THE INFLUENCE OF ARTISANAL GOLD MINING ON AGRICULTURAL LAND IN IKOLOMANI SUB-COUNTY KAKAMEGA COUNTY, KENYA

BY

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SCHOOL OF ARTS AND SOCIAL SCIENCES

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DECLARATION

Declaration by student

I, the undersigned, hereby declare that this thesis is my original work and that it has never been presented for a ward of any degree or academic work in any other university or elsewhere.

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DEDICATION

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ABSTRACT

In the entire world, 40.5 million people were directly engaged in artisanal gold mining (AGM). In Kenya, AGM is characterized with; massive clearing of vegetation and land destruction in AGM areas, overnight conversion of once arable and grazing land to AGM activities, replacement of once arable and grazing land with heaps of debris, overburden and open pits from AGM activities associated to income generation. In Ikoloman Sub County, AGM activities are intensive, notwithstanding the fact that,the Sub County is endowed with fertile soils and high amounts of rainfall nonetheless crop yields are generally low, with maize and beans yields being below 0.9 tones. This points to the fact that AGM poses a serious threat to agricultural land in Ikolomani Sub County. The purpose of this study was therefore to examine the influence of AGM on agricultural land in Ikolomani Sub County of Kakamega County. The specific objectives of the study were to: examine the influence of AGM income on the acreage of arable land; determine the influence of the acreage of land under AGM on food crop yields; and establish the influence of acreage of land under AGM on livestock grazing area in Ikolomani Sub County. A cross-sectional descriptive research design was employed. A minimum sample size of 273 households was drawn from a study population of 950 households engaging in AGM on their farming land using Fisher's formula. Random sampling was used to identify household heads engaging in AGM from the thirteen Sub Locations of Ikolomani Sub County. Purposive sampling was used to identify key informants such as artisanal gold mining opinion leaders, chiefs, village elders, officers from Petroleum and Mining and Agricultural departments who were interviewed in Sub locations. Primary data were collected through questionnaires administered to household heads, interview schedules for key informants, Focus Group Discussions, and photography .Quantitative data were analyzed using descriptive statistics: percentages, frequencies, means, and simple linear regression. Qualitative data were analyzed thematically along the research objectives and presented in narrative form. Simple linear regression was used to predict the influence of: AGM income on acreage of arable land; acreage of land under AGM on food crop yields; acreage of land under AGM on livestock grazing area. The findings were presented in the form of tables, graphs, plates and discussions. The results show that 63% ($r^2=0.63, p < 0.05$) of the variation of acreage of arable land can be explained by income from AGM. That acreage of arable land had reduced considerably as farmers practiced or leased it out for monetary gains from AGM. About 55% ($r^2=0.55, p < 0.05$)of the variation of food crop yields can be explained by acreage of land under AGM. This can be explained by the fact that: the acreage of arable land has been taken up for artisanal gold mining activities such as; construction of mining factories, makeshift structures for miners , the land was compacted due to human traffic, motor cycles and degraded rendering it infertile and pools of stagnant water had offered conducive breeding conditions for mosquitoes leading to rampant malaria spread limiting the populace in engagement in productive farming thereby reducing on food crop yields. The acreage of land under AGM explained only 16% ($r^2=0.16, p < 0.05$)variation of livestock grazing area. That livestock grazing area had been put under AGM concessions, heaps of debris and overburden had consumed livestock grazing area non-bio generable sacks sprawled the livestock grazing area and livestock grazing area had been flooded by water pumped by AGM miners to the surface. Using the results policy makers and society at large can gain insight on how AGM is influencing agriculture land. This will assist in control and management of AGM activities in Ikolomani Sub County.

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AGM	Artisanal Gold Mining
AVGMI	Average Monthly Income
CASM	The Collaborative Group on Artisanal and Small Scale gold Mining
DFID	Department for International Development
ERG	Existence Relatedness and Growth levels
FGD	Focus Group Discussion
FAO	Food and Agriculture Organization
FIS	Forage Information System
GDP	Gross Domestic Product
GMME	Ghana's Ministry of Mines and Environment
GOK	Government of Kenya
ILO	International Labor Organization
ICMM	International Community of Mines and Minerals
KDPR	Kakamega Development Plan Report
KMMR	Kenya Miners and Mineral Report
KNPCR	Kenya National Population Census Report
KNBS	Kenya National Bureau of Statistics
KKCVR	Kakamega County Climate Variability Report
MMIR	Ministry of Mines and Inventory Report
NEMA	National Environment Management Authority
SPSS	Statistical Package for Social Sciences
SLF	Sustainable Livelihood Theory
UNEP	United Nations Environment Programme
WGC	World Gold Council

