposed to measurement errors and better reflects households ability to meet their basic needs (CSA, 2005; FAO, 2002). Thus, household food security status has been determined using the consumption approach based on the 2016/17 household consumption expenditure survey. Taking this method in to account, household food security situation can be set according to the amount of caloric consumed. In order to determine the household food security status, the first step is listing the package of food items consumed by households were measured in terms of 100g solid food using conversion factors and liter for liquid food items (Ravallion and Bidani, 1994). The second step is assigning each food item a caloric content value based on the 2001 food composition table by ENHRI. The Total Net Calorie (TNC) has been expected according to the total weights of consumed food groups for each household in the study area. The third step is adjusting the household size to adult equivalent household size recommended by the World Health Organization. Finally, the household food security status has been defined based on the consumption per adult equivalent per day. This can be described as:

$$HFS_i = \frac{\text{Total net calorie consumption}}{\text{Household size adult equivalent}};$$

Where;  $HFS_i$  = Household Food Security of the  $i^{th}$  household and  $i = 1, 2, 3 \dots 378$  (sample size of the study).  $HFS_i$  = described as:

$$HFS_i = \begin{cases} 0, & Y_i < R(\text{food insecure}) \\ 1, & Y_i \geq R(\text{food secure}) \end{cases}$$

Where;  $Y_i$  is daily per capita calorie available;  $R$  is the minimum recommended national standard rate of calories per person per day, which is 2,200 kilo calorie (i.e., demand) and  $HFS_i$  food security status of the  $i^{th}$  household,  $i = 1, 2, 3 \dots \dots (n = 378, \text{sample households})$ .

Estimates of daily calorie per capita requirements vary widely. For instance, ‘*In Indonesia, the level is set at 2,100 kcal (Ravallion and Bidani, 1994.pp21), for Kenya 2,250 kcal (Greer and Thorbecke, 1986.pp17), while 2,350 kcal had been suggested by the World Bank (Schubert, 1994.pp.34)*’. According to the Ethiopia Food Security Strategy Paper (EFSSP), food security in Ethiopian context is defined as an entitlement or access to balance food basket per person per annum, or 2,200 kcal per day per adult equivalent. Thus, the 2,200 kcal is the minimum acceptance weighted average nutritional requirement for a person to lead a normal physical life under

Ethiopian conditions as estimated by the Ethiopian government (FDRE 2002, MoFED, 2002). Accordingly, the food security line has been set at 2,200 kcal per adult per day for this study.

Households whose consumption calories found to be greater than their calorie requirement were regarded as food secure and assigned a value of 1, while households who faced with calorie deficiency during the study year were regarded as food insecure and they were assigned a value of 0. Hence, the dependent variable, food security status of the  $i^{th}$  household, was measured as a dichotomous variable:  $Y_i = HFS_i \geq 2200kcal$  (Food secure),  $Y_i = HFS_i < 2200kcal$  (Food insecure), Where;  $Y_i$  was food security status of the  $i^{th}$  household,  $i$  1, 2, 3... ..... (n=378).

**The food insecurity severity of household:** In this analysis, the head count ratio, food insecurity gap and total food insecurity gaps were calculated using the following formulas.

**The head count ratio:** can be calculated using  $IFI = m/n \times 100$ ; where, IFI implies Incidence of Food Insecurity,  $m$ =Number of food insecure households and  $n$ =the total sample size. The food insecurity gap can be calculated using  $FIG_i = \frac{TCR_i - TCC_i}{TCR_i}$ , where  $FIG_i$  is food insecurity gap of  $i^{th}$  food insecure household;  $TRC_i$  is Total Calorie Requirement for  $i^{th}$  food insecure household and  $TCC_i$  denotes the Total Calorie Consumption by  $i^{th}$  food insecure household.

**The Total Food Insecurity Gap (TFIG):** indicates the depth of food insecurity among the food insecure households, was expressed as:  $TFIG = \sum_{i=1}^m \frac{FIG_i}{m}$ . Eventually, the squared Food Insecurity Gap (SFIG), which indicates severity of food insecurity among the food insecure households, is given as:  $SFIG = \sum_{i=1}^m \frac{(FIG_i)^2}{m}$ .

**The severity level of food insecure households:** The calorie intake shortfalls were estimated based on the nutritional reference level (2200kcal/day/adult). According to Devereux (2006), the calorie consumption estimates can be used directly to categorize the degree of severity of food insecurity. Therefore, the study has applied the above cutoffs to categorize households in various levels of food security in the study area.

Table 3. 5 The degree of severity of food insecurity of sample households

Food security status	Calorie consumption per person per a day
Food secured	Above 2200 kcal
Marginally food insecure	Between 1800 kcal and 2200 kcal
Moderately food insecure	Between 1500 kcal and 1800 kcal

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(Source: Devereux, S., 2006)

### 3.2.7.5.2. Propensity score matching (PSM)

The impact of any program intervention can be evaluated using different estimation techniques and hence, this sub-section has employed PSM technique to estimate the impact of ASGM participation on the food security and income of households. PSM has been preferred because it avoids biasness and corrects for initial differences between the participants and non-participant groups by matching each participant household to a non-participant household based on similar ‘observable characteristics (Ticci, 2011). PSM is vital to summarize the conditional probability of participation given pre-treatment (Rosenbaum and Rubin, 1983). The first step in estimating the treatment effect is to estimate the propensity score. To determine the propensity scores, any standard probability model (logit or probit) can be used (Rajeev *et al.*, 2007). Since the propensity to participate in ASGM was unknown, the first task in PSM was to estimate the propensity scores and any result from estimates of participation effect rests on the quality of the participation and it can be carried out using any choice model (logit/probit) but the fitness of the choice model depends on the nature of the participation being evaluated. PSM uses a probit/logit model can be used for binary choice for yes or no options. In this case, the dependent variable is ‘participation’ and the independent variables are the factors affecting the participation and its outcome. According to the Pindyck and Rubinfeld (1981), the cumulative logistic probability function was specified as:

$$P_i = F(Z_i) = F[\alpha + \sum_{i=1}^m \beta_i X_i] = \left[ \frac{1}{1 + e^{-[\alpha + \sum \beta_i X_i]}} \right] \dots \dots \dots (1)$$

Where:  $P_i$  = the probability that an individual participates in credit program

$X_i$  = represents the  $i^{\text{th}}$  explanatory variable

$\alpha$  and  $\beta_i$  = are parameters to be estimated.

$e$  = represents the base of natural logarithms

In this case, interpretation is easier if the logistic model can be written in terms of the odds and log of odds (Gujarati, 2004). The odds ratio implies that the ratio of the probability that ( $P_i$ ) indicates participant household but the ( $1 - P_i$ ) implies non-participant household. The probability that a non-participant household is defined by:

$$[1 - P_i] = \left[ \frac{1}{1 + e^{Z_i}} \right] \dots \dots \dots (2)$$

By applying the above equations 1 and 2, the odds ratio becomes

$$\left[\frac{P_i}{1-P_i}\right] = \left[\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right] = e^{Z_i} \quad \text{or} \quad \left[\frac{P_i}{1-P_i}\right] = \left[\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right] = e^{[\alpha + \sum_{t=1}^m \beta_t X_{ti}]} \dots (3)$$

The above natural logarithms gives give the logit model as defined below;

$$Z_i = \ln \left[\frac{P_i}{1-P_i}\right] = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_m X_{mi} \dots (4)$$

Where;  $\alpha$  is an intercept  $\beta_1, \beta_2$  and  $\beta_n$  are partial slopes of the equation in the model.  $Z_i$  is natural logarithm of the odds ratio, which is not only linear in variable X but also linear in the parameters.  $X_2$  is vector of explanatory variables for household  $i$ . If we consider a disturbance term  $u_i$ , the complete logit model specified as below:

$$Z_i = \alpha + \sum_{t=1}^m \beta_t X_{ti} + U_i \dots (5)$$

Therefore, the binary logistic model would be as follows:  $Pr(ASGMP) = f(X)$

Where: ASGMP= Probability of Artisanal Small-scale Gold Mining Participation;  $f(X)$  is the dependent variable ASGM participation and  $X$  is a vector of observable covariates of the households. After obtaining the predicted probability values conditional on the observable covariates from the binary estimation, matching has been done using a matching algorithm. In case of binary treatment of the ASGM participation, the treatment indicator:  $D_i$  equals 1 if a household  $i$  receives treatment and 0 otherwise. The potential outcomes are then defined as:  $Y_i(D_i)$  for each household  $i$ , where  $i=1, 2, \dots, 378$ , then the treatment effect of the household  $i$  can be defined. Thus, the effect of participation in ASGM on food security of households(Y) is specified below:

$$T_i = Y_i(D_i=1) - Y_i(D_i = 0) \dots (6)$$

Where:  $T_i$ = treatment effect (effect due to participation in ASGM),  $T_i$  is the outcome on household  $i$ ,  $D_i$  is whether household  $i$  has got the treatment or not (i.e., whether household participated in ASGM or not). Note that  $Y_i(D_i=1)$  and  $Y_i(D_i=0)$  cannot be observed for the same household at the same time. Based on the position of the household in the treatment (ASGM participation), either  $Y_i(D_i=1)$  or  $Y_i(D_i=0)$  is known as *counterfactual outcome* (unobserved outcome). In fact, estimating each treatment effect ( $T_i$ ) is so difficult and hence, estimating the Average Treatment Effect (ATE) of the whole population is appropriate. The widely used ATE estimation is the Average Treatment Effect on the Treated ( $T_{ATT}$ ), and it is defined below.

$$T_{ATT} = E(T|D = 1) = E[Y(1)|D = 1] - E[Y(0)|D = 1] \dots (7)$$

In this section, variables that determine households' decision to participate in ASGM could also affect households' food security status. Therefore, the outcomes of households from treatment and

comparison group would differ even in the absence of treatment leading to a self-selection bias. Therefore, by subtracting  $E[Y(0)|D = 0]$  from both sides, ATT can be specified as:

$$E(T(1)|D = 1) - E[Y(0)|D = 0] = T_{ATT} + E[Y(0)|D = 1] - E[Y(0)|D = 0] \dots \dots \dots (8)$$

In the non-experimental studies, there are certain assumptions to solve the selection biases. The assumption of the common support region is defined as: (overlap region)  $0 < P(D = 1|X) < 1$ . This assumption ensures that households with the same X values have a positive probability of being both participants and non-participants.

Finally, the PSM estimator of ATT can be written as:

$$T_{ATT}^{PSM} = E_{P(X)|D=1} \{E[Y(1) |D=1, P(X)] - E[Y(0) |D=0, P(X)]\} \dots \dots \dots (9)$$

Where:  $P(X)$  is the p-score calculated using the covariates. The PSM estimator has been considered as the  $\bar{X}$  difference in outcomes over the common support region appropriately weighted by the p-score distribution of participants.

**Matching algorism:** There is no best algorism which wins over the other. Each has advantage and disadvantage. Thus, the choice of a specific algorism depends on the degree of overlap between the treatment and control groups. In this specific objective, the three algorisms (NNM, RM and KM) were applied to estimation the impact of ASGM on food security of the participant and non-participant households in the study area.

**The common support region:** PSM requires checking the overlap of the propensity scores of the treated and control groups (Rosenbaum and Rubin, 1985). Accordingly, the common support region of the estimated propensity scores of the treated and control groups laid between 0.354738 and 0.287349. Therefore, observations whose propensity scores which laid outside the above range were dropped from the estimation of ATT.

Sensitivity analysis of the treatment effect: provides critical information related to the unmeasured covariates. Rosenbaum (2002) suggests bounding method to check the sensitivity of ATT with regard to deviation from the common support region. The key question to be answered here is that the inference about ATT may be altered by overlooked factors (Ticci, 2011).

Definition of dependent variable: The dependent variable of this analysis is participation of households in ASGM. It is a dummy variable and hence, ‘1’ denotes households’ participation in ASGM and ‘0’ otherwise.

**A) Defining outcome variables**

**Household food security:** It is one of the outcome variables as a result of the ASGM participation in the study area. Food security of households may vary due ASGM participation and the outcome variable can be influenced by several explanatory variables.

**Income of the households:** this outcome variable is influenced by households' participation in ASGM activities and it is estimated using the choice model. This outcome variable is measured in ETB based on the current market value.

B) **Explanatory variables:** The key explanatory variables which had been expected to influence the food security and income of households were carefully selected and defined below.

**Sex of the household head (sexhh):** In most rural areas, male-headed households have more access to land, information, technologies and other resources as compared to female-headed households. Besides, female-headed households are mostly affected by food insecurity situation than male-headed households (Beyene and Muche, 2010). As a result, it is hypothesized that the variable has a negative effect in food security status of female headed households. It is a dummy variable which takes the value '1' if the household head is male and; '0' otherwise.

**Age of the household head (agehh):** It is a continuous variable and hence, measured in years. Age is said to have a positive or negative effect on food security status of household (Kidane, 2006). Indeed, older household heads are expected to have better access to resources and experience but mining operation needs physical fitness and hence, as the age of the household head increases the extent of participating in ASGM obviously decreases. Thus, age of the households head definitely influences the food security status of households.

**Family size of the household (fsh):** it is continuous variable and is measured in number. It is assumed that the larger the household size, the higher the anticipation of more food consumption in a household (Beyene and Muche, 2010). In this study, it is hypothesized that households with large in size are more productive in ASGM actively than the small one and are expected to be food secure. Thus, it is hypothesized that size of the household can have a positive or negative effect on food security status of households.

**Education of household head (eduhh):** It is categorical variable which takes different values (0-5). Education is described as a social capital which has a positive effect on household food security because literate people have a better chance of adopting technologies and access to information

that lead to better productivity (Tadesse and Belay, 2004). It is hypothesized that household heads with better education can have higher chance of being food secure.

**Access to information (acinfo):** is a binary that variable takes ‘1’ if the household had access to information and ‘0’ otherwise. Access to market information is important because it enables households to sell their commodity. Quick and accurate access to information is required for households to make right decision on the amount of products to be supplied to market and which price to receive. Therefore, it is hypothesized that access to market information is positively influencing the decision of households’ in supplying their product to the market.

**Off/non-farm income of households (offinc):** studies revealed that farm income is not the only source of livelihood for the rural households. Thus, the food security condition of the rural households largely depends on the ability to get access to off/non-farm job opportunities which could serve as livelihood diversification strategies (Beyene and Muche, 2010). Hence, it is hypothesized that the availability of off/farm income can be certainly related with household food security in the rural areas. It takes ‘1’ if the household generates off/farm income and ‘0’ otherwise.

**Size of cultivated land (scl):** is a continuous variable measured in hectare. It is a key resource in the rural areas which is expected to be associated with food security status of households (Grootaert and Narayan, 2004). As the cultivated land size increases, the possibility to get high yield increases and ensure food security. Therefore, it is hypothesized that households with large cultivated land would have better food security status.

**Total livestock in unit (tlu):** It is a continuous variable and measured in TLU. It refers to the number of the total number of livestock holding of the household can be measured using Tropical Livestock Unit (TLU). Rural households accumulate their wealth in terms of livestock as they are prominent sources of wealth in many rural Ethiopia. Thus, as the number livestock increases, the probability of households to be food secures increases (Yilma, 2005). It is hypothesized that livestock possession is positively affects the food security of a household. It takes ‘1’ if the household owns livestock and ‘0’ otherwise.

**Oxen ownership (oxow):** Number of oxen is another determinant of the food security status of households. In most agrarian societies, oxen possession affects households’ crop production because it enables them to cultivate large size of land and execute agricultural operations timely (Tadesse and Belay, 2004). Therefore, there is a positive relationship between oxen ownership and food security households. It takes ‘1’ if the household owns oxen and ‘0’ otherwise.

**Use of chemical fertilizer (ucf):** enhances productivity per unit of cultivated area. Households who have the willingness to use chemical fertilizer are expected to have better food production capacity and ensure food security than those who don't use it (Babu and Tashmatov, 1999). Therefore, this variable is hypothesized that households who use chemical fertilizer have better food security status than the non-users. Use of chemical fertilizer is a dummy variable taking value of '1', if a household uses chemical fertilizers and 0 otherwise.

**Access to credit service (accres):** access to credit serves as a means to boost production and increase income of the household (Devereux, 2006). Households which have access to credit service are motivated to participate in off/non-farm activities and achieve food security (Beyene and Muche, 2010). Thus, it is hypothesized that households who have access to credit is more likely to be food secure than those who don't receivers credit. It is a dummy variable taking the value '1', if the household receive credit '0' otherwise.

**Use of improved seed (usimse):** improved seed affects crop production. They can increase agricultural productivity by boosting overall production, which in turn contributes to attaining food security at the household level (Lipton, 2005). Thus, using improved seeds has positive association with household food security. It is a dummy variable taking value of '1', if a household used improved seeds and '0' otherwise.

**Distance to nearest market center (acnmc):** Closeness to market centers creates access to additional income via off/non-farm employment opportunities, easy access to information on inputs and transportation (Devereux, 2006). That is, households having better access to market have better opportunity to be food secure than those who don't have access. Therefore, it is hypothesized that there is positive association between access to the nearest market center and household food security. It is dummy variable which takes the value of '1' if a household has nearest market center and '0' otherwise.

Table 3. 6 Summary of key variables

Variables'	Description of variables	Measurement	Expected effect
sexhh	sex of household head	1= male, 0=female	(-)
agehh	age of household head	<i>Number</i>	(+ or -)
fsh	family size of the household	<i>Number</i>	(+)
eduhh	education of household head	Categorical	(+)
ofinc	off/non-farm income of hh	Dummy: 1= Yes; 0= otherwise	(+)
acinfo	access to market information	Dummy: 1= Yes; No=otherwise	(+)
scl	size of cultivated land	Hectare	(+)
tlu	total livestock in unit	TLU	(+)

oxow	oxen ownership	Dummy: 1=own ;0=otherwise	(+)
ucf	use of chemical fertilizer	Dummy : 1=yes, 0= otherwise	
accrse	access to credit service	Dummy: 1= if the HH has received credit service; 0= otherwise	(+)
usimse	use of improved seeds		
acnmc	access to the Nearest Market Center	Dummy:1= Yes; 0= otherwise	(+ or -)

Source: The authors' construction (2017/18).

### 3.2.7.6. Methods of data analysis for poverty status of households

This specific objective analyzed the poverty situation of households using the Multi-dimensional Poverty Index (MPI) and Propensity Score Matching (PSM) techniques.

#### 3.2.7.6.1. The MPI methods of analyzing poverty of households

MPI is the data analysis technique which comprises 3 dimensions (education, health and living standards) and 10 indicators (Alkire, S. et al, 2015). Previously, income or consumption have been widely used measurements of poverty but recently, due to the dynamics of poverty, other tools such as MPI have been developed as alternatives measures of poverty (Alkire and Santos, 2010). MPI is becoming useful as an analytical tool to identify the most vulnerable people - the poorest among the poor, revealing poverty patterns within countries and over time, enabling policymakers to target resources and design policies more effectively (UNDP, 2016). In this study, MPI is preferable in assessing poverty status of the people in the study area using a household as unit of analysis as data were assumed to be available at the household level.

In applying MPI, some steps were followed. Among others, a cross-sectional survey data were collected, a household was taken as the unit of analysis to undertake the study, three dimensions and 10 indicators were used to assess the poverty situation of households, indicators' deprivation cut-offs were determined and  $Z_i$  denotes the cut-off, so that a  $HH_i$  is poor/deprived if its achievement in that indicator  $X_i$  is below the cut-off ( $X_i < Z_i$ ).<sup>33</sup> In MPI, the three dimensions are equally weighted, so that each of them receives a 1/3 weight. The indicators within each dimension are also equally weighted. Thus, each indicator within the health and education dimension receives a 1/6 weight and each indicator within the living standards dimension receives a 1/18 weight.

The final step could be choosing the poverty cut-off to identify. Each household is assigned a deprivation score according to its deprivations in the component or indicators. The deprivation

<sup>33</sup> UNDP (2006) *Poverty in Focus: What is poverty? Concepts and measures*. International Poverty Center.

score of each household has been calculated by taking a weighted sum of the number of deprivations so that the deprivation score for each household lies between 0 and 1. The score increases as the number of deprivations of the household increases and reaches its maximum of 1 when the household is deprived of all component indicators. A household which was not deprived in any indicator receives a score equal to 0.<sup>34</sup> The other cut-off or threshold is used to identify the multi-dimensionally poor was called the poverty cut-off. In this chapter, we define the poverty cut-off as the weighted deprivations a household must have in order to be considered poor, and it is denoted by  $k$ . In this way, a household is considered poor if its deprivation score was equal or greater than the poverty cut-off ( $K=1/3$ ). Formally, a household is poor if deprivation score  $C_i \geq K$ . In the MPI, a household is poor if it has a deprivation score higher than or equal to 1/3.

The MPI also reflects headcount ratio (H) and the average intensity (A) of their poverty, the average proportion of indicators in which poor people were deprived (Alkire, S. et al., 2014). The MPI can be calculated by multiplying the incidence of poverty by the average intensity across the poor. That is,  $MPI = H \times A$ ; where ‘H’ is percentage of people who are MPI poor (incidence of poverty) while ‘A’ is average intensity of MPI poverty across the poor. A household is identified as poor if it is deprived in at least 1/3 of the weighted indicators. But those who identified as vulnerable to poverty deprived between 20% – 33.33% of the weighted indicators and those who identified as ‘Severe Poverty’ are deprived in 50% and above (Seth, S., et al, 2014). As explained above, the MPI combines two key pieces of information: (1) the proportion/incidence of people who experienced multiple deprivations and (2) the intensity of their deprivation. Formally, the first component is called the multidimensional headcount ratio (H):  $H = \frac{q}{n}$ . Here,  $q$  is the number of people who were multidimensional poor and  $n$  is the sampled population. The second component is called the intensity of poverty (A). It is the average deprivation score of the MP people and can be expressed as  $A = \frac{\sum_{i=1}^n C_i(K)}{q}$ ; Where  $C_i(K)$  is the deprivation score of household  $i$  and  $q$  is the number of households who are MPI poor. The MPI is the product of both:

$$MPI = H \times A = \left[ \frac{q}{n} \right] \times \frac{[\sum_{i=1}^n C_i(K)]}{q}$$

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<sup>34</sup> *Acute multidimensional poverty: A new index for developing countries. OPHI Working paper, Oxford Poverty & Human Development Initiative, Oxford University.*

### 3.2.7.6.2. The propensity score matching technique

In the second sub-section, Propensity Score Matching (PSM) was employed to estimate the impact of ASGM on poverty status of households in the study area. According to Caliendo and Kopeinig (2008), the PSM probabilities function is expressed by:

$$P(X) = Pr\{D = 1 \mid X\} = E\{D \mid X\} \dots \dots \dots (1)$$

Where  $D = \{0, 1\}$  is the binary variable: '1' denotes participation and '0' otherwise.  $X$  is the vector of household characteristics.

**The Average Treatment Effect on the Treated (ATT):** The value of ATT is expressed as the difference between expected outcome values of treated group (participant households) and control group (non-participant households) in ASGM participation. The outcome variables are total annual income and total annual expenditure of the treated and control groups. Thus, the ATT was calculated using Nearest Neighbor Matching (NNM), Radius Matching (RM) and Kernel-Based Matching (KM) to analyze the impact of ASGM on the poverty reduction of households.

**The NNM and RM techniques :** In the NNM, each treated group is matched with a control group (Caliendo & Kopeinig, 2008). Whereas in RM, the outcome of the control group is matched with the outcome of the treated group only if the PSM falls in the predefined radius of the treated groups (Mingxiang Li, 2012) Thus, according to Becker and Ichino (2002), the ATT is estimated using NNM and RM techniques. This can be expressed as (Becker and Ichino, 2002)

$$ATT = \frac{1}{N^T} \left[ \sum_{i \in T} Y_i^T - \frac{1}{N_1^c} \sum_{j \in C} Y_j^c \right] \dots \dots \dots (ii)$$

Where,  $N_T$  = the number of households in the treated group (participant households).

$N_1^e$  = a weighting scheme that equals the number of cases in the untreated group.

**Kernel Matching (KM):** In the kernel matching, all treated groups were matched with a weighted average of all untreated groups using weights that had been inversely proportional to the distance between the PSs of treated and untreated groups. The weighting value is determined by the distance of PSs, bandwidth parameter *represented by*  $h_n$ , and a kernel function  $k(\cdot)$ . According to Becker and Ichino (2002). The kernel matching estimator is represented by the following formula:

$$ATT^k = \frac{1}{N^T} \sum_{i \in T} \left[ Y_i^T - \frac{\sum_{j \in C} Y_j^c G\left(\frac{P_j - P_i}{h_n}\right)}{\sum_{k \in C} G\left(\frac{P_k - P_i}{h_n}\right)} \right] \dots \dots \dots (iii)$$

Where  $G(\cdot)$  is a kernel function and  $h_n$  is a bandwidth parameter, under standard situation on the bandwidth and kernel matching, the formula given below is consistent estimator of the counterfactual outcome  $Y_{0i}$ . The outcome equation can also be represented by:

$$\text{Outcome } Y_{0i} = \frac{\sum_{j \in C} Y_j^c G\left(\frac{P_j - P_i}{h_n}\right)}{\sum_{k \in C} G\left(\frac{P_k - P_i}{h_n}\right)} \dots\dots\dots (iv)$$

**The covariance balancing technique:** PSM has employed the covariate balancing technique to apply the Standardized Bias (SB) and the Bias Reduction (BR) techniques to check the balance of the score and covariates which were included in the study.

**The Standardized Bias (SB)** calculates the difference of sample means in the treated and the matched untreated groups. Each covariate  $X$  is described as the difference of sample means in the treated and untreated groups and as the proportion of the *square root* of the average of sample differences in both groups. The SB is also used to quantify the bias between the treated and untreated groups (Ticci, 2011). Before matching, the SB is given by this formula:

$$SB_{\text{Matching}}(X) = 100 \frac{\bar{X}_{\text{treatment}} - \bar{X}_{\text{control}}}{\sqrt{V_{\text{treated}}(X) + V_{\text{control}}(X)}} \dots\dots\dots (v)$$

Where:  $\bar{X}_{\text{treatment}}$  and  $\bar{X}_{\text{control}}$  indicates the sample mean of covariate in treated and untreated groups respectively, whereas,  $V_{\text{treated}}$  and  $V_{\text{control}}$  indicates the sample variance of the covariate in treated and untreated groups respectively.

**The Bias Reduction (BR) Technique:** The bias reduction (BR) can also be computed using the following formula

$$BR = 100 \left( \frac{1 - B(X)_{\text{After}}}{B(X)_{\text{Before}}} \right) \dots\dots\dots (vi)$$

**Common Support Region (CSR):** The probability  $P(X)$  of the CSR lies between 0 and 1. It is also assumed that for all  $X$ , there is positive probability of either participating in ASGM ( $D=1$ ) or not participating ( $D=0$ ). The CSR ensures that households with the same characteristics have positive probability of being treated or not treated in the ASGM. Households that lies outside the CSR were omitted from the estimation processes. The CSR is an important precondition to assure the significance of the matching to estimate the ATT (Becker and Ichino, 2002).

The CSR is presented as:  $0 < pr(D = 1|D) < 1 \dots\dots\dots (v)$

### 3.2.7.7. Methods of data analysis for vulnerability of livelihood assists to ASGM participation

The last but not least specific objective of the study focused on the vulnerability context of the livelihood assets as result of ASGM activities in the study area. Sustainable Livelihood Framework (SLF) was applied to analyze the data to understand the vulnerability context of livelihood assets and its effect on the rural households in the study area. SLF is used for livelihood vulnerability assessment because it provides a holistic picture of livelihood outcomes (Chambers & Conway, 1991). The underlying assumption in SLF was that people pursue all forms of livelihood outcomes based on a range of livelihood assets through the use of a variety of livelihood strategies (Ellis, 2000). According to DFID (1999), the strategies that people use to generate livelihood outcomes and the way they reinvest in asset building are driven by the transforming institutional structures such as government sectors. Livelihood outcomes are largely influenced by the vulnerability context (stressors, hazards, and shocks) overall trends and seasonal variations (DFID, 1999). SLF provides a systematic diagram where vulnerability context is presented as a major determinant of sustainability of livelihood assets as it directly influences livelihood strategies, institutional process and livelihood outcomes of the community (Lamichhane, 2010). Similarly, availability of livelihood resources, entitlement to those resources, functional institutional structures and efficient livelihood strategies are essential elements for sustainable livelihood outcomes (Ellis, 2000).

A) **Livelihood Assets/the 5 Capitals:** The Livelihood Vulnerability Index was used to analyze livelihood assets or capitals as a result of ASGM. The livelihood assets/capitals are divided into 14 components and 37 livelihood indicators. Using the indicators, percentage responses to each category by the households were calculated. The indicators are described below.

- **Human capital:** is the software aspect livelihood assets. In this case, 2 components: (1) human health; (2) knowledge and skills. 3 indicators were used to represent human health whereas 5 indicators were represented for knowledge and skills component (Hahn *et. al.*, 2009).
- **Natural capital:** It is a critical asset for the rural households. In this case, 3 components and 11 indicators were used to assess livelihood vulnerability context of natural capital (Hahn *et. al.* 2009; Lamichhane, 2010).
- **Financial capital:** is another essential asset for households and concerned with the regular inflow of money and saving. 2 components and 2 indicators were employed to assess the financial capital in the study area (Ellis, 2000).

- **Physical capital:** provision of infrastructure facilities and producer goods needed to support livelihoods are considered as physical capital (DFID, 1999). Thus, 4 components and 3 indicators were used to assess the vulnerability context of households in the study area.
- **Social capital:** social resources upon which households pursue their livelihood objectives. It encompasses 2 components and 4 indicators (DFID, 1999).

It shall be noted that the LVI employed a balanced weighted average approach where it is assumed that each sub-indicator contributes equally to the overall vulnerability context (Sullivan et al., 2002; Lamichhane, 2010). Since all of the indicators are measured on different scale, each of them is standardized as an index. The average of the standardized index of each indicator is calculated to estimate the indices for each livelihood assets. Finally, the balanced weighted average of all the components was considered as the final LVI score for the households (Shah et al., 2013; Sullivan et al., 2002; Lamichhane, 2010). The LVI is scaled from 0 (least vulnerable) to 1 (most vulnerable).

**B) Livelihood Vulnerability Index (LVI):** This section is intended to calculate the extent of the vulnerability context of ASGM in the study areas. Livelihood Vulnerability Index (LVI) and balanced weighted approach have been used to analyze data. A simple method with equal weights is applied for all major components because each indicator was measured on a specific scale; it is, therefore, normalized as an index (Sullivan 2002; Hahn et al. 2009). For this purpose, the equation used in the LVI calculation as shown below:

$$Index_{sv} = \frac{S_v - S_{min}}{S_{max} - S_{min}} \dots\dots\dots (1)$$

Where:  $S_v$  was the value of a sub-component for sample household;  $S_{min}$  and  $S_{max}$  were the minimum and maximum values respectively.

$$Index = \frac{\text{Observedvalue} - \text{Minimumvalue}}{\text{Maximimvalue} - \text{Minimumvalue}}, \text{ for each individual indicator.}$$

After normalizing sub-component or indicator values, the value of each major indicator was calculated by:

$$M_{vj} = \frac{\sum_{i=1}^n Index_{sv}}{n} \dots\dots\dots (2)$$

Where,  $M_{vj}$  was the value of major indicator  $j$  for the sample household;  $index_{svi}$  represents the value of sub-component  $s$  indexed by  $i$  of the major component  $M_j$ ; and  $n$  was the number of sub-component in the major component. The major component values (human capital, natural capital, social capital, physical capital and financial capital) were directly used in Equation (3) or

aggregated to five values for livelihood assets<sup>35</sup> before used in Equation (4) to obtain the weighted average of LVI:

$$LVI_v = \frac{\sum_{j=1}^n WM_j M_{vj}}{\sum_{j=1}^n WM_j} \dots\dots\dots (3)$$

$$LVI_v = \frac{wH H_v + wN N_v + wS S_v + wP P_v + wF F_v}{wH + wN + wS + wP + wF} \dots\dots\dots (4)$$

Where,  $LVI_v$  is the livelihood vulnerability index of the sample household and weight value (w) of major component j; wH, wN, wS, wP, wF are weight values of asset H, N, S, P, F, respectively. The LVI ranges from 0 to 1; 0 denoting least vulnerable and 1 denoting most vulnerable. A household is less vulnerable when LVI is below 0.50, moderately vulnerable if LVI ranges from 0.50-70 and is severely vulnerable as the LVI exceeds 0.70 to the different degree of vulnerability (Shah et al., 2013; Sullivan et al., 2002; Lamichhane, 2010).

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<sup>35</sup>[H (Human capital), N (Natural capital), S (Social capital), P (Physical capital) and F (Financial capital)]

## CHAPTER FOUR

### Describing the Socio-Economic Condition of Sample Households

#### 4.1. Introduction

This chapter highlights the general feature of the ASGM participation in the study area. Key socio-economic variables have been described to have a good insight on the mining sector in the study. Explaining the socio-economic characteristics of the mining sector believed to have paramount importance in understanding the nature of the work and related issues. Different data analysis techniques such as frequencies, percentage, graphs, figures were applied to analyses the overall socio-economic condition of households in the study area.

#### 4.2. Demographic characteristics of households

A total of 378 sample households (both participants and non-participants in ASGM) have been included in the survey study. Of the total sample households, 160 and 218 respondents were found participants and non-participants in ASGM activities respectively. The response rate the data collection process was 98.2%. A total of 50 key informants from federal, regional and local officials were carefully interviewed. In addition, a total of 15 FGDs were conducted to collect additional information to supplement the survey data. Demographic characteristics of households such as sex and age of the household head, family size of the household, and educational level of households have been analyzed using both descriptive such as percentage, frequencies, tables figures and the like and inferential statistics such as chi-square test for categorical variables and t-test for continuous variables.

Table 4. 1 Summary of descriptive statistics for continuous variables

Demographic Variables	Participants (N=160)		Non-participants (N=218)		Total (N=378)		T-value for mean difference
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev	
Age of the household head	46.06	14.74	52.43	18.54	47.18	16.068	31.45***
Family size of household	5.27	2.67	4.48	3.40	4.68	3.06	5.98**
Livestock ownership	3.50	1.917	1.264	0.984	2.854	1.76	27.268

(Source: Computed from the survey data, 2017/18)

The age group of household head is a key factor which determines the participation decision of households in the ASGM in the study area. The younger the age group, the more physically fit to participate in gold mining activities. The result shown that the mean age of the participants and

non-participants households were 46.06 and 52.43 respectively. The age of the participant and non-participant households ranged from 22-62 and 27-69 respectively. Therefore, comparing the participants with non-participants, it is statistically significant at less than 1% probability level.

Out of the 378 sample households, 29.9% of them were found female-headed households whereas 70.1% of them were male-headed households. Of the 113 female headed households, 40.7% of them were found participants in ASGM activities while 59.3% of them were non-participants in the ASGM. On the contrary, among the 265 male-headed households, only 43% and 57% of them were found participants and non-participants in ASGM respectively. The chi-square result shows that it is statistically significant at  $p < 1\%$  probability level.

Family size of the household is a key variable in influencing the ASGM participation in the study area. As the number of household increases, the labor force of the household increases and hence, more income can be obtained. Thus, family size of the household has a direct relationship with production capacity of households due to the fact that gold mining needs adequate labor to undertake the mining operation. The result has shown that the average family size of participant and non-participants households has been found 6.7 and 5.2 respectively. Therefore, family size of the participant households was found statistically significant at  $p < 1\%$  probability.