OPERATIONAL DEFINITION OF TERMS

Artisanal Gold Mining activities	These activities include (1) Removal of vegetation cover on land which was measured by acreage of land under AGM.(2) Mining and selling of gold which was measured by mean monthly income from gold in Kenyan shillings
Agricultural land	Land utilized for arable farming and livestock rearing. Arable farming was measured by the acreage of arable land; Food crop farming was measured by yields of food crop after growing season; Livestock farming was measured by area of grazing land
Acreage	Measure of land
Arable Land	Land that is suitable for cultivation and for growing crops
Household head	The person who is entitled to the family land title deed
Sustainable	Exploitation of resources with a conscious that the future generations have their share too
Food security	The measure of availability of food and individuals ability to access it
Livestock grazing area	It included area of unused agricultural area, permanent pastures and other grazing areas. It did not include the crop area used for grazing after harvest.
Acreage of arable land	Measure of land designated for food crop cultivation only in acres
AGM Income	Monetary gains from either the sale of gold or from leased out land for gold mining

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

The rise in global demand and the price of gold have stimulated new gold mining activities by multinational companies and small-scale gold miners throughout the world (Burry and Creek 2009). In the world 40.5 million people were directly engaged in AGM in 2017 up from 20 million in 2014 (Morgane 2018}. The high demand of gold as a resource has therefore resulted in shrinking of natural resources, an estimated 1000 km^2 of agriculture land or natural resource disappears annually (Koaliner and Roland 2013).A long side this, illegal gold mining activities were identified as the cause of environmental problems such as water pollution, deforestation, poor soil fertility and limited access to land for agriculture production (Obiri et *al* 2019)These studies have succeeded in bringing to the fore the vulnerability state of farming land as a result of AGM activities on a general perspective. However, there is need to narrow the scope of generalization and zero in on specific AGM parameters: income from AGM, and AGM space occupancy and assess their influence on agricultural land.

Destruction of vegetation and farm land by miners affect agriculture and food production (Hayes 2008). In addition, Surface mining removes vegetation and soils, interrupts ecosystems surface flows and results in investable and often permanent farm land loss. (Bebbingtone and Burry 2009). In Peru and Ecuador AGM takes place alongside large scale formal mining leading to land use conflicts between AGM and other agricultural activities (ICMM , 2010). . There is need therefore for land as a resource to be given a critical focus in the context of its sustainability based on exploitation of other livelihood resources.

In Africa the resilience of AGM activities especially during economic crisis has proved to be one of the major sources of livelihoods in the local communities where gold deposits are found since, they provide employment and income for the day to day survival (Twerefou, 2009). A long side this, AGM is an important source of income for the poor members of the community especially during periods of drought and economic crisis. (Talent2011) .For example AGM has contributed to production of gold in Ghana, creation of employment hence provision of income in Ghana and Burkina Faso respectively. (Arah 2014 ;.Pokony *et al*2019). These studies conducted in Africa have scored on portraying AGM as a source of income. However, there is need to draw a link between income from AGM to agricultural land.

In Ghana mines have the potential to generate significant negative spillovers to farmers such as pollution and competition for key inputs such as land and labor.(Aragon and Juan 2012) .The release of chemical substances by the mining processes into the soil discourages and destroys crops and in effect not much crops are cultivated in the mine area and food becomes scarce.(Ocansey2013) .Besides, AGM workers are exposed to cyanide and mercury which make them vulnerable to several health risks hence not being able to engage in any productive agriculture.(Yaaba and Ato (2017) This comes out clearly that mining activities in Africa and related pollutants lead to low agricultural production. In retrospect on what has been said it is critical to determine how AGM mining activities affect food crop production and livestock grazing area.

In Kenya, agriculture is the backbone of the country as it accounts for 34.15 % of the total GDP earnings. Despite this, the country is not food sufficient as witnessed in a performance deceleration from 6.1 % in 2018 to 3.6 % in 2019 in production of selected crops and pasture for livestock. For example maize production reduced from 44.6 million bags in 2018 to 39.8 million bags in 2019.(KNBS 2019). Notwithstanding the fact that the county is endowed with conducive climatic conditions for good agricultural production, rainfall performance is above average exhibiting a bimodal distribution with two distinct wet seasons averaging 1000-1200 mm for the long rains and 500-800 for the short rains. (KNBS, 2019).This is indicative of the fact that, the weather is good for production of most of the staple crops in the country. On the other side, AGM is a collective term which covers formal and informal mining which is characterized by low capital intensity and high labour intensity and relatively simple methods for exploration, extraction and processing. It can involve men and women working on an individual basis as well as those working in family groups, in partnerships or as members of co-operatives or other types of associations (WGC 2012). It is estimated that over 250000 people engage in AGM in Kenya (UNDP 2017) Furthermore AGM is also a crucial player in the informal sector employment particularly in the rural areas (KNBS, 2019) . It is practiced in places such as Migori, Nandi , Vihiga ,Kisumu and Siaya where it is gaining popularity over other sources of livelihoods. (Barreto *et al* 2018). This has culminated in the gross domestic product activities of mining and quarrying to increase from 545842 in 2015 to 673296 in 2019.Despite this its contribution to the Gross Domestic Product cannot outmatch that of the agricultural sector which has increased sharply from 30.2 % the year 2015 to 34.1 % the year 2019 compared to mining and quarrying