Table 4. 2 Demographic characteristics of households (discrete variables)

Variables	Values	Participants (N=160)	Non-participants (N=218)	Total (N=378)	Chi-square test ( $\chi^2$ )
Sex of the household head	Female =0	46(28.75%)	67(30.7%)	113(29.89%)	12.6435***
	Male =1	114(71.25%)	151(68.3%)	265(70.1%)	
Education level of HH head	0	5(1.3%)	15(4%)	25(5.3%)	66.9327
	1	54(14.3%)	62(16.4%)	116(30.7%)	
	2	39(10.3)%	54(14.3%)	103(24.6%)	
	3	8(2.1%)	6(1.6%)	14(3.7%)	
	4	13(3.5%)	15(4.5%)	28(8%)	
	5	41(10.9%)	72(19.1%)	113(30%)	

(Source: survey data, 2017/18)

\*\*\* denotes 1% level of significance

Education is a key variable which helps household heads decide and creates awareness while adopting of technology. The distribution of the literacy level of households, 1.3 percent and 4 percent of the participants and non-participants were found illiterate respectively; 14.3 percent and 16.4 percent of the participants and non-participants had attended 1-4 grade levels respectively; 10.3 percent and 14.3 percent of the participants and non-participants had attended 5-8 grade levels respectively; 5.6 percent and 5.6 percent of the participant and nonparticipant households had

attended 9-12 grade levels and 10.9 percent and percent 19.1 percent of the participants and non-participants were found read and write without formal education respectively. However, as has been depicted in table 4.2 above, chi-square test for education level of households was found insignificant between participant and non-participant households.

The livelihood of rural households mainly depends on both farm and off farm activities in the study area. The farm income is generated from different sources such as agricultural and livestock production. The off farm activities include gold mining, petty trading, grain and livestock trading, sales of *Tela* (local beer), sale of firewood and charcoal, pottery, handcraft and so on. The mean annual farm income of the participant households was found to be 15,241.67 ETB with a minimum of Birr 6,824.86 ETB and the maximum annual income of 19,371.60 ETB. Whereas the mean annual income of the participant households generated from gold mining was 42,235.89 ETB with a minimum income of 7,856.34 and maximum of 46,476.32 ETB (excluding the outliers).<sup>36</sup>

Conversely, the mean annual farm income of the non-participant households was found 17,497.34 ETB with a minimum of 3,697.65 ETB and the maximum of 21,876.36 ETB. On the other hand, the mean annual off farm income of the non-participant households was found 9, 168.48 ETB with a minimum of 2,876.74 ETB and a maximum of 11, 456.83 ETB. Therefore, the t-test analysis revealed that the mean annual total income difference of the participants and non-participants households have been found statistically different from each other at 1% probability level. The result indicates that the participant households generate more income than the non-participants households from the off farm sector. Specially, the ASGM sector in the study area is the major source of off farm income to the local community. However, much has been left to improve the ASGM sector as many of the operations are still being performed in traditional manner.

Table 4. 3. Distribution of income of households

Variables	Sample households				
	Participants	Non-participants	Difference	Std error	t-value
Household Income					
Mean Farm income	15,241.67 ETB	17,497.34 ETB	2,255.67	262.81	12.76***
Mean Off/non-farm income	42,235.92 ETB	9,168.48 ETB	33,067.44	370.22	7.63***
Total	57,467.59 ETB	26,655.82	30,811.77		

(Source: Computed from Survey data, 2017/18)

<sup>36</sup> *Very few miners may suddenly find rich deposit of gold by chance and hence can sale millions of ETB at a point of time. Such data may mislead to the wrong conclusion and recommendation. Hence, such outlier data were excluded from the study.*

### 4.3.The Existing Socio-Economic Condition of ASGM Involvement

#### 4.3.1. The ASGM participation status households in the study area

ASGM has been a source of survival for the rural poor in many less developing countries (Artisanal Gold Mining Council, 2017). In Ethiopia, more than a million miners are being engaged in ASM and more than 7 million people rely directly and indirectly on the sector (Yared, 2013). Besides, about 50,000 miners are currently organized in to cooperatives and having legal license for ASM but still a number of miners are operating without license. Households were asked if they had participated in ASGM activities in their locality. Accordingly, 42.4 percent and 57.6 percent of them were found participants and non-participants in ASGM respectively as per the inclusion criteria. The result indicated that majority of the sample households were non-participants in ASGM in the study area. Table 4.4 depicted the main reason why households didn't participate in gold mining. Accordingly, 28.4 percent of them replied 'the mining sites are too far' to reach easily while 20.2 percent of them said 'they are physically weak', 13.8 percent of them reacted 'they lacked land for gold mining' and 12.4 percent of the households believed that gold mining activity is a time wastage to engage as ASM depends on chance, and 15.6 percent of the non-participants had health problem.

Table 4. 4 Reasons why people were not engaged in ASGM in the study area

Alternatives	Frequency	Percentage	Rank of the reasons
Physically unfit for gold mining operation	44	20.2	2 <sup>nd</sup>
Long distance to travel to mining sites	62	28,4	1 <sup>st</sup>
Lack of land for gold mining operation	30	13.8	4 <sup>th</sup>
Gold mining is a time wastage activity	27	12.4	5 <sup>th</sup>
Households are busy in farm activities	21	9.6	6 <sup>th</sup>
Unable to participate due to health problems	34	15.6	3 <sup>rd</sup>
<b>Total</b>	<b>218</b>	<b>100</b>	

(Source: Survey data, 2017/18)

#### 4.3.2. The push factors of the miners to engage in ASGM

The mining sector has become a source of livelihood for tens of millions of people in Africa and elsewhere in the world (African Economic Outlook, 2012). In the last decades, there have been a proliferation of ASM activities in Ethiopia in general and Tigray region in particularly. Miners were asked the push and pull factors which forced them to engage in ASGM participation in their locality. The result indicated that 25 percent of them were pushed by lack of employment

opportunities, 33 percent of them were pushed by economic hardship and 10 percent of them reacted that gold mining is a customary practice for the local people. On the other hand, among the pull factor, 20 percent of them replied they pulled by ‘quick wealth creation’ and 12 percent of responded ‘rush gold mining’ reacted that the need to supplement income of the household.

Of the push factors, majority of the miners replied that they were pushed by economic hardship limited employment opportunity and customary practices which had been steyed for centuries. However, among the pull factors, quick wealth creation was the first reason that miners pulled to take part in artisanal gold mining followed by rush gold mining where large deposit found suddenly. This result was a bit similar to what was reported by World Bank (2013) in that ASM is poverty driven and hence, reduces poverty, creates employment and provide immediate debt relief. Hilson (2010) added that people who engage in ASM because the sector is viable income-earning activity in areas where there is limited job opportunity. He argued that in many countries like China, South Africa, Ghana, Tanzania, and others, ASM has substituted farming as the primary source of livelihood. Hilson and Garforth (2012) argued that ASM has been strictly an activity carried out by rural households as a supplementary income activity that provides extra income during non-farming periods. On the other hand, the pull factors of ASM have been attributed to low barriers to entry, low technical skill requirement, low capital, and rising global mineral prices (World Bank, 2005; Hayes, 2008; Banchirigah & Hilson, 2010). During the field survey, data were also collected from KII and FGD about the push and pull factors of ASGM participation in the study area:

*Nowadays, farm income is unable to cover all expenses of the rural people unless households engage in off farm activities. By any means, food and non-consumption expenditures can't be covered from farm income. Thus, miners were involving in gold mining activities because they haven't had anything else to do to take care of their kids. Most people, who had been involved in artisanal gold mining, were mainly because of poverty and economic hardship. They had been engaged in gold mining activities solely to earn money to survive and get employed. In the study area, there are no job opportunities even for those who graduated from universities. Thus, miners want to be employed and have alternative income sources to sustain their livelihood in the study area. As a result, people need to have alternative strategies that can sustainably supplement their livelihood and fulfill their basic needs for their family.*

Therefore, the discussants had summarized that most artisanal gold mining activities are poverty driven in their locality as a result of a struggle for survival, unemployment and lack of alternative livelihood strategies. Undeniably, few miners are uplifted from poverty because of gold mining but these miners may discover large deposit of gold as a matter of chance. In fact, these miners were excluded from the study because they can distort the finding and lead to wrong conclusion.

### **4.3.3. Income sources, financial status of households and credit services**

Authors such as Hayes (2008) and Hinton (2005) argued that lack of financial resources of the miners can reduce their mineral productivity. In their study, they explained that access to finance is essential for miners to enable food secure, reduce poverty, improved production and transform in to large scale mining. But the ASM sector is being suffered from severe financial constraints. Information was collected from miners about their source of income was gold mining in their locality. Accordingly, 28.8 percent of them replied that their sole source of income was gold mining while 71.2 percent of them reacted that gold mining was not their major source of income. With regard to other sources of income of the households, 28.9 percent of them said ‘farming’ was another source of income generating sector, 13.2 percent of them were public servants, 21 percent % of the respondents replied petty trading, 16.7 percent of the households were daily laborers and 20.2 percent of them were responded that firewood and charcoal were additional sources income of the miners in the study area. The result of the study is in line with the work of Hilson and Garforth (2012) on mining seasonality. Hilson and Garforth (2012) argued that ASM was a seasonal activity carried out by rural households as a supplementary income activity that provides extra income during non-farming periods. They added that miners were totally shifted from farming but mining is used as complementary income sources as a result of economic hardships. In line with the above argument, farming is the main stay of the Ethiopian economy but the ASM sector supplements the rural households to smooth their livelihood (Beyene, 2016). Moreover, miners were requested to answer their financial status as well as the availability of credit services in the study area. The result implies that 11.9 percent of the miners reacted that their financial status was ‘very good’ while 39.4 percent of the miners reacted that their financial status had been ‘good’, 27.5 percent of the miners said ‘somehow good’, 14.4 percent of them answered ‘poor’ and 6.9 percent of them replied ‘very poor’. The result shows that majority 51.3 percent of the households had good financial status and the rest 48.8 percent of them were found somehow poor financial status. With regard to the credit service of ASGM, 66.2 percent of the miners reacted that they didn’t get credit service while 33.8 of them were able to get credit services. Despite the importance credit service for gold miners to be able get mining inputs but majority of the participant households 66.2 percent didn’t get credit service in the study area.

#### **4.3.4. ASM operation and the livelihood of participant households**

As has been described previously, the ASM sector is the main source of rural livelihood in Africa, Asia, Latin America and elsewhere in the world, particularly, people who have limited access to different source of income in remote areas (Hilton, 2005; World Bank, 2005). In Ethiopia, the majority of the artisan gold miners depend their livelihood on the ASM sector. A study conducted by Beyene (216) revealed that 74% of the livelihood of the miners depend their livelihood on ASM though there are variations across the regions. A study conducted by Hilson (2010) revealed that ASM contributed to livelihood improvement through income generations, asset acquisitions, creating job opportunity, reducing poverty and ensuring food security.

Respondents were also asked whether the ASGM activity can smooth their livelihood or not. The result of the study showed that 26.9 percent of the miners reacted that the gold mining supplements their livelihood, 44.4 percent of them said that 'to some extent' supplements their livelihood, 18.1 percent of them replied that it 'poorly' supplements and 10.6 percent of them said that it is 'a matter of chance' as mining is done by try and error. Hoadley and Limpitlaw (2004) conducted a study on the relationship between ASM and sustainable livelihoods. They found that ASM greatly contributes to sustainable livelihood and poverty alleviation. However, unless the sector is properly regulated, the adverse effect of the ASM sector exceeds its benefit. Among the reasons why people have been involved in ASM was lack of alternative livelihoods in the study area. Prior to diversifying their livelihoods to ASM, many miners were predominantly engaged in agriculture but nowadays, the sector has been deteriorated due several factors and hence, it has become unviable economic activity for many youngsters (Hoadley and Limpitlaw, 2004).

#### **4.3.5. Access to mining land and artisanal and small scale gold mining**

Limited access to land for gold mining is one of the barriers faced by most miners. Survey study conducted by Siegel and Veiga (2010) shows that lack of access to mining land in Africa has been the critical problem through which miners entered to conflict because. Conflict can arise over land claims and access to resources with the entry of any type mining. Lack of tenure right of land may result in conflict among the local people. Similarly, conflict may arise when gold rush occurs in the mining sites since those who rented the can be arbitrarily evicted and land owners need to mine themselves. Respondents were asked whether they had access to land or not but if not, where they mine gold. Accordingly, 43.1 percent of the miners didn't have access to land for gold mining

while 56.9 percent of them have had access to land for gold mining. Besides, miners had also been requested which alternative would have they used if they hadn't access to their own land for gold mining. The outcome shows that 44.9 percent of them used common land, 23.2 percent said rented land, 18.8 of them used land for shared benefit and 13.1 percent of miners had used temporary land given by local administrators. World Bank (2005) reported that limited access to land for gold mining resulted in proliferation of illegal miners in Latin America, Africa and Asia. Moreover, a study conducted by Hilson (2010) revealed that one of the reasons for the expansion of illegal mining was that because miners didn't have their own land for gold mining.

#### 4.3.6. Modes of entering into small-scale gold mining

Evidence show that the modes of entry to the ASM participation are not identical. Among others, poverty, employment, quick wealth creation, new mineral discovery, low barrier to entry, family tradition and so on are the major factors which forced the local enter the ASGM sector (Hayes, 2008). Unfortunately, little attention has been given to date about the ASM sector in Ethiopia despite the country is endowed with potential mineral resources (EEITI, 2016). Table 4.4 below shows that the reasons why artisanal and small scale gold miners enter ASGM participation in the study area. Accordingly, 17.5 percent of the miners said that they were influenced by those who have been mining in their locality while 28.8 percent said that they were entered to support their livelihood. On the other hand, 16.9 percent of the respondents reacted that they were motivated by the raising price of gold nationally and internationally while 13.8 percent of them were influenced by their friends, 16.3 percent of them due to frequent drought in the study area and 6.9 percent of them said they were influenced by other factors. The result implies that the key factor which determine the participation of the local people in ASGM was to 'support their livelihood'.

Table 4. 5 Households' modes of entry or prohibition in to ASGM participation

Modes of entry in to the ASGM(N=160)			Modes of prohibition from ASGM(N=218)		
Description of variable	F	%	Description of Variables	F	%
Influenced by Miners	28	17.5	Physically weak	44	27.5
To support their livelihood	46	28.8	long distance	62	38.8
Motivated by price increment of gold	27	16.9	Lack of land for gold mining	30	18.8
Influenced by friends	22	13.8	It is time wastage activity	27	16.9
Drought	23	14.4	Busy by farm activities	21	13.1
Other factors	11	6.9	health problem	34	21.3

(Source: Survey data, 2017/18)

Table 4.4 above also depicts factor that prohibit the local community from ASGM participation in the study area. The result shows that 38.8 percent of the non-participant households had not been participated in ASGM because of the long distance from their residence to the mining sites while 27.5 percent of them replied they were physically weak. On the other hand, 18.8 percent of the non-participant households replied that they lack land for gold mining, 16.9 percent of them believed that gold mining activity is time wasting, 13.1 percent of them were busy by farm activities and 21.3 percent of the households responded that they had health problems. In line with the above result, a study conducted by Nabaasa, N (2016) revealed that the majority (71%) of the artisanal and small-scale gold miners travel long distance and hence, such long journey to reach the mining sites made many miners to home and pursue other economic strategies near to their residence. Others reported that physical hazards associated with mining contributed to reduce food production. A total of 56% reported physical hazards such as malaria, physical injury, diarrhea and respiratory tract infections and the like (Hilton, 2005; Nabaasa, 2016).

#### **4.3.7. Mode of operating artisanal and small-scale gold mining**

Efforts have been made by governments and practitioners to improve the mining sector. For this purpose, policies, laws and regulations have been put in place to regulate and improve the performance of the ASM sector (Hinde, 2010; Beyene, 2016). Unfortunately, the ASM sector could bring insignificant change and hence, more than 80% of the ASM operation is carried out informally elsewhere in the world. It has been noted that the ASM sector plays an essential role globally with an estimated more 150 million people rely in the sector (Artisanal Gold Mining Council, 2017). In Africa, about 9 million people are directly engaged in the sector and affect the livelihood of 54 million people (Artisanal and Small-scale Mining Knowledge Sharing Archive, 2017). The number of ASM miners in Ethiopia has been reached more than 1.5 million people but the direct and indirect beneficiaries of the sector at 7.5 million people (Yared, 2013). According to the local officials and mining practitioners, the number of artisan miners is estimated to be higher than the figure mentioned above. However, of the total estimated number of artisan miners, about 94% are illegal miners while only 6% of them have license (Beyene, 2016). Currently, the informal mining operation is dominating the formal one and many miners in the country are neither have license nor pay royalty to the government. For different reasons, the government is unable to stop the illegal mining activities due to lack of commitment, limited budget, skilled man power, poor logistics and the likes.

#### **4.3.8. Processes and methods ASGM participation in the study area**

There are certain steps to be followed so as to carry out mining operations. Firstly, selecting a unit of land which is assumed to have gold deposit and then after the sample soil is tested. If the first panning test demonstrates that there are signs of gold, enough soil is moved near to water sources using man power, pack animals and other means of transportation. Such soil can be extracted from surface, sub-surface and underground tunnels (EEITI, 2016). The local panning materials which are used to separate gold from the soil are called *Rahba*. Once the soil is panning using water, then after, gold can be separated from the soil by the use of gravity and put in any container for further refinery processes (Hagos, *et al*, 2009). The extraction of gold involves the mechanical means of digging, crushing, grinding, and washing that enable the separation of gold from its waste material (AMTCCP, 2009).

Gold panning is the most common technique for placer of gold extracting processing in the study area. Some miners do practice repeated grinding and then panning to extract gold form a hard rock. Adult men had been dominating all the series of activities in gold mining such as digging, rock breaking, grinding and transporting. Whereas are mainly engaging in transporting, washing and providing support for men. Extraction process also differs with the nature of the gold deposits, that is, placer or hard rock deposits. Placer of gold deposits is a place where gold grains are found in stream sediments such as river gravels, beach sands and so on while hard rock gold deposits are found in layers of mass rock (Beyene, 2016).

The study tried to assess the commonly used type of mining in the study area. Accordingly, 45.6 percent used open surface mining, 30.6 percent used open-pit mining and 23.5 percent of the miners used sub-surface mining. The result designated that majority of the miners used open surface mining as it is commonly associated with placer mineral deposits and the simplest process of mining activity. Especially, this type of mining is suitable for women since it doesn't require physical labor such digging, breaking rocks and other hard activities. Nonetheless, nowadays, placer gold deposit is nearly exhausted everywhere in many parts of the study area (Beyene, 2016). Open-pit mining consists of shallow depth and open-pit deep hole, which involves discovery of gold ore from an open pit in the ground. Men are mainly engaged in open-pit mining and it may go as deep as 5-10 meters in some localities and deeper to 20-40 meters in some areas. Sub-surface mining consists of digging tunnels or shafts into the earth to reach buried gold ore deposit (EEITI, 2016) and it is increasingly practiced in the study area. As a result, the number of

miners in open pit and subsurface mining operations relatively smaller than the open surface mining in the study area (Hagos, *et al*, 2009).

#### 4.3.9. Artisanal and small scale gold production

Estimating the volume of gold produced by the artisan gold miners is very difficult due to lack of scientific records and fear of gold producers to give accurate information. As it is very hard to know how much a gold has been produced per year, techniques estimating the production can be used. The total gold production per year is equals to an average gold produced by a household or an individual per month in a gram is multiplied by the number of months worked in a year and this is multiplied by total population involved in the ASGM (Beyene, 2016).

Table 4.5 below indicates that the amount of gold produced in each season. Of the four seasons, 60.6 percent of the households mined less than one gram of gold during the winter season. The reasons why miners produced less than one gram in the winter season were justified. Firstly, the winter is the dry season so that miners couldn't get water for gold panning in the mining sites. Secondly, the temperature is getting high so that miners are unable to cope with the temperature. On the other hand, miners have produced more during the summer season because they could get water easily for gold panning; alluvial mining has become common and due to the availability of the moisture, easy to dig soil and hence, gold can be easily extracted. Gold mining process requires large volume of water for washing the soil which contains gold ore and it available during the rainy season. Thus, as has been depicted in table 4.5 below, summer season has more or less good frequency distribution followed by spring and autumn.

Table 4. 6 Amount of gold produced by each household

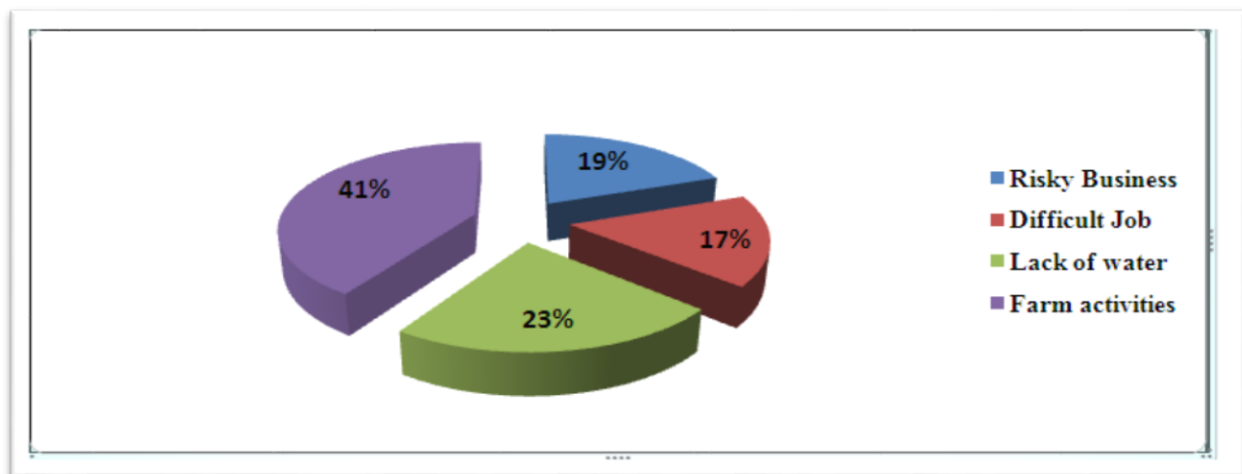
Amount of gold produced by artisanal miners	Autumn		Winter		Spring		Summer	
	F	%	F	%	F	%	F	%
Less than one gram	23	14.4	97	60.6	17	10.6	5	3.1
1-2 gram	52	32.5	19	11.9	56	35	124	77.5
3-4 gram	16	10	7	4.4	11	6.9	67	41.9
5-6 gram	5	3.1	0	0	7	4.4	22	13.8
7-8 gram	0	0	0	0	3	1.9	12	7.5
9-10 gram	2	1.3	0	0	0	0	4	2.5
Above 10 gram of gold	0	0	0	0	0	0	1	0.63

(Source: Survey data, 2017/18)

#### 4.3.10. The mining seasons and the extent of ASGM in the study area

ASGM is carried out in year round mining and seasonal mining. Year round mining can be undertaken throughout the year but the intensity of gold mining depends such as cooperative miners whereas others engage in part time mining activity for the majority of the illegal miners. Thus, out of the total number of miners, only few of them are operating throughout the year. For the majority of the artisan miners, ASGM activity is a seasonal work. In Ethiopia, 15 percent of the total miners have been operating throughout the year (EEITI, 2016). Figure 4.1 depicted that 29.4 percent of the households had been operating year round whereas 70.6 percent of the miners were seasonal miners. The main reasons why miners didn't participate in the year round were analyzed. As a result, 40.7 percent of them replied that they had been busy on farm activities, 23 percent of them reacted that lack of water for planning process, 16.8 percent of the households answered that mining is a difficult job that can't be carried out all the time while 19.5 percent of them said that mining is a risky business.

Figure 4. 1. The reasons for part time work of ASGM in the study area



(Source: Survey data, 2017/18)

The survey data were supplemented by the information obtained from KKI and FGD and was summarized below:

*Majority of the miners are seasonal and there are several reasons why the local people mainly engage in seasonal mining. Firstly, gold mining activity is considered as a risky business because miners are not sure that they can produce gold. Since the activity is based on trial and error, no one is certain that he or she can produce gold every day. Hence, only risk averting mining households do not fully engage in gold mining, instead, they want to diversify their income on other off farm activities to minimize the risky nature of the sector. Secondly, the operation is tiresome and hence, miners want to shift to other business activities and come back to mining when the season is suitable for gold mining as all season are not equally conducive for the gold mining involvement. Thirdly, the availability of water is very critical problem for artisanal gold mining production process and*

*hence, miners need to work during rainy season. Fourthly, gold mining is an additional source of income for many rural people in the study area and it supplements their livelihoods (FGD: 2017/8).*

The above quotation indicates that no-body is sure about how many grams of gold can produce since the activity depends on the trial and error activities. It is a matter of chance that a person may not obtain gold for the consecutive days or may get large amount of gold after several days trail of searching gold deposit. Hence, many households have not been participating because they expect that gold harvesting is wasting time and ultimately, it would result, its opportunity cost is higher than the benefit obtained. That's why many of the local community refrain from gold mining participation in the study area. Besides, majority of the miners are seasonal while few of them mine year round. This indicates that ASGM is uncertain activity which requires continuous trial and searching for gold deposit using modern or traditional techniques.

With regard to the degree of gold mining participation in each season, table 4.6 below indicates that the involvement of both the year round and seasonal participants differ across the seasons. Among the four seasons, summer was found the most preferable season whereby both the year round and seasonal miners intensively participate in artisanal gold mining in the study area. The result of the study has also shown that 67.5 percent of the miners had been participating during the summer season. Similarly, more than 90 percent of the respondents had been involved during the summer and this was due to the availability of water for gold panning in the study area. It must be noticed that artisanal gold mining operations are located near to the water sources as it is quite difficult to undertake the job without water. As a result, the intensity of gold mining participation was found higher in summer seasons followed by spring and autumn. On the other hand, since the temperature reached as high as 40<sup>0</sup>C in most mining sites, miners are unable to cope with the high temperature and engage in gold mining participation in the study area. Thus, the lowest magnitude of participation was recorded in the winter season than any other season.

ASM operation is usually undertaken based on rudimentary and manual techniques such as pick and shovel, hand panning and sluicing (Gavin, 2002). Besides, it doesn't have defined working time but can be practiced early in the morning and late in the afternoon to avoid strong sunlight (MoM, 2012). However, it is estimated that on average, miners can work 20 days per month but because of frequent holidays, the number of working days falls below the average. In order to assess the number of working of gold mining, information was gathered in this regard. Table 4.6 has depicted that 89.4 percent of the households had worked from 15-20 days per month in the

summer season. Whereas 75.6 of them had worked 21-25 days during the summer season. In the spring season, 76.3 percent of them had worked 15-20 days per month while 81.9 percent of them had worked 21-25 days. On the other hand, only 10.6 percent of the miners had worked less 10 days during summer season. In the winter season, 59.4 percent of the miners had worked less than 10 days per month but only 0.6% percent of them had worked less than 10 days during the summer season. This implies that large number of the miners were not year round miners in the study area.

Table 4. 7.The extent of gold mining participation in each season

Variables	Autumn		Winter		Spring		Summer	
	F	%	F	%	F	%	F	%
Year round participation <sup>37</sup>	36	22.5	24	15	41	25.6	47	29.4
Seasonal participation	72	45	33	20.6	93	58.1	108	67.5
<10 days per month	23	14.4	95	59.4	22	13.8	17	10.6
10-15 days per month	44	27.5	22	13.8	66	41.3	72	45
15-20 days per month	90	56.3	15	9.4	122	76.3	143	89.4
21-25 days per month	73	45.6	11	6.9	102	63.8	121	75.6
>25 days per month	31	19.4	04	2.5	44	27.5	98	61.3

(Source: Survey Data, 2017/18)

#### 4.3.11. ASGM and its legal status in the study area

In the pre-1991, the mining sector was directly controlled by the central government and in the post 1991, new mining policies and regulatory frameworks had been introduced and such situation opened for private investors and let the artisanal and small-scale miners to participate in the mining sector (MoM, 2012; Engda, 2011). Since then, the government has enacted a serious of proclamations to address the challenges associated to the mining sector in the Ethiopia (Beyene, 2016). However, the vast majority of miners and mineral traders are still operating informally. In this regard, data were collected on why majority of the miners didn't have license and had been operating illegally. Accordingly, 60 percent of the households reacted that mining license didn't have any relevance to carry out gold mining while 40 percent of them responded that mining license has relevance for gold mining. The result fits with Beyene's (2016) finding and he found that regardless of the need of license, many of the miners operate here and there without legal permission. People think that they can be restricted their movement if they have license since they

<sup>37</sup>Year round ASGM participation refers to a year round engagement of miners in gold mining activities. The livelihood of the household depends on ASGM activity other than farm and other sources. However, Full time ASGM participation in this context doesn't mean that miners work strictly like that of civil servant (Monday –Friday and 8 hours per day) in the year round. Instead, gold mining activity depends on the suitability of the season for gold mining as the four seasons don't have same temperature and suitability.

had been mining for generations. He also argued that miners had two reasons to choose the informal activity. The first reason is that miners are not interested to have a license due to lack of skilled man power to inspect the activity properly, poor logistics and remoteness of the mining sites. The second reason is that restriction of mobility from site to site. Most miners thought that if they are legally registered, they may be confined and denied mobility from place to place.

Data have been gathered on the issue of mining license and the result shows that 70.6 percent of the miners didn't have mining license, 39.4 percent of them said it limits their mobility, 26.25 percent of them believed that they may pay royalty to the government. A study conducted by Beyene (2016) found that only 6 percent of the artisanal gold miners had license while 94 percent of them didn't have. As a result, 65 percent of artisanal and small scale gold miners were not able to pay royalty to the government but only 35 percent of the miners had paid royalty.

The ASM sector has been challenging by several factors and such factors hinder the effectiveness and efficiency of the sector (MoM, 2012). According to the information collected from survey about the challenges that critically affect the gold mining participation in the study area, 26.9 percent of the respondents replied that weak institutional capacity to implement the rules and regulations, 21.9 percent of them replied backward mining practices, 19.4 percent of them said lack of awareness about laws and regulations of the mining sector, 18.1 percent of them reacted lack of political commitment to manage and regulate the sector and 13.8 percent of the miners reacted that unreliable market system for artisanal and small scale gold production in the study area. Similar findings were observed in Beyene's 'Situational Analysis of the ASM sector' in Oromiya, Tigray, SNNP and Amhara regions. He found that the ASM sector had been suffering weak institutional capacity; lack of follow up and support, poor awareness of the stakeholders, backward technology, and dominance of illegal mining practice, absence of database, limited infrastructure, illegal market and lack sustainability of the sector (Beyene, 2016).

#### **4.4. Chapter Summary**

The study found that large proportion of the survey respondents were not participating in gold mining in their locality and the majority of them were found male-headed households. The result of the study indicates that as age of the household head increases the ability to engage in gold mining decreases because the activity requires physical strengthens. Family size of the participant households is found statistically significant at  $p < 1\%$  level comparing with the non-participant. Majority of the household heads had been exposed to formal education but the chi-square test for

education level of households was found statistically insignificant and this implies that formal education is less likely to influence gold mining participation. In the study area, 63.1 percent of them were found illegal miners. The study also revealed that the push and pull factors for gold mining participation in the study area were limited job opportunities, economic hardship, quick wealth creation and gold rush. It has been found that the key challenges which hinder gold mining participation include lack of access to land for gold mining, long distance to reach the gold mining sites, bad governance, limited access to market information, lack of occupational safety and health. Of the types and methods of mining operations, open surface mining was found the simplest and commonly used mining operation in the study area. Among the seasons, summer season has got the highest frequency distribution of ASGM participation followed by spring and autumn. The result also indicates that miners are not interested to have a license as it restricts mobility from place to place. The study has also identified that poor regulatory tools, lack logistics and remoteness of the mining sites are some of the factors which exacerbate the illegal gold mining and informal gold market operations in the study area. Besides, very weak institutional capacity, backward mining practices, lack of awareness, lack of political commitment and unreliable market for gold supply have been among the factors affecting the performance of the sector.

## CHAPTE FIVE

### Governance Practices and Policy Environment of Artisanal and Small-scale Mining

#### 5.1. Introduction

Despite the socio-economic benefits of mining sector, it has been facing with numerous challenges which hamper its performance. In many instances, the ASM sector continues to be an activity plagued with problems of inadequate policy and regulatory frameworks and this resulted in impediment on gold productivity and generate adequate income from the sector. In the post 1991, several policy reforms had been in place to improve the overall performance of the mining sector but the desired outcomes are not realized yet. Therefore, this chapter discusses the governance practices and policy environment of the mining sector.

#### 5.2. Governance Practices and Artisanal and Small-scale Mining

##### 5.2.1. Aspects of good governance in ASGM in the study area

The policy environment and good governance of the mining sector can play a vital role to improve performance of the sector. Data were collected from survey respondents on the governance practices of gold mining in the study area and the results have been depicted in table 5.1 below.

Table 5. 1 Issues of good governance on ASGM participation

Alternatives	SDA,DA,DD,A,SA <sup>38</sup> (Mining HHs N=160)									
	SDA		DA		DD		A		SA	
	F	%	F	%	F	%	F	%	F	%
◆Miners are happy with the existing governance of ASGM in your locality.	43	26.9	81	50.6	18	11.3	13	8.1	5	3.5
◆Miners are effectively participating on the issues of governance of ASGM.	48	30	51	31.9	19	11.9	28	17.5	14	8.8
◆Local leaders are responsive in resolving the challenges of ASGM sector	45	28.1	36	22.5	21	13.1	24	15	34	21.3
◆There is transparency on managing the ASGM sector in the study area.	56	35	39	24.4	18	11.3	31	19.4	16	10
◆Local leaders are accountable for unable to manage the sector effectively	79	49.4	44	27.5	23	14.4	11	7.5	3	1.9
◆The rules and regulations of ASGM sector are effective in the study area.	69	43.12	47	29.4	14	8.8	21	13.12	9	5.63

(Source: Survey data, 2017/18)

<sup>38</sup>(SDA=strongly disagree; DA= Disagree ;DD= Don't Decide; A=Agree; SA= Strongly Agree)

The results in table 5.1 indicate that miners were found unhappy with the existing governance practices of gold mining in the study area. According to Hilson (2009), the ASM continues to be an activity plagued with problems of good governance stemming from an overall inadequate legal and regulatory framework. The qualitative data obtained from the of FGD in My-hanse site supports the above result. The key points of FGD has been summarized as:

*Basically, the ASM sector has not given proper attention from the federal, regional and local governments. Most gold mining operations are located at the remote areas and this might be the reason the sector is ignored and not regulated properly. As a result many illegal activities socio-economic problems such as conflicts, abuse of child labor, illegal market dealers and smuggling of gold via different routes are common phenomenon in the study area. Besides, the overall governance structure of the gold mining operation (Federal-local) are not well arranged and structured to manage the sector. Even the mining sector doesn't have its own separate offices at local level and hence, the policy, rules and regulations are poorly implemented to govern the gold mining sector.<sup>39</sup>*

As has been plausibly described by the focus group discussants, one can infer that there is a serious challenge of good governance in managing the mining sector in the study area. In countries where there is poor governance practices of ASM, majority of the miners operate illegally and hence, the sector's contribution to the national economy has become insignificant (Hilson, 2010). Hentschel, T. et al (2003) argued that weak regulatory and policy environment of ASM would result in less sustainable livelihood of the mining community.

Participation is one of the pillars of good governance and it a process by which people can take part actively to influence decisions (Shrestha, 2009; World Bank, 2002). Data were collected on the issue of participation to implement policies, rules and regulations of gold mining in the study area. Accordingly, 61.9 percent of the households replied that they didn't participate on the issues of governance about gold mining in the study area. D. Kaufmann (2005) argues that participation is the corner stone to ensure good governance but the result of the study revealed that less attention has been given for effective participation of miners on the issues of gold mining in the study area.

Responsiveness is another pillar of good governance and it is about prompt service delivery to the customers, miners in this context. The interface between citizens and the state is a crucial factor to make trust on the government (Shrestha, 2009). Responsiveness can build confidence of citizens and satisfy their needs (UN, 2005). Miners were asked whether or not local administrators had been responsible for the local people in process of gold mining in the study area. Accordingly, 50.6 percent of the respondents didn't agree that local administrators are responsive to the local

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<sup>39</sup> The qualitative data obtained from the Focus Group Discussion (FGD) from the My-hanse gold mining site in 2017/18 G.C.

people in general and gold miners in particular in the study area. This indicates that local governments have been less sensitive towards delivering timely service on various issues of gold mining activities and hence, the sector has failed to bring the expected outcome.

Transparency and accountability are the core issues of good governance (Shrestha, 2009). They play a vital role in preventing corruption and rent seeking in service provision (World Bank, 2010). Thus, government policies, rules and regulations shall be made transparent and accountable is very crucial to hold public officials accountable for their actions and decisions (UN-Habitat, 2004). Data were gathered from survey household on the system of transparency and accountability practices in the study area. The result indicates that 59.4 percent of the households 'DA' on the application of transparency in the gold mining participation in the study area. Moreover, more doubled 76.9 percent 'DA' on the issue of accountability in the gold mining participation. The result implied that there had been very poor system of transparency and accountability in managing the gold mining sector in the study area.

The application of rule of law is another key factor in ensuring good governance (World Bank, 2002). Despite the formulation of policies, rules and regulations, the mining sector has been suffering from several challenges (Beyene, 2016). To examine the effectiveness of the rules and regulations of the mining sector in general and the gold mining in particular, data were collected from survey households, KII and FGD. The result revealed that 72.52 percent of the respondents 'DA' on the effectiveness of the policy, rules and regulations in managing the gold mining participation. The qualitative data gathered from the focus group discussants supplements the above result and is described as follows:

*Most of the policies, rules and regulations formulated by federal and regional governments are poorly implemented at local levels for different reasons. Firstly, the federal-local structure to manage the gold mining participation has not been well designed in way to manage the sector. That's, the administrative and market structure of gold mining in the study area has been poorly channeled from the federal to the local mining sites. Secondly, the mining sector doesn't have separate system to manage the overall governance practices which are related to gold mining in the study area. Besides, the market issue of gold mining participation has not been channeled from federal to the site marketing systems. Therefore, both administrative and marketing systems of the mining sector has been suffering from poor governance and illegal gold market problems.<sup>40</sup>*

In line with the result of the FGD, World Bank (2012) has elucidated on the existing regulatory mechanisms of the mining sector in many less developing countries. Many states try to formulate

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<sup>40</sup> Qualitative data gathered from the focus group discussants at Adi- Ahmeday mining site in 2017/18

laws and regulations to manage the mining sector but practically, the existing laws and regulations at national, regional and local levels have been less effective because there are lack of coordination, political commitment and lack of active participation of stakeholders (World Bank, 2005).

### 5.2.2. Institutional and administrative issues of artisanal and small-scale mining

Institutions are rules and norms that organize social, political and economic relations (North, 1990). There are formal and informal institutions. The former include the written constitution, laws, policies, rights and regulations enforced by government officials whereas the later unwritten social norms, customs that can shape thought and behavior (World Bank, 2013).

In order to assess the institutional and human capacity of the mining sector, booth quantitative and qualitative data were collected from the participant households. Table 4.7 has depicted that 63.8 percent of the respondents reacted that the federal, regional and local governments lack commitment to manage the mining sector. Moreover, government institutions that have been poorly organized and hence, they are unable to regulate and improve the gold mining practices in the study area. In terms of human resource, 50 percent of the respondents replied that the gold mining sector lacked trained and skilled manpower at the local levels. In both GTP I and GTP II, the mining sector in general and gold mining in particular is expected to be one of the major source of foreign exchange earnings. However, the amount of gold supplied to the formal market has been deteriorated from time to time (MoMPNG, 2016). The reasons behind declining the volume of gold supply to the formal market include lack of skilled and trained manpower at local levels, absence of committed leadership to regulate the marketing system of gold in the study area. As a result, illicit trade has become rampant as the effort made to stop such illegal marketing system is very limited (MoMPNG, 2017). Therefore, shortage of skilled manpower and the existence of bad governance resulted in weak implementation of policies, laws and regulations of mining sector.

Table 5. 2 Institutional and administrative issues of ASGM

Variable description	Yes		No		Don't know	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Skilled and trained manpower	30	18.8	121	75.6	9	5.6
Government's commitment	41	25.6	102	63.8	17	10.6
Government institutions	57	35.6	84	52.5	19	11.9
Community institutions	75	46.9	62	38.8	23	14.4

(Source: Field Survey, 2017/18)

In general, government institutions were found ineffective due to lack of trained manpower; well organized governance structure, separate office that can specifically address the challenges related to the ASGM participation in the study area. On the other hand, 46.9 percent of the respondents replied that informal institutions are more effective than the formal ones in protecting the natural environment. The result of KII from the study *woredas* are summarized below:

*The ASM sector has paramount contribution to the livelihood of the local community. It can smooth the livelihood of the rural areas where job opportunity is limited. And for few, it is also a source of wealth. However, the ASM sector has been given less attention by federal, regional and local governments. Policies, rules and regulations have been formulated but they are poorly implemented. Gold is very precious resource in the study area. It can generate foreign exchange earnings, create employment, supplements the livelihood on the local people but practically, the federal and regional governments are less committed to work and improve the sector. For instance, at woreda level, there is no separate office that can specifically address the mining sector. Instead, it is merged in the water and energy bureau. Besides, there has been weak support and control to make the sector effective and efficient. This clearly indicates that the sector has been given poor attention which resulted in deteriorating its performance and management. Moreover, lack of extension workers and government agents who can technically support the miners and regulate the marketing channel of gold at the mining sites. Therefore, in order to make the ASM sector effective and efficient, the federal, regional and local governments should cooperate and revisit the policies and regulations the mining sector.<sup>41</sup>*

From the above primary data, one can infer that the structure and chain of command to manage the ASM sector was found poorly organized. Besides, the federal and regional governments had given insufficient attention to regulate the ASM sector. Instead, the informal institutions have been playing vital role in preventing the negative effects of the sector via local elders.

### **5.2.3. Policy and regulatory frameworks of ASM sector**

Policies, laws and regulations frameworks are ineffective in regulating the ASM sector due to poor of political will of the government (De Soto, 2000). Studies indicate that lack of political commitment, lack of skilled and trained man power result in ineffective implementation of policies, laws, rules and regulations in ASM (Hilson, 2010).

In this regard, data were gathered about the awareness of the local community on the mining policies, laws, rules and regulations. Table 5.3 depicted that 50.6 percent of the respondents ‘DA’ they are aware of the policies, laws and regulations of the mining sector. With regard to the compliance of the rules and regulations, 48.8 percent of the respondents ‘DA’ that the rules and regulations were being obeyed in the study area.

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<sup>41</sup>Primary data which have been collected from key informant interview from Asgede Tsimbla Woreda, North western Zone of TNRS.

Table 5. 3.Issues of Regulatory Frameworks of ASGM

Alternatives	SDA		DA		DD		A		SA	
	F	%	F	%	F	%	F	%	F	%
◆Miners are aware of the rules and regulations of ASGM participation	13	8.1	68	42.5	14	8.8	36	22.5	29	18.1
◆Miners and market agents abide by the policies, laws and regulations of gold mining.	23	14.4	55	34.4	13	8.1	42	26.3	27	16.9
◆There is effective policy implementation of ASGM in the study areas.	27	16.9	72	45	5	3.1	38	23.8	19	11.9
◆The policies, rules and regulations of ASGM can protect the environment.	59	36.9	41	25.6	11	6.9	33	20.6	16	10

(Source: Survey Data, 2017/18)

The above result indicated that despite the mining sector is poorly managed and coordinated. As a result, the informal gold mining operations has been dominating throughout the country. Data were also collected on the implementation of policies and regulatory frameworks of the mining sector. The result revealed that 61.3 percent of the respondents were ‘DA’ on the effective implementation of mining policies and regulations the mining sector. Therefore, the enforcement of the policies and regulations have been found ineffective in the study area.

ASM has an adverse effect on the natural environment unless it is properly regulated. Information was gathered about the mining laws and regulations in protecting the natural environment. Accordingly, 67.7 percent of the respondents ‘DA’ on the effective protection of the laws and regulations. Therefore, one can infer that the policies, the existing regulatory mechanisms have serious deficiency in protecting the natural environment which is being damaged by mining activities. Many of the ASM activities are carried out informally and traditionally with no limit in time and boundary. As indicated in Beyene’s situational analysis report (2016), 64 percent of the precious minerals (gold, opal and tantalum) had been marketed illegally. According to MoMPNG’s report in 2017/18, the supply of gold has been declined to the formal market agents due to various reasons such as smuggling and contrabands of gold via different illegal trade routes.

However, the question here is that why the policies and proclamations of the mining sector have been ineffective to regulate the ASM sector? Qualitative data were collected from FGD and key informants interview on the effectiveness of the policies and laws adopted by the government to manage the ASM sector. The core points of the discussants and KII are summarized below:

*“Basically, the laws and regulations which have been enacted so far are unable to effectively manage the ASM sector and hence, need to be reconsidered. For instance, Proc. No. 678/2010 stipulates that miners should necessarily be organized as cooperative to make them legal and formal but the amended Proc. No 816/2013 totally overlooks the relevance of cooperatives participating in ASM. The law says nothing about the necessary support to cooperative miners such as extension service, credit service and other supports to make them effective and efficient. In addition, the new regulation (816/2013) has little attention on the benefit of cooperative miners’ as an entity and the period of validity of the licenses for cooperative miners was decreased from a possible nine years (with renewals) to a maximum of two years and it was found very difficult to improve the livelihood of miners within this time frame. The proclamation has limited the use of technology and artisanal gold miners were obliged to use traditional and rudimentary hand tools and manual operations. Besides, the duration of trading license was too short for the traders and hence, they have shifted themselves to illegal gold market. This implies that there has been policy gaps which need to be addressed to achieve what is expected from mining sector”.*<sup>42</sup>

The Mining Operation Proclamations No. 678/2010 allowed artisanal cooperatives to function up to nine and market dealers to actively involved in mineral supply to the local Banks. However, the amended proclamation 816/2013 stipulated that artisanal cooperatives should be dissolved in two years’ time limit or transform into small-scale mining or totally shift to other businesses.

Despite the policies and regulatory mechanisms have been in place to generation revenue (royalty and tax pavements) from the mining sector; miners/traders are reluctant to pay royalty for the government (Beyene, 2016). Besides, though the law strongly insist gold producers/traders to supply the gold to banks, they are still pursue the informal market due to the non-compliance of the miners and traders. In general, as per the result the secondary data and field observation, the study found that severe policy gaps have observed in the mining sector in Ethiopia.

### **5.3. Major challenges that affect the formalization process of ASM participation**

In many countries, prohibiting ASM operation has not been successful because the activity is located in the remote areas, it is poverty-driven and hence, likely to continue so long as poverty is persisting (World Bank, 2013; Hilson, 2010). At present ASM is simply a livelihood strategy adopted by most rural people as source of livelihood and their right to survival must be respected (MMSD, 2002; Burke, 2006). However, the environmental problems caused by mining activities are immense and hence, carefully managed (UNEP, 2017). In some countries, attempts have been made to forbid ASM activities because of its negative effect but such attempts had not been successful, rather ASM activities have been flourishing more than any other time (MMSD, 2002). Nonetheless, irrespective of its illegal nature, socio-economic and environmental problems, the ASM sector contributes to the livelihood of the rural poor and national in many less developing

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<sup>42</sup>The outcome of Focus Group Discussion from the fifteen tabias/rural kebelles.

countries. As result, NGOs and national governments have recognized the importance of the sector and have been trying to formalize ASM sector (Hilson.2010). Hence, by way of formalizing the ASM sector, it would operate in an organized and coordinated manner (Hentschel et al., 2003).

However, the efforts made to formalize the ASM sector so far has not been successful and hence, the sector is still dominated by illegal mining activities. Previous studies indicated that more than 75 percent (D'Souza, 2002) and 80 percent (Yakovleva, 2006) of the ASM activities were operating under the illegal mining. For illegal mining to flourish, the system has failed to serve the sector (Arwa, 2013). Though the legal frameworks exist, they have not been dynamic enough to cope with the demands of miners. Besides, many countries have not taken a holistic approach to formalize artisanal mining (Barreto, 2014). Governments are failed transform the informal ASM into formal mining operations by enabling miners to gain legal and transferable rights to mineral titles. The factors affecting the formalizing process of ASM sector have been elucidated below.

### **5.3.1. Lack of land access for gold mining**

The biggest challenge of formalization the ASM sector was lack of access to land for gold mining (Mutemeri and Petersen, 2012). Geologically, most mining sites are not surveyed and miners simply use trial and error because they couldn't know the exact location of mineral deposits (EGS, 2010). In addition to this, artisanal miners are not able to get titles on mining plots and such situation hinders them from improving their mineral production (Hilson, 2010). Lack of access to sustainable land for mining resulted in poor incentive to invest on and don't bother to register their operations (Beyene, 2016). This indicates that land access for ASM operating has become one of the key variable affecting formalization process. It is precondition for any land related investment decision made by miners (Gyan-Baffour, 2003).

Data were collected on the extent and ranking of the land access for gold mining in the study area. Table 5.4 depicts that 44.4 percent of the respondents ranked 'High'. This implies that access to land for gold mining has become serious problem in the mining sites. Thus, the issue that lack of land tenure security<sup>43</sup> has been found the key challenge that prevent miners from formalizing the ASM sector. Thus, sustainable land access to artisanal miners would be vital if they are to be encouraged to invest in ASM operations and improve mineral productivity. Gyan-Baffour (2003)

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<sup>43</sup>Security of tenure refers to legal provisions that guarantee miners against undue termination of licenses as a result of changes in political or administrative governance (Deininger, 2001).

argues that formalizing the sector would enable miners obtain proper legal titles to the land and in turn, they would be more responsive to the environment and other problems related to it.

### **5.3.2. Lack of access to credit services**

Another factor that can affect the formalization process of ASM has been inaccessibility to credit facilities. The sector is poverty-driven and miners may be faced with lack enough capital to undertake their mining activities and hence, they need financial support from lending institutions (DDI, 2005). Table 5.4 depicted that lack of credit service is ranked very high (41.9%) on the issue of formalization the illegal artisanal miners to formal miners. In the study area, miners who are operating outside the legal title were not allowed to credit service and hence, they remain illegal miners. Mutemeri and Petersen(2002) argue that miners should have access to credit service in their locality, however, the problem is that lending institutions require collateral while most artisanal miners do not have collateral (Mutemeri and Petersen, 2002). Access to credit helps miners upgrade their technologies and use improved technology, reduced occupation and health risks, improve efficiency and productivity. (IIED, 2005).

### **5.3.3. The presence of illegal trade of gold in the mining sites**

Illegal mining and illicit marketing go hand in hand (IIED, 2005). By virtue of the illegal nature of artisanal mining, miners were not able to have access to legal marketing system. For this reason, the sector has been dominated by small-time dealers and middlemen who also dominate the trading and marketing aspects of most of artisanal mining (Hilson, 2007). The global experience shows that 80 % of ASMs are carried out informally (Mwaipopo et al, 2004). The prevalence of illegal gold marketing in the mining sites allows miners to supply their gold product to contrabandists (illegal dealers). Table 5.4 below depicted the rankings of the factors affecting the formalization of ASGM in the study area. Accordingly, 31.9% of the respondents ranked this factor as ‘high’, on the prevalence of illicit gold marketing in the study area. Proclamations No. 678/2010 states that gold production that have been collected by legal buyers at production sites from both legal and informal producers should be directly channeled to the National Bank of Ethiopia (NBE). The NBE is responsible to buy and collect gold at different branches to greatly reduce gold smuggling. However, at the local market, traders and brokers have been engaged in smuggling gold using various mechanisms. The volume of gold marketed through formal (legal) channel was estimated at only 39 percent of the total production but the remaining 61percent goes through informal channel that is largely absorbed in the local or central markets, and some possibly exported through

sales to tourists and foreign passengers (Beyene,2016). Moreover, gold supply to the NBE has been tremendously decreased for the last three years. According to MoFED (2010), the contribution of mineral export the national economy has less than 1 percent in 1990s. Whereas the sector’s contribution had been increased to 5.8% in 2007/8 production year, however, the rate of export had been deteriorating since recently due to illegal marketing channels at the gold production sites.

Table 5. 4 Factors affecting the formalizations of the informal mining

Factors affecting the formalization process of ASGM	Ranking scale					Ranking the effect
	Very high	High	Medium	Low	Very low	
Lack of land access for mining	56(22.5%)	71(44.4)	23(14.4%)	7(4.4%)	3(1.9)	High
Lack of access to credit services	67(41.9%)	49(30.6%)	26(16.3%)	13(8.1%)	5(3.1%)	Very High
The prevalence of illicit trade of gold	37(23.1%)	51(31.9%)	32(20%)	25(15.6%)	15(9.4%)	High
Absence of extension services	59(36.7%)	44(27.5%)	37(23.1%)	8(5%)	12(7.5%)	Very High
Limited support of the government	39(24.4%)	27(16.9%)	78(48.8%)	11(6.9%)	5(3.1%)	Medium
Lack of geological information	41(25.6%)	77(48.1%)	23(14.4%)	13(8.1%)	6(3.4%)	High
Weak Commitment of the gov’t	33(20.6%)	63(39.4%)	29(16.3%)	22(13.8%)	13(8.1%)	High

(Source: Field Survey, 2017/18)

#### 5.3.4. Absence of extension services

Access to extension services plays a critical role to improve the productivity of miners by providing them with modern technology, technical and financial supports. Moreover, miners who have frequent contact with extension workers might increase their gold productivity. Therefore, access to extension service influences miners’ participation in gold mining. Despite its contribution to national economy and sustainable livelihood of the rural community, there are lack of extension services to improve gold production (MMSD, 2002). Table 5.4 below shows that 36.7 percent of the respondents ranked it as ‘very high’. This implies that lack of extension service to the ASM has been affecting the formalization process of the sector in the study area.

#### 5.3.5. Limited support of the government

Since the 1970s, the ASM sector has recognized for its immense contribution in reducing poverty and food insecurity, generating foreign exchange earnings and national economy but little has been done to improve the working conditions of the miners with insufficient institutional support for artisanal miners (World Bank, 2005; UNDP, 1997). While the ASM sector has been recognized ASM has virtually been ignored for centuries in spite of its demonstrated potential to support

development activities at local, national and regional economies unlike to large scale mining which has been receiving remarkable support from governments (Mutemeri and Petersen, 2002). In most cases, governments made little effort to improve the ASM sector and hence, it hasn't been formalized and transformed in the formal economy (Hilson, 2010). Data were gathered on the extent of government support in formalizing the informal gold mining and improve production capacity of the miners. As a result, 48.8 percent of the respondents ranked 'medium' on the of government support to facilitate and legalizing the ASM sector. This implies that limited technological, technical and financial support of the government would result in poor formalization process and wide spread illegal gold mining operations in the study area.

### **5.3.6. Lack of geological information**

Most ASM operations are undertaken traditionally using random trial and continuous search for mineral ore and hence, this method is time wasting activity (EGS, 2010). Lack of geological data causes miners to search gold here and there since they don't have geological data where gold is deposited. Therefore, availability of geological data is one of the determinant factor help miners which can minimize wastage of time. In this regard, miners had been solicited to rank lack of geological data and its importance in the mining process. Accordingly, 48.1 percent of the respondents ranked 'high' and this implies that lack of geological data prevented miners to participate in the formal mining activities. Therefore, absence of geographical data on the location of gold deposit had been another major challenge that miners had faced with. In most ASM activities, miners don't have geological maps which help them find the exact location of gold deposit to save their time and energy. However, in most cases, legal miners are given very small plot of land and which may or may not have mineral deposit. Therefore, miners are unwilling to be limited themselves to particular mining site due to absence of geological data and majority of them are operating in the informal mining in the study area.

### **5.3.7. Commitment of the government to support the ASM sector**

For the formalization of ASM to be successful, governments should take the initiative and play the leading role to create conducive environment for miners to perform effectively and efficiently. However, what has been observed so far is that governments lack the political will to formalize the ASM sector. Hentschel et al., (2003) argue that lack of political commitment to create an enabling condition to formalize the ASM sector is explained by personal benefit linked to corruption, money laundering and illegal mineral trading which are commonly observed in the

informal mining participation. In this case, information was collected on the commitment of the government to legalize and improve the ASM sector it using policy and regulatory frameworks in the study area. The result shows that 20.6 percent and 39.4 percent of the respondents ranked ‘very high’ and ‘high’ respectively for ‘weak commitment of government’ to improve the ASM sector. This implies that more than half of the respondents ranked ‘very high’ and ‘high’ and hence, there has been very poor determination of the government towards formalizing the ASM sector in the study areas. A summary of qualitative data collected from KII, FGD and local elders’ supplements the above result is described below:

*Even if the gold mining participation has considerable contribution to the livelihood of the local community and national economy in terms of foreign exchange earnings but the federal-regional-local structure is not properly organized in a way to effectively control the mining sector. As a result, the ASM sector is dominated by informal mining and illegal market channel due to lack of proper attention from the federal, regional and local governments. The government doesn't collect the royalties (taxations) which is supposed to collect from the gold mining participation in the study area due to mismanagement of the sector. Generally, the gold mining activities in the study area are poorly supported, inspected and controlled by the federal, regional and local governments. Although there are some attempts to follow up the illegal marketing of gold, the efforts to control the illegal market dealers of gold in the mining sites is very limited and inadequate. Smuggling of gold is common practice and hence, royalties are not properly collected by local authorities. The security apparatus of the local governments are less sensitive to the wide spread contraband of gold in the study area. Therefore, the ASM sector needs especial follow and administrative structure to minimize the illegal mining and smuggling of minerals in the region and the country at large.<sup>44</sup>*

The above quotation focused on the lack of government’s commitment and poor institution structure would result in failure to manage the ASM sector. In countries where there is weak governance structures, officers unwilling to effectively supervision activities (MMSD, 2002). Instead, they can abuse their powers and engage in corrupt practices by making relations with mineral contrabandists. Besides, the registration procedures are bureaucratic, complicated and take too long before operators can get their licenses. This situation makes miners vulnerable to corruption in exchange to get licenses and permits (Kambani, 2003).

#### **5.4.Chapter Summary**

Despite there have been efforts to improve the governance of the ASM sector, the study found that it is plagued with several challenges. Various policies, laws and regulations have been formulated to improve the overall performance of the ASM sector but the desired outcomes have not been achieved yet. Thus, the survey result indicates that majority of the miners were found less happy with the existing governance practices of gold mining in the study area. Lack of trained man power

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<sup>44</sup> Qualitative data collected from the FGD and local elders of the study area,2017/18

at local levels, low levels of participation, weak level of transparency and accountability and poor responsibility of the local authorities to govern gold mining have been some of the bottlenecks largely observed in the study area. The ASM sector doesn't have an independent administrative structure (from federal-local levels), instead, it is merged with energy and water resource at *woreda* level. The commitment of the government to effectively manage, improve its performance and regulate the gold mining and gold marketing channel at local level was found disorganized. Thus, widespread contraband activities have been observed and gold supply to the formal market agents has been declining from time to time in the study area.

The study identified several challenges which hinder the formalizing process of ASM participation such as lack of land access for gold mining, limited access to credit services, the prevalence of illicit trade, absence of extension services for the ASM sector, inadequate support from the government, lack of geological data and weak commitment of the government to improve its performance were found some of the key challenges of the gold mining participation in the study area. All these challenges resulted in impediment on the overall capacities of the sector to generate adequate production in the sector.

## **CHAPTER SIX**

### **Determinants of Artisanal and Small-Scale Gold Market Supply**

#### **6.1.Introduction**

This chapter presents the determinants of Artisanal and Small Scale Gold Supply (ASGS) to the formal market agents using descriptive, inferential and econometric techniques. In the econometric part of data analysis, Heckman two stage model was applied to analyze the key factors that affect ASGS to the formal market and its impact on the income of the suppliers. If two decisions are involved such as participation and level of income of the household as a result of participation, the Heckman two stage model was found appropriate. It comprises two stage, the first step focuses on estimating the participation decision using binary probit model and the second stage emphasis on estimating income of the household who had supplied gold to the formal market agents using Ordinary Least Square (OLS) method.

#### **6.2 Descriptive Statistics of Households**

In this part, the demographic, socio-economic, institutional and physical characteristics of the respondents have been discussed. Of the 160 mining households, 30 percent of them have been found suppliers to the formal market while 70 percent of them were not supplying to the formal market. The Artisanal and Small-scale Gold Supply (ASGS) to the formal market has been exposed to several factors which hinder the legal gold marketing activities in the study area. Thus, 17 explanatory variables have been used to analyze the gold supply to the formal market and extent of income of the households. These were age of the household head, sex of the household head, family Size of household, educational level of the household head, off farm income, perception of miners to price fluctuation, incentives to increase gold supply, perception of miners on the illegal market, member of cooperative mining, access to market information, good governance of ASGM, access to illicit trade of gold, access to credit service, access to transportation, distance from home to the mining sites, distance from the market center and access to local market of gold have been used as proxy variable to analyze this specific objective.

##### **6.2.1. Socio-economic and institutional characteristics of households**

Age of the household head of the participant households ranged from 20 to 48 years. The mean age of suppliers was found 42.39 years with standard deviation of 2.33 whereas the mean age of

non-suppliers was 49.82 with standard deviation of 2.96 respectively. The mean age difference between the two groups was found significant at 1% probability level which demonstrates that age has an influence on the participation decision of households to supply gold to the formal market.

The average family size for supplying and non-supplying households to the formal market were found 5.66 and 4.82 adult equivalent, respectively and that of the total participant households was found 5.92. The family size in the household is a key variable for participation decision in ASGS to the formal market. The mean difference between the supplying and non-supplying households to the formal market was found significant at 5% probability level and this implies that family size influences households' decision to supply gold to the formal market in the study area.

The mean distance to reach the mining sites for participant households was found 18.56 km with a standard deviation of 5.34 km as shown in Table 6.2. The mean distance for the non-supplying households to reach the mining site 21.45 km with standard deviation of 3.93 km. The result indicates that there was a significant difference related to distance to reach the main road between the supplying and non-supplying households to the formal market at 1% probability level.

Distance to nearest market center has negatively influenced the probability of ASGS participation decision and significant at 1% probably level. The most probable reason for such difference could be most mining households are far away from the nearest market center which incurs high cost of transportation and requires much time to reach the formal market and this situation could discourage them to supply gold to the formal market. The negative association implies that for a unitary increase in distance between the mining sites and the nearest market centers, there is less probability of households to supply gold to the formal market. As miners are far from the market center, the cost reach the formal market could be high and hence, they are less interested to supply gold to the formal market in the study area.

Table 6. 1 Summary of descriptive statistics for continuous variables

Variables	Suppliers(n=48)		Non-suppliers(n=112)		Total (N=160)		t-value
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev	
Agehhh	49.33	12.04	46.28	12.59	47.36	12.24	0.001***
Fshh	6.48	2.30	5.27	2.24	5.92	2.35	0.004**
dishmsi	18.56	5.34	21.45	3.93	19.45	4.93	0.000***
disnmc	6.84	2.93	11.25	4.37	7.32	3.89	0.000***

(Source: survey data, 2017/18)

\*\*\* and \*\* are significant at 1% and 5% respectively

Sex of the household head has been found a key variable influencing the participation decision of ASGS to the formal market. According to the data collected from survey households in the study area, 71.25 percent of the participant households were found male-headed while 28.75 percent of them were female-headed households. Of the total suppliers (n=48), 12(25%) and 36(75%) of them were found female-headed and male-headed supplying households respectively. On the other hand, out of the total non-supplying households (n=112), 34 (30.36%) and 78(69.64%) of the respondents were found female-headed and male-headed non-supplier households to the formal market respectively. The result implies that male-headed households had relatively better access to gold supply to the formal market than female-headed households. This is so because male can travel long distance to reach the formal market and supply gold but female miners are less interested to travel long distance and supply gold to the formal market. As a result, the likelihood of participating in ASGS to the formal market was found less than their counterpart. The chi-square test for sex distribution was found statistically significant at 5% probability level.

Education is a key variable that helps households to adopt new technology, have access to market information and better awareness on the mining policies and regulatory frameworks. The distribution of total sample respondents in terms of literacy level has shown in table 6.2. below and 19.42% of the households were found illiterate at least they cannot read and write, 18.21% informally literate, they could read and write, 27.03% had attended formal education from grade 1 to 6, 20% have been attending formal education from grade 7 to 8 and the remaining 15.34% have succeeded in reaching higher levels of grade 9 and above. With regard to the composition by access to formal market supply, the result reveals that 17.44% of the suppliers and 35% of the non-suppliers were found to be illiterate, 14.18% of the suppliers and 21.64% of the non-suppliers could read and write, 17.97% of the suppliers and 5.36% non-suppliers attended formal education from grade 1 to 6, 9.38% and 3.91% of the suppliers and non-suppliers had access to formal education from grade 7-8 and above 9 respectively. The  $X^2$ -test shows that there is a significant difference between suppliers and non-suppliers to the formal market in relation to education level, at 1% probability level.

Perception of miners towards gold price assumes that price fluctuation of gold could affect gold supply to the formal market. The result shows that 23.13% of the supplying and 40% of the non-supplying households replied price fluctuation affects households' participation decision to supply

gold to the formal market whereas 6.79% of the supplying and 30% of the non-supplying households reacted it doesn't affect. Accordingly, the chi-square test shows that price fluctuation affects the gold supply the formal market at 1% probability level.

Providing various incentives to miners is expected to increase the supply of gold to the formal market (MoMPNG, 2017). Comparing the two groups, 10.13% of the supplying and 63.13% of the non-suppliers replied existing incentives couldn't increase gold supply while 3.13% of the supplying and 6.79% of the non-supplying households replied that the existing incentives could increase gold supply the formal market. Thus, there was a significant difference between the supplying and non-supplying households at 5% probability level.

Many miners perceive black market can benefit more because the price paid in the formal market is lower than the price paid by the black market. The result shows that 10.63% of the supplying and 55.63% of the non-supplying households replied that contraband can benefit more to them while 19.38% of the supplying and 14.38% of the non-supplying households replied that it can't benefit. Thus, the chi-square test shows that it was found significant at 1% probability level.

It is assumed that if miners are formally organized with cooperatives, they are expected to supply gold to the formal market and it is one of the factors affecting the participation decision of gold supply in the study area. As a result, 23.125% of the supplying and 45.625% the non-supplying households were not members of the gold mining cooperatives whereas 6.785% and 24.375% of the supplying and non-supplying households were members of the gold mining cooperatives. It can be inferred that since majority of the non-suppliers were not members of cooperatives, they may not have interest to supply gold to the formal market. Thus, the chi-square statistics indicates that there has not been statically significant difference between the participants and non-participants of gold supply to the formal market in the study area.

Access to market information encourages miners to produce and supply more because it has positive influence to improve household's income in the study areas. Comparing the groups, 19.38% of the supplying and 28.13% of the non-supplying households replied they had access to information while 10.63% of the supplying and 41.88% of the non-supplying households didn't have access to it. This shows that having access to market information could increase gold supply and hence, this variable was found statistically significant at 1% probability level.

It is obvious that good governance affects gold supply participation in the study area. This is because the mining sector has been suffering from serious deficiency in regulating the sector. Of the total participant households, 4.38% of the supplying and 20.63% of the non-supplying households replied there is good governance practices in the gold mining sector whereas 25.63% of the supplying and 49.38% of the non-supplying households said there is no good governance in managing the gold mining sector. The difference between the two groups on the good governance in the ASGM sector was found significant at 5% probability level.

It is obvious that gold mining in the study area is dominated by illegal miners and informal market channel which practically decreases the volume of gold supply to the formal market. Thus, this variable is one of the factors that can affect gold supply in the study area. According to the survey result, 28.75% of the supplying and 65.63% of the non-supplying households reacted that there was illicit trade in the study area which eventually resulted in declining the volume of gold supplied to the formal market. The difference between the two groups was found insignificant.

Access to credit service can positively influence gold supply to the formal market. The comparison by access to credit service disclosed in table 6.2 and hence, 21.88% of the supplying and 15.63% of the non-supplying households replied that access to credit service had influenced gold supply to the formal market while 8.13% of the supplying and 54.38% of the non-supplying households said that this variable didn't influence on ASGS to the formal market. The chi square test result revealed that access to credit service was found statistically significant at 1% probability level.

It is true that a lack of access to transportation may result in a limited supply of gold to the formal market. Hence, access to transportation can negatively affect the gold supply to the formal market in the study area. Accordingly, 13.75% of the supplying and 28.13% of the non-supplying households replied there was lack of access to transport because most gold mining activities are located in the remote areas. Whereas 16.26% of the supplying and 41.88% of the non-supplying replied they had no access to transportation. The difference between the two groups on the access to transportation was statistically significant at 5% probability level.

Access to site marketing of gold was also another key factor to sell their gold product around the physical setting of gold mining. Hence, it was considered as one of the factors affecting gold supply to the formal market. The survey result shows that 7.5% of the supplying and 20.63% of the non-supplying households replied there was access to site marketing whereas 22.5% of the supplying and 43.13% of the non-supplying households reacted there was no access to site marketing in the

study area. Therefore, the chi-square test result has shown that there was statistically significant difference between supplying and non-supplying households at 5% probability level.

Table 6. 2 Summary of deceptive statistics for discrete variables

Variables	values	Suppliers (n=48)	Non-suppliers (n=112)	Total sample N=160)	Chi-square ( $x^2$ )
sexhhh	0	12(7.5%)	34(21.25%)	46(28.75%)	0.000***
	1	36(22.5%)	78(48.75%)	114(71.3%)	
eduhhh	0	1(0.63%)	4(2.5%)	5(3.13%)	0.000***
	1	21(13.13)	12(7.5)	32(20%)	
	2	16(10%)	6(3.75%)	22(13.75%)	
	3	21(13.13)	12(7.5)	32(20%)	
	4	5(3.13%)	2(1.25%)	7(4.38%)	
	5	6(3.75%)	2(1.25%)	8(5%)	
	6	9(5.63%)	4(2.5%)	13(8.13)	
	7	4(2.5%)	7(4.375%)	11(6.79%)	
	8	7(4.38%)	11(6.79%)	18(11.25%)	
	9	3(1.88%)	8(5%)	11(6.79%)	
pmpf	0	11(6.79%)	48(30%)	59(36.79%)	0.001**
	1	37(23.125%)	64(40%)	101(63.1%)	
iningosu	0	45(28.13%)	101(63.13%)	144(90%)	0.049**
	1	5(3.13)	11(6.79)	16(10%)	
pebeilma	0	31(19.38)	23(14.38%)	54(33.75%)	0.015**
	1	17(10.63%)	89(55.63%)	106(66.3%)	
mcom	0	37(23.125%)	73(45.63%)	110(68.75%)	1.432
	1	11(6.79%)	39(24.38%)	50(31.3%)	
acinfo	0	17(10.63%)	67(41.88%)	84(52.5%)	0.001***
	1	31(19.38%)	45(28.13%)	76(47.5%)	
Goas	0	41(25.63%)	79(49.38%)	120(75%)	0.041**
	1	7(4.38%)	33(20.63%)	40(25%)	
iltrgo	0	2(1.25%)	7(4.38%)	9(5.63%)	1.016
	1	46(28.75%)	105(65.63%)	151(94.38%)	
accrse	0	13(8.13%)	87(54.38%)	100(62.5%)	0.000***
	1	35(21.88)	25(15.63%)	60(37.5%)	
laactr	0	36(22.5%)	69(43.13%)	105(65.63%)	0.000***
	1	12(7.5%)	33(20.63%)	55(28.13%)	
aclomago	0	26(16.26%)	67(41.88%)	93(58.13%)	0.025**
	1	22(13.75%)	45(28.13%)	67(41.88%)	

(Source: Survey data, 2017/18)

\*, \*\* and \*\*\* indicate significance level at  $p < 0.1$ ,  $p < 0.05$  and  $p < 0.01$  respectively

## 6.2.2. Results of the Econometrics Model

### 6.2.2.1. Estimation Procedures

Before the estimation of the parameters of the Heckman model, the problem of multicollinearity, and heteroskedasticity were checked using STATA commands version 14. As a rule of the thumb, variables with VIF less than the cut off value (10) don't have multicollinearity problems whereas

those variables with the VIF above 10 are assumed to have a multicollinearity problem (Wooldridge, 2003). Therefore, using the VIF, these variables had been checked and for all continuous explanatory variables, the values of VIF were found less than 10 (threshold). Besides, as a rule of thumb, the threshold for contingency coefficients for dummy and discrete variables is 0.75. Thus, the values below 0.75 indicate the existence of weak association and above 0.75 indicate strong association of variables and hence, it had been confirmed that the values of the dummy and discrete variables were found less than 0.75. Thus, both continuous, dummy and discrete variables had been included in the model for final analysis. Moreover, the goodness of model fit was using  $R^2$ , which works on the principle that if the predicted probability of the event is greater than 0.50, the event occurs; otherwise the event won't occur. Therefore, the model result shows the correctly predicted percent of household was greater than 0.50 point.