which stands at 0.9% the year 2015 and 0.7 % the year 2019. This therefore awakens the need to ensure that AGM activities should exist in a sustainable manner alongside other sources of livelihoods particularly the major economic drivers of the economy such as agricultural land.

The Kenya mining legal frame work of 2016 has legalized AGM in order to make it a sustainable venture through minimizing of environmental degradation. Livelihoods are anchored on environment in that , a livelihood is environmentally sustainable when it maintains or enhances the local and global assets on which livelihoods depend, and has net beneficial effects on other livelihoods (Wikipedia). Despite this, the bureaucracy involved in miners being allowed to engage in AGM is more time consuming making room for AGM sector to be porous to illegal mining. This therefore immensely leads to AGM impacting on agriculture land through land degradation and vegetation destructions leading to massive soil erosion.(Odhiambo 2010).This is supported by KCIDP (2018-2022) that , the major contributors to environmental degradation are ; poor waste management initiatives, lack of a designated waste disposal site, quarrying and poor land use practices, and degree of environmental enforcement of environmental laws which comparatively lead to reduced farm yields. For example in Kenya , land degradation is registered in AGM areas as a result of soil erosion, heavy mercury bio-accumulation in fishing waters and risk of human exposure through mercury vapor and fish consumption.(Ogola *et al* 2001) .In addition, AGM has resulted in the loss of farm land in Rongo (Odhiambo 20100).Apart from the impact mining activities have on the natural environment they also reduce farm labor or they make farm land vulnerable due to lack of labor (Otieno , (2017) .This, therefore, raises a question on how does AGM shape livelihood sustenance through crop yields?

Although AGM is not a major economic activity in Kenya, historically, making reference to the famous gold rush in Kakamega. 1930s. which witnessed an influx of European gold prospectors who established the largest gold mine in Rostermine near Kakamega. The gold mine operated till its closure in 1952 (MEMR). This paved way for the indigenous scavenging for gold in the famous gold mine and also on their private farms. This has seen gold become a major source of livelihood with majority of the populace being lured into it due to poverty and the need to make quick money(NEMA 2008). Notwithstanding the fact that Ikolomani Sub County is coupled with low food production issues with maize and beans yields being below 0.9 tonnes per ha.(KKCVR 2017). This has seen Ikolomani attract a lot of scholarly attention. For example a study

by Macharia *et al*(2016)exposed the nature of conflicts associated with AGM. Mulinya *et al*(2020)further indicated the level of environmental degradation from mining in Ikolomani. Much as these studies directly address themselves to mining activities , the state of agriculture land in the area has not received the much needed attention and yet it remains at the core of AGM activities in Ikolomani.

1.2 Statement of the Problem

AGM has gained popularity worldwide as a source of income due to the high demand for gold as a resource. In Ikolomani Sub County AGM is expanding due to the need for the populace to earn income. Most of the AGM activities are operating illegally characterized with poor exploitation mechanisms, large land destructions and occupation as huge parcels of land are fenced off for AGM. The once arable and grazing land is gradually shrinking in acreage as it is replaced by heaps of stock piles, overburden and open excavated pits. Notwithstanding the fact that land occupancy per household is minimal , standing at 0.57 Ha (KKCIDP 2018 – 2022).Despite this, the influence of AGM on agricultural land in the Sub County had not been critically studied. The area has also registered deaths of reared animals as a result of accidents caused by abandoned excavated mines. Yet the influence of acreage of land under AGM on livestock grazing area had not attracted the much needed attention in Ikolomani Sub County. According to KKCVR (2017) maize and beans production was low with the Sub County, being below 0.9 tons per Ha. On the contrary, the Sub County is endowed with high amounts of rainfall and fertile soils which could support agriculture. However the available reviewed literature did not reveal how the acreage of land under AGM has influenced food crop yields in Ikolomani Sub County. Therefore, there was a need to conduct this study so as to examine the influence of AGM on agricultural land. The study was therefore relevant because it has clearly brought out the relationship between AGM income and acreage of arable land, acreage of land under AGM and food crop yields and livestock grazing area. Finally based on the problem stated the purpose of this study was to examine the influence of artisanal gold mining on agricultural land in Ikolomani Sub County Kenya.