### **6.2.3. Results of probit model for the factors affecting ASGS participation decision**

In this particular objective, the Heckman two stage model has been used to identify and analyze factors affecting gold supply to the formal and the level of income of the households in the study area. In the first stage, probit model was used to regress 17 variables and these include agehhh, sexhhh, eduhhh, fshh, pmpf, iningosu, pebeilma, offinc, mcom, acinfo, goas, iltrgo, accrse, actr, dismr, disnmc and acfoma have been entered and regressed using STATA command version 14. From the 17 explanatory variables which had been expected to influence gold supply to the formal market, 13 variables had significant effect on gold supply to the formal market in the study area. Variables which had significant effect but negatively signed include age of the household head, distance to the nearest market place, distance to the mining sites, lack of access to transportation (laactr), governance of ASGM (goas), and perception on the benefit of the illegal market. Nonetheless, variables which had significant effect on gold supply to the formal market but positively signed and positively signed include access to information (accinfo), access to the local gold market (aclogoma), illicit trade of gold (iltrgo), (pebeilma), sex of the household head (sexhhh), family size of the household (fshh) and access to credit service. On the other hand, variable which had not significant effect on gold supply to the formal market agents include education level of the household head (eduhhh), price fluctuation of gold (pmpf), incentives to increase gold supply and being a member of a cooperative. This implies that these variables had less significant effect on gold supply to the formal market. Having discussed the brief background, the effects of each explanatory variable on gold supply to the formal market were elucidated below.

**Age of the household head** has been negatively influenced gold supply to the formal market and statistically significant at 1% ( $p=0.009$ ) significance level. Lack of site marketing for gold supply for households to be limited near home and sell their product to the informal dealers. Besides, the negative result could be due to the fact that aged heads can't travel long distance to supply gold.

**Sex of the household head (sexhhh):** gold mining requires physical fitness and hence, male-headed households are more likely to engage in sector than female-headed households. In addition to physical fitness, it is obvious that females have multiple household burdens; have less interest to travel long distance and have limited access to information than male-headed households. The result revealed that sex of household head was statistically significant at 5% ( $p=0.018$ ). The marginal effect indicates that keeping all other variables constant at their mean value, male headed households had 47.31 percentage points more chance of supplying gold to the formal market than female headed households. In other words, the discrete effect of a change from 0 to 1 in sex of the households head increases the probability of gold supply by 47.31 percentage points while keeping all other variables constant at their mean value.

**Education level of the HH head (eduhhh):** Educated people can easily adopt new technologies, have access to information, understand, interpret and analyze the market issues. However, the study found that the level of education acquired by a household head was not statistically significant to have an effect on gold supply to the formal market agents. The marginal effect of the variable shows that keeping all other variables constant at their mean value, educated household heads had 0.175 percentage points more chance of gold supply to the formal market.

**Family size of households (fshh):** This variable had a positive effect on gold supply to formal market. The more active labor in the household, the more income is generated. Hence, this variable was found significant at 5% ( $p=0.034$ ) level. The marginal effect of the variable shows that other things being constant at their mean value, households with large active family size had 5.27 percentage points more chance of gold supply to the formal market comparing with household having small family size keeping all other variables constant at their mean value.

**Perception on the benefit of the illegal market (pebeilma):** The perception of households towards the benefit of the illegal market was a key variable expected to influence gold supply to the formal market. Miners are shifted to illegal gold marketing to sell gold because they thought that the benefit obtained from the illegal market is higher than the benefit obtained from the formal market. This variable was statistically significant at % ( $P=0.042$ ) level. The marginal effect of the

variable shows that the probability of participating in illegal gold supply increases by 5.27 percentage points higher than those who supplied to the formal market, other things are constant.

**Access to information (acinfo):** Market information is one of the determinant factors of gold supply to the formal market. In this context, market information is crucial for gold producers to know the real price of gold, encourages miners to produce more and has a positive effect on improving the miners' gold supply to the formal market. The study found that access to information was statistically significant at 1% ( $p=0.001$ ) level and the marginal effect has shown that those miners who had access to information have 22.6 percentage points more chance of supplying gold to the formal market than those who didn't not have access to information.

**Good governance of ASGM:** refers to the governance is a key factor in artisanal and small-scale gold mining activities. Conversely, lack of good governance would result in wide spread illegal mineral marketing. This variable was found statistically significant at 10% ( $p=0.91$ ) level. The marginal effect of the variable shows that keeping all other variables constant at their mean value, the existence of poor governance in the mining sector had 13.2 percentage points more chance of gold supply to the informal market channel than supplying to the formal one.

**Access to credit services (accrse):** it plays a crucial role for miners to produce more and in turn supply more gold to the formal market. Moreover, credit service provides miners with loan to be able to use better technology for mining purposes. The result reveals that access to the credit service was statistically significant at 10% ( $p=0.66$ ) level and the marginal effect implies that households who had access to credit have 16.37 percentage points more chance to supply gold to the formal market than their counterparts, keeping other variables constant at their mean value.

**Distance to the nearest market center (disnmc):** is a key variable that can affect gold supply to the formal market. It is assumed that as miners are far from the market center, the transaction cost could be high and hence, they are less interested to supply gold to the formal market. The model result has showed that distance of the mining sites from the nearest market center was found significant at 1% ( $p=0.009$ ) level. The negative association implies that for a unitary increase in distance between the mining sites and the nearest market center, there is less probability for households to supply gold to the formal market. The marginal effect shows that the probability of supplying gold to the formal market reduces by 6.36 percentage points other things being constant.

**Distance from home to the formal (dishofoma):** This variable has negatively related between the distance from residence and the formal market. The farther households' home from the location of the formal market, the lesser to supply gold because long distance to reach the formal market would incur much cost. Conversely, the nearer the residence to the formal market, the higher the probability of gold supply. This variable was negatively influenced miners and significant at 1% (p=0.006) level. The marginal effect indicates that the probability of supplying gold to the formal market increases by 8.8 percentage points, keeping other variables constant at their mean value.

**Access to local market of gold (aclogoma):** was expected to positively influence the gold supply to the formal market. It was statistically significant at 5% (p=0.28) level. The positive relationship could be because households who had access to local market had better probability of supplying gold to the formal market. The marginal effect revealed that miners who had access to local market of gold has 5.5 percentage points more chance of supplying gold to the formal market than those miners who didn't have, keeping the all other variables constant at their mean value.

**Lack of access to transport (actr):** contrary to the expectation, access to means of transportation has been negatively affecting the ASGM participation decision as the activity is located at remote areas at 10 % (p=0.055) level of confidence. The result of marginal effect indicates that as gold producer households lack access to transport, the decision of participation in gold market supply decreases by 16.38 percentage points. This might be due to the reason that the gold mining households use alternative means of transportation to reach at the mining sites.

Table 6. 3 The Maximum likelihood estimates of the binary probit model.

Variables Codes	Coefficient	Std.error	P>  Z	Marginal Effect
Age of the hhh	-22.31104	0.0461455	0.009 ***	0.0348453
Sex of the hhh	1.3367105	0.7621233	0.018 **	0.4731251
Education level of the hhh	0.455021	0.1566117	0.065*	0.1762011
Family size of the household	0.1364162	0.3206758	0.034**	0.0526475
Perception of miners to price fluctuation	0.8522833	0.5649482	0.131	0.0469175
Incentives to increase gold supply	-0.8876593	0.330235	0.057*	0.0424368
Perception on the benefit of illegal market	-0.8876593	0.330235	0.042**	0.0424368
Membership of cooperative mining	-0.0032065	0.2406775	0.966	-0.0002667
Access to market information	0.7959678	1.3220354	0.001***	0.2262395
Governance on the ASGM	0.049089	0.029028	0.091*	0.1326078
Access to Illicit trade of gold	0.2178363	0.0178063	0.733	0.0278063
Access to credit service	-2.26773	1.336057	0.066*	-0.163735
Distance to the nearest market center	-0.1547589	0.1543863	0.009***	-0.0728405
Distance from home to the mining sites	-0.3650352	0.3965968	0.006***	-0.0880337
Access to the formal local market	0.9352274	0.1799271	0.028**	0.0545781
Access to transportation	2.35852	1.227069	0.055*	0.163735

cons	-1.024722	1.567501	0.556
Dependent variable	Artisanal and Small-scale Gold Supply (ASGS) participation decision		
No. of observations	378		
Log likelihood	-68.423569		
Pseudo R2	0.5642		
Wald chi2(16)	121.0000		
Prob>chi2	0.0000		

(Source: Survey result, 2017/18).

The astrics \*\*\*, \*\* and \* show statistically significant effect on artisanal gold supply to the formal market agents at  $p < 0.01$ ,  $p < 0.05$  and  $p < 0.1$  respectively.

(+) For dummy variables the marginal effect is the discrete change of dummy variables from 0 to 1  $P > |z|$  correspond to the test of the underlying coefficient being 0.

#### 6.2.4. Heckman two stage model estimates for the effect of ASGS on income of the HHs

This section attempts to address the impact of ASGS on the total annual income of the mining households in the study area. It can help understand why some households have been able to get better income by supplying gold to the formal market than others. Since many households do not obtain income from supplying gold to the formal market as a result their income is not observed for the non-participants. Hence, applying Ordinary Least Square (OLS) method using data from the participant samples only without correcting for selection bias can give us biased and inconsistent coefficients. For this reason, Heckman two stage model was applied to estimate the income equations because Heckman model helps us to consider observations that have missed data (Heckman, 1979, Madala, 1992). The covariates that were applied to analyze the ASGS participation to identify the factors that affect income of the participant households.

In order to avoid identification problem that could arise during estimation, some variables have been excluded from the income equation and had been used only in the corresponding selection equation. The results for the outcome equations of the Heckman two stage models were depicted below. In this case, results for the outcome equations are estimation results for determinants of income. According to the model output, the estimates of LAMBDA (inverse Mills ratio) has been statistically significant at 5% probability level providing evidence for the presence of selectivity bias and hence, justifying the use of Heckman's two-stage procedure. The negative sign suggests that the error terms in the participation and outcome equations were negatively correlated. This shows that those unobserved factors which make the household participate in gold mining are likely to be negatively associated with household income level.

The first stage of the Heckman model represents participation decision of households, which has already been discussed in the previous section; the second stage describes the impact of ASGS participation on the income of the households in the study area. Out of the total 17 explanatory variables, output for the income /outcome equation of the model, seven variables were found significant in determining the income of participant households due to gold supply to the formal market. These variables include age of the household head (agehhh), sex of the household (sexhhh), access to information (acinfo), access to means of transportation (actr), access to formal market (acfoma), being a member of cooperative mining (mcomi), access to credit service (accrse) and the inverse Mills ratio ( $\lambda$ ). The effect of the key explanatory variables on the income of the participant households' are discussed below.

**Access to formal market (acfoma):** The existence of formal market agents near to the mining sites where miners can supply their gold product is one of the factors which determine the income of the household. Since the formal market provides various incentives for those who supply gold to the legal market agents, it is obvious that participant households can increase their income. In doing so, it can help miners to increase gold production and income. Therefore, access to formal market near the mining sites influences the household total income significantly with a positive sign as expected. It is statistically significant at 5% level of significance. The result shows that, in the study area those who have access to formal market have the chance to provide gold easily, as a result increased their income. The coefficient of this variable revealed that, *cetrus puribus*, on average the total annual income of households who supplied gold to the formal market would be higher by 6,856.23 ETB than households who did not participate in ASGS to the formal market. Participation in ASGS to the formal market, therefore, enables participant households to improve their livelihood in terms of rising income and smoothening living condition.

**Sex of the household head (sexhhh):** In the context of ASGM, male-headed household had more income compared to female-headed households. There are many reasons for such outcome. Firstly, male headed households have better initiative to travel long distance to reach of better market center than female-headed households whereas female-headed households are less interested to go and sell their gold product in the formal market. Secondly, females have much burden such as household activities, reproductive, childcare and face man-made and natural the challenges. Thirdly, it is expected that male headed households have better exposure on gold market and have access to better information which enables them to participate in ASGS to the formal market and

their income is higher than their counterparts (female-headed households). The result revealed that *sexhhh* was statistically significant at 5% probability level and the coefficient of this variable also shows, *ctrus puribus*, on average income of those male-headed households exceeded by 8,639.74 ETB compared to those households headed by female.

**Age of the household head (agehhh):** is also another factor which influenced the income of the household. The nature of the work requires physical strengthens to operate the job and travel long distance in search of better market. The ASGS to the formal market decreases as the household head gets older. This is so because older households' heads can sell gold with relatively cheap price near to the mining sites than young who have the capability to travel and search better gold market. Thus, age of the household has been found significant at 1 % (P=0.009) level. The coefficient indicates *ctrus puribus*, on average income of young households exceeded by 5,834.72 ETB compared to the old households.

**Family size of the household (fshh):** As has been hypothesized, the result of this study found that family size of a household affected significantly the income of household at 10% (p=0.074). The coefficient indicates, keeping other things constant, on average income of the households has been found higher in households who have more adult members than those who have less number of adults. Put differently, the result indicates that as household size increases by single adult member in a household, the level of households' income increases by 2,441.45 ETB.

**Member of the cooperative mining (mcomi):** this variable has been affecting the income of the households in the study area. Gold mining cooperatives are expected to have very close linkage with the formal market agents so that information relative to gold price can be easily available. Besides, cooperative members can get government support in terms of getting loan, extension service and the like. Thus, the income of households who are members of cooperative have been found higher than households who didn't members of gold mining cooperatives by 3,456.09 ETB.

**Access to transportation (actr):** is one of the key factor affecting the income of households from supplying gold to the formal market. As has been described previously, the ASGM operation mainly taken place in the remote areas. Hence, many of the mining households are expected to travel long distance to reach the formal institutions which can buy gold. As a result, miners are exposed to illegal buyers, brokers and market dealers. Due to lack of access to transportation to reach the formal market agents, they usually sell their product with lower price. This variable is statistically significant at 10 % ( p=0.061) level. The coefficient of the variable indicates, *ctrus*

*puribus*, on average income of those male headed households was higher by 3,621.5 ETB compared to those households headed by female.

**Access to credit service (accrse):** has been expected to have a positive impact and significant influence on income of households, and it was statistically significant at 1% level. Credit service resolves the financial liquidity constraints of households and it enables miners to purchase mining inputs such as labor, machineries and mining equipment to increase productivity and income of the household. According to the results of the study, keeping all other variables constant, on average the income of households who have access to and utilized credit would be higher by Birr 4,468.21 compared to households who didn't have access to credit service in the study area.

**Access to market information (acinfo):** as expected, access to market information affected the amount of income generated from ASGS to the formal market at 1% probability level. As indicated in table 8 below holding other variables constant, households who had access to market information about gold could increase their income since there are periodic increments on the price of gold. As a result, those who have access to the market information of gold increases their income by Birr 2, 956.89 compared with those who didn't have market information.

Table 6. 4 The Heckman two stage model estimates for the outcome equation

Variables Codes	Coefficient	Standard error	P>  Z
cons	3425.198	0.6584342	0.860
age of the household head	5834.723	23.0461455	0.009 ***
sex of the household head	8639.741	45.8792695	0.031 **
education level of the household head	65.227327	4.860485	0.965
family size of the household	5834.72	53.87806	0.074*
off farm income	-543.9873	0.0001082	0.517
access to information	2956.89	41.27353	0.007***
access to information	3621.586	1.227069	0.061*
incentives to increase gold supply	56.887659	0.330235	0.057
perception of miners to price fluctuation	0.8544922	0.5649482	0.131
perception on the benefit of illegal market	-99.887659	3.330235	0.042
governance of ASGM	78.049089 5	0.029028	0.091
access to formal market	56.23	1.0178063	0.039**
distance to the nearest market center	-69.254332	0.0542398	0.864
distance from home to the mining sites	12.9743	0.2985632	0.871
access to illegal gold market	57.200836	5.0178063	0.733
access to credit service	68.2106	0.336057	0.003***
LAMBDA	-2634.4968	13.33876	0.035**
Dependent variable = households' total amount of income.			
Number of observations =160	LAMBDA ( $\lambda$ )= -2634.4968		
Rho ( $\rho$ ) =0.476598	Sigma ( $\sigma$ ) = 49.569763		

Censored observation =48	Uncensored observation =112
Wald chi <sup>2</sup> (26) = 273.78	Prob >chi <sup>2</sup> 0.0000

Source: computed from survey data (2017/18)

Note: \*\*\*, \*\*, and \* indicate statistically significant at the 1%, 5%, and 10% level, respectively

### 6.2.5. Ordinary Least Score (OLS) model

This chapter has also employed the Ordinary Least Square (OLS) model to compare the result of the estimate with the Heckman two stage analyses. As expected the model result identified that access to formal market is a significant determinant of household total annual income. But the size of the coefficient for the Heckman model is higher than that of the OLS regression result. Thus, using OLS regression model underestimates the effect of ASG supply on household total annual income level.

Table 6. 5 The result of OLS regression model

Explanatory variables C	Coefficient	P>  Z
cons	8365.198	0.860
Age of the household head	209.875	0.436
Sex of the household head	3245.154	0.001 ***
Education status of households	463.22732	0.188
Family size of households	-89.72	0.201
Off farm income of households	44.196	0.517
Access to market information	-576.89	0.657
Access to transport	-159.586	0.933
Inceptives to increase gold supply	23.0091	0.032**
Perception of miners to price fluctuation	-77.85449	0.931
Perception on the benefit of illegal market	-14.0465	0.442
Access to formal market	64.2076	0.000***
Access to the illegal trade	57.2008	0.733
Access to credit service	75.8765	0.001***
Dependent variable = households' total amount of income.		
Number of observations =160	R-squared =0.7943	
F(12,87 3) =156.53	Adj R-square =0.8034	
Pro>F = 0.007		

Source: Computed from survey data, (2017/18)

Note: \*\*\*, \*\*, and \* indicate statistically significant at the 1%, 5%, and 10% level, respectively

### 6.3. Chapter Summary

Identifying the key factors influencing gold supply to the formal market and income of the households in the study area could be useful for father policy intervention. This specific objective attempts to identify and analyze the determinants of gold supply to the formal market agents and the income of the households. The result has shown that 30% of the households have been found to be participants in gold supply to the formal market agents whereas 70% of them didn't. Using the Heckman two stage models, 13 variables were found significant at 1%, 5% and 10% probability levels. Age of the household head, access to market information, distance to the nearest market center and distance from home to the mining sites have been found significant at 1% level. On the other hand, sex of the household, family size of the household, perception of the benefit obtained from illegal market and access to the formal market were found significant at 5% level. Whereas education level of the household head, incentives to increase gold supply, governance of ASGM, access to credit service and lack of access to transport have been found significant at 10% level.

In the outcome model, age of the household head, access to market information and access to credit service were found significant at 1% level. Whereas sex of the household head, access to formal market and LAMBDA ( $\lambda$ ) have been found significant at 5% level. On the other hand, family size of the household and lack of access to transportation have been found significant at 10% level. The study found that the income of supplying households had registered relatively better income than the non-supplying households. Moreover, the overall result revealed that participant households were suffering from long distance to the mining sites, lack of access to transportation which has been affecting the participation decision and supply of gold to the formal market negatively. Indeed, miners have had access to information via mobile phone, TV, Radio and the like but still they are hesitant to supply gold to the formal market. Besides, lack of site marketing and the misguidance of the brokers and illegal market channels were found series challenges which affected gold supply to the formal market in the study area.

## CHAPTER SEVEN

### Artisanal and Small-scale Gold Mining Participation and Its Impact on Food Security Status of Households

#### 7.1. Introduction

This chapter presents the results of gold mining participation and its impact on food security of households in the study. To make it convenient, this chapter is divided into three sub-sections. The first sub-section focuses on measuring of food security using Household Food Insecurity Access Scale (HHFIAS), Household Food Consumption Score (HFCS) and Food Energy Intake (FEI) approach. The second sub-section presents results of descriptive statistics of households using percentages, frequencies, tables and inferential statistics such as chi-square test and t-test statistics. The third sub-section discusses the econometric model and Propensity Score Matching (PSM) to compare participant and non-participant households in gold mining in the study area.

#### 7.2. Measuring Food Security Status of Households

##### 7.2.1. Household food insecurity access scale (HFIAS)

HFIAS has been employed to measure the food insecurity situation of households because it provides a continuous measure of household food insecurity situation by categorizing into four levels of households' food insecurity or security. Accordingly, the result has been depicted in table 8.5 below and out of the 160 participant households, 106(66.3%) of them have been found food secure whereas 11(6.9%) of the participant households mildly food insecure, 7(4.4%) of them were found moderately food insecure and 36(22.5%) of the participant households have been found severely food insecure in the study area. One can say that about 54(33.8%) of the participant households were food insecure though the difference varies from mild to severely food insecure.

Table 7. 1 Household food security status by HFIAS

Household Food Security status	Participant Households (N=160)		$X^2$	Non-participant Households (N=218)		$X^2$
	Frequency	%		Frequency	%	
<b>Food Secure</b>	<b>106</b>	<b>66.3</b>	<b>11.262</b>	<b>98</b>	<b>45</b>	<b>7.245</b>
Mildly food insecure	11	6.9	4.567	36	16.5	2.876
Moderately food insecure	7	4.4	0.59	22	10.1	1.640
Severely food Insecure	36	22.5	2.9	62	28.4	3.134
Total food insecure	54	33.7		120	55	
<b>Total</b>	<b>160</b>	<b>100</b>		<b>218</b>	<b>100</b>	

(Source: Field survey data, 2017/18)

On the other hand, out of the 218 non-participant households, 98(45%) of them were food secure while 36(16.5%) of them were mildly food insecure, 22(10.1%) moderately food insecure and 62(28.4%) of them were severely food insecure. The result indicates that nearly 120(55%) of the non-participant households were food insecure with different levels of food insecurity. If we compare the food security status of participant and non-participant households, the participant households had better food security status by 21.3 percentage points than the non-participant households. The chi-square test shows that there was significant difference between participant and non-participant households at 5% level.

### 7.2.2. Household food consumption score(HFCS)

The threshold for HFCS was developed by World Food Program (WFP) in 2007 and IFPRI in 2008. Accordingly, households with poor food consumption have a food score of 0-28, households with borderline food consumption have a food score of 28.5-42 and households with adequate food consumption have a food score of above 42 which was viewed as acceptable. The data on food consumption of 378 households were collected and capture the variety and frequency of different foods consumed on 7 days recall period. Table 7.2 below shows the results of households' food security status using HFCS for both participant and non- participant households.

Table 7. 2. Food consumption status of participant and non-participant households.

Frequency	Food consumption status of participant households (N=160)									Sum FC	HFCS Status * >42 adequate * 28.5-42 border * 0-28 poor HFCS
	Staples F×W	Pulses F×W	Veg. F×W	Fruit F×W	Meat F×W	Milk F×W	Sugar F×W	oil F×W	Cond. F×W		
83(51.9)	6×2=12	4×3=12	2×1=2	3×1=3	1×4=4	2×4=8	4×0.5=2	7×0.5=3.5	4×0=0	46.5	Acceptable HFCS
49(30.63%)	4×2=8	2×3=6	1×1=1	1×1=1	0×4=0	2×4=8	4×0.5=2	6×0.5=3	2×0=0	29	Borderline HFCS
38(23.8%)	3×2=6	3×3=9	0×1=0	2×1=2	0×4=0	0×4=0	2×0.5=1	3×0.5=1.5	1×0=0	19.5	Poorly HFCS
	Food consumption status of non-participant households (N=218)										
97(44.5%)	5×2=10	3×3=9	2×1=2	1×1=1	2×4=8	2×4=8	4×0.5=2	7×0.5=3.5	5×0=0	42.5	Acceptable HFCS
73(33.5%)	5×2=8	3×3=9	2×1=2	1×1=1	1×4=4	1×4=4	3×0.5=1.5	7×0.5=3.5	4×0=0	33	Borderline HFCS
48(22%)	4×2=8	2×3=6	1×1=1	1×1=1	0×4=0	0×4=0	4×0.5=2	4×0.5=2	3×0=0	20	Poorly HFCS

(Source: Computed from Survey data, 2017/18)

By applying the HFCS cut-off given above, 83(51.9%) of the participant households were found food secure since their HFCS  $\geq 46.5$  which is above the 42 acceptable cuff point while 49(30.63%) of them had the HFCS of between the range of 28.5-42 and hence, they are borderline food security and 38(23.8%) of them had the FCS of 19.5 and are poorly food secure. On the other hand,

97(44.5%) of the non-participant households had the HFCS of 42.5 and are food secure, 73(33.5%) of them had the HFCS of 33 and are on the borderline food security status and 48(22%) of the non-participant households have been poorly food secure. The result revealed that the number of food secure participant households had been greater than the non-participant households.

### 7.2.3. The food energy intake approach

This study employed FEI approach to analyze the food security status of households in the study area. Accordingly, a household was deemed food insecure if the amount of calorie taken per adult equivalent per day is less than 2200 or considered to be secure if the amount of calorie per adult equivalent is greater than 2200 per day (FDRE, 2001; MoFED, 2002). Thus, the food insecure and food secure households in the study area has been identified using food energy intake approach. After identifying the households as food secure and food insecure, the three indices of food security were computed.

In using FEI approach, adult equivalent has been found a popular one since households were composed of families having differences such as age, sex, consumption habits, and preferences. Hence, the study employed FEI approach by summing up the quantities of bundles of items that households consumed. So as to identify the food secure and insecure households, firstly, the lists of food items consumed by households shall be identified, secondly, each bundle of food item was weighted with the appropriate unit of measure (usually in kilograms or litters), thirdly, to get the total amount of food bundle of a household consumed in a month each of the weighted bundles of food items were summed up.

*The bundle of food Items include: Teff, +Wheat+ Maize+ Barely+ Potato+ Onion+ Beans+ Peas+ Vegetable + Dry Pepper+ Edible Oil+ Milk+ Butter (Cow and Vegetable) + Meat+ Sugar.*

This can be represented as,  $K_1+K_2+...+ K_n$ ; where K refers to the value in kilogram or Litter of each food basket. Fourthly, the aggregate value of baskets of food items consumed by a household in a month was divided to the corresponding sample size of the household to get the number of kilograms each adult individual gets in a month.

$\frac{\sum_{i=1}^n x_i}{\sum_{i=1}^n y_i} = L$  = the amount of kilogram or Litters of food items a household consumed in a month.

Where n= denoted the sample households;  $X_i$ =a total basket of different food items in kilograms or litters a household consumed in a month and  $Y_i$ = the family size of the surveyed household.

Fifthly, the number of Kilograms each household consumed in a month was again divided by 30 days to get the number of kilograms each adult individual consumed in a day. This was Equivalent to L/30 days. The number of kilograms a household consumed in a day was again converted into Calorie intake and was calibrated to the predetermined 2200 calories per day per adult equivalent. The conversion factor of the food items as indicated in table 9.1 below.

Table 7. 3 Calorie contents of different food items

Consumption Per 100 gram	Energy in Calorie	Consumption Per 100 grams	Energy in Calorie
Teff	355	Lentil	525
Wheat	340	vegetables	75
Maize	344	Dry Paper	73
Barely	370	Edible	900
Potato	75	Cow Milk	79
Onion	38	Butter	700
Beans, peas	310	Meat	626
		Sugar	375

Source: Food Consumption ECSA and Ethiopian Health and Nutrition Research Institute (2003)

Finally, the number of food secure and food insecure households in the study area could be identified. If X is total calorie intakes of a household in a day and Y is the family size of the surveyed household in the study area, then the standardized poverty line using the FEI internationally agreed 2200 kcal per day for an adult person as recommended by FDRE (2001) and MoFED (2002). First, the number of food secure and food insecure households have been determined by applying its sample size (n=160).

➤ Thus,  $\frac{\sum_{i=1}^{160} x_i}{\sum_{i=1}^{160} y_i} \geq 2200$  kcal = 94 households were found food secure but 66 of them were found food insecure. Note that 94 participant households are above the standard energy intake  $\geq 2200$  kcal whereas 66 of the participant households were below the international food security line ( $< 2200$  kcal). Second, the number of food secure and food insecure non-participant households were determined by applying its sample size (n=218).

➤  $\frac{\sum_{i=1}^{218} x_i}{\sum_{i=1}^{218} y_i} \geq 2200$  kcal = 89 households are found food secure but 129 of them were found food insecure. Note that 89 non-participant households are above  $\geq 2200$  kcal (food secure) whereas 129 of the participant households are below 2200 kcal (food insecure).

As a result, out of the total sample households in the study area (n=378) households, 183(48.4%) of them have been found to be food secure while 195(51.6%) of the households are found to be

food insecure. However, there is a significant difference between participant and non-participant households in terms of food security situations. Thus, of the 160 participant households, 94(58.8%) the households were found food-secure whereas 66(41.3%) of them were found food insecure. On the other hand, out of 218 non-participant households, 89(40.8%) of them were found food secured bur 129(59.2%) of the households are found food insecure. Moreover, the calorie consumed by food secure participant households ranges from 2,350-8,260 kcal/AE/day while the calorie consumed by the food insecure participant households ranges from 984-2038 kcal/AE/day. The mean calorie consumption of the food secure and food insecure participant households is 4,842.46 and 1,568.52 kcal/AE/day respectively. On the other hand, the calorie consumed by food secure participant households ranges from 2,058-6,842 kcal/AE/day whereas the calorie consumed by food insecure non-participant households ranges from 642-1866 kcal/AE/day. The mean calorie consumption of food secure and food insecure non-participant households was 3,156.82 and 1,354.49 kcal/AE/day respectively.

As depicted in Table 7.4 below, the minimum and maximum calorie consumed food secure participant households are 2,350 and 8,260 kcal/AE/day while for the food insecure participant households is 984 and 2038 kcal/AE/day respectively. However, the minimum and maximum calorie consumed food secure non-participant households are 2,058 and 6,842 kcal/AE/day while for the food insecure non-participant households is 642 and 1866 kcal/AE/day respectively

Table 7. 4 Amounts of calories consumed by adult equivalent per day

Calorie consumed by AE per day(in Kcals)	Mining Households(160)	
	Food secure HHs(n=94)	Food insecure HHs(n=66)
Minimum	2350	984
Maximum	8260	2038
Means	4842.46	1562.52
Standard Deviation(SD)	378.3862	132.6345
Calorie consumed by AE per day(in Kcals)	Non-mining Households(n=218)	
	Food secure HHs(n=89)	Food secure HHs(n=129)
Minimum	2058	642
Maximum	6842	1866
Means	3156.86	1354.49
Standard Deviation(SD)	426.4658	182.5634
t-value		

(Source: Survey data, 2017/18)

The study also revealed that the mean calorie consumption of the food secure and food insecure participant households is 4,842.46 and 1,568.52 kcal/AE/day with a standard deviation of

378.3862 and 132.6345 respectively. Conversely, the mean calorie consumption of food secure and food insecure non-participant households was 3,156.82 and 1,354.49 kcal/AE/day with the standard deviation of 426.4658 and 182.5634 respectively. This implies that the food secure participant households had higher mean calorie consumption than the mean calorie consumption of food secure non-participant households by 1675.64 kcal. Likewise, the food insecure participant households had higher means of calorie consumption than the mean calorie consumption of food insecure non-participant households by 214.03 kcal. Therefore, it can be deduced that gold mining plays a significant role in ensuring the food security situation of households in the study area.

#### **7.2.4. Food security indices of households**

Even though the above measures gave us the number of food secure and insecure households from both the mining and non-participant households, it is impossible to know the proportion and severity of the food insecure households (Deverxu, 2006). Therefore, once the food insecurity of households has been determined, the next task could be determining the head count ratio and severity of food insecure households.

**A) The head count ratio of the households:** it measures the proportion of the households who faced the shortfalls of 2200 kcals per AE a day. Based on the threshold calorie requirement, i.e. 2200 kcals/day/adult equivalent (FAO, 2007), the study found 66(41.3%) of the participant and 129(59.2%) of the non-participant households were found to be food insecure. Thus, to calculate the head count ratio (the number of incidence in food insecure over the total sample of households) of the participant and non-participant households can be described as:  $IFI = \frac{m}{n} \times 100$  where, IFI is Incidence of Food Insecurity,  $m$ =number of food insecure households and  $n$ =the total sample size for each group. Therefore, the incidence of food insecurity of participant and non-participant households was calculated as  $\frac{66}{160} \times 100 = 41.3\%$  and  $\frac{129}{218} \times 100 = 59.2\%$  respectively. Hence, the head count ratio of the participant and non-participant households was 41.3% and 59.2% respectively. The average head count ratio of the food insecure households was 50.25% in the study area.

**B) The food insecurity gap of the households (FIG):** The food insecurity gap measures the mean depth of food insecurity of households. It is the mean proportion by which the food insecure households' fall below the minimum level of calorie requirement. The result of this study indicated that food insecurity gap of the participant and non-participant households were 29.8% and 36.5%

far off from the minimum level of calorie requirement i.e. 2200 kcal respectively. The average food insecurity gap of both participant and non-participant households was 33.15%.

**C) The squared food insecurity gap (SFIG):** The severity of food insecurity among the food insecure households can be measured the squared food insecurity gap. The squared food insecurity gap of the participant and non-participant households has been 17.4% and 15.8% respectively and average squared food insecurity gap is 16.6% as has been described in below.

Table 7. 5 Food Insecurity Indices

<b>Calorie Consumed per Kcal/AE/day</b>	<b>Participant Households(n=160)</b>	<b>Non-participant Households(n=218)</b>	<b>Average</b>
Head count ratio	41.3%	59.2%	50.25%
Food insecurity gap	29.8%	36.6%	33.15%
Squared food insecurity gap	17.4%	15.8%	16.60%

(Source: Field Survey Data, 2017/18)

### **7.2.5. Coping mechanisms of food insecurity households**

Ellis (2000) has noted that coping strategies are employed following the failure of the normal sources of food, and these are regarded as accidental responses to an unanticipated failure in major sources of livelihoods. Maxwell and Caldwell (2008) coping strategies are involuntary responses encompassing distressing, erosive and non-erosive strategies. In each categories, there are options to be employed during the food shortage. In this analysis, questions were prepare to assess the coping strategies of households used to fulfill their food shortage when any man made or natural disaster occurs in their locality using non-erosive, erosive and distressing strategies. In case of non-erosive strategy, households reduce the frequency of meals, and the consumption of less preferred food. Erosive strategies are the sale of productive assets and selling of livestock that may reduce the ability to earn income. Distressing strategies are maintaining strategies of households during food shortage such as begging or send members of the households to eat elsewhere (Maxwell and Caldwell, 2008). Households in the study area had various coping mechanisms during food shortage period and hence, information was gathered from sample households about which type of coping strategies used during food shortage in the study area(see table 7.6 below).