1.3 Objective of the Study

1.3 .1 General Objective

The main objective of the study was to investigate the influence of artisanal gold mining on agricultural land in Ikolomani Sub County of Kakamega County, Kenya.

1.3.2 Specific Objectives

The specific objectives of the study were;

i. To examine the influence of AGM income on the acreage of arable land in Ikolomani Sub County.

ii. To determine the influence of acreage of land under AGM on food crop yields in Ikolomani Sub County.

iii. To examine the influence of acreage of land under AGM on the livestock grazing area in Ikolomani Sub County.

1.4 Research Questions

The study addressed the following research questions;

i. What is the influence of the income generated from AGM on acreage of arable land in Ikolomani Sub County?

ii. What is the influence of acreage of land under AGM on food crop yields in Ikolomani Sub County?

What the influence of acreage of land under AGM on livestock grazing area in Ikolomani Sub County?

1.5Justification of the Study

There is an emerging concern of the rising cases of destructions on agricultural and Poor land management systems and uses such as AGM had been noted as the leading cause in agricultural land destruction in Ikolomani Sub County (KKDIP 2018 – 2022). Agriculture land as a resource has to satisfy the needs of people and livestock through food provision. The Kenyan rapid population growth as of 2018 and changing food consumption patterns of people following animal free diet have significantly increased , A cording to KCCVR (2017) , this is one of the major drivers for the dry beans and maize production. However in Ikolomani Sub County maize and beans yields are generally low , being below 0.9 tonnes per Ha .This is despite the fact that

the Sub County is endowed with fertile soils and a double maxima rainfall regime which was above the normal rainfall registered in Kenya in the year 2018 (KNBS, 2019).

This is counterproductive going by Vision 2030 which envision Kenya as a country sufficient in food production. It is regrettable to note that, in Ikolomani Sub County the once arable and grazing land has been taken up for AGM activities for income generation, settlement by miners and construction of mining factories thereby shrinking in acreage. This is coupled with the fact that there is inadequate regulatory measures in place to check on the AGM activities spread despite having a legal framework provision for AGM operations in Kenya. .Despite these much attention of literature on Ikolomani Sub County has focused on: climate variability, on farms and off farms efforts and urbanization and its influence on agricultural production. Due to these arguments there was a need to assess issues of AGM on agricultural land and evaluate the extent to which AGM income influences the acreage of arable land, acreage of land under AGM influence food crop yields and acreage of land under AGM influence livestock grazing area in Ikolomani Sub County. The findings of the study will assist policy makers and society at large to have an insight on how AGM is influencing agricultural land. This understanding will prompt the need to come up with control and mitigation measures on agriculture land destruction by anthropogenic activities by policy makers and community at large. This will go hand in hand to improve the state of agriculture land for now and posterity.

1.6 Scope and Limitations of the Study

The study was confined to only two Sub Locations of each four wards of Ikolomani Sub County giving a total of eight Sub Locations. The wards are; Idakho North, Idakho East, Idakho Central, and Idakho South. This is because AGM is widely spread in the Sub County. The study looked at the social and economic aspects of AGM keeping to the confines of income generated from AGM and its influence on acreage of arable land. On the influence of AGM on agriculture land the study specifically addressed; the AGM income and its influence on acreage of arable land the acreage of land under AGM and its influence on the respective food crop yields (maize and beans in kgs) (Maize and beans are the staple foods for Kenyans and therefore according to (KKDIR 2018 -2022) it is predominantly planted by households in Ikolomani Sub County .) .This was done for a period of two seasons because remarkable change on agriculture land could

be observed, the acreage of land under AGM and its influence on livestock grazing s area in acres for a period of two seasons in Ikolomani Sub-County.

Data collection was affected by language barrier in that the questionnaire was constructed in English and few people were observed not to have known this language. The problem was solved by the use of a translator from the community. Food crop yields is also affected by changes in weather patterns, pests and diseases but these factors were not considered in this study. This was because such factors are independent of artisanal gold mining in the area. Nonetheless such factors are likely to influence food crop yields. However future synergistic multivariate investigations into such variables together with artisanal gold mining in the study area is encouraged. This study therefore sought to; examine the influences of AGM income on the acreage of arable land, the influence of acreage of land under AGM on food crop yields and the influence of acreage of land under AGM on livestock grazing area in Ikolomani Sub County.

CHAPTER TWO

LITERATURE REVIEW

2.1Introduction

The literature review has three distinct sections. The first section has focused on AGM income and its influence on arable land. The second section has focused on acreage of land under AGM and its influence on food crop yields. The third section has focused on acreage of land under AGM and its influence on livestock grazing area.

2.2 AGM Income and its Influence on the Acreage of Arable Land

In the entire world, 40.5 million people were directly engaged in AGM in 2017 up from 20 million in 2014 (Morgane *et al* 2018). High jewelry demand has stimulated a high gold demand (WGDT 2019).For years the international community has been commenting on small scale mining potential to play an important role in economic and social development in developing and rural contexts. Mining is practiced and exists in many countries (MacDonald 2002). Over the years, the extraction of precious minerals such as gold and diamond has led to a magnificent impact on the socioeconomic lives of people and communities involved directly or indirectly in the mining sector (Hilson and Banchirigah 2002).Mining is practiced and exists in many countries (MacDonald 2002). It provides significant livelihood for rural communities in Africa and serves as a means of alleviating poverty (Collaborative Group on Artisanal Gold Mining (CASM 2005)).The CASM (2005) further observes that AGM employs and engages more people than large-scale gold mining and reduces the poverty levels in rural communities. In countries such as Mongolia, the mining sector is said to account for about 17 percent of Gross Domestic Product (GDP), 65%of industrial value added and 58%of export, hence making it the largest contributor to the Mongolian national economy (The World Bank 2006). Despite the novel insights of these studies on the potential of AGM as a source of income , globally much has been documented on influence of this AGM income on other sources of livelihoods through employment creation.. This study has capitalized on this to expand the scope of understanding on how the AGM income influence the acreage of arable land.

In Colombia, the gold mining sector generates more than 140 000 permanent jobs and an unknown number of informal employments in small-scale mining operations (ILO 2008). In Latin American, the gold mining sector is growing rapidly, Bebbington and Burry (2009), with production increasing from 414 000 ounces to 542 000 ounces of gold in the last decade. Small-

Scale Miners work in more than 80 countries and on every continent except the Antarctic (Telmer *et al*2009). In addition, artisanal and small-scale gold mining employed 200 000 people in the Brazilian Amazon in 2008(Sousa *et,al* (2011). In Peru, large scale mining contributed an average of 6% to the GDP between 2000 and 2010 (W G C 2012). Ontoyin and Agyamang (2014) alluded that, mining, especially, AGM, represents a significant livelihood and source of income for rural communities and poverty-driven population in the world .In Suriname, gold mining supports the livelihood of more than 60 000 people (12% of the population) (Talent *et al* 2011).Globally these studies have succeeded in portraying AGM as having an impact on social economic lives of people on a general perspective on the contrary the current study narrowed its scope and addressed the influence of AGM income on the acreage of arable land .

In the entire world, mineral resource extraction through, particularly A G M takes different forms of contributions at both local and national level such as earnings from exports and making import of resource possible (Iddrisu and Tsikata 1998). Hentschel *et al,* (2002) indicated in their studies conducted in Bolivia that the reason for people's engagement in AGM operations is purposely to improve their livelihoods. Studies amply show that not only are men engaged in AGM operations but also women participate in the activities (Hentschel *et al* 2002). The study also elucidated that 75% of those involved in AGM activities in Guinea are women while those of Ghana, South Africa, and Indonesia are 44%, 5%, and 10%, respectively. These studies are positively pointing out that AGM has immensely contributed to the generation of income with a short fall on the effects of this income on other sources of livelihoods like agriculture land. The current study therefore sought to addresses the influence of AGM income on the acreage of arable land.

Davis (2010) resonated that; approximately 90% of rural households are involved in farming activities, 70% of the household income in rural areas is from farming activities in Asia, while in Latin America, 50% of income is from farming activities. He further connoted that in these rural populations small scale farming, fishing, livestock rearing are some of the common livelihoods that these populations survive on for sources of livelihood. Land as a resource is finite, due to competing pressures from increased food, fiber, fuel production, infrastructure, urbanization, population increase and high demand of resources, hence an estimated $1000km^2$ of agriculture land disappears annually (Koalinear and Roland 2013).

Presently cropland consists about 10 percent of the world area whereas agricultural area in total comprises around 33 percent; land use from 1961 -2007 has increased by 11 percent or 150 million hectares globally (Koalinear and Roland 2013). These studies are correctly showing that farming is a major source of livelihood for communities. However the studies are not bringing to the fore how anthropogenic activities such as mining are influencing the acreage of arable land. There is need for more studies to link AGM income on the acreage of arable land for sustainable use of both AGM and farming as sources of livelihoods. The current study therefore found this as a missing knowledge gap and therefore zeroed in to address the influence of AGM income on the acreage of arable land.