Table 7. 6 Major Coping Strategies of Households

Strategy	Opinion	Mining HHs(n=160)		Non-mining HHs(n=218)	
		Frequency	Percent	Frequency	Percentage
Distressing strategy	Food loan from neighbors	03	1.9	05	2.3
	Engage in labor work	12	7.5	26	11.9
	Borrowing or purchasing on credit	16	10	08	3.7
	Eating less preferred foods	08	05	12	5.5
	Purchase cheaper food	13	8.1	15	6.7
	Use food aid	07	4.4	21	9.6
	Migration	10	6.3	06	2.8
<b>Sub-total</b>		<b>69</b>	<b>43.1</b>	<b>93</b>	<b>42.7</b>
Non-erosive strategies	Reducing number of meals	19	11.9	22	10.1
	Reducing quantity of meals	11	6.9	16	7.3
	Going without food the whole day	03	1.9	09	4.1
<b>Sub-total</b>		<b>33</b>	<b>20.6</b>	<b>47</b>	<b>21.5</b>
Erosive strategies	Sales of livestock to buy food	17	10.6	24	11
	Eat reserved seeds	04	2.5	11	5.1
	Selling household assets	21	13.1	20	9.2
	Selling woods and charcoal	16	10	23	10.6
Sub-total		58	36.3	78	35.8
Total		160	100	218	100

(Source: Survey data, 2017/18)

As indicated in the Table 7.6 above, 69(43.1%) of the participant households reflected that they were using distressing strategies such as food loan from neighbors, engage in labor work, use food aid, borrowing, purchasing on credit, eating less preferred foods, purchase cheaper food and migration whenever food shortage occurred. About 33(20.6%) of them were employing the non-erosive strategies such as reducing number of meals, reducing quantity of meals and going without food throughout the day. Whereas, 58(36.3%) of them were applying erosive strategies such as sales of livestock to buy food, eat reserved seeds, selling household assets and selling woods and charcoal. Conversely, 93(42.7%) of the non-participant households replied that they were using distressing, 47(21.5%) of them non-erosive strategies and 78 (35.8%) of them were applied the erosive strategies in the study area.

### 7.3. Descriptive statistics of sample households

In this sub-section, the demographic and socio-economic characteristics of the respondents have been described using various data analysis techniques. A total of 12 explanatory variables have been used to analyze the factors affecting deterrents gold mining participation in the study area. Four variables are continuous variables and these include age of the household head, family size, size of the cultivated land and number of livestock owned. Out of the total variables, 8 of them are

discrete and these include sex of the household head, educational level of household head, off farm income, oxen ownership, use of chemical fertilizer, access to credit service and access to the nearest market center. In the descriptive statistics, key outcome variables have been analyzed with appropriate statistical tools like mean, frequency, percentages, tables, figures, standard deviation, t-test, chi-square and other data analysis techniques.

### **7.3.1. Demographic and socio-economic characteristics of households**

In terms of participation status of sample households, out of 378 sample respondents, 160(42.3%) of the households have been participants while 218(57.67%) of them were non-participate in gold mining activities in the study area. The result shows the mean age value of the food secure participant household heads was found 42.21 years while the mean age value of the food insecure non-participant households was 54.22 years. The p-value for food secure participant and food insecure non-participant households was found significant at less than 1% probability level.

In this context, the higher the number of economically active family members in a household could increase productivity while households with large number of economically dependent family members had faced with food insecurity. Taking this assumption in to account, the mean size of food secure participant and food insecure non-participant households were found 4.8 and 6.5 respectively. The t-value signifies there was statistically significant difference between food secure participant and food insecure non-participant households at  $p < 0.1\%$  probability level.

The size of cultivated land in rural area plays a significant role in the household food security situation. According to FAO (2009), the size of the land in agriculture influences household food security. The mean land holding for food secure participant households was found 0.78 hectare with minimum (0.28 hectare) and maximum (1.33 hectare) land holding whereas the mean land holding for food insecure non-participant households was found 1.45 hectare with minimum (0.54 hectare) and maximum (2.36 hectare) land holding. The t-value revealed that there is statistically significant difference between the two groups at 1% level of confidence. This indicates that the mean land holding for the participant households was smaller than the mean land holding of non-participant households and hence, the households who had smaller land holding tend to participate in gold mining in the study area.

According to Storck, et al (1991), the total livestock owned by households are converted using the conversion factor in to their respective Total Livestock Unit (TLU) values. Therefore, the mean

livestock number of the food secure participant households was found 1.81 in TLU whereas the mean livestock number possessed by the food insecure non-participant households was found 3.73 in TLU. Thus, the t-value result shows that there was significant difference between the food secure participant and food insecure non-participant households at less than 5% level.

Table 7. 7 Descriptive characteristics of sample households (continuous variables)

Description of variables	Food secure Participant households (n=94)		Food insecure Non-participant households (n=129)		t-value
	Mean	Std.dev	Mean	Std.dev	
Age of the HH head	42.21	14.6	54.22	22.4	32.145***
Family size (AE)	4.82	1.42	6.4	2.12	25.623*
Land size of the HH (hectare)	0.78	0.46	1.45	0.452	13.458*
Livestock ownership (TLU)	1.81	2.33	3.73	2.64	33.281**

(Source: survey data, 2017/18)

Education of the household head is one of the key factors affecting the food security of households. In chapter four, the education level household heads has been described using frequencies and percentages and no need of reaping here. With regard to the significance level proportion of food secure participant households, the chi-square value for the food secure participant and food insecure non- participant households was not found significant to influence the food security condition of households in the study area.

Rural households often engage in different off-farm activities rather than depending only in the agricultural sector to improve their food security and income status. Out of the 378 sample households, 222(58.7%) of them had been participating in various off farm activities. Whereas 156(41.3%) of them didn't participate in off farm activities in the study area (Table 8.6). Of the total food secure households (n=183), 119(61.03%) of them had been participating in off farm activities. Conversely, from the total food insecure households (n=195), 156(80%) of them didn't participate in off farm activities to supplement their livelihoods. In the study area, the proportion of participating in off farm activities differ depending the preferences of households and hence, gold mining participation (54%), petty trade (13.6%), selling fire woods and charcoals (14%), labor (11%) and other (7.4 %). It is apparent that majority (54%) of the food secure households had been participating in gold mining activities though there were other off farm activities for households to supplement their livelihoods. The result implies that engagement in off farm activities could be more important to increase the annual income and food availability of

households. The chi-square value shows that there was significant difference in food secure participant and food insecure non-participant at  $p < 0.05$  significant level.

Table 7.3 depicted that the oxen ownership per households ranged from 0 to 4. The total number of oxen owned by participant and non-participant households were 142 and 226 respectively. This implies that the number of oxen owned by food insecure non-participant households was higher by 0.15 from the oxen owned participant households in the study area. The number oxen owned by food secure participant and food insecure non-participant households were 31(33%) and 83(64.34%) respectively. This implies that the food secure participant households had owned less number of oxen than the food insecure non-participant households by 31.34 percentage points. Thus, there was a significant difference between food secure participant and food insecure non-participant households in terms of oxen ownership at  $P < 0.1$  significant level.

Access to credit service was an essential variable which can influence the gold mining participation in the study area to purchase input and adopt new technology to increase gold production. However, the result has indicated that out of 387 sample households, 213(56.5%) of them had access to credit service while 165(43.7%) of the households didn't have access to credit service. Specifically, out of the food secure participant households ( $n=94$ ), 61(64.9%) of them had access to credit service. On the other hand, 72(55.8%) of the food insecure non-participant households ( $n=129$ ) of them had access to credit service in the study area. The chi-square value indicated that there was significant difference in access to credit service between food secure participant and food insecure non-participant households at less than 1% significant level.

Use of chemical fertilizer was expected to have association with households' food security status. Table 7.8 depicted that 72 (76.6%) of the food secure participant households were found users of chemical fertilizer. Conversely, 97(75.2%) and 20(9.2%) of the food insecure non-participant households were users of chemical fertilizer. This implies that those households who had access to fertilizer are more likely to be food secure than those who had no access to fertilizer use in the study area. The result of the chi-square value revealed that there was no significant difference between users and non-users of chemical fertilizers.

Table 7.8 depicted that 65(69.2%) of the food secure participant households were found users of improved seeds whereas 78(60.5%) of the food insecure non-participant were found users of improved seeds. The result of the chi-square value revealed that there was significant difference between users of food secure participants and food insecure non-participant households at less than

5% significance level. Access to the nearest market center was one of the factors affecting the food security of households. Accordingly, 36(38.3%) of the food secure participant and 49(38%) food insecure non-participant households had access to the nearest market center. The chi-square value indicated that there was no significant difference between the two groups.

Table 7. 8 Summary statistics of discrete variables

Description of variables	Food secure participant HHs (n=94)	Food insecure participant HHs (n=129)	$\chi^2$ -value
Sexhhh	Male(1)	76	10.9876**
	Female(0)	18	
Eduhhh	Illiterate (0)	01	0.8651
	1-4 grade (1)	13	
	5-8 grade (2)	18	
	9-12grade (3)	21	
	≥Diploma (4)	19	
Offinc	Read and write (5)	22	21.4752**
	Yes (1)	85	
Accrse	No(0)	09	15.983*
	Users (1)	61	
Ucf	Non-users(0)	33	43.2874
	Users (1)	72	
Oxon	Non-users(0)	22	10.698*
	Yes(1)	31	
Usimse	No(0)	63	8.354**
	Yes(1)	65	
Acnmc	No(0)	33	29.654
	Yes(1)	36	
	No(0)	58	
	Yes(1)	80	

(Source: Survey data, 2017/18)

\*\*\*, \*\*and \* indicate level of significance at <1% < 5% and <10% respectively.

#### 7.4. Results of the econometric model

This part deals with the results of Propensity Score Matching (PSM). PSM has been employed to estimate the ATT between participants and non-participants households. To estimate the outcome variables, the binary logit model was used to get the propensity scores and the matching estimator to find out the impact of gold mining on the mean values of the outcome variables. In order to measure the Average Treatment Effect on the Treated (ATT) for income and food security, a logit model was used in order to get the propensity scores and the matching estimator which best fit to the data was chosen. Accordingly, the matching between participants and non-participants was applied to find out the impact of ASGM participation on the outcome variables (income and food

security). Thus, the required algorithms to calculate the ATT were applied to identify the impact of gold mining on the food security and income of households.

#### **7.4.1. Multicollinearity test for covariates**

However, explanatory variables have been tested for the presence of multicollinearity and heteroscedasticity problems before running binary logistic regression to estimate propensity scores. The Inflation Factor (VIF) was used to diagnose if there is multicollinearity problem continuous explanatory variables (Gujarati, 2003). This was specified as:  $VIF = (X_i) = \frac{1}{1-R_i^2}$

Where; VIF = Variance Inflation Factor and  $R_i^2$  is the square of multiple correlation coefficients between  $X_i$  and the other explanatory variables. The VIF less than the cut off value (10) don't have multicollinearity problems whereas those variables with the VIF above 10 are assumed to have a multi-co linearity problem (Wooldridge, 2003). The values of VIF were found less than 10 (threshold). Besides, the dummy and discrete variables were checked by contingency coefficients and if the contingency coefficients for dummy and discrete variables is 0.75. Thus, the values below 0.75 indicate the existence of weak association and above 0.75 indicate strong association of variables and hence, it was confirmed that the values of the dummy and discrete variables were found less than 0.75. Moreover, the goodness of model fit, R2, which works on the principle that if the predicted probability of the event  $>0.50$ , the event occurs; otherwise the event won't occur. Therefore, the VIF values displayed in Table 7.9 shows that all the discrete and continuous explanatory variables have no serious multi-collinearity problem.

**Heteroscedasticity:** is another problem of regression analysis because the presence of heteroscedasticity can nullify the statistical tests of significance. Hence, one of the assumptions in regression analysis is that the errors ( $u_i$ ) have a constant variance  $\sigma^2$ . If the errors do not have a constant variance, then the problem of heteroscedasticity occurs (Maddala, 1992). In this analysis, heteroscedasticity has been checked all variables using *robust standard error test*. Thus, there has not been serious problem of heteroscedasticity in the model.

#### **7.4.2. Estimation of ASGM participation**

The binary logistic regression model was used to estimate propensity scores for matching the treated with control groups. In this study participation in ASGM is the dependent variable and takes value '1' if the households had participated in ASGM and '0' otherwise. To estimate propensity scores, the study considered key explanatory variables and these encompass age, sex,

and education level of the household head, family size of the household, distance from home to the mining sites, access to information, land holding size, livestock ownership, oxen ownership, use of chemical fertilizer and access to credit service. The logistic regression model results in which treatment status has been regressed, are presented in table 7.9 below.

Table 7. 9 Logistic estimates for calculating propensity scores.

Covariate variables	Coefficient	Std.err	Z	P>Z	Marginal Effect
Age of household head	-0.0901137	0.081	-1.12	0.0017***	0.0348
Sex of the household head	-1.2478157	0.369	2.43	0.015 **	0.4641
Education of household head	0.4872343	0.423	2.84	0.455	0.6884
Family size of household head	0.1364162	0.020	2.13	0.033**	0.0527496
Access to transport	-0.456324	0.082	0.982	0.132	0.7245432
Dista home to mining sites	-0.164586	0.346	-2.66	0.008**	-0.0584534
Access to information	-0.8989766	1.765	3.25	0.001***	0.3566543
Size the cultivated land	0.1690745	0.391	1.23	0.000***	0.0653783
Livestock owner (TLU)	0.1507195	0.331	2.99	0.003***	0.0382805
Off/non-farm participation	0.63165497	0.563	0.963	0.575	-.07687609
Oxen ownership	0.7261072	0.620	0.90	0.352	0.6025183
Use of Chemical fertilizer	0.1029363	1.407	0.41	0.683	0.0399565
Credit services	0.9352274	0.314	3.45	0.071*	0.3479231
Constant	-1.036743		-0.33	0.786	
<i>Number of observation</i>	378			<i>Prob <math>\chi^2</math></i>	0.012
<i>LR chi2(7)</i>	0.33			<i>Pseudo R<sup>2</sup></i>	0.067
<i>Wald chi2(13)</i>	112.98			<i>Correct prediction</i>	66.56%

\*\*\*, \*\* and \* indicate the significance level of 1%, 5% and 10% respectively.

(+) For dummy variables the marginal effect is the discrete change of dummy variables from 0 to 1  
 $P > |z|$  correspond to the test of the underlying coefficient being 0.

The model indicates that 66.28% of the sample observations were correctly identified and hence, the model was significant ( $Prob. > \chi^2 = 0.012$ ) association of participation with the covariates in the model. The pseudo  $R^2$  (0.067) shows goodness model fit and the pseudo  $R^2$  between 0.2 and 0.4 shows goodness of model fit (Ticci, 2011).

Table 7.9 above depicted that age of the household head was found significant at  $p < 1\%$  probability level and showed negative relationship in explaining the participation decision of households in gold mining. This means, as the age of the household head increases by a single year, *ceteris paribus*, and the likelihood of participating in gold mining decreases by a factor of 0.348. It is assumed that when the heads age advances, they are expected to have stable economy than younger heads. However, in this context, due to the nature of the work, younger heads have been more

active than the older heads in this context. This shows that the household with active working age had the probability of engaging in gold mining, get income and are expected to be food security.

Sex of the household head is found significant at less than 5% probability level and the coefficient indicates a negative relationship with food security status of households. This implies that male headed households have higher probabilities of participating in gold mining than their female counterparts, *ceteris paribus*. Therefore, the probabilities of female-headed households to participate in gold mining decreases by a factor of 46.41 in the study area.

Size of the household was found significant at  $p < 5\%$  probability level elucidating the participation decision of households. The positive sign indicates that as the increased number of economically active household members motivates them to participate in gold mining. Therefore, *ceteris paribus*; an increase of a single member of the household rises the likelihood of households' to participate in gold mining by a factor of 5.3.

Access to information was expected to determine the participate decision of households in gold mining and hence, found significant at  $p < 1\%$  probability level. Thus, *ceteris paribus*, the probabilities of getting information to participate in gold mining increases as the households have access to information. Thus, the higher the household had access to information, the decision to participating in gold mining increases by a factor of 35.62.

Distance from home to the mining sites was found statistically significant at  $p < 0.01$  probability level but had a negative relation with participation decision in gold mining. This indicates that the longer the distance from home to the mining sites, the probability of participating in gold mining decreases by the factor of 5.84, keeping other factors constant at their mean value.

Land holding size is a key variable which is expected to affect the participation decision of households in gold mining in the study area. It is obvious that gold mining activities isn't taken place in a vacuum and hence, miners need to have land for mining operation. Miners who don't have land for gold mining are forced to have rented land. Thus, land holding is not only influencing farm activities but also gold mining activities. Thus, land hold size was found significant at  $p < 0.01$  probability level on the participation decision of households in gold mining. The marginal effect of this variable indicates that as the land holding size of the household increases, the probability to participate in gold mining increases by a factor of 6.53.

Total livestock ownership has been found to have positive and significant effect at 1% level of significance on the probability to participation in gold mining. The positive association indicates that households having larger can earn money that be able to spend on any possible cost to participate in gold mining. The marginal effect shows that as the number of livestock in TLU increases, by a unit, the participation decision of the household increases by a factor of 3.8, *ceteris paribus*. This implies that livestock holding has an influence on the participation decision in gold mining as households can sell their animal and purchase input for gold mining activities.

Access to credit service is another variable that positively influences ASGM participation decision of households in the study area. It has been found significant at 10% probability level. The positive association could be households who had access to credit service have improved possibility of obtaining technologies which help for ASGM operation. Credit helps miners incur costs for mining operation and hence, the probability of participating in ASGM increases. The marginal effect of this variable indicated that households who had access to credit service have 35.46 percentage points more chance of participation in gold mining than those households who do not have access to credit, while keeping the all other variables constant at their mean value or the discrete effect of a change from 0 to 1 in access to credit of the household increases the probability of participation in gold mining by 35.46 percentage points, *ceteris paribus*.

To put in a nutshell, age and sex of the household head and distance from home to the mining sites were negatively correlated but have significant effect on the participation decision of household in gold mining. Livestock ownership and access to credit service had positive correlation and significant. However, access to transportation and access to information are negatively correlated but didn't have significant effect on the participation decision of households in gold mining. Family size of households and land holding size are positively correlated and were found significant. The rest of the variable was not affecting the participation decision of households in gold mining. Finally, households' participation in gold mining was strongly associated with demographic and socio-economic and characteristics of households in the study area.

### **7.4.3. Matching participant and non-participants**

Prior launching the matching the scores, the predicted values of the covariates of gold mining participation were estimated. Second, the common support region was imposed on the propensity score distributions with and without the gold mining participation. Third, discarding observations

their p-scores fall outside the range of the common support region. Lastly, sensitivity analysis was done to check the robustness of the estimation.

Caliendo and Kopeinig (2005) have developed two approaches to map a common support region for the p-score distribution; these are minima & maxima approaches. Table 7.5 depicted that the distribution of estimated p-scores and the estimated p-scores differ between 0.02 and 0.98 (mean=0.73) for treated HHs and between 0.00 and 0.95 (mean = 0.22) for untreated HHs. The common support region lies between 0.02 and 0.95. In other words, HHs whose estimated p-scores less than 0.02 and larger than 0.95 were not considered in this matching exercise.<sup>45</sup>

Table 7. 10 Distribution of estimated propensity scores

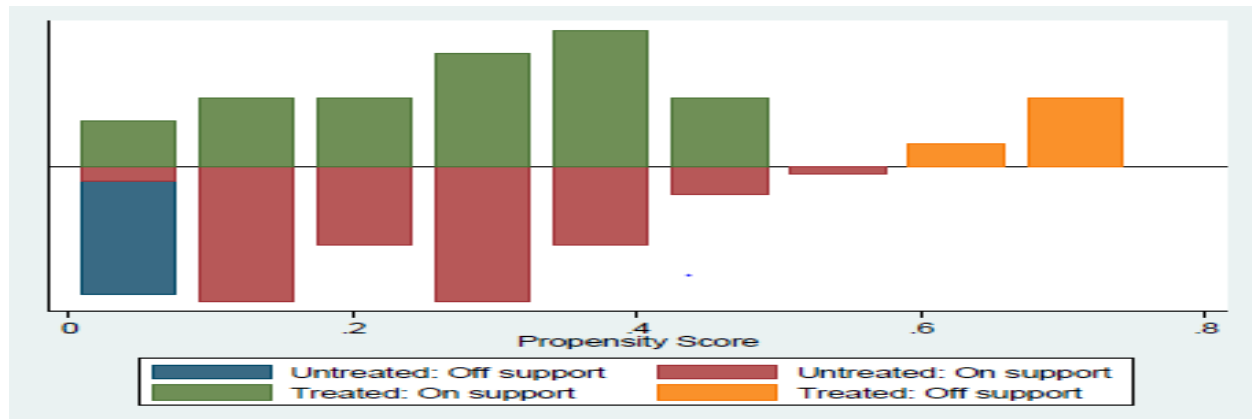
Groups	No. observations	Mean	Std	Min	Max
Total Households	378	0.466	0.378	0.004	0.996
Treated Households	160	0.732	0.253	0.021	0.979
Untreated Households	218	0.219	0.246	0.001	0.952

Source: Survey Result (2017/18)

Figure 7.1 shows there is high probability of obtaining good matches and the propensity score distribution has been skewed to the left /right for non-participants/participants households. This is based on the minimum and maximum approach of the common support region identification exercises (Caliendo and Kopeinig, 2005). Therefore, of the 378 the total households, 148 participant and 184 non-participant households were within the range of the common support region 0.195 and 0.674 (on support region). This implies that there is an adequate overlap in the characteristics of the treated and untreated groups to find enough matches used to estimate the effects of participant households and satisfy the common support region.

<sup>45</sup> *Some Practical Guidance for the Implementation of Propensity Score Matching. IZA Discussion Paper No. 1588. DIW Berlin Department of Public Economics. Königin-Luise-Str. 5, 14195 .Berlin. Germany.*

Figure 7. 1 Distribution of the Propensity Score



#### 7.4.4. Balancing test for propensity scores and covariates

Prior to matching was conducted, some variables exhibited statistically significant differences but after matching almost all of the covariates have been balanced. As has been depicted in the table 7.11 below, the t-values of all the covariates are statistically insignificant, which mean after matching the difference between the means of the treatments and the control groups has been minimized. This has been ascertained by considering different test methods like the reduction in the mean standardized bias between the matched and unmatched HHs, using t-test and chi-square test for joint significance of the variables used (Ticci, 2011). It is justified that the balancing of p-score for all covariates has been fulfilled. Accordingly, all the covariates were found insignificant and hence, they were included in the matching exercise.

Table 7. 11 Balancing test for propensity score and covariates after matching

Variables	Sample HHs	Mean		% bias	% reduction bias	T-test	
		Treated	Untreated			t	p >  t
SEXHHH	Unmatched	36.5	34.8	3.93		-0.57	0.637
	Matched	25.6	29.12	-0.91	-14.0	-0.91	0.323
AGEHHH	Unmatched	0.662	0.492	-2.07		-1.85	0.106
	Matched	0.653	0.614	-1.35	-7.9	-0.03	0.891
FSHH	Unmatched	4.755	5.045	4.13		0.85	0.232
	Matched	6.005	4.901	-2.29	-2.5	-0.91	0.501
ACINFO	Unmatched	2.986	0.785	4.53		0.75	0.534
	Matched	2.325	1.374	-3.97	19.1	-1.62	0.732
OFFINC	Unmatched	1.895	2.302	0.74		-0.53	0.261
	Matched	2.571	2.413	-2.65	-13.0	-0.27	0.365
TLU	Unmatched	0.637	0.281	1.45		-2.95	0.225
	Matched	0.725	0.636	-2.22	12.7	-0.81	0.536
OXEN	Unmatched	2.883	2.209	3.38		0.36	0.855
	Matched	3.120	3.676	-4.51	-9.57	-0.03	0.371
UCF	Unmatched	2.054	1.709	1.02		-5.06	0.321

	Matched	1.945	1.734	-2.34	17.5	0.04	0.855
USIMSE	Unmatched	2.875	1.703	3.6		1.38	0.732
	Matched	2.753	2.934	-2.0	23.7	0.04	0.401

(Source: Survey data, 2017/18)

#### 7.4.5. Results for balancing before and after matching

Some of the covariates were found significant before matching but after matching, the p-value for both NNM, KM and RM were insignificant. Table 7.14 depicted that before matching Pseudo-R2 values was 0.1624 but after matching for NNM, KM and RM, the Pseudo-R2 values were 0.009; 0.030 and 0.026 respectively. Specifically, the Pseudo-R2 value from NNM was very low and has been selected as a best fit matching estimator. Nonetheless, there has not been logical differences in the distribution of covariates between both participants and non-participants in gold mining after matching. The low Pseudo-R2 supports the premise that both participants and non-participants in gold mining have the same distribution in covariates after matching.

Table 7. 12 Results of balancing before and after Matching

Before Matching			
	LR Chi2	Pseudo-R2	P -value
	34.36	0.1426	0.0000***
After Matching			
	LR Chi2	Pseudo -R2	P -value
NNM	2.25	0.009	0.863
KM	7.58	0.030	0.641
RM	13.76	0.026	0.149

(Source: survey data, 2017/18) \*\*\* denotes significance level at 1% probability

#### 7.4.6. Estimating treatment effect on the treated (ATT)

In this sub-section, the effect of gold mining on the outcome variables (food security and income of households) has been evaluated and compared the difference between the treated and untreated groups. The result indicated that there was a statistically significant difference between treated and untreated groups in terms of food security and income of the households.

The ATT has been computed by matching the treated and untreated groups in gold mining activities that are closest in terms of their propensity scores using various matching algorithms (Ticci, 2011). The pre-treatment differences between the treated and untreated groups was controlled using PSM (Becker, and Ichino, 2002). The differences in the income and food security of the two groups are supposed to be due to the effects of gold mining in the study area. The average differences in terms of income and food security levels between the treated and untreated

groups was computed using different matching algorithms. Thus, the counterfactual estimates represent the income and food security outcome of the participant households.

#### 7.4.7. Estimating the effects of ASGM on the income and food security of households

##### 7.4.7.1. Impact estimate of ASGM on households' income

The impact of ASGM on the annual income of households was evaluated and the differences between treated and untreated groups have been compared. The result, revealed that there was a statistically significant difference between participants and non-participants households in terms of the annual income of households (see table 7.13).

Table 7. 13 Estimates of ATT on the annual income of households

Household Income	Treated groups	Untreated groups	Difference	Std. error	t-value
Farm income	16,672.41	19,821.32	3,148.91	145.34	6.85***
Off//non-farm income	40,804.48	6,834.54	33,969.94	67.83	3.42***
<b>Total</b>	<b>57,476.89</b>	<b>26,655.86</b>	<b>30,821.03</b>		

(Source: Survey data, 2017/18) \*\*\* denotes significance level at 1% probability

The ATT on total annual income the participant households was found 57,476.89ETB and was significant at 1 % level. On the other hand, the ATU was 26,655.86 ETB which signifies the household income shows that if the untreated households did participate in gold mining, their incomes would increase by about 23,584.15 ETB. This indicates that participants in gold mining had more income from both farm and non-farm sources than non-participants in the study area. Therefore, the result revealed that income of the household was found significant at 1% level.

##### 7.4.7.2. Impact estimation of ASGM on food security of households

Table 7.12 depicted that 259 matched observations were found in the NNM, 226 in KM, and 130 in RM. The PSM result signified that households' participation in ASGM has a significant impact on their food security The NNM results show that the food security of the participant households was raised by 19.65 percent as the results of gold mining participation. The counterfactual result reveals that, the food security of participant households would be less by 19.65 percent in a situation if they didn't participate in gold mining. The impact of ASGM on food security was also

estimated using KM and RM. The results show that the estimated impact of SGM participation was found consistent with the average estimates of 17 percent.

Therefore, comparing the two groups, the results signified that the probability of being in the food secure category for the participant households was higher on average by 19.65 percent than those who didn't participate gold mining. That means, participation in gold mining explains greater than 19.65 percent of the difference in the food security levels between the participant and non-participant households. Overall, the matching results demonstrated that ASGM participation has a significant impact on food security of households in the study area.

Table 7. 14 Impact of ASGM on food security of households

Algorithms	Treated groups	Untreated groups	ATT	Std. Err	T-statistics
NNM	148	184	0.1965	0.08764	2.781
KM	148	211	0.1789	0.06483	2.983
RM	77	126	0.1436	0.05875	2.054
					P>0.05

(Source: survey data, 2017/18)

#### 7.4.8. Test for joint significance

In this analysis, the chi-square was used to test the joint significance test for the equality of means between treatment and control groups for all the covariates. Before machining, there was significant difference between the two groups in some of the covariates but after matching, the Pseudo R2 value was low and this signifies there was insignificant mean difference between the two groups as indicated in the mean bias (table 7.15). The standardized bias before and after matching should be less than 5 after matching (Rosenbaum and Rubin, 1985). Thus, the distributions of covariates have no significant difference for treated and control groups.

Table 7. 15 Testing the joint significance

Ps R2	LR	Chi2	p>chi2	Mean Bias	Med Bias	Bias	Reduction	%Var
0.009	7.86	0.66	0.784	3.2	4.1	15	0.85	0.02

(Source: survey result, 2017/18)

### 7.4.9. The sensitivity analysis

The sensitivity analysis has also been analyzed using the critical value of gamma ( $\Gamma$ ). The result revealed that the lowest and the highest critical value of Gamma ( $\Gamma$ ) ranges from 3.4 to 5.6 and this shows that the unobserved heterogeneity doesn't distort the inference made about the estimated treatment effects and the results have become insensitive to hidden bias (Rosenbaum, P.R. and Rubin, D., 1985). Table 7.13 depicted that the mean bias in the independent variables after matching was found below 20 percent level of reduction in bias and hence, the PSM technique significantly balanced the covariates. The pseudo-R2 for both outcome variables after matching were generally low and all of the analytical statistics were significantly equal to zero, indicating that the overall outcome from the matching has been sufficient in balancing the covariates between the treated and untreated groups. The findings show that that if rural households participate in ASGM, their food security and incomes could be significantly improved.

Table 7. 16 Treatment effects and sensitivity estimates

Outcome variables	PSM			Critical V $\Gamma$ (Gamma)	Treated groups		Control groups	
	ATT	ATU	ATE		On support	Off support	On support	Off support
Food Security	0.45*** (7.34)	0.32*** (3.46)	0.38*** (0.43)	3.4	122	38	156	62
Income of HHs in ETB (2017/18)	57,476.9 (9.24)	26,655.86 (6.51)	30,821.03 (7.96)	5.6	148	12	186	32

Source: Author's computation using STATA version 14

\*, \*\*, and \*\*\* denote significance level at 10%, 5% and 1% respectively

### 7.5. Chapter Summary

Different food security measurements were applied to determine the food security status of households in the study area. The result from HFISA indicated that 66.3% and 45% of the participant and non-participant households were found food secure respectively. According to the HFCS, 51.9% of the participant and 44.5% non-participant were found food secure respectively. The result revealed that the number of food secure participant households by higher than the non-participant households by 5.6 percentage points. Likewise, according to FEI, 58.8% and 40.8% of the of the participant and non-participant households were found food security respectively.

As per the result of the descriptive statistics, age of the household head, dependency ratio and livestock ownership were significant at 5% level; family size (AE), distance to the mining site and oxen ownership were significant at 10% level; landholdings size, and distance to the market was significant at 1% level. The result from logistic regression indicated that 12 explanatory variables had been associated with households' food security and tested in the model. Out of which 4 variables (sex of household head, livestock ownership, and credit service) had been positively associated with the food security of households and were significant at less than 5% level significance. On the other hand, 3 variables (age of the households head, family size of the households and dependency ratio) were negatively associated to the food security of households and were significant at less than 5%, 1%, 10% level of significance respectively.

According to PSM, the ATT for household total annual income indicates that participating in gold mining increases the income of the household by 23,584.86 ETB. On the other hand, the ATT on food security using the NNM, RM and KM have been found 19.65%, 17.89% and 14.36% respectively. This shows that participating in gold mining increases the food security situation of households by a factor of 19.65, 17.89 and 14.36 percentage points. Thus, it can be inferred that participating in gold mining would help HHs ensure their food security condition in the study area.

# CHAPTER EIGHT

## Artisanal and Small-scale Gold Mining and Its Impact on Poverty Status of Households

### 8.1. Introduction

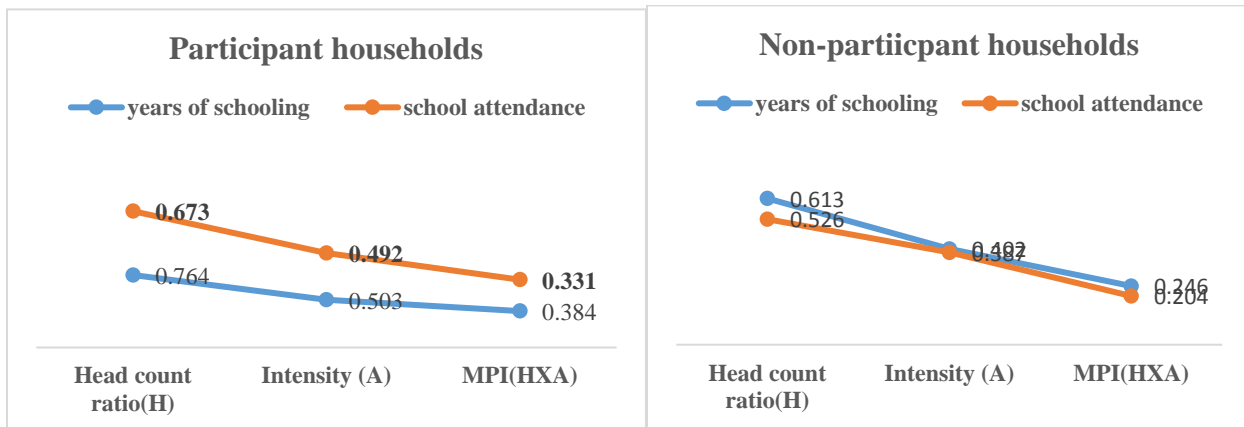
This chapter presents the multidimensional poverty situation of households in the study area. This chapter comprises two parts of data analysis techniques. The first part employed Multidimensional Poverty Index (MPI) and in using this index, 3 dimensions and 10 indicators to assess and analyze the effect of gold mining on poverty situation of households. The second part presents the impact of gold mining participation on households' annual per capita expenditure. PSM has been employed to evaluate the ATT as a result of gold mining using the three matching algorithm.

### 8.2. Descriptive Results of the Dimensions of MPI

#### 8.2.1. Educational condition of households

Years of schooling and child school enrollment are the key indicators to assess the education dimension of households (Alkire and Santos, 2010). According to this dimension, a household is deemed to be deprived in years of schooling if no member of the household has any level of formal education. On the other hand, child enrollment focuses on school-aged children in a household. A household is deprived in child enrollment if any school-aged child is not enrolled in school.