Mining has played a significant role in the development process of a country like Ghana that is rated second after South Africa in terms of gold production on the African continent (Akabzaa . and Darmani2001). It also has a major impact on employment in developing countries, especially, in the rural areas where there are limited job opportunities (Hilson 2001). Hilson and Banchirigah (2002) in their studies in Ghana concluded that most of the small-scale miners are involved in gold extraction because it generates income quickly. A study by Talent *et al,* (2011) established that AGM is an important source of income for the poor members of the community especially during periods of drought and economic crisis. The resilience of AGM activities especially during economic crisis has proved to be one of the major sources of livelihoods in the local communities where gold deposits are found since they provide employment and income for the day to day survival (Yeboah 2013). Backing the same studies (2013) asserted that; AGM has contributed to production of gold in Ghana and creation of employment. Pokony *et al* (2019) resonated that AGM can generate job opportunities and cash income for local households in Northern Burkina Faso. In Africa, these studies are lopsided only addressing AGM in regard to its economic benefits .There is need for more studies to be objectively conducted to address both the negative and positive ramifications of AGM on agricultural land.

According to Ontoyin and Agyamang (2014) AGM has helped to reduce the rate of unemployment in the lives of the average people, that AGM has contributed to livelihood enhancement through income generations, increased wellbeing and asset acquisition such as building houses and ownership of cars, hence it provides a means of living. Ontoyin and

Agyamang (2014) alluded that miners have been able to build their own houses and own taxi cabs.

Francis *et al*, (2015) asserted that AGM has contributed to livelihood enhancement through income generations and asset acquisition such as building of houses and buying of cars. These reviewed studies are correctly linking AGM to provision of income in Africa and livelihood enhancement using parameters' such as; living standards, types of houses, and property ownership. However the current study will zero in on Ikolomani Kenya which is a different region with distinct household characteristics to examine the influence of AGM income on acreage of arable land which is a different parameter.

In Kenya, a study by Kibukho (2015) revealed that 70.2% of all AGM miners practiced mining as the principal economic activity that mining income is used to support livelihoods by meeting most basic needs, with purchase of food being the dominant use represented by 95.99%. Otieno (2017) asserted that, AGM activities had encroached into agricultural land and reduced its acreage Otieno (2017) . .A study by Kirui (2021) asserted that increasing AGM activities in Western parts of Kenya has led to increasing land degradation. With the increasing rate of AGM operations in Kenya, the extent to which specific AGM parameters such as; AGM income influences agriculture land in different ecological conditions is not well-indicated in empirical literature, prompting the current study to zero in and broaden the scope of understanding by examining the influence of AGM income on the acreage of arable land in Ikolomani.

In Ikolomani AGM is one of the major sources of livelihood that the populace in Ikolomani sub-county is lured into gold mining due to poverty and need to make quick money (nem2008).there is need for more studies to be carried out in Ikolomani sub county to draw a link between AGM income and acreage of arable land.

2.3 The Acreage of Land under AGM and its Influence on Food Crop Yields

Surface mining resulted in deforestation (58%), a substantial loss of farm land (45%) within mining concessions, and widespread spillover effect as relocated farmers expand farmland into forests (Schueler and Schroder 2011). Overall, surface mining in the developing world often erodes livelihood foundations, forcing populations to relocate and farmers to develop alternative income strategies (Kumah, 2006). Hayes (2008) alluded that the destruction of vegetation and

farmlands by miners affect agriculture and food security**.** This shows that land use has already altered more than half of the planet's terrestrial ecosystems, mainly for increasing the provision of a few ecosystem services, such as food production (Ellis 2008).

Bebbington and Burry (2009) asserted that; surface mining removes vegetation and soils, interrupts ecosystem service flows and results in inevitable and often permanent farmland loss. In countries such as Peru and Ecuador, AGM takes place alongside large scale formal mining leading to land use conflicts between AGM and other agricultural activities (ICMM, 2003).AGM is an important component of the economy of mining nations particularly in the developing world for example 25% of Guinean and 59% of South Africa's GDP as well as the majority of foreign resources of these countries are mining related (Schueler and Schroder2011). However, livelihoods rarely profit from mining activity because mining has widespread and drastic environmental effects on them. Despite the novel insights provided by these studies globally, on the influence of the AGM on farmland, its influence on food crop production remain poorly understood which the current study looked at to fill the knowledge gap.

In Ghana Over 70% of the total area in Tariwa is open pit large scale mining concessions, destroying farmlands as well as vegetation in the area (Akabzaa *and* Darimani2001). According to Ghana's ministry of miners and environment 30% of Ghana's land is currently under gold concession to gold mining firms and each year more arable land is diverted to this use. This therefore reduces other sources of livelihood rendering people more vulnerable to forces of hunger and drought. The rampant spillage of cyanide and mercury by AGM pollutes water bodies and affects food crops, (Obiri *et al*2006). There is mass displacement of people, violent conflicts, lost livelihoods, exploited workers and contaminated ecosystems which have serious questions about the mining industry in Tanzania and internationally (Lusner, 2011). AGM tends to destroy vegetation and farmlands, causes pollution, creates open pits and causes displacement of people (Teschner, 2012). Ontoyin *et al,* (2014) asserted that AGM has affected rural livelihood by lowering agricultural activities, reducing fishing, reducing Shea nut picking and firewood collection and almost eliminating hunting. Yaaba and Ato (2017) resonated that land has been rendered unproductive due to the inability of dominant AGM firms to reclaim lands after mining in Ghana.Sheriff *and* Bashiru (2018) alluded that, in Southern Sierra Leone AGM is carried out in inland valley swamps that are used for rotational subsistence agriculture (rice

cultivation and as well as vegetable gardening). The uncontrolled digging and turning over of top soil that is rich in plant nutrients by miners caused destruction of land beyond economic and technical reclamation, he further connoted. These studies are successfully bringing out the vulnerability state of farm land due to AGM activities. However in Africa there is paucity of peer reviewed literature on the influence of the acreage of land under AGM on food crop yields which the current study prioritized.

In the natural and environmental science discipline, researchers have widely documented the effect of pollutants from mining (mostly airborne) on crop yields (Maggs *et al* 1995; Emberson *et al*2001) These studies, mostly in controlled environments, found drastic reductions in yields of main crops such as rice, wheat, and beans as a result of exposure to air pollutants associated to the burning of fossil fuels, such as nitrogen oxides and ozone. Depending on the type of crop, the yield reductions were as high as 30 to 60%.This also backs up the assertion by Environmental Canada that, mining activity may also contaminate terrestrial plants. Metals may be transported into terrestrial ecosystems adjacent to mine sites as a result of releases of airborne particulate matter and seepage of groundwater or surface water. According to Action Aid research (2006) it was reported that there were serious poisoning of local crops in areas of historic gold mining activity, with high levels of mercury, zinc, and arsenic found in local foods. In some cases, the uptake of contaminants from the soil in mining areas can lead to stressed vegetation. In such cases the vegetation could be stunted or dwarfed (Environment Canada, 2009). Ocansey (2013) indicated that release of chemical substances by the mining processes into the soil discourages and destroys crops and in effect not much crops are cultivated in the mine area and thus food becomes scarce. Yaaba and Ato (2017) established that the workers exposed to cyanide and mercury are made vulnerable to all manner of health risks making them not able to engage in profitable agricultural activities. These studies have successfully linked mining pollutants to low crop yields having been done experimentally in a laboratory setting (controlled environment), while this current study assessed the actual field data to establish how the acreage of land under AGM influences food crop yields.

Aragon and Juan (2012) asserted that mines have the potential to generate significant negative spillovers to farmers such as pollution and competition for key inputs such as land and labor. Mining has been associated with land grabbing and increases in the cost of living in mining

communities. The situation could further lead to an increase in agricultural input prices and consequently production cost (Argon and Juan 2012). Food production levels drop as more and more people opt for mining jobs other than farming leading to low food production level in the farming communities. Ocansey (2013) again revealed that the youth who should take up farming as occupation are engaged in the mining sector and this has contributed to the precarious food insecurity problem in the area. Francis *et al* (2016)resonated that small scale miners and farmers as well as farmlands, forests, and water resources are most vulnerable to adverse effects of AGM activities. In future more studies should postulate more on AGM parameters such as; acreage of land under AGM and its influence on food crop yields

In Kenya studies conducted by Ogola *et al,* (2001) pointed out that; land degradation is registered in AGM areas as a result of soil erosion. Research by Ogola *et al* (2003) revealed heavy mercury bio-accumulation in fish and risk of human exposure through mercury vapor and fish consumption, the study also revealed that gold mining activities also produce silica rich reparable dust particles that can cause silicosis and tuberculosis. Odhiambo (2010) resonated that AGM has caused the destruction of farm land in Rongo. Otieno (2017) alluded that, farm labour had suffered as the young and energetic populace had taken up mining roles. With the increasing rates of AGM operations in Kenya, the extent to which AGM activities influence food crop yields is not well-indicated in empirical literature. This is because these studies in Kenya are based on employment dynamics , environmental, and health ramifications of AGM. However, the current study explored the influence of acreage of land under mining on food crop yields.