Figure 8. 1. Education Dimension of Households



(Source: survey data, 2017/18)

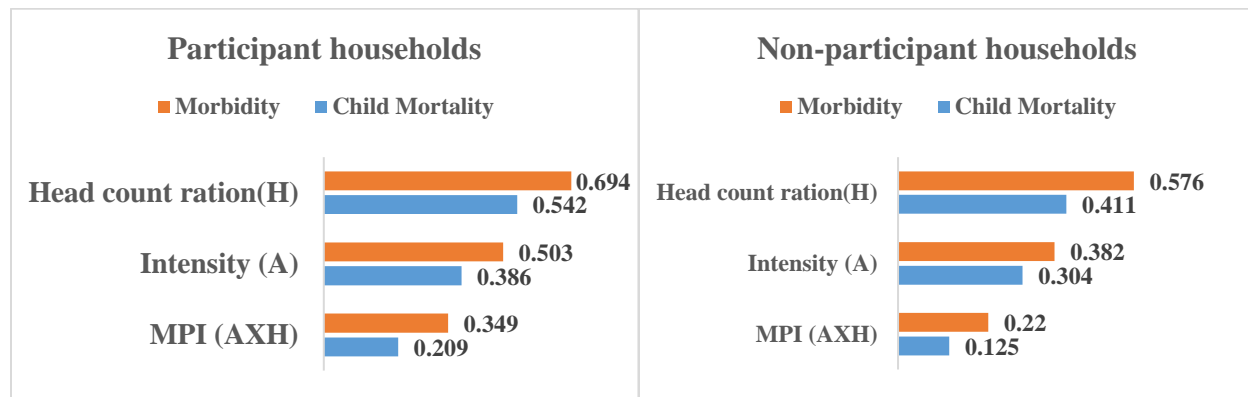
Table 8.1 depicts the results obtained from the survey households, the MPI result for participant and non-participant households in terms years of schooling were found 38.4% and 24.6% respectively. This implies that the participant households were found more deprived in terms of

years of schooling than their counterparts by 13.8 percentage points. Moreover, the MPI for school attendance of participant and non-participant households were found 33.1% and 20.4% respectively. In the same token, the participant households were found more deprived than the non-participant households by 12.7 percentage points. This result fits with Hilson’s work (2010). In his study, he reported that the drop out in participant households was higher than the drop out in the non-mining households in Peru. This was so because children were engaging in mineral extraction process to support their parents.

### 8.2.2. Health condition of households

Child mortality and nutrition/morbidity are the two key indicators of health condition of households (Alkire and Santos (2010)). A household is deprived in child mortality if at least one child death has been observed in the household in the past five years before the survey has been conducted. Besides, a household is deprived of morbidity/illness if there has been a report on illness from the member of the household during the four weeks prior to the survey. According to the bench mark developed by Alkire and Santos (2010), the results of the two indicators (child mortality and morbidity/adult illness) of household in the study area were analyzed below.

Figure 8. 2. Health Dimension of Households



(Source: survey data, 2017/18)

Table 8.6 depicts that the MPI results for participant and non-participant households in terms of the child mortality were 20.9% and 12.5% respectively. This indicates that participant households were MPI poor more than the non-participant households by 8.4 percentage points in child mortality. The reason why participant households had been associated with the risky nature of gold mining sector. Moreover, the MPI results for participant and non-participant households in terms of morbidity were found 34.9% and 22% respectively. The result made clear that the participant

household had more morbidity (illness report) from their counter parts by 129 percentage points. The result fits with what had been reported by UNEP (2017) reported. The ASM has an adverse effect on the human and natural environment and hence, needs policy intervention to be protected.

### **8.2.3. Living standard of the sample households**

In the third dimension MPI, six indicators have been considered to assess the living standards of households in the study area. The justification for these indicators had been adequately discussed in the literature of Millennium Development Goals (MDG). These included access to electricity, clean drinking water, improved sanitation, quality of housing and the use of clean cooking fuel and asset ownership (Alkire and Santos, 2010).

According to the survey result of the study, the non-participant households were found MPI poor in indicator 1(access to electric city) higher than the participant households by 27.4 percentage points. The result was synonymous with the result reported by Mwaipopo, R., et al (2004). Their finding disclosed that income generated from ASM was very much helpful to pay fees for electivity consumption. As a result, miners had better access to electricity than their counterparts (non-participant households). Similarly, participant households in the study area had better access to electricity than the non-participant households for they can easily afford the service charge and exposed to the growing towns. Table 8.6 also depicts that the non-participant households had been MPI poor in access to clean water higher than the participant households by 13.7 percentage points. This shows that non-participant households were more deprived in indicator 2 comparing than their counterparts. As shown in Klasen et al. (2012), mere access to water without quality may result in worse health outcomes for it can easily be contaminated. Participant households had better access to clean drinking water since they may use various means to have access clean drinking water. Improved sanitary is another indicator of MPI in the living standard dimension (Gunther et al. 2010, Gross & G'unther 2014) and it has been used to assess to the sanitation condition of households. Accordingly, the non-participant households were found MPI poor by 11.1 percentage points higher than the participant households. This implies that the issue of sanitary had been very server (52.53%) in the non-participant comparing the participant households in the study area. Moreover, the result shows that in terms of flour materials and access to durable assets, the non-participant households were deprived of by 18 and 11 percentage points than their counter parts whereas in terms of cooking material, participant households were deprived by 7.3 percentage points than the non-participant households.

Table 8. 1 Summary of the major dimensions, indicators and MPI

Major dimensions	Indicators <sup>46</sup>	Participant households (N=160)			Non-participant households(N=218)			MPI
		H	A	MPI	Indicators	H	A	
Education	Indicator 1	0.764	0.503	0.348	Indicator 1	0.613	0.402	0.246
	Indicator 2	0.673	0.492	0.331	Indicator 2	0.526	0.387	0.204
Mean average		0.523	0.498	0.358		0.570	0.395	0.225
Health	Indicator 1	0.694	0.512	0.349	Indicator 1	0.576	0.382	0.220
	Indicator 2	0.542	0.386	0.209	Indicator 2	0.411	0.304	0.141
Mean Average		0.618	0.449	0.279		0.494	0.34.3	0.181
Livening standard	Indicator 1	0.581	0.347	0.203	Indicator 1	0.730	0.652	0.477
	Indicator 2	0.566	0.463	0.262	Indicator 2	0.720	0.554	0.399
	Indicator 3	0.704	0.586	0.412	Indicator 3	0.802	0.652	0.523
	Indicator 4	0.806	0.785	0.632	Indicator 4	0.34	0.869	0.812
	Indicator 5	0.915	0.864	0.582	Indicator 5	0.743	0.684	0.509
	Indicator 6	0.765	0.675	0.717	Indicator 6	0.811	0.773	0.627
Mean Average		0.532	0.629	0.335		0.589	0.714	0.420

(Source: Computed from survey data, 2017/18)

### 8.3.The Raw Headcount Ratio of Households

The raw headcount ratio of each indicator which shows the percentage of households deprived in a particular indicator has been summarized in Table 8.2 below. Thus, the results have shown that the majority of households in the study area have been deprived by almost the indicators.

Table 8. 2 The raw headcount ratio of households in the selected indicators

Dimension	Indicator	Participant HHs(n=160)		Non-participant HHs (n=218)		Total HHs (n=378)	
		F	%	F	%	F	%
Health	Nutrition	68	42.5	133	61	129	34.1
	Child mortality	9	5.6	26	11.93	35	9.3
Education	Years of schooling	56	35	93	42.7	149	39.4
	School attendance	29	18.1	38	17.43	67	17.7
Livening standard	Drinking water	91	56.9	137	63.84	228	60.3
	Improved sanitary	84	52.5	129	59.2	213	56.4
	Electric city	78	48.8	144	66.1	222	58.7
	Floor material	93	58.1	156	71.6	149	39.4
	Cooking fuel	72	45	120	55.1	192	50.8
	Durable assets	58	36.3	138	63.3	196	51.9

(Source: survey data, 2017/18)

The total deprivation level of the study area indicates that HHs were deprived of drinking water, electricity and improved sanitary by 60.3%, 58.7 and 56.4 respectively. In the raw headcount ratio,

<sup>46</sup> In the Education dimension: Indicator 1 refers to years of schooling and Indicator 2 denotes school attendance

In the Health dimension: Indicator 1 denoted child mortality and indicator 2 denotes morbidity (adult illness)

In the Living standard dimension: Indicator 1 refers to drinking water, indicator 2 denotes improved sanitary, Indicator 3 refers to electricity, Indicator 4 denotes floor material, Indicator 5 shows cooking fuel and Indicator 6 Indicates durable assets.

participant HHs had been severely deprived of floor material by 58.1%, drinking water 56.9% and improved sanitary 52.5%. On the other hand, the non-participant households had been severely deprived of floor material 71.6%, electricity 66.1%, drinking water 63.84%, durable assets 63.3%, improved sanitary 59.2% and cooking fuel 55.1%. This implies that non-participant HHs had been severely deprived by at least five indicators but participant households deprived by three indicators. Thus, there was a significant difference in the raw headcount ratios of participant and non-participant HHs in the study area. The above result fits with World Bank (2015) which had reported that indicators which had the highest contribution to MPI were found electricity 71.9%, floor material 69.3%, water 65.1% drinking and improved sanitary 49.5% in the rural Ethiopia.

The MP indices are decomposed in to specific indicators in order to identify the highest and lowest contributor to the MPI of the households in the study area. As presented in table 8.2, the highest contributors to the MPI for the participant households were floor material 71.7%, cooking fuel 61.9%, durable asset 59%, electricity 49.6%, years of schooling 38.2%, improved sanitary 37.4% and drinking water 38.9% respectively. However, indicators which were considered as least contributors to MPI were child mortality (23.8%) and nutrition/morbidity (32%) in the study area.

#### **8.4. Severity and vulnerability to multidimensional poverty**

In applying the MPI, the severity and vulnerability of households to the MP is considered as an indicator of the depth of poverty beyond the incidence of poverty (OPHI, 2014). As illustrated in Table 8.4 below, out of the total surveyed households, those who are under severe MP accounted for 19.05%. These households deprived over 50% of the weighted indicators. Severity to MP in the rural areas of Ethiopia in 2014 as reported by OPHI (2015) had been 21% which was higher than the result of the present study. Looking into the non-participant households, the proportion of households in severe MP had been 25.23% which was higher by 4.23 and 14.6 percentage points than the national figure (21%) and participant households (10.63%) in the study area. With respect to the less poverty severity, out of the total households surveyed, the average total had been found 23.81 % and this figure was lower than the less poverty severity of participant and non-participant households by 3.07 and 2.24 percentage points respectively in the study area. The proportion of households which had been in less severe poverty of the participant households was higher by 5.32 percentage points from the non-participant households.

Table 8. 3 Severity and vulnerability to multidimensional poverty of households

Levels severity and Vulnerability to MP	Participant HHs (n=160)		Non-participant HHs (n=218)		Total (n=378)	
	F	%	F	%	F	%
Severe poverty	17	10.63	55	25.23	72	19.05
Less severe poverty	43	26.88	47	21.56	90	23.81
Vulnerability to poverty	30	18.75	39	17.89	69	18.25
No vulnerability to poverty	70	43.75	77	35.32	147	38.89
<b>Total</b>	<b>90</b>	<b>100</b>	<b>141</b>	<b>100</b>	<b>378</b>	<b>100</b>

(Source: survey data, 2017/18)

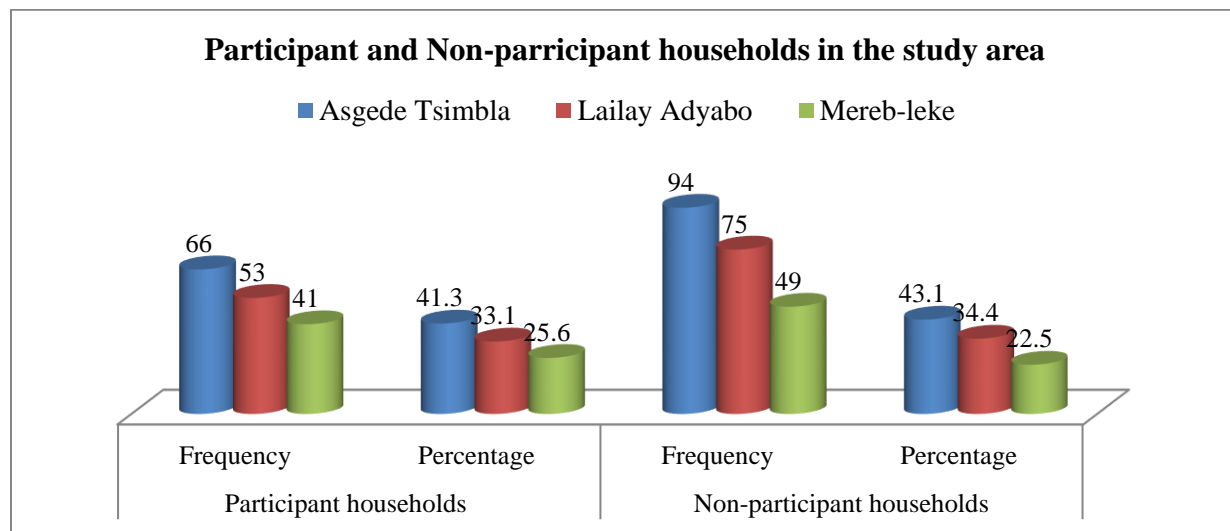
Regarding vulnerability of households to MP, 18.25% of the surveyed households have been found vulnerable to MP while some 38.89% hadn't been vulnerable to MP. The extent of vulnerable households to MP in the study area (18.25%) is less than the extent of vulnerable to MP in rural areas of the country accounted for 24% in 2015. Table 8.4 indicates that there was no statistical difference between the participant and non-participant households in terms of vulnerability to MP.

### 8.5.Results of Propensity Score Matching

#### 8.5.1. Description of participant and non-participant households

Data were gathered from the sample households whether or not they had been participated in artisanal and small-scale gold mining in the study area. Table 8.1 below depicted that 160(42.3%) and 218(57.7%) of the sample households were found participants and non-participants respectively. The result implies that majority of sample households were found non-participants.

Figure 8. 3 Participants and non-participants households in ASGM



(Source: Survey data, 2017/18)

## 8.5.2. Descriptive statistics of continuous and discrete variables

Table 8.1 has depicted the statistical analysis of continuous variables. Accordingly, annual per capita expenditure and age of the household head were found significant at 10% level. This indicates that there was significant difference between the annual per capita expenditure of participant and non-participant households and such difference might have been emanated from gold mining. Similarly, the age of the household head was the key factor for participating in the gold mining as the job requires physical fitness to undertake it. Annual income of the household, family size and distance to the nearest market center were found significant at 1% level probability. Gold mining is a business activity which requires cooperative working but size of the cultivated land and distance from home to the mining site was found significant at 5% probability levels.

Table 8. 4 Summary of descriptive statistics for continuous variables

Variables	Participant HHs		Non-participant HHs		Total		t-value for $\bar{X}$ diff.
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev	
Annu. Exp. Per cap (ETB)	38,261.67	18,276.34	26,532.43	15,653.12	32,454.65	17,586.52	26.878*
Annual income	57,476.89	22,342.23	33,892.72	26,213.45	46,654.73	34,376.34	38.64***
Family size	5.22	3.2	6.04	3.46	5.68	3.3	4.625***
Size of cultivated land	1.74	1.02	2.06	0.86	2.42	1.08	2.493**
Livestock holding (TLU)	4.15	2.67	7.40	1.83	5.86	2.05	8.365
Dist. to the market (Km)	16.15	9.44	18.25	8.63	17.8	9.15	-5.372***
Distance to home (Km)	12.71	7.61	18.13	6.42	16.65	10.83	-2.869***
Age of the HH head	42.34	13.08	49.43	15.00	46.55	13.32	2.7651*
Annual Saving( ETB)	19,215.22	10,346.34	7,360.29	4,321.86	12,267.43	7,543.72	17.876***

(Source: Survey data, 2017/18)

\*\*\*, \*\*& \* indicates significance at 1%, 5% and 10% significant levels respectively.

As shown in Table 8.2, sex of household head appeared significant at 10% level which implies that male-headed households had higher probability of participating in gold mining than female-headed households. Off-farm income was also found significant at 5% level signifying that it has a positive influence on households to participate in gold mining. Access to information was found statically significant at 5% level. The result shows that higher access to information could increase participation in gold mining in the study area. Limited access to transportation was found significant at 1% level. This indicates that most gold mining activities area located in the remote areas and hence, limited access transportation influences households' participation in gold mining and was found significant at 1% level. This signifies the more households have access to transportation the more they participate in the mining activities and the vice versa is true. Access to credit service was found significant at 10% level and this signifies that there is a high association

between credit service and gold mining. That is, lack of credit service had negatively influenced the participation of households in gold mining in the study area. Nonetheless, education level of household head, oxen ownership and use of chemical fertilizer were found insignificant to influence the participation decision of households in the study area.

Table 8. 5 Summary of descriptive statistics for discrete variables

Variables	Category	Treated		Untreated		Total		t-value
		F	%	F	%	F	%	
sex of the HH head	Female	46	28.8	67	30.7	113	29.9	0.07*
	Male	114	71.3	151	69.3	265	70.1	
education level of HH head	Illiterate (0)	5	3.13	13	5.96	18	47.4	0.45
	1-4 grade (1)	28	17.5	50	22.9	78	20.6	
	5-8 grade (2)	55	34.4	79	36.2	134	35.5	
	9-12grade (3)	23	14.4	19	8.7	42	11.1	
	≥Diploma (4)	12	7.5	2	0.92	14	3.7	
off income participation	Read and write (5)	36	22.5	55	25.2	91	24.1	0.03***
	Yes(1)	160	42.4	165	75.5	325	85.9	
access to information	No(0)	0	57.3	47	24.3	47	14.2	0.05**
	Yes(1)	126	78.8	139	63.8	265	71.3	
access to transport	No(0)	34	21.3	79	36.2	113	28.8	0.00***
	Yes(1)	67	41.9	53	16.1	120	31.7	
oxen ownership	No(0)	93	58.1	165	83.9	258	68.3	0.28
	Yes(1)	51	31.9	152	69.7	203	53.7	
use of chemical fertilizer	No(0)	109	68.1	66	30.9	175	46.3	0.96
	Yes(1)	112	70	122	56	234	35.4	
access to credit services	No(0)	48	30	96	44	144	64.6	0.06*
	Yes(1)	36	22.5	73	35	110	29.1	
	No(0)	124	77.5	145	66.5	269	70.9	

Source: survey result, 2017/18.

## 8.6. Estimation of the propensity score using probit regression

The probit model was employed to estimate the propensity scores of the treated and untreated household. The dependent variable was binary signifying whether the household was participant in ASGM and takes the value of 1 and 0 otherwise. The probit estimate result appears to be good for the intended matching exercise. The pseudo-R2 value 0.067834 shows that the matching households had similar characteristics so that finding a good match between the treated and non-treated households. The maximum likelihood estimate of the probit regression model result indicates that gold mining participation has been significantly influenced by age of the households, sex of household head, annual income, family size, access to market information, limited access to credit service, distance to the nearest market center and distance from home to the mining sites had affected the probability of participating in gold mining in the study area.

Table 8. 6 Estimation of the propensity score using probit regression

<i>Variables Codes</i>	<i>Coefficient</i>	<i>Std.error</i>	<i>Z-value</i>	<i>P&gt;  Z </i>
<i>Age of the household head</i>	-0.09011	0.081	-1.12	0.00***
<i>Sex of the household head</i>	-1.24781	0.369	2.43	0.02**
<i>Annual income of the household</i>	-2.07342	0.153	-1.68	0.00***
<i>Education level of the household head</i>	0.487234	0.423	2.84	0.455
<i>Family size of the household</i>	0.136416	0.020	2.13	0.03**
<i>Access to market information</i>	-0.89897	1.765	3.25	0.00***
<i>Limited access to credit service</i>	0.935227	0.314	3.45	0.07*
<i>Distance to the nearest market center</i>	-0.16458	0.346	-2.66	0.00***
<i>Distance from home to mining sites</i>	-0.36504	0.396	-1.07	0.00***
<i>Limited access to transportation</i>	2.358527	1.227	0.982	0.13
<i>Livestock owner (TLU)</i>	0.150719	0.331	2.99	0.00***
<i>Off/non-farm participation</i>	0.636549	0.563	0.963	0.58
<i>Oxen ownership</i>	0.726107	0.620	0.90	0.35
<i>Use of chemical fertilizer</i>	0.102936	1.407	0.41	0.68
cons	-1.024722	1.567501		0.556

(Source: Survey result, 2017/18). \*\*\*, \*\* and \* denote sig. at 1%, 5% and 10% respectively.

### 8.6.2. Matching estimated propensity scores for treated and untreated groups

The common support region lies between the minimum and maximum propensity scores of treatment and untreated groups respectively (Caliendo and Kopeinig, 2005). Table 8.8 below shows that the estimated propensity scores for participants households vary between 0.053728 and 0.985322(mean=0.565328) and between 0.13242 and 0.924607 (mean=0.336294) for non-participant households. Therefore, the common support region would lie between 0.0523891 and 0.924607 which means households whose estimated propensity scores less than 0.0523891 and 0.924607 were not considered for the matching exercise. As a result of this restriction, 46 participant households and 67 non-participant households were discarded. Table 8.7. Distribution of the estimated propensity scores

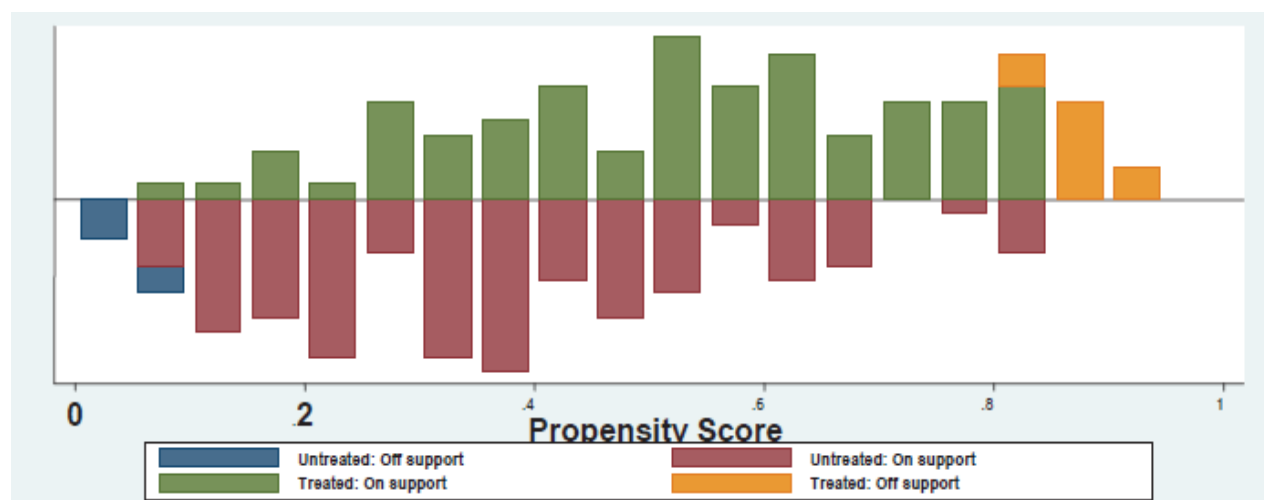
Table 8. 7 Distribution of the estimated propensity scores

Sample households	Observation	Mean	Std.dev	Minimum	Maximum
Treated HHs	160	0.565328	0.267643	0.0523891	0.985322
Untreated HHs	218	0.336294	0.238567	0.014242	0.924607
Total HHs	378	0.47	0.285329	0.014242	0.985322

(Source: Survey data, 2017/18)

The distribution of the propensity score can be quickly grasped from the figure below.

Figure 8. 4 Distribution of the Propensity Score



### 8.6.3. Balancing the propensity scores and covariate

Once the matching algorithms had chosen, the balance of propensity score and covariate were checking using different procedures. The t-test statics and chi-square test were applied to ensure the balancing powers and matching quality. Hence, reduction in the mean standardized bias between the matched and unmatched households was used to describe the critical level. The standardized variation in covariates before matching were 3.3 percent and 56.9 percent but the remaining standardized variation of almost all covariates ranges from 0.3 percent and 14.5 percent after matching. This signifies below the critical level of 20 percent suggested by Caliendo and Kopeining (2005).

Table 8. 8 Covariance balancing indicators before and after Matching

Variable	Unmatched Matched	Mean value		Statndard Bias %	% Reducce  bias	T-statstics Test	
		Treated	Untreated			t	P> t
_pscore	Unmatched	.5648	.3653	3.87		7.45	0.265
	Matched	.4876	.4279	2.28	23.35	0.58	0.387
Age of the HH head	Unmatched	49	51	-3.15		-5.67	0.165
	Matched	44	44	-0.75	13.52	-0.38	0.567
Sex of the HH head	Unmatched	.7465	.5053	-4.59		2.55	0.655
	Matched	.7053	.7262	-7.63	22.57	-0.56	0.587
Edu. level of HH head	Unmatched	1.76	1.45	1.56		2.87	0.874
	Matched	1.83	1.66	0.77	1.43	1.02	0.292
Annual income	Unmatched	1.204	5.104	-1.92		-4.89	0.452
	Matched	1.302	5.104	7.98	14.00	1.63	0.135

Family size of HH	Unmatched	5.678	4.874	-2.61		-1.55	0.653
	Matched	6.587	5.654	-3.54	9.74	-0.72	0.376
Dependency ration	Unmatched	0.563	0.727	-4.32		-4.65	0.543
	Matched	0.648	0.674	-1.67	3.52	-1.43	0.436
Distance to the nearest market center	Unmatched	19.37	17.38	31.98		4.98	0.123
	Matched	19.36	26.45	-123.38	-20.48	-14.9	0.654
Livestock owner (TLU)	Unmatched	2.123	3.064	-37.34		-3.65	0.345
	Matched	2.109	0.948	0.67	-13.86	4.60	0.654
Off/non-farm income	Unmatched	16465.6	1.105	-2.65		-4.26	0.321
	Matched	16062.5	32045.3	-3.92	17.63	-3.64	0.543

(Source: survey data,2017/18)

Table 8.4 above indicates that shows that few variables were statistically significant before matching but after matching, the covariates were balanced. Therefore, before matching, the P-value was significant at 1% level but after matching, p-value for NNM, KBM and RM were not significant. Besides, before matching, Pseudo  $R^2$  value was 0.1598 whereas after matching for NNM, KBM and RM, the Pseudo- $R^2$  values were 0.006; 0.040 and 0.049 respectively. With the matching quality of the above indicators, the Pseudo- $R^2$  value from NNM was found very low and selected as a best fit matching estimator but there was no significance differences in the distribution of covariates between participant and non-participants households in the gold mining participation after matching. The low Pseudo- $R^2$  supports the idea that both the treated and untreated groups have the same distribution in covariates after matching. The results were used to assess the impact of gold mining participation on the poverty situation of participant and non-participant households who had similar characteristics. This technique permits researchers to compare the observed outcomes of the participant with non-participant households taking the common support region.

Table 8. 9 Results of balancing scores before and after matching

Before matching		After matching					
		Nearest Neighbor Matching		Kernel Matching		Radius Matching	
LR Chi2	13.19	LR Chi2	1.66	LR Chi2	5.23	LR Chi2	10.34
Pseudo-R2	0.1598	Pseudo-R2	0.006	Pseudo-R2	0.040	Pseudo-R2	0.049
P-value	0.0000***	P-value	0.76	P-value	0.0563	P-value	0.145

Sources: Calculated from survey data, 2017/18) \*\*\* denotes significant at 1% level.

The above tests indicate that the matching algorithms had been found appropriate for the survey data and the ATT for the participant and non-participant households have been discussed below.

### A) Estimation of ATT using nearest neighbor matching(NNM)

Table 8.2 has depicted the ATT on total annual income the participant households was found 30,821.23 ETB and was significant at 1 % level. The results also indicated that the ATT on total annual expenditure for participant households was found 10,783.98 ETB. This shows that participant households in gold mining had more annual expenditure than the non-participants households. The t-test for annual total expenditure was found significant at 10% level.

### B) Estimates of ATT using kernel matching

On the other hand, the ATT on the total annual income was found 32,651.46 ETB and was found significant at 1% level. Moreover, the ATT on total annual expenditure was 7,997.35 ETB. This signifies that participating households in gold mining had more annual expenditure by 7,997.35 ETB comparing to non-participants and was significant at 1% level.

### C) Estimates of ATT using radius matching

On the other hand, the ATT on the total annual income found 33,927.95 ETB and was found significant at 10% level. Besides, the ATT on total annual expenditure was 6,874.35 ETB. That is, participant households in gold mining had more annual expenditure of 6,874.35 ETB comparing to non-participants and was significant at 5% level.

Table 8. 10 Estimation of ATT using NNM, KM and RM algorithms

<b>A) The Nearest Neighbor Matching (NNM) technique</b>						
Variables	Sample	Treated	Untreated	Difference	Std.error	T-statistics
Tot.ann.inc	Unmatched	57,476.89	33,892.72	23,584.15	24.346	4.34
	ATT	57, 476.89	26,655.86	30,821.23	31.456	2.56***
	ATU	33,892.72	38,234.15	4,341.78		
	ATE			9,764.49		
Tot.Ann.Exp	Unmatched	38,261.67	26532.42	11,729.25	49.329	6.285
	ATT	38,261.67	27,477.69	10,783.98	53.456	3.46*
	ATU	26532.42	34,764.57	8,232.15		
	ATE			13,465.23		
<b>B) The Kernel Matching (KM) technique</b>						
Tot.ann.inc	Unmatched	57,476.89	33,892.72	23584.15	24.346	4.34
	ATT	57, 476.89	24,825.43	32,651.46	31.456	2.64***
	ATU	33892.72	36,234.15	2,341.43		
	ATE			12,764.49		
Tot.Ann.Exp	Unmatched	38,261.67	26,532.42	11,729.25	49.329	6.285
	ATT	38,261.67	30,264.32	7,997.35	53.456	3.96**
	ATU	26532.42	41,764.57	15,232.15		
	ATE			9,465.46		
<b>C) The Radius Matching(RM) technique</b>						
Tot.ann.inc	Unmatched	57476.89	33892.72	23584.15	24.346	4.34
	ATT	57, 476.89	18,654.46	38,822.43	31.456	2.83*
	ATU	33892.72	37,234.12	3,341.40		

Tot.Ann.Exp	ATE			11,764.49		
	Unmatched	38,261.67	26532.42	11,729.25	49.329	6.285
	ATT	38,261.67	25,768.42	12,493.25	53.456	4.17**
	ATU	26532.42	36324.86	9,792.44		
	ATE			9,465.46		

(Source: Computed from survey data, 2017/18)

To put in a nutshell, NNM, KBM and Radius Matching indicated that participation in gold had a significant impact on poverty reduction of rural households. That is, households who participated in gold mining have increased their total annual income and expenditure more than non-participant households and hence, they can reduce poverty.

#### 8.6.4. Test for joint significance

As has been described in the previous chapter, chi-square tests was applied to test the joint significance for the equality of means between treatment and control groups for all the covariates. Before machining, the Pseudo R2 was found 0.1598 but after matching, the Pseudo R2 value was 0.0496 which was low and the likelihood ratio (LR) before matching was 13.19 but after machining, the LR value was found 5.743. Thus, the test was found insignificant and this signifies there was insignificant mean difference between the two groups as indicated in the mean bias (table 7.15). The standardized bias before and after matching should be less than 5 after matching (Rosenbaum and Rubin, 1985). From the entire balancing test results, the distributions of covariates have no significant difference for treated and control groups.

*Table 8. 11 Testing the joint significance*

Ps R2	LR	Chi2	p>chi2	Mean Bias	Med Bias	Bias	Reduction	%Var
0.0496	5.74	0.36	0.64	2.2	3.7	13	0.65	0.01

(Source: survey result, 2017/18)

#### 8.6.5. Sensitivity test and analysis

In order to control for unobservable biases, Rosenbaum bounds were used and the results have been positive and significantly different from zero. The first column of the table 16 shows those outcome variables indicate the statistical difference between treated and control groups. The rest of the values which corresponds to each row of the significant outcome variables are p-critical values at different critical value of  $e^{\gamma}$ . Table 16 below shows the result of sensitivity of ASGM participation on food security and income of the households (outcome variables)

Table 8. 12 Result of sensitivity analysis

Outcome	$e^{\gamma} = 1$	$e^{\gamma} = 1.25$	$e^{\gamma} = 1.50$	$e^{\gamma} = 1.75$	$e^{\gamma} = 2$	$e^{\gamma} = 2.25$	$e^{\gamma} = 2.50$	$e^{\gamma} = 2.75$	$e^{\gamma} = 3$
Ann. exp	0.000	0.000	0.000	0.000	3.6e-14	1.2e-13	2.2e-12	1.6e-12	1.2e-10
Income	0.000	0.000	0.000	0.000	4.2e-15	1.2e-13	1.8e-11	1.6e-12	1.2e-10

(Source: Computed from survey data, 2017/18)

The  $e^{\gamma}$  (Gamma) is equals to log odds of differential due to unobserved factors where Wilcoxon significance level for each significant outcome variable is computed. At various level of critical value of  $e^{\gamma}$ , the p-critical values were found significant which signifies that important covariates had affected both participation and outcome variables. Thus, it can be concluded that ATT were found insensitive to unobserved selection bias and the effects of ASGM participation.

### 8.7. Chapter Summary

Poverty is complex, multidimensional and hence, there is no single measurement of poverty. This chapter, Multidimensional Poverty Index (MPI) and Propensity Score Matching (PSM) have been employed to analyze the Impact of ASGM on poverty situation of households in the study area. The result of MPI shows that in terms of education dimension, 38.4% of the participant and 24.6% of the non-participant households were found PMI poor in years of schooling. Similarly, 33.1% the participant and 20.4% of the non-participant households were found MPI poor in school attendance. In terms of health dimension, 20.9% of the participant and 12.5% of the non-participant households were found MPI poor in child mortality. Likewise, 34.9% of the participant and 22% of the non-participant households were found MPI poor in morbidity in the study area. With regard to the living standards of the households, the non-participant households were found MPI poor as compared with the non-participant HHs in the study area.

In terms of the raw headcount ratio, the non-participant households were deprived of by five indicators (flour materials, electricity, drinking water, durable assets, improved sanitary and cooking fuel) while the participant households deprived of by three indicators (flour materials, drinking water and improved sanitary). Besides, the highest contributors to the MPI were floor material, cooking fuel, durable asset, electricity, years of schooling, improved sanitary and drinking water respectively but the least contributors were child mortality and nutrition in the study

area. With regard to the major dimensions, the largest contributor to the MPI has been living standard which contributed more than 11.8% followed by education 5.8% and health 2.9%.

The mean t-test, chi-square test and PSM have been used to evaluate the impact of gold mining on the annual per capita expenditure of households in the study area. The descriptive statistics indicates that the annual per capita expenditure for participant and non-participant household were found 38,261.67 ETB and 26,532.43 ETB respectively. The mean difference was 11,729.24 ETB and was statistically significant at 10% level. Besides, the mean annual income of participant and non-participant households were found 57,476.89 ETB and 33,892.72 ETB respectively. The mean difference between the treated and untreated groups was 23,584.17 ETB. The result shows that annual income of the two groups was statistically significant at 1% level.

The ATT from NNM signifies that households who had participated in gold mining increased their total annual income and expenditure by 30,821.23 ETB and 10,783.98 ETB respectively. The t-values for the total annual income and expenditure between participant and non-participant households were found significant at 1% and 10% level respectively. On the other hand, the result from KM shows that the ATT for households who had participated in gold mining improved their total annual income and expenditure by 32,651.46 ETB and 7,997.35 ETB comparing with non-participants households respectively. The t-test for total annual income and expenditure between participant and non-participant households was found significant at 1% and 5% levels respectively. Finally, the ATT from RM shows that households who had participated in gold mining improved their total annual income and expenditure by 33,927.95 ETB and 12,493.25 ETB as compared to the non-participants households respectively. The t-test for the total annual income and expenditure were found significant at 10% and 5% level.

## CHAPTER NINE

### Artisanal and Small Scaled Gold Mining and Livelihood Assets of Households

#### 9.1.Introduction

This chapter describes the adverse effects of ASGM on the livelihood assets in the study area. The gold mining operation believed to have a negative effects on the livelihood assets of households. The adverse effects of gold mining on human and physical environment in the study area shall be carefully investigated using appropriate research techniques to address the challenges related to the mining sector. Livelihood Vulnerability Index (LVI) has been applied to assess the livelihood assets of sample households in the study area and the results have been compared and contrasted.

#### 9.2.Results of Livelihood Vulnerability Index

The adverse effects of gold mining participation on the livelihood assets had been computed using the Livelihood Vulnerability Index (LVI) by adding the weighted averages of the five capitals ( $wA_1+wA_2+wA_3+wA_4+wA_5$ ) of the participant and non-participant households in the study area. Finally, the balanced weighted average of all the components was considered as the final LVI score for the community (Shah et al., 2013; Sullivan et al., 2002; Lamichhane, 2010). The LVI is scaled from 0 (least vulnerable) to 1 (most vulnerable). A household is less vulnerable when LVI is below 0.50, moderately vulnerable if LVI ranges from 0.50-0.70 and is extremely vulnerable when the LVI exceeds 0.70 to different degree of vulnerability (Shah et al., 2013 and Lamichhane, 2010).

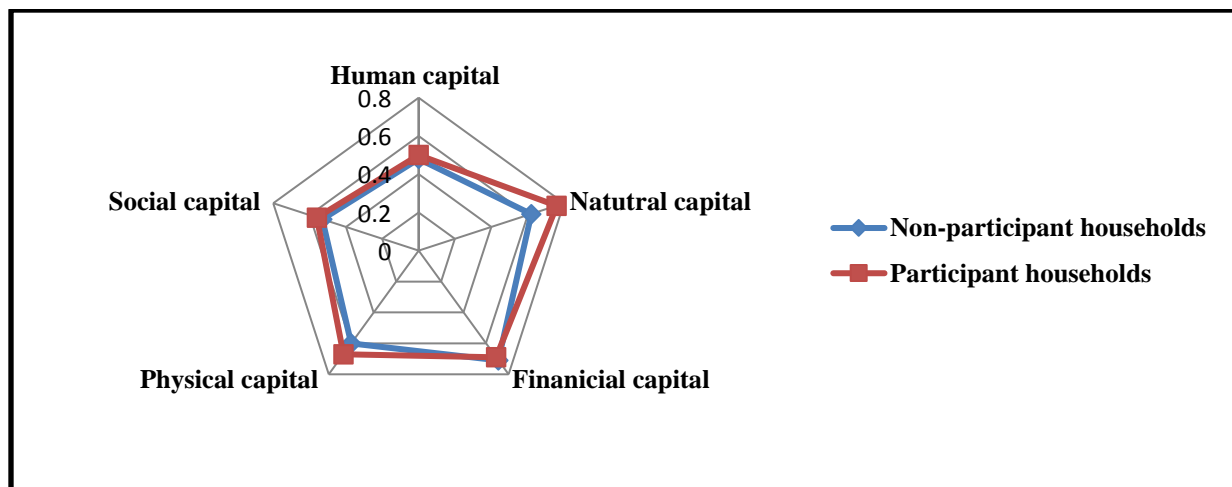
Therefore, the balanced weighted average of all the components for participant households in terms of human, natural, financial and social capitals was 0.61 and this is by addition all the five capitals( $wA_1=0.52+wA_2=0.76+wA_3=0.69+wA_4=0.67+wA_5=0.56$ ) respectively. Likewise, the balanced weighted average of all the components for non-participant households in terms of human, natural, financial and social capitals was 0.59 and this is by addition all the five capitals ( $wA_1=0.48+wA_2=0.62+wA_3=0.71+wA_4=0.60+wA_5$ ) respectively. The balanced weighted average of LVI of the study area was found 0.60 ( $LVI=0.61+LVI=0.59\div 2=0.60$ ).

As per the classification made by Shah et al. (2013) and Lamichhane (2010), participant and non-participant households were found extremely vulnerable in terms of natural capital (0.76) and financial capital (0.71) respectively. Conversely, participant households have been vulnerable in terms of all assets as it is depicted in fig.9.1 below but non-participant households were less vulnerable in terms of human capital but have been vulnerable in the rest of the assets. The result

has revealed that the assets in participant households are relatively vulnerable to the effect of mining operations as compared to that of non-participant households with 0.05 percentage points which was found to be slightly vulnerable.

Besides, the participant households were found more vulnerable in all assets than non-participant households except financial capital. That's, the participant households were found more vulnerable in terms of human, natural, physical and social capitals by 0.14, 0.18, 0.07 and 0.03 percentage points than non-participant households respectively. However, in terms of financial capital, non-participant households were found more vulnerable by 0.03 percentage points in the study area.

Figure 9. 1 Livelihood Vulnerability of the 5 Capitals/ Assets



(Source: survey data, 2017/18)

### 9.3. Decomposing the Effect of ASGM by Livelihood Assets/capitals

In the previous sub-section, the major components of livelihood assets have been discussed using the balancing weighted average of each livelihood asset and comparing the aggregate weighted averages of the participant and non-participants households. The following sub-section discusses the decomposed livelihood assets and indicators by comparing the results between the participant and non-participant households.

#### 9.3.1. Human capital vulnerability

The result revealed that the balanced weighted average of human capital was found 0.52 which signifies moderate vulnerability. Whereas the human capital vulnerability of participant and non-participant households in the study area were found 0.56 and 0.48 respectively. The result implies that although the result of human capital vulnerability has been found moderate for both participant

and non-participant households, the human capital vulnerability of the participant households was found higher than non-participant households by 0.08 percentage points in the study area. The reason why the LVI of participant households exceeded the non-participant households in the study area might be because of the hazardous nature of the gold mining participation. Besides, the limited health care facilities near to the mining sites were also the factors that made participant households vulnerable in terms of health vulnerability than the non-participant households. The study was also found that on average, the nearest health post took around 140 minutes for the participant households but 100 minutes for non-participant households to travel to the nearest health post. Most of the mining sites are located at the remote areas and hence, the availability of health services for the participant households has become difficult. As a result, the health vulnerability of non-participant households is lower by 0.18 percentage points than the participant households. The result fitted with what has been reported by Ticci (2011) states that mining community were found more vulnerable in terms of human capital comparing with non-mining community.

Table 9. 1 Human capital vulnerability of households

Capital/ Assets	Major components	Sub-components/indicators	Results of LVI	
			Participants	Non-participants
	Health	Average time to nearest health center	0.64	0.52
		Member of the household died due to ASGM	0.19	0.04
		Family member who is seriously ill or disabled	0.60	0.27
		<b>Average for Health vulnerability(A1)</b>	<b>0.48</b>	<b>0.30</b>
	Knowledge Skill	HH head formal year of schooling	0.40	0.57
		Access TV program	0.83	0.90
		Access to a radio program	0.48	0.59
		Access to mobile phone	0.23	0.43
		HHs which received training	0.81	0.90
		<b>Average knowledge and skill vulnerability(A2)</b>	<b>0.56</b>	<b>0.67</b>
		<b>Average human capital vulnerability(A1+A2)</b>	<b>0.52</b>	<b>0.49</b>

(Source: Survey data, 2017/18)

Besides, knowledge and skill vulnerability of participant and non-participant households have been found 0.56 and 0.67 respectively. This is to mean that the non-participant households had been found more vulnerable than the participant households by 0.11 percentages in the study area. The reason for this might be associated with access to information since participant households were expected to own mobile phones, radio and other sources information which could help them obtain relevant information about their product. Generally, in terms of human vulnerability, the participant households had been found more vulnerable by 0.03 percentage points than the non-

participant households in the study area. Nonetheless, households in the study area had still limited access to different mass media.

### 9.3.2. Natural capital vulnerability

The natural capital vulnerability of participant and non- participant households have been found 0.76 and 0.62 respectively. The average LVI of natural capital is found 0.69. The former had been considered as an extreme vulnerability while the latter was moderate vulnerability. As has been depicted in table 9.1 below, participant households are more vulnerable in terms of natural capital than the non-participant households by 14 percentage points. Farm income was the major source of livelihood in the study area followed by gold mining but the land holding size of households is found very small. The result has shown that 68% of the participant and 45% of the non-participant households had been vulnerable to access to land in the study area. In this case, the participant households had been found more vulnerable by 23 percentage points than the non- participant households. Most of the respondents were less aware of the existing land policies, land ownership rights and related issues. Thus, it has been associated with the failure of government to provide sufficient information regarding land ownership and land certificate to the local people. Despite the community participation in water and soil conservation, reforestation program and the like in the study area, climate variability has created an adverse effect on the livelihoods of the local community. On the other hand, forest vulnerability of the participant and non-participant households had been found 0.86 and 0.78 respectively. In this sub-component, both households were found extremely vulnerable in terms of forest vulnerability but it was found higher in the participant households by 0.08 percentage points. In addition to the cooking indicator, trees are being cut down for gold mining purposes and this might be the reason that the participant households were found more vulnerable than the non-participant households in the study area.

Table 9. 2 Natural capital vulnerability of households

Capital/ Assets	Major components	Sub-components/indicators	Results of LVI	
			Participants	Non-participants
Land		Access to land for ASGM	0.76	0.46
		Land size of the household	0.36	0.39
		Land lost for ASGM	0.78	0.51
		Awareness and knowledge land degradation	0.83	0.44
		<b>Average for land vulnerability(A1)</b>	<b>0.68</b>	<b>0.45</b>
Forest		Forests are the only energy sources for cooking?	0.85	0.95
		The average time to fetch firewood	0.80	0.66

	Scarcity of firewood today than ever	0.92	0.72
	<b>Average for forest vulnerability(A2)</b>	<b>0.86</b>	0.78
Water	Availability of sufficient and clean water in locality?	0.81	0.75
	The prevalence of conflict over water resources	0.57	0.37
	Sources of water in the study area	0.69	0.56
	Distance to fetch water	0.91	0.89
	<b>Average for water vulnerability(A3)</b>	<b>0.75</b>	<b>0.64</b>
	<b>Average for water vulnerability(A1+A2+A3)</b>	<b>0.76</b>	<b>0.62</b>

(Source: Survey data, 2017/18)

The water vulnerability of the participant and non-participant households had been found 0.76 and 0.62 respectively. The result shows that participant households had been found extremely vulnerable to water as the vulnerability index exceeds 70%. Water is very limited resource in the study area and hence, participant households had been found more vulnerable than the non-participant households by 0.14 percentage points. However, the amount and sources of water differs from season to season. During the raining season, the amount and sources of water increases because of the raining season whereas during the dry season the amount and sources of water decreases tremendously and households become extremely vulnerable to the availability of water. Accordingly, long distance to reach the water source and the quality of drinking water in river had been a big concern in the study area. Thus, households had been vulnerable to water-borne diseases and its ramifications would be seen in other livelihood outcomes. This result conforms to that of Hentschel 2000; 2002, indicated that the main impacts of mining were soil erosion, deforestation and land degradation; open pits and health hazards.

### 9.3.3. Financial capital

The financial vulnerabilities of the participant and non-participant households had been found 0.54 and 0.71 respectively. The result shows that the financial vulnerability of the non-participant had been found very high. The average LVI of financial capital has been found 0.63. Specifically, the LVI of debt of participant and non-participant households have been found 0.44 and 0.64 whereas the LVI for saving in both households were found 0.64 and 0.78 respectively. Most of debts were obtained from relatives, neighbors, Relief Society of Tigray and *Dedebit* microfinance. Particularly, during holly days, most of the households had been burrowing money to celebrate their festivities and this situation demands considerable expenses in the study area. The result is similar with what was reported by Shah, Kalim U., et al., (2013) saying that financial capital was found the most critical factor influencing the human capital of households.

Table 9. 3 Financial Capital Vulnerability of households

Capital/ Assets	Major components	Sub-components/indicators	Results of LVI	
			Participants	Non-participants
Financial Capital	Financing	Debt of the households	0.44	0.64
		Saving of the households	0.64	0.78
		<b>Average for financial vulnerability</b>	<b>0.54</b>	<b>0.71</b>

(Source: Survey data, 2017/18)

#### 9.3.4. Physical capital

The physical capital vulnerability of participant and non- participant households had been found 0.67 and 0.60 respectively. The average LVI of physical capital was found 0.64. However; participant households had been extremely vulnerable to energy supply (0.87) and housing (0.79) while non- participant households had been extremely vulnerable to energy supply (0.91) and housing (0.92). The result indicates that non-participant households were found more vulnerable than participant households in terms of energy supply and housing in the study area. This result fits with the findings of Lamichhane (2010) and had reported that households who had not involved in off-farm activities were financially vulnerable than these who hadn't participated in it.

Table 9. 4 Physical capital vulnerability of households

Capital/ Assets	Major components	Sub-components/indicators	Results of LVI	
			Participants	Non-participants
	Transportation	Average time to reach nearest vehicle station	0.61	0.55
		Households who had means of transportation	0.54	0.34
		<b>Average for transport vulnerability(A1)</b>	<b>0.58</b>	<b>0.45</b>
	Energy supply	Access to electricity (solar) in your house	0.87	0.91
	Production input	Access to production input	0.43	0.22
	Housing	Housing ownership	0.79	0.92
	School distance	The average time to reach nearest school	0.69	0.49
		<b>Average vulnerability(A2)</b>	<b>0.67</b>	<b>0.64</b>
		<b>Average Natural capital vulnerability(A1+A2)</b>	<b>0.63</b>	<b>0.54</b>

(Source: Survey data, 2017/18)

Moreover, in the study area, there was no proper transportation system that connects to the highway and it took on average 60 minutes' walk to reach the nearest public transportation. The absence of proper transportation facility has become another challenge to other aspects of livelihood vulnerability. According to most of the respondents, proper connection to road and transportation facilities could offer range of alternatives and opportunities for them to secure their livelihood as well as cope with various stressors. Distance to public school has been found another

challenge of the study area where students have to travel an average of 50 minutes to reach nearest school. As a result, many students can simply drop out from school. For this purpose, collective efforts from all the stakeholders, public institutions and the people of the study area shall look for sustainable physical infrastructures that would help local households improve their livelihoods. To sum up, in terms physical capital vulnerability, participant households have been found more vulnerable by 0.09 percentage points than non-participant households in the study area. These finding were found similar with the reports of World Bank (2013) saying that ASM is a poverty driven business activity and hence, supports the livelihood of the participant households. However, since ASM is located in the remote area, there is very limited physical infrastructure facilities to support miners reach the mining sites.

### 9.3.5. Social capital

The social capital vulnerability index indicates that the participant and non-participant households had been found 0.56 and 0.53 respectively. The balanced average LVI of social capital was found 0.55. The weighted average for demography vulnerability of the participant and non-participant households were found 0.71 and 0.72 respectively where both households were under extreme vulnerability in terms of demography. On the other hand, the weighted average for social network and relationship vulnerability of the participant and non- participant households is 0.40 and 0.32 which can be considered as less vulnerable. The overall social vulnerability index is found 0.51, which is moderate level of vulnerability in terms of social capital. Generally speaking, most households are found less vulnerable in terms of social interaction and network. Majority of the households had received or providing help to their neighbors. Looking at the households' interaction, network and relationship within the community, very limited number of households said they did not receive help from neighbors or friends recently. Thus, less social vulnerability implies strong social network and such situation is important aspect of socio-economic security in context of rural households in the study area.

Table 9. 5 Social capital vulnerability of households

Capital/ Assets	Major components	Sub-components/indicators	Results of LVI	
			Participants	Non-participants
Social Capital	Demography	Dependency Ratio of the households	0.82	0.88
		Household head	0.68	0.68
		Family size of the households	0.63	0.58
		<b>Average for demographic vulnerability(A1)</b>	<b>0.71</b>	<b>0.72</b>
		Offering support to neighbor recently	0.46	0.29

Social	Getting Assistance from local government	0.43	0.35
Networking	Group affiliation of the household head	0.54	0.68
	Any kind of support received recently	0.31	0.18
	Participation I national and local election	0.25	0.20
	<b>Average for social network vulnerability(A2)</b>	<b>0.40</b>	<b>0.34</b>
	<b>Average for social vulnerability(A1+A2)</b>	<b>0.56</b>	<b>0.53</b>

(Source: Survey data, 2017/18)

The result signifies that more 70% of the households replied that they did not go to any government office for assistance in the past 12 months. Long distance and financial costs have limited their access to public services. All of the government offices and services are concentrated at the district headquarter in each study *woreda*. The local governments had poorly contributed the basic public services of the people in the study area. Besides, many households in the study area were not affiliated with active members of different political parties since the region has been dominating single party until recently. A study conducted by Ticci (2011) has reported that mining communities were found more vulnerable by 0.18 percentage points.

#### **9.4. Summary of descriptive statistics of the livelihood assets/capitals**

The last chapter has focused on providing information on the vulnerability context of livelihood assets of gold mining activities in the study area. It is obvious that gold mining affect the human, natural, financial physical and social resources of the local community. Therefore, table 9.6 depicted the mean, standard deviation and t-values of the participant and non-participant households. Accordingly, the mean value for the human capital vulnerability of participant and non-participant households in the study area was found 0.52 and 0.49 respectively. The result has shown that the LVI for the participant households was found higher by 0.04 percentage points and was statistically significant at 5% probability level. The result was similar with what was reported by Ticci (2011) saying that the human capital of mining households was found vulnerable to the effect of mineral extraction processes. The table also has depicted that the mean value for natural capital vulnerability of participant and non-participant households in terms of was found 0.76 and 0.62 respectively. This signifies that the LVI for the participant households was found higher by 0.14 percentage points and was statistically significant at 1% probability level. The result is found similar with what was reported by UNESCO (2003) which indicated that the main impacts of mining are deforestation and land degradation; open pits causing animal traps and health hazards. In terms of financial capital, the mean value for participant and non-participant households was found 0.54 and 0.71 respectively. The result indicates that the non-participant households had been found

more vulnerable financial resources than the participant households by 0.17 percentage points and it was statistically significant at 10% probability level in the study area. This result conforms to Tieguhong et al. (2009) that revealed that artisanal mining has been a source of income for millions of population in areas where there is limited job options. The mean physical capital vulnerability for the participant and non-participant households was found 0.63 and 0.54 respectively. The LVI of participant households was found more vulnerable than their counterparts by 0.09 percentage points and was found statistically significant at 5% probability level.

Table 9. 6 Summary of LVI results of the major components (assets/capitals)

Description of variables	Participant HHs		Non-participant HHs		Total		t-value
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev	
Human capital	0.52	2.13	0.49	19.02	0.50	2.00	12.39**
Natural capital	0.76	1.65	0.62	1.34	0.52	1.62	-8.51***
Financial capital	0.54	1.90	0.71	2.07	0.51	1.84	-17.46*
Physical capital	0.63	2.33	0.54	1.52	0.51	1.43	6.564**
Social capital	0.56	0.96	0.53	1.18	0.50	0.95	3.481

(Source: Survey data, 2017/18) \*\*\*, \*\* and \* denote significance level at 1%, 5% and 10% respectively

## 9.5. Chapter Summary

This chapter has assessed the effects of gold mining participation on the vulnerability context of livelihood assets in the study area. The Livelihood Vulnerability Index (LVI) has been applied to assess the livelihood assets (five capitals) of the sample households using the vulnerability threshold developed by (Shah et al., 2013 and Lamichhane, 2010). For these authors, the threshold which shows the levels of vulnerability includes: LVI less than 0.5 (less than 50) refers to less vulnerable, LVI between 0.5-0.7 (50-70) refers moderate Vulnerability and LVI above 0.7 (70) refers to extremely vulnerable. A contextual interpretation of the indices combined with the perspectives and narratives of households is needed to have a complete understanding of livelihood vulnerability. The summary of the descriptive statistics signifies that the participant households were found extremely vulnerable in terms of natural capital and was significant at 1% level. Whereas non-participant households were extremely vulnerable in terms of financial capital and significant at 10% probability level. Participant households were moderately vulnerable in terms of human, financial, physical and social capital. Likewise, non-participant households were moderately vulnerable in terms of natural, physical and social capitals but less vulnerable in terms of human capital.

## CHAPTER TEN

### Conclusions and Recommendations of the study

#### 10.1. Introduction

This dissertation has intended to investigate artisanal and small scale gold mining participation and its impact on the livelihood of rural households in Tigray National Regional State. Evidences show that the ASM sector contributes to the national economy and livelihood of the rural households. However, the sector is entangled with lack of good governance; informal market channel; lack of skilled and technical know-how on the sector, most gold mining operations apply backward method, lack of geological data, dominated by illegal mining and the like. As a result, the contribution of the sector to the national income and rural livelihoods have been deteriorated in the recent years for different reason. Research works on artisanal and small scale gold mining and its impact on the livelihoods of the rural households' have been scanty and insufficient. Therefore, despite limited literature is available in this sector, the researcher was motivated to conduct a study on the gold mining sector so as to address the challenges associated to the mining sector. ASM related theories, empirical reviews and conceptual frame works have been incorporated. Multiple data gathering and analysis techniques have been applied to investigate the effect of ASGM participation on the livelihood of rural households. Major finding have been summarized in each chapter. Lastly, conclusive remarks and the possible recommendations have been suggested to improve the drawbacks of the sector.

#### 10.2. Concluding Remarks

Like majority of the Ethiopia population, more than 80% of the Tigray Nowadays, agriculture is unable to feed its population due to climate change, backward technology, population pressure and the rural population are forced to diversify their livelihood strategies to cope up with the economic hardship. Thus, the study confirmed that artisanal and small-scale gold mining is the major source of livelihood for the rural households and foreign exchange earnings for the country. It was also indicated that food insecurity, economic hardship, limited job opportunities, quick wealth creation have been proved the push and pull factors for the rural households to engage in gold mining participation in the study area.

Despite the policy and regulatory frameworks are in place to manage the ASM sector, the study concluded that the governance and administrative structure of the sector was found defective. It

can also be observed that the federal-regional-local administrative structure to regulate the sector is poorly organized and ill-staffed with trained manpower with inadequate support from the federal and regional governments to legalize the sector. Thus, it can be inferred that the mismanagement of the sector has resulted in widespread contraband activities and this eventually, deteriorates the foreign exchange earnings of the country.

ASM participation requires physical fitness to undertake the gold mining. Besides, miners are expected to travel long distance to reach the mining sites and engage in physical work and hence, the number of male-headed households had been found higher than female-headed HHs in the study area. Thus, it can be realized that the ASM sector is dominated by male-headed households and this might be the reason for the limited number of female-headed HHs in the study area.

After conducting a rigorous analysis on factors affecting gold supply participation to the formal market, it has been proved that sex of the household head, access to transportation, access to information, access to local marketing of gold, price fluctuation of gold, widespread illicit trade of gold, absence of site marketing, poor system of governance and perception of miners towards the benefit of illicit trade had a negative effect on the supply gold to the formal market agents. On the other hand, education level of the household and being a member of mining cooperatives had not been significantly influenced the gold supply to the formal market agents. Besides, the commitment of the federal and regional governments to enforce the mining policies, laws and regulation had been proved poor and less effective. The regression result of the study had also confirmed that age of the household head, distance to the nearest market place, distance to the mining sites, access to transportation, price fluctuation of gold, governance of gold mining and perception on the benefit of the illegal market had significant effect on the dependent variable but negatively signed. Whereas access to market information, access to the local gold market, illicit trade of gold, sex of the household head, family size of the household head and access to credit service had significant effect on gold supply to the formal market agents but positively signed. On the other hand, education level of the household head, incentives to increase gold supply and being a member of a cooperative hadn't been significantly effected on gold supply to the formal market agents in the study area.

According to HFIAS, majority of the participant households (66.3%) had better food security status than the non-participant households (45%). Similarly, 51.9% of the participant and 44.5% of the non-participant households had adequate HFCS respectively. Besides, the FEI outcome

indicated that 58.75% of the participant and 40.8% of the non-participant households in the study area. Besides, the head count ratio ( $P_0$ ) for the food insecure participant and non-participant households was found 0.41.3 and 0.592 respectively. It can be inferred that proportion of food insecure non-participant households was found higher than the participant households in the study area. The food insecurity gap and squared food insecurity gap indicates that the non-participant households had deep food insecurity gap than their counterpart. Thus, it can be safely concluded that gold mining participation has paramount importance for rural households to ensure their food security. That is, participant households had better food security status than the non-participant households in the study area. The descriptive statistics for continuous variables confirmed that age of the HHs head, distance to nearest market center, distance to the mining sites, livestock possession and oxen ownership of HHs have been significantly influencing the food security status of HHs at various levels of confidence. Conversely, the results of descriptive statistics for discrete variables signified that sex of the household head, the marital status of HHs head, chemical fertilizers and off/non-farm activities were significantly influencing the food security status of HHs.

With regard to PSM, the study concluded that gold mining participation increased the annual income of participant households by 23,584.86 ETB. That is, if the non-participants households did participate in gold mining, their incomes would have increased by 23,584.86 ETB. Thus, it has been confirmed that participating in gold mining increased the food security situation households by a factor of 19.65, 17.89 and 14.36 percentage points according to the NNM, RM and KM algorithm. Besides, the result from the logistic regression has been improved that the age and sex of the household head and distance from home to the mining sites, livestock ownership, and access to credit service, family size; access to transportation and access to information had significant effect on the participation decision of household in gold mining. However, variables such as education of the household head, off-farm participation, oxen ownership and use of chemical fertilizer had less effect on the participation decision of households in gold mining.

Poverty status of households has been analyzed using MPI. In terms of education dimension, 38.4% of the participant and 24.6% of the non-participant households were found PMI poor in years of schooling. Hence, it can be inferred that the non-participant households were deprived more than the participant households in the study area. Similarly, 33.1% the participant and 20.4% of the non-participant households were found MPI poor in school attendance. Therefore, it can be

concluded that school attendance was found high on the participant households. In terms of health dimension, 20.9% of the participant and 12.5% of the non-participant households were found MPI poor in child mortality. Hence, it can be confirmed that child mortality was found high in the participant households. Likewise, 34.9% of the participant and 22% of the non-participant households were found MPI poor in morbidity in the study area. Thus, there proportion is higher in participant than the non-participant households. There reason why the participant households were found more MPI poor in both dimensions might be because of gold mining participation. With regard to the living standards of the households, it has been proved that the non-participant households were found MPI poor as compared with the non-participant HHs in the study area.

On the other hand, in terms the raw head count ratio, the non-participant HHs were found severely deprived by 5 indicators (floor material(71.6%), electricity (66.1%), drinking water (63.84%), durable assets (63.3%), and improved sanitary (59.2%) and cooking fuel (55.1%) than the participant HHs which are deprived by 3 indicators floor material (58.1%), drinking water (56.9%) and improved sanitary (52.5%). Thus, it can be deduced that gold mining participation has a positive effect in reducing the level deprivation of the indictors in the study area.

The annual per capita expenditure for participant and non-participant household was 38,261.67 ETB and 26,532.43 ETB respectively. The mean difference was 11,729.24 ETB and was statistically significant at 10% level. Besides, the mean annual income of participant and non-participant households was found 57,476.89 ETB and 33,892.72 ETB respectively. The mean difference between the treated and untreated groups was 23,584.17 ETB. The result shows that annual income of the two groups was statistically significant at 1% level. It can be concluded that the gold mining has an impact on the livelihood of the rural households in the study area. The ATT from NNM, KM and RM revealed that households who had been participating in gold mining increased their total annual income and expenditure comparing to the nonparticipant households. Therefore; it can be safely concluded that the gold mining participation had a positive impact on the livelihood of households in the study area.

The last but not least concluding remark of the study is that the livelihood assets are moderately vulnerable to effects of ASGM participation since the LVI of the study area has been found 0.60. The participant and non-participant households have been extremely vulnerable in terms of natural capital (0.76) and financial capital (0.71) respectively in the study area. Therefore, the study concluded that the participant HHs are more vulnerable to the effect of gold mining than the non-

participant HHs in the study area. Finally, it has been confirmed that participant households have been found more vulnerable than the non-participant HHs in many of the livelihood assets and this might be due to participant HHs had been involved in gold mining activities.

### **10.3. Recommendations of the study**

The results and findings of this study are immense. It is, therefore, very difficult to forward recommendations on the bases of all these results and findings of this research. Therefore, the following recommendations are forwarded on the bases of the major results, the stated research questions and specific objectives.

#### **A) Improving the good governance practices of Artisanal and small-scale gold mining**

It is confirmed that the ASM sector has been poorly managed and as a result, the sector is dominated by informal mining and illicit trading of gold in the study area. Most gold mining activities are poorly regulated by the existing rules and regulations and hence, the sector has been exposed to illegal extraction of gold mining and smuggling of gold via different illegal channels which ultimately resulted in serious declining of foreign exchange earnings in the country.

There should be a decentralized powers and duties whereby the local governors enable them to effectively control of the gold mining operations as most of the activities are located in remote areas. The nearer the branch office to the mines sites, the better experts understand the sector, the fewer challenges exist and effective decision can be made. It can also reduce the cost of travel and bureaucratic processes across the tiers of the government structure. Thus, decentralized governance enables local governments to enforce the rules and regulations closely. The local authorities shall be equipped with adequate institutional capacity and independent governance structure from the federal to local levels to address the challenges prevailing in the mining sector. The gold mining sector doesn't have an independent structure and merged with energy and water source office at *woreda* level. Therefore, there should be an independent (federal-regional-local) structure to specifically address the problems related it.

Policies, laws and regulations that govern the gold mining shall have local context. The policies, laws and institutional frameworks of the mining sector should incorporate the fundamental mining rights. These include rights of transfer and upgrade consenting, successive permit renewals, right to process minerals, right to land for mining, and the right to sell at market price. There should be

awareness creation activities about the existing the policy, legal frameworks, rights and obligations of the miners, experts and stakeholders to effectively implement of the mining policies and regulations. The miners shall be fully informed about the adverse effects of gold mining participation. Incentives to encourage miners, financial and technical supports and the criteria and legal procedures to obtain mining license shall be improved in away miners can get mining license quickly access to mining license. These factors could play a vital role in legalizing the sector. The federal and regional governments should assign consultants to assist miners at the mining sites.

Currently, majority of artisanal gold miners are not paying royalties to the government. As result, the federal and regional governments should strengthen their institutions and open branch offices near to the mining sites collect royalties from sector. In this case, both the federal and local government should work aggressively to regulate the sector and collect royalties from the gold mining participation. It requires strong political commitment from the government and prevents the illegal operation of gold mining. Government institutions (federal-regional-local levels) shall be strengthen in terms of human and financial resources. Federal, regional and local institutions should create synergy and smooth flow of information for effective control and support of the sector. Empowering the social institutions can also have paramount importance preventing the adverse effect of gold mining in the study area.

The study has identified key challenges of the ASM sector. Hence, capacity building, provision of extension services, technical skills and occupational safety training shall be given for miners about the adverse effects of gold mining on the natural environment. Miners should have a geological data to exactly locate the gold deposit to minimize time wastage in search of gold in the study area.

#### **B) Enhancing the volume of gold supply to the formal market agents**

Currently, there is widespread illegal gold marketing channels at national level in general and at regional and local levels (Beyene, 2016). In fact, few miners supply gold to local banks and other legal agents but many miners engage in illegal gold marketing. Therefore, the government should provide incentives that can benefit the miners better than the benefit obtained from the black market. Gold mining activities are undertaken at the remote areas and hence, miners are unable to find legal financial institutions near to the mining sites. In this case, they are easily brokered by the gold smugglers and contrabandists. Therefore, the government should establish site marketing that enable miners supply gold to the formal market agents and hence, minimize the illegal gold

marketing channels at the local level. In doing so, much work is needed to formalize or legalize the informal mining sector and regulate and reduce the mineral smuggling activities.

The federal and regional governments should jointly design a strategy on how to combat illegal gold marketing channels in the study area. The policy actions which had been in place to control the illegal marketing were found less effective to increase the volume of gold supply to the formal market. Therefore, the government should revise its previous policy actions and come up with additional package of incentives that benefit gold miners so that the volume of gold supplied to the formal market increases. Besides, the government should fix better price which can attract miners to supply gold local banks comparing the price paid by black market. An integrated extension services is needed to support miners in terms of technology, geological data, marketing information, and so on. Finally, a special department at regional and local level shall be organized to effectively manage the overall marketing system of ASM participation. For this purpose, the federal, regional and local authorities should work cooperatively to control the illegal gold marketing channels.

### **C) Ensuring the food security condition of households**

The results of various food security measurements indicated that participant households had better food security status than the non-participant households. Besides, the PSM result on the outcome variables show that gold mining participation had created a positive impact on food security and income of households. However, many households were unable to diversify their livelihood strategies to generate income and ensure their food security.

Therefore, as per the major findings of the study, pertinent suggestions have been forwarded on the food security of households in the study area. Firstly, emphasis should be given to livelihood diversification in the rural areas because food security of households can be achieved not only from the farm productivity but also from other off/non-farm income sources.

Currently, the number of population is growing tremendously while agriculture is unable to feed its population due to climate change, land degradations and the likes. Diversifying the sources of income shall be given priority for the non-participant households to generate income and ensure their food security. This is so because diversifying income sources could help households to their immediate problem, minimize risk and enable them to acquire the basic needs. Gold mining participation is one of the off/non-farm income generating activities which plays an essential role

in ensuring the food security of the rural households in the study area. Therefore, the regional and local governments should design strategies as to how the local people can make use gold extraction and production to ensure the food security of households in the study area.

#### **D) Improving the poverty situation of households**

In accordance with the major findings this specific objective, the result from the head count ratio signifies high incidence of poverty in the study area despite people are engaging in various income generating activities. Normally, livelihood diversification may not necessarily pull the poor out of poverty unless basic support services (credit service, capacity building, training, etc.) shall be in place at the local level. Thus, the regional governments should revisit the poverty reduction strategies that can address the incidence of poverty by designing specific policies that can fit the local context.

The result from the raw weighted indicators indicated that most households had been deprived by almost all indicators and were found MPI poor. As a result, the regional government should work to change the traditional way of living by proving simple technology in the rural areas. The results on education dimension demonstrate household heads in terms of years of schooling and school attendance were found MPI poor and hence, the human assets shall be improved. Intensive training shall be given for miners and local administrators as how to protect the adverse effects of gold mining participation. Moreover, children drop out had found series due to gold mining activities and hence, the regional and local government education bureau should work with stakeholder to reduce school absenteeism by introducing incentives such as school feeding to motivate students and attend their education.

The health dimension was found relatively MPI non-poor in the study area but still there are challenges associated with lack of medical equipment, medicine, trained nurses, and related issues. The gold mining participation has been highly exposed to health related problems and hence, improved health extension services are needed to reduce the health effects of gold mining. Therefore, the health sector needs attention to fill the gaps which were found in health service delivery in the rural areas.

With regard to the living standards of sample households, non-participant households were more deprived of in the living standard indicators. This might be because participant households can have better access to income than the non-participant households. Therefore, the regional and local

government should have a special attention as to how the deprived households can improve their living standards in the study area by avoiding one-size-fits-all approach. That is, the local government should design a proper program to mobilize the local resources like finance, labor and agricultural inputs to pull the poor from economic hard ship. Policy intervention is needed by the regional government that targets the severe and moderate MPI poor households in the study area.

#### **E) Protecting the livelihood assets of households**

Lastly, the results of the study revealed that the social, physical, human, natural and physical assets were found vulnerable to the effects of gold mining. Therefore, policies and regulatory frameworks shall be designed to protect the livelihood assets in the study area. The federal, regional, local governments, and local community should be integrated to reduce the effect of gold mining on the livelihood assets in the mining sites.

The Environmental Protection Agency (EPA) should collaborate with the local governments to prevent the destruction and contamination of water bodies in the mining sites. Moreover, media coverage is needed to create awareness on ASM and its effects on livelihood and the environment. Furthermore, the federal and regional governments should focus on reducing poverty and unemployment by incorporating the gold mining sector into poverty reduction strategies and reduce the vulnerability of the livelihood assets in the study area.

#### **10.2.Suggestions for future research**

Despite its contribution to the national economy and livelihood of the rural poor, the ASM sector has been overlooked by governments, policy makers and researchers. Limitations and constraints of the study have prompted suggestions for further research. This study has attempted to investigate the nexus between the artisanal and small scale gold mining and its impact on the livelihood of rural households in Tigray National Regional State. Thus, the study focused on gold mining and limited only in single region and selected *woredas*. Therefore, having this benchmark, further research works could be done on the value chain of gold mining, miners' health and occupational safety, the impact of artisanal and small scale mining on the natural environment in wider context, research works could also be needed at national level including the mineral potential regions to fill the gaps exist in each region, artisanal and small scale mining productivity and value chain, the social impact of the mining sector in wider context.

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## Annexes

### Annex 1. Variance Inflation Factors for Continuous variables to test multicollinearity

Variable	VIF	1/VIF
agehhh	1.09	0.91743
fshhh	1.04	0.49504
dishmsi	2.02	0.98039
disnmc	1.07	0.93457
Offinc	2.01	0.49751
Mean VIF	1.446	

Source: Computed field survey data, (2017/18)

### Annex 2. Contingency coefficient for discrete variables to test multicollinearity

	ASGS	sexhhh	eduhhh	pmpf	iningosu	pebeilma	mcom	acinfo	goas	iltrgo	accrse	laactr	aclomago
ASGS	1.0000												
sexhhh	0.4823	1.0000											
eduhhh	0.3021	0.1976	1.0000										
pmpf	0.4783	0.1018	0.2981	1.0000									
iningosu	0.2987	0.5321	0.2987	0.0179	1.0000								
pebeilma	0.1964	0.2987	0.2301	0.3084	0.1560	1.0000							
mcom	0.4981	0.1890	0.3214	0.1203	0.2910	0.1002	1.0000						
acinfo	0.2310	0.3765	0.1301	0.2097	0.1062	0.2319	0.3309	1.0000					
goas	0.5086	0.4021	0.2962	0.5642	0.3201	0.3201	0.2312	0.1904	1.0000				
iltrgo	0.7354	0.6098	0.2098	0.3022	0.2093	0.3542	0.3267	0.2983	0.2421	1.0000			
accrse	0.1098	0.2138	0.1242	0.4653	0.2202	0.0345	0.4532	0.3621	0.4532	0.3214	1.0000		
laactr	0.8093	0.5097	0.4328	0.5083	0.3200	0.3403	0.4458	0.5762	0.3302	0.4381	0.4598	1.0000	
aclomago	0.3097	0.2314	0.5642	0.7623	0.2301	0.3004	0.2033	0.2316	0.1123	0.2354	0.1200	0.3122	1.0000

Source: Computed field survey data (2017/18)

### Annex 3. Conversion factors used to estimate Tropical Livestock Unit (TLU)

Livestock	TLU	Livestock	TLU
Calf	0.2	Sheep and goat	0.13
Bull	1.0	Cow and Ox	1.0
Donkey	0.7	House/Mule	1.1
Heifer	0.75	Chechen	0.013

Source: (Desale, 2008)

### Annex 4. Conversion factors used to estimate adult equivalent

Age in Years	Men		Women		Children		
	kcal	Conv. factor	kcal	Conv. factor	Year	kcal	Conversion factor
11-14	2500	0.98	2200	0.86	0-1	75	0.29
15-18	3000	1.18	2200	0.86	1-3	1300	0.51
19-24	2900	1.14	2200	0.86	4-6	1800	0.71
25-50	2900	1.14	2200	0.86	7-10	2000	0.78
≥ 50	2300	0.90	1900	0.75			

(FAO, 2007).

### Annex 5: STATA (version 14) output for Heckman two stage models

totinc	Coef.	Std.Err.	Z	P> Z	[95% Conf. Interval]
agehhh	234.723	23.046	0.264	0.009	114.84 83.949
sexhhh	8639.741	45.879	2.582	0.031	263.241 120.35

eduhhh	65.227	4.860	0.427	0.965	- 37.583	30.421
fshh	5834.72	53.878	1.325	0.074	220.518	605.437
acinfo	2956.89	41.273	2.673	0.007	-135.763	459.772
iningosu	56.887	0.330	1.269	0.157	-170.583	233.465
pmpf	0.854	0.564	0.096	0.531	47.865	89.465
pebeilma	-99.887	3.330	0.872	0.042	-432.543	321.986
goas	78.049	0.029	2.051	0.291	37.583	30.421
aclomago	6856.23	1.017	1.540	0.039	1560.544	3472.36
disnmc	-69.254	0.054	3.635	0.864	-461.528	340.864
dishosi	12.974	0.298	1.097	0.871	-332.094	225.329
acilgoma	57.200	5.017	0.452	0.733	53.671	135.260
accrse	4468.210	0.336	0.673	0.003	3240.74	5163.01
_cons	30603.41	9654.2	5.654	0.021	17020.91	52985.43

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gold mining|

agehhh	-22.311	0.046	1.029	0.009	-0.255	0.075
sexhhh	1.336	0.762	0.582	0.018	10.241	87.353
eduhhh	0.455	0.157	2.427	0.065	0.064	0.909
fshh	0.136	0.321	1.325	0.034	0.018	0.254
offinc	0.000	0.000	0.020	0.517	0.385	2.110
acainfo	0.796	1.322	0.673	0.001	0.3354	1.462
iningosu	-0.888	0.330	0.432	0.057	-0.145	0.482
pmpf	0.852	0.564	2.096	0.131	31.065	11.200
pebeilma	-0.89	0.330	1.108	0.042	-0.255	0.075
goas	0.049	0.029	0.051	0.091	2.015	0.265
aciltrgo	0.218	0.018	0.745	0.733	0.871	0.564
disnmc	-0.155	0.154	1.054	0.009	-0.291	-0.039
dishosi	-0.365	0.397	0.432	0.006	-35.094	12.329
acilgoma	0.935	1.017	1.540	0.039	0.544	3.369
accrse	-2.268	1.336	0.963	0.066	-0.368	1.502
-cons	-1.025	1.567	-0.53	0.556	-5.629	3.593

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Mills |

Lambda	-2634.496	13.338	-3.22	0.035	3234.231	-219.823
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Rho ( $\rho$ )	0.476598
Sigma ( $\sigma$ )	49.569763
Lambda ( $\lambda$ )	-2634.4968

Number of obs	240
Censored observation	48
Uncensored observation	112
Wald chi <sup>2</sup> (26)	273.78
Prob >chi <sup>2</sup>	0.0000

Annex 6. Marginal effects of the probit model for the determinants of HHs' participation in ASGS

ASGS	df/dx	Robust Std. Err.	Z	P> z	x-bar	[95% Conf. Interval]
agehhh	.034845	.046145	.329	.009	46.33	.074232 .225420
sexhhh	.473125	.762123	.501	.018	.946	.334225 .545729
eduhhh	.176201	.156611	1.086	.065	.897	.360378 .346478
fshh	.052647	.320675	.497	.034	5.543	.024984 .301483
acainfo	.226239	1.322035	.563	.001	.504	.150049 .524431
iningosu	.042436	.330235	.045	.057	.729	.060378 .208743
pmpf	.046917	.564948	.721	0.131	.543	.352903 .676543
pebeilma	.042436	.330233	.108	0.042	.207	.534257 .076543
goas	.132607	.029025	.044	0.091	.043	.405615 .265546
aciltrgo	.027806	.017804	.274	0.733	.832	.356254 .765430
disnmc	-.072840	.154386	.084	0.009	9.74	-3.2991 -.873942
dishosi	-.088033	.396596	.532	0.006	12.5	-47.432 71.3295
acilgoma	.054578	.179927	.412	0.039	.387	.544287 .369023
accrse	-.163735	1.33605	.465	0.066	.291	-.54322 .502347

Number of obs	160
Wald chi2 (13)	108.78
Prob > chi2	0.0000
Log pseudo likelihood	-53.198789
Pseudo R2	0.6792

Annex 7. OLS estimation of model variables

totinc	Coef.	Std. err	t	P>  Z	[95% conf. interval ]
agehhh	209.875	153.8504	2.12	0.436	104.6634 352.2986
sexhhh	3245.154	635.6543	3.98	0.021	432.6934 365.7654
eduhhh	463.22732	412.5634	1.51	0.188	-132.5421 218.6534
fshh	-89.72	234.1432	-0.42	0.201	-4132.5432 349.8756
offinc	44.196	5362.6533	1.75	0.517	-276.3215 871.4323
acmainfo	-576.89	633.3652	-0.40	0.657	-2654.4239 1635.6543
actr	-159.586	125.4602	22.23	0.933	-543.8734 254.6542
iningosu	1923.0091	5032.6543	-2.99	0.032	439.7645 384.4653
pmprfl	-77.8544	118.6534	-4.45	0.931	2131.8756 6525.8774
peilma	-14.0465	12.7645	-0.34	0.442	328.3764 442.7643

acfoma	907.2076	317.6753	3.55	0.000	6521.7645	2376.6534
aciltr	57.2008	74.8747	-5.98	0.733	253.6534	1203.8743
accrse	75.8765	552.7641	-1.65	0.001	5435.8745	985.2645
_cons	8365.198	648.8253	6.76	0.860	354.9875	9812.9885

Dependent variable = households' total amount of income.

Number of observations =160

R-squared = 0.7943

F (12, 873) =156.53

Adj R-square = 0.8034

Pro>F = 0.007

#### Annex.8: STATA outcome for logistic estimates

gold mining	Coef.	Std.error	Z	P>Z	[95% Conf. Interval]
agehhh	-0.0901137	0.081	-1.12	0.0017	23.7652 189.8758
sexhhh	-1.2478157	0.369	2.43	0.015	55.9851 387.5342
eduhhh	0.4872343	0.423	2.84	0.455	654.9752 3542.9856
fshh	0.1364162	0.020	2.13	0.033	54.0985 126.8745
actr	-0.456324	0.082	0.982	0.132	-263.9856 254.6345
dishmsi	-0.164586	0.346	-2.66	0.008	-453.9856 234.1745
acnifo	-0.8989766	1.765	3.25	0.001	39.6452 651.8562
scl	0.1690745	0.391	1.23	0.000	543.8745 78.9562
ltu	0.1507195	0.331	2.99	0.003	43.6545 577.9856
offinc	0.63165497	0.563	0.963	0.575	87.7645 1239856
oxon	0.7261072	0.620	0.90	0.352	353.8745 534.8745
ucf	0.1029363	1.407	0.41	0.683	66.8746 321.9756
accrse	0.9352274	0.314	3.45	0.071	-534.0975 128.9845
_constant	-1.036743	-0.33	0.786		

Number of observation

378

LR chi2(7)

0.33

Wald chi2(13)

112.98

Prob  $\chi^2$

0.012

Pseudo R<sup>2</sup>

0.067

Correct prediction

66.56%

## Annex 9: Livelihood assets, components and sub-components of the participant HHs

s/n	Capital/Asset	Major Indicator	N0. of sub-indicators	Weighted Average(WA)	LVI
1	Human Capital	-Health	3	$(0.52+0.04+0.27)\div 3=0.30$	0.28
		-Knowledge and skill	5	$(0.57+0.90+0.56+0.43+0.90)\div 5=0.67$	0.67
The weighted average of human capital(A1)					<b>0.48</b>
2	Natural Capital	Land	4	$(0.46+0.39+0.51+0.44)\div 4=0.45$	0.45
		Forest	3	$(0.95+0.66+0.72)\div 3=0.78$	0.78
		Water	4	$(0.75+0.37+0.56+0.89)\div 4=0.64$	0.64
The weighted average of natural capital(A2)					<b>0.62</b>
3	Financial Capital	Debt	1	$0.64\div 1=0.64$	0.64
		Saving	1	$0.78\div 1=0.78$	0.78
The weighted average of financial capital(A3)					<b>0.71</b>
4	Physical Capital	Road	2	$(0.55+0.34)\div 2=0.45$	0.45
		Energy supply	1	0.91	0.91
		Production input	1	0.22	0.22
		Housing	1	0.92	0.92
		School distance	1	0.49	0.49
The weighted average of physical capital(A5)					<b>0.60</b>
5	Social Capital	Demography	3	$(0.88+0.69+0.58)\div 3= 0.72$	0.72
		Social Network	5	$(0.29+0.35+0.68+0.18+0.2)\div 5=0.34$	0.34
The weighted average of social capital					<b>0.53</b>
<b>Total Livelihood Vulnerability of non-mining households Index(A1+A2+A3+A4+A5)=</b>					<b>0.58</b>

## Annex 10: Livelihood assets, components and sub-components of the non-participant HHs

s/n	Capital/Asset	Major Indicator	N0. of sub-components	Weighted Average(wA)	LVI
1	Human Capital	Health	3	$(0.64+0.19+0.60)\div 3=0.48$	0.48
		Knowledge and skill	5	$(0.40+0.83+0.48+0.81+0.23)\div 5=0.56$	0.56
The weighted average of human capital(A1)					<b>0.52</b>
2	Natural Capital	Land	4	$(0.76+0.36+0.78+0.83)\div 4=0.68$	0.68
		Forest	3	$(0.85+0.80+0.92)\div 3=0.86$	0.86
		Water	4	$(0.81+0.57+0.69+0.91)\div 4=0.75$	0.75
The weighted average of natural capital(A2)					<b>0.76</b>
3	Financial Capital	Debt	1	$0.44\div 1=0.44$	0.44
		Saving	1	$0.64\div 1=0.64$	0.64
The weighted average of financial capital(A3)					<b>0.54</b>
4	Physical Capital	Road	2	$(0.61+0.54)\div 2=0.58$	0.58
		Energy supply	1	0.87	0.87
		Production input	1	0.43	0.43
		Housing	1	0.79	0.79
		School distance	1	0.67	0.67
The weighted average of physical capital(A4)					<b>0.67</b>
5	Social Capital	Demography	3	$(0.82+0.68+0.63)\div 3= 0.67$	0.71
		Social network and relationship	5	$(0.46+0.43+0.54+0.31+0.25)\div 5=0.40$	0.40
The weighted average of social capital(A4)					<b>0.56</b>
<b>Total Livelihood Vulnerability of mining households Index(A1+A2+A3+A4+A5)=</b>					<b>0.61</b>

Annex-11-Questionnaire and Interview Guidelines  
Addis Ababa University  
College of Development studies  
Center for rural development  
Survey Questionnaire for sample Households in the study area

Dear respondent,

The purpose of this study is to investigate ‘Artisanal Small-scale Gold Mining Participation and Its Impact on the Livelihood of Rural Households in Tigray Region, Ethiopia.’ For the successful completion of the study, your genuine and kind response to the items has paramount importance during data collection processes. Your information will be kept confidential and used only for academic purpose. It won't be used for decisions that might affect your personal life. Hence, you are kindly requested to carefully complete the questionnaire. You can choose the best answer from the given alternatives and the number in the box indicates your correct response.

*Thank you in advance for your cooperation!!*

**Part I: Instructions for Enumerators**

- ✓ make a brief introduction to each farmer before starting the interview;
- ✓ greet them in the local way; know each other and ask his/ her name;
- ✓ tell them the purpose and objective of the study;
- ✓ get the informed consent from respondents and ask if any confusion on the items;
- ✓ please, fill up the interview schedule according to the respondent's reply
- ✓ please, use simple terms while discussing with respondents
- ✓ write the answer of the respondent on the space provided;
- ✓ tick or encircle the chosen answer in the space provided;
- ✓ Prove that all questions are asked and properly completed; and at the end, leave the miners with words of thanks.

**Name of enumerator:** \_\_\_\_\_ **Date:** dd \_\_\_\_\_ /mm \_\_\_\_\_ /yy \_\_\_\_\_

**1. Identification Information**

1.1. Questionnaire code \_\_\_\_\_

1.2. Name of your zone \_\_\_\_\_ *woreda* \_\_\_\_\_ *Tabia* \_\_\_\_\_

1.3. Do you participate in artisanal and small scale gold mining in your locality?

1= Yes

0= No

1.4. If your answer in Q.13 is “Yes”, in which type of mining are you participating?

1= Informal/illegal mining

0= Formal/legal mining



		5= land given by the local administrators	
7	Is gold mining activity the major source of income of the HH?	1= Yes      0= No	<input type="checkbox"/>
8	If your answer for Q.9 is "NO", what is the major source of livelihood to your household?	1= Farming    2= Public servant    3= food for work 4= petty Trading/business    5= daily laborer 6= remittance	<input type="checkbox"/>
9	In 2009/2010 E.C, how many grams of gold had the household produced?	1= <5 gram      2= 5-10gram      3= 11- 15 gram 4= 16-20 gram      3= 21-25 gram      5= >25gram	<input type="checkbox"/>
10	Why do you think the reason that many people are not participating in ASGM activity?	1= lack of access land for mining    2= lack of access to credit 3= price fluctuations of gold    4= lack of market information	<input type="checkbox"/>
11	Which is the common way of operating ASGM in your locality?	1= open surface mining    2= shallow (less than 5 meters) 3= deep holes and underground tunnel (15 to 25 meters)	<input type="checkbox"/>
12	Do you have a gold mining license?	1= Yes      0= No	<input type="checkbox"/>
13	Do you think that mining license is relevant for you?	1= Yes      0=No	<input type="checkbox"/>
14	Is it very difficult to have a mining license in your locality?	1= Yes      0= No	<input type="checkbox"/>
15	If your answer to Q16 is "Yes", What is the serious challenge to get a license for gold mining in the study area?	1= the procedure is long and takes time 2= travelling long distance to get the license 3= the criteria are not easy to fulfill 4= it requires capital investment	<input type="checkbox"/>
16	What are the main reasons for the local people to participate in gold mining in your locality?	1= Poverty      2=drought      3=unemployment 4= fulfill basic needs      5= financial savings 6= food insecurity	<input type="checkbox"/>
17	Do you think that ASGM is a quicker wealth creation activity in your locality?	1= Yes, it is      2= a matter of chance 3= somehow      4= No, it is not	<input type="checkbox"/>
18	What are the push factors of the local people to engage in ASM gold mining in your locality?	1= discovery of gold deposit      2= high gold price 3= ASM is not prohibited      4= customary practice	<input type="checkbox"/>
19	Which type of transport do miners use to sell their gold production in your locality?	1= Car      2= motor cycle      3=Horse/mule 4= by Foot      5= others	<input type="checkbox"/>
20	What is the potential challenge of the current ASGM participation in your locality?	1= massive informal mining in the study area 2= lack of awareness about laws and regulations 3= weak institutional capacity 4= backward mining practices 5= informal marking channel of gold product 6= absence infrastructure facilities 7= weak political commitment from the government	<input type="checkbox"/>

#### Part IV: Governance Practices of Artisanal and Small-Scale Gold Mining (Linkert scale)

The second part of this research is going to investigate the *governance practices of artisanal and small-scale gold miners* to improve the performance of sector and use the likert scale to answer the questions.<sup>47</sup> In this section, Yes, No and don't know questions as well as ranking the extent of the problems have been used to gather information about the good governance on ASGM participation in the study area.

<sup>47</sup> 1=Strongly Disagree(SDA); 2= Disagree(DA); 3= Don't decide(DD); 4= Agree(A) ; 5= Strongly Agree(SA)

Description of variables	Options/choices				
	SDA	DA	DD	A	SA
<b>A) Issues of good governance on ASGM participation</b>					
1. Miners are happy with the existing governance of ASGM in your locality	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Miners are effectively participating on the issues of governance of ASGM	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Local leaders are responsive in resolving the challenges of ASGM sector	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Local leaders are accountable for unable to manage the sector effectively	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. There is transparency on managing the ASGM sector in the study area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Local leaders are accountable for unable to manage the sector effectively	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>B) Issues of Regulatory Frameworks of ASGM</b>					
1. Miners are aware of the rules and regulations of artisanal small scale gold mining participation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Miners and market agents abide by the policies, laws and regulations of ASGM in the study area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. There is effective policy implementation of ASGM in the study areas.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The policies, rules and regulations of ASGM can protect the environment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>C) Factors affecting the formalizations of ASGM</b>					
	<b>V. high</b>	<b>High</b>	<b>Medium</b>	<b>Low</b>	<b>V. low</b>
1. Lack of land access for mining	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Lack of access to credit services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The prevalence of illicit trade of gold	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Absence of extension services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Limited support of the government	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Lack of geological information	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Weak Commitment of the government	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. The rules and regulations of ASGM sector are effective in the study area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>D) Institutional and administrative issues of ASGM</b>					
	<b>Yes</b>	<b>No</b>	<b>Don't know</b>		
1. The ASGM sector is led by the killed and trained manpower	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
2. The federal, regional local governments are committed to support the ASGM sector	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
3. Government institutions are effective in managing the ASGM sector	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
4. Informal or community institutions are more effective to regulate the ASGM sector	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

**Part V: Questionnaires required for analyzing the determinant factors affecting ASGS and its level of income of the HHs**

1. What is the annual income of the HH obtained from the off/non-farm activities \_\_\_\_\_ (in ETB)?
2. What is the annual income of the HH obtained from ASGM participation \_\_\_\_\_ (in ETB)?
3. Do you think that Price fluctuation of gold affects the supply of gold to the formal market? 1=Yes 0= No
4. Do you think that the Incentives in placed so far able to increase gold supply to the formal market? 1= Yes 0= No
5. Do you think that the illegal marketing of gold benefits more than the formal market? 1= Yes 0= No
6. Are you a member of cooperative mining? 1= Yes 0= No
7. If your answer to Q.no.6 is yes, is it beneficiary being a member of gold mining cooperatives? 1= Yes 0= No
8. Do you have access to market information about gold in your locality? 1= Yes 0= No
9. Do you think that there is good governance in the ASGM sector in your locality? 1= Yes 0= No
10. Do you think that there rampant illicit trade of gold in your locality? 1= Yes 0= No
11. Is there access to credit service in your locality? 1= Yes 0= No
12. Is there access to access to the means transportation in your locality? 1= Yes 0= No
13. What is the average distance from home to the gold mining sites \_\_\_\_\_ (in KM)?

14. What is the average distance to the nearest market center \_\_\_\_\_ (in KM)?  
 15. Do you have access to the formal market in your locality? 1= Yes 0= No

**Part VI: Questionnaires required for analyzing factors affecting food security of the HHs**

1. Do you participate in off/non-farm income activities in your locality? 1= Yes 0= No  
 2. Do you have access to market information? 1= Yes 0= No  
 3. What is average cultivated land size of the household ? \_\_\_\_\_ (in hectare)  
 4. What is the total livestock owned by the household? \_\_\_\_\_ (in TLU).  
 5. Does your household have oxen? 1= Yes 0= No  
 6. Does your household apply chemical fertilizer? 1= Yes 0= No  
 7. Do you have an access to credit service in your locality? 1= Yes 0= No  
 8. Have you ever used improved seeds? 1= Yes 0= No  
 9. Do you have access to the nearest market center? 1= Yes 0= No

**VII: Multidimensional Poverty Index (MPI) dimensions, indicators, thresholds and weighted**

Dimensions and indicators		Responses	Codes
1	<i>Education( each indicator is weighted equally at 1/6) encircle your choice</i>		
1.1.	Is there any member of the HH who has completed five years of schooling?	1= Yes 0= No	<input type="checkbox"/>
1.2.	Is there any school-age child who is not attending school in years 1-8 grade levels	1= yes 0= No	<input type="checkbox"/>
2	<i>Health (each indicator is weighted equally at 1/6)</i>	Responses	
2.1.	Is there any child in HH who has died in the family four weeks prior to this survey?	1= Yes 0= No	<input type="checkbox"/>
2.2.	Is there any adult HH member has experienced illness prior four weeks prior to this survey?	1= Yes 0= No	<input type="checkbox"/>
3	<i>Living Standard(each indicator is weighted equally at 1/18)</i>	Responses	
3.1.	Do you have access to electricity?	1= Yes 0= No	<input type="checkbox"/>
3.2.	Do you have improved sanitary?	1= Yes 0= No	<input type="checkbox"/>
3.3.	Do you have access to improved drinking water and available at least a 30-min walk?	1= Yes 0= No	<input type="checkbox"/>
3.4.	Is the floor of your house made up of dirt, sand, dung and related materials?	1= Yes 0= No	<input type="checkbox"/>
3.5.	Does your household use firewood, charcoal and related materials for cooking?	1= Yes 0= No	<input type="checkbox"/>
3.6.	Does your household radio, TV, telephone, bicycle, motorbike or refrigerator	1= Yes 0= No	<input type="checkbox"/>

**A) Household food consumption score**

s/n	Food items (in group)	Weight	Frequency	Sum of HFCS
Q.1.	Did your HH consume the main staples in the last 7 days?	2		
Q.2.	Did your HH use pulses in the last 7 days?	3		
Q.3.	Did your HH consume Vegetables in the last 7 days?	1		
Q.4.	Did your HH eat fruits in the last 7 days?	1		
Q.5.	Did your HH eat meat, eggs and related food in the last 7 days?	4		
Q.7.	Did your HH drink milk and milk product in the last 7 days?	4		
Q.8.	Did your HH consume sugar in the last 7 days?	0.5		
Q.9.	Did your HH use oil and related food in the last 7 days?	0.5		
Q.10	Did your Household ever consume condiments	0		

(Source: WFP, 2008)

### Household Food Insecurity Access Scale (HFIAS) Questions<sup>48</sup>

s/n	Food insecurity occurrence and frequency questions	Alternatives/options	Codes	
1	Did you worry that your HH would not have enough food?	0 = No (skip to Q2)	1=Yes	<input type="checkbox"/>
1a	How often did this happen?	1 = Rarely (once/twice) 3 = Often (> 10times)	2 = Sometimes (3 - 10 times)	<input type="checkbox"/>
2	Was any HH member not able to eat the kinds of foods he/she preferred b/c of lack of resources?	0 =No (skip to Q.N0.3)	1=Yes	<input type="checkbox"/>
2a	How often did this happen?	1 = Rarely (once /twice) 3 = Often (>10 times)	2 = Sometimes (3 - 10 times)	<input type="checkbox"/>
3	Did any HH member eat limited variety of foods?	0 = No (skip to Q.N0.4)	1 = Yes	<input type="checkbox"/>
3a	How often did this happen?	1 = Rarely (once/twice) 3 = Often (>10 times)	2 = Sometimes (3 -10 times)	<input type="checkbox"/>
4	Did you or any HH member eat some foods that he/she did not want to eat b/c of lack resources?	0 = No (skip to Q.N0.5)	1 = Yes	<input type="checkbox"/>
4a	How often did this happen?	1 = Rarely (once/ twice) 3 = Often (>10 times)	2 = Sometimes (3 -10 times)	<input type="checkbox"/>
5	Did any HH member eat a smaller meal than he/she needed b/c there was not enough food?	0 = No (skip to Q.N0.6)	1 = Yes	<input type="checkbox"/>
5a	How often did this happen?	1 = Rarely (once or twice) 3 = Often (>10 times)	2 = Sometimes (3 to 10 times)	<input type="checkbox"/>
6	Did any household member eat fewer meals daily due to lack of food?	0 = No (skip to Q.N0.7)	1 = Yes	<input type="checkbox"/>
6a	How often did this happen?	1 = Rarely (once/twice) 3 = Often (>10 times)	2 = Sometimes (3 -10 times)	<input type="checkbox"/>
7	Have you experienced no food to eat of any kind in your HH b/c of lack of resources to get food?	0 = No (skip to Q.N0.8)	1 = Yes	<input type="checkbox"/>
7a	How often did this happen?	1 = Rarely (once/twice) 3 = Often (>10 times)	2 = Sometimes (3/10 times)	<input type="checkbox"/>
8	Did any HH member go to sleep at night hungry because of lack of food?	0 = No (skip to Q.N0.4)	1 = Yes	<input type="checkbox"/>
8a	How often did this happen?	1 = Rarely (once/twice) 3 = Often (>10 times)	2 = Sometimes (3 -10 times)	<input type="checkbox"/>
9	Did any HH member go the whole day and night without eating anything because of lack of food?	0 = No (skip to Q.N0.9a)	1 = Yes	<input type="checkbox"/>
9a	How often did this happen?	1 = Rarely (once/ twice) 3 = Often (>10 times)	2 = Sometimes (3- 10 times)	<input type="checkbox"/>

### VIII: Questions related to consumption expenditure

1. How much is your household annual expenditure (in Birr)?
  - A. Below 10,000
  - B. 10,000-20,000
  - C. 20,000-30000
  - D. Above 30,000
2. How much does your family spend to basic needs per month? \_\_\_\_\_ ETB?
3. How much for the non-basic needs do you spend in a month? \_\_\_\_\_ ETB?
4. Quantify the following items with the appropriate units of measure.

<sup>48</sup>Each question in the above table is requested with a recall period of the past 12 months (from December 2016/17 up to December, 2017/18). The time framework is chosen due to the reason that access to food from agricultural production period in Ethiopia. The time chosen for this particular survey was more or less normal period for rural households to give appropriate response concerning food security.

**Table1.1. Household expenditure monthly and annual households' expenditure**

Items	Food/Drink items on monthly bases	Amount in Kg, liters	Price in Birr
1.	Teff		
2.	Wheat		
3.	Maize		
4.	Barely		
5.	Potato		
6.	Onion		
7.	Beans & Peas		
8.	Lentil		
9.	Vegetables		
10.	Dry Pepper		
11.	Edible Oil (Litter)		
12.	Milk (Litter)		
13.	Butter (Kg)		
14.	Meat ((Kg)		
15.	Sugar (Kg		
<b>Non-food Items (on yearly bases)</b>			
16.	Clothes (in Birr)		
17.	Ceremony (in Birr)		
18.	Entertainment (in Birr)		
19.	Any monthly contribution		
Total			ETB

**Part IV: Assets/Capitals, Major components (Indicators) and Subcomponents (indicators) of LVI**

Capitals	Indicators	Sub indicators/sub components	Description of Responses
Human capital	Health	1. What is the average distance to nearest health centre?	_____km code
		2. Is anybody in your family chronically ill or disabled? 1=Once ; 2=twice ; 3=trice ; 4=nil	
		3. Has any member of the HH been died due to mining	1= Yes 0= No
		4. Has anyone in your family been suffered by Malaria other diseases in the past six months?	1= Yes 0= No
		5. Did any member of the HH take any kind of training?	1= Yes 0= No
	Knowledge & skill	1. Has head of HH attended formal school?	1= Yes 0= No
		2. Does your HH have access TV program at home?	1= Yes 0= No
		3. Does your HH have access to a radio at home?	1= Yes 0= No
		4. Does your HH have access to telephone?	1= Yes 0= No
		5. Does your HH have access to internet?	1= Yes 0= No
Natural capital	Land	1. Does your HH have access to land?	1= Yes 0= No
		2. What is the farm size of your HH?	1=<0.5 ha 2=>0.5
		3. Have your HH lost its farm land to miners?	1= Yes 0= No
		4. Does your HH have land certificate?	1= Yes 0= No
		5. Does your HH have knowledge land degradation in the last 10 yrs?	1= Yes 0= No
	Forest	1. Does your HH only use forest-based energy for cooking?	1= Yes 0= No
		2. What is the average time to fetch firewood?	1= Yes 0= No
		3. Is the availability of firewood being scarce today than ever?	1= Yes 0= No
	Water	1. Does your HH obtain sufficient and clean water in locality?	1= Yes 0= No
		2. Was there any conflict related to water resources?	1= Yes 0= No
		3. Does your HH collect water directly from river, streams, ponds, hand pump? 1= Yes 0= No	
		4. How much time does your HH take to fetch water?	1= <30 min 0= >30 min
	Financial Capital	Finance	1. Does your HH have any debt?
2. Does your HH have any savings?			1= Yes 0= No

Physical Capital	Transport	1.	What is the Average time to reach the district capital	1= < 1hr	0= >1hr
		2.	Does your HHs having any means of transport	1= Yes	0= No
	Power	1.	Does your HH have access to electricity (solar)?	1= Yes	0= No
Social capital	School	1.	What is the average time to reach nearest elementary school?	_____ km	
	Demography	1.	Is your HH female-headed?	1= Yes	0= No
		2.	What is the average family member of the HHs?	In number _____	
	Network and relationship	1.	Has your HH been received any kind of support recently?	1= Yes	0= No
		2.	Has your HH been given any support to the neighbor recently?	1= Yes	0= No
		3.	Has your HHs been gone to local government to get assistance?	1= Yes	0= No
		4.	Was there any family member who was affiliated by any group?	1= Yes	0= No

## Annex-12-Interview Guideline

### Part I: Interview Guide for key informants at Federal, Regional and Local Levels

#### 1. Current socio-economic condition of Artisanal and Small-scale Gold Mining

- a) What are the overall existing socio-economic practices of ASGM in the study area?
- b) What are the push and pull factors of ASGM participation in the study area?
- c) Why do the majority of the artisanal miners prefer informal gold mining participation?
- d) What are the positive and negative effects of participating in the ASGM sector?

#### 2. Governance Aspect of Artisanal and Small-scale Gold Mining

- a) Why do the policy and regulatory frameworks of ASGM have become less effective in managing the sector?
- b) Does the existing governance structure (federal-regional and local structure) effective in regulating the ASGM sector?
- c) Are the issues of participation, transparency and accountability being implemented to regulate the ASGM sector effectively in the study area?
- d) What are the main challenges of good governance in the ASGM sector?

#### 3. The Marketing Issue of Artisanal and Small-scale Gold Mining

- a) Why the ASGS<sup>49</sup> to the formal market agents is drastically declined from time to time?
- b) Why do artisanal gold miners prefer illegal gold market gold to legal gold market?
- c) What are the key factors that determine artisanal and small-scale gold supply to the formal market agents?
- d) What is the effect of ASGM on the income of the participant household in the study area?

#### 4. Food Security Issues of Artisanal and Small-scale Gold Mining

- a) What is the food security status of participant households comparing to the non-participant households in the study area?
- b) What are the key factors which determine the food security status of households in the study area?

#### 5. Multidimensional poverty condition of Households

1. Issues related to education
  - a) What is the education status of households in the study area?

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<sup>49</sup> ASGS: is an abbreviation for Artisanal Small scale Gold Supply

- b) What is the school attendance of children in your locality?
2. Issues related to health service of the local community
- c) Can you describe the health service delivery to the local community?
- d) How can you describe the child mortality of the study area?
- e) Can you say something about malnutrition of the local people?
3. Do the local people have access to electricity?
4. Do they have access to sanitary?
5. Do they have access to drinking water?
6. Do they have improved flouring?
7. Do they have access to cooking fuel?
8. Do they own assets of different types(durable and non-durable assets)

**Part II: Basic Guiding Questions for Focus Group Discussion (FGD)**

1. What are the main reasons for the local people to engage in gold mining activities?
2. Do you think that the ASGM sector is smoothing the livelihood of HHs in your locality?
3. Do miners understand the negative effect of ASGM on human and natural environment?
4. Is the government supportive to improve the performance of the sector in your locality?
5. Is the mining sector helpful in developing the assets of the mining households?
6. What are the major livelihood strategies adopted by the local community?
7. How did the miners improve their livelihoods?
8. How was the relationship between local governments and the local community?
9. What are the adverse effects of ASGM on the natural environment in the study areas?
10. Do miners perceive the ASGM sector can change their livelihoods?
11. What are the major challenges of ASGM sector in the area?
12. What solutions can you suggest to address the challenges?

*Thank you in advance for your cooperation!!*