In Ikolomani Sub-County a study conducted by Macharia *et al,* (2016) brought to the limelight the nature of conflict resulting from AGM on a general perspective. But the study underscored on giving the influence of acreage of land under mining on food crop yields in Ikolomani Sub County, which the current study prioritized to fill the knowledge gap.

2.4 Acreage of land under AGM and its influence on livestock grazing Area

About 20% of the world's pastures and rangelands have been degraded to some extent and the proportion may be as high as 73% in dry areas (UNEP 2004). Livestock is the world's largest user of land resources with grazing land and crop land dedicated to the production of feed representing almost 80% of all agricultural land, the sector uses 34 billion hectares for feed crops (Steinfeld *et al*2006). There are three major trends relating to pasture lands: valuable ecosystems are being converted to pasture land e.g. clearing of forest, pasture land is being converted to other crop land uses, urban areas; forest and pasture land is degrading (Wassenaar *et al*2006).
AGM and its associate activities is one of the contributors to the degradation of pasture lands (Hagos and Geta2016). Despite this in Africa there are few known rates on how grazing land under AGM areas has been degraded and the subsequent influence on livestock grazing area. This therefore gave the current study a leeway to broaden the knowledge scope on how the acreage of land under AGM influences livestock grazing space.

Kitula (2006) in his studies on Tanzania alluded that open pits are not seen as a serious problem, although they have caused disturbances to livestock keepers and farmers in the mining areas, the pits make land unfavorable for agricultural activities following closure and also adversely impact livestock and wildlife resources. He further resonated that; the number of pits in the mining areas lie between 100 and 1000, at shaft depths ranging between 10meters and 1000meters thereby destroy both grazing and agricultural land. Ontoyin and Agyamang (2014) alluded that; AGM has affected farming by causing the death of livestock. Hagosand Geta(2016) alluded that striping of the overburden to expose the mineral bearing horizons result in limiting the domestic and wild animals from accessing their feeding points. These studies in Africa have successful brought to the fore the vulnerability state of livestock feeding points.. Despite the interesting insight provided by these studies on the effects of AGM on livestock feeding points ironically none of them clearly analyze the effect of acreage of land under mining on livestock grazing area

In Kenya Wangari (2012) elucidated that; pollution from mining activities affects neighboring communities and also soil erosion is common around mined areas and therefore the land use change becomes inevitable because the mined sites no longer accommodates farming activities such as crop farming, cattle grazing, and provision of ecosystem services as pollination. There is

need for an in-depth understanding on how AGM activities influence livestock grazing space due to the paucity of peer reviewed literature in this area.

Even though many people with various reasons of engagement in AGM have benefited from it, the various vulnerability contexts of other sources of livelihoods such as grazing land encroachment by AGM mining activities have not been well demonstrated and investigated by environment researchers. In Ikolomani the landscape is characterized by; mine stock piles rills, gullies and open excavated pits reducing livestock grazing space. The current study addressed the influence of acreage of land under mining on livestock grazing space in Ikolomani Sub County.

2.5 Theoretical Framework

The study was guided by two theories: Maslow's hierarchy of needs theory and sustainable livelihood theory. The Sustainable Livelihood Approach (SLA) with the Department for International Development (DFID)'s Sustainable Livelihood Framework (SLF) was adapted to guide the study in giving a clear understanding of the relationship between AGM and agriculture land which is a source of livelihood. The frame work came into being as a result of debates and discussion on sustainable livelihood poverty reduction and assets (WCED1987). Brundtland Commission on Environment was the first to put sustainable livelihood notion on board (WCED 1987).The concept was then expanded by the 1992 United Nation Conference on environment and development which advocated for the achievement of sustainable livelihoods as a goal for poverty eradication (WCED1992). Many livelihoods studies have adapted and applied the SLF approach giving grounds for development studies, thinking and research (Scoones 1998).

The SLF focuses on people and their livelihoods and how people can use their assets to realize their basic needs of life and reduce poverty (Ashley and Carmey1999).The SLF has five main components; vulnerability context (in terms of stress, shocks and seasonality), livelihood assets, transforming structures and processes, livelihood strategies and livelihood outcomes. The SLF shows that sustainable livelihoods are achieved through access to a variety of livelihood sources such as; natural capital (land) that are combined together in the pursuit of livelihood strategies to realize livelihood out comes (Ashley and Carney1999).Livelihood strategies consists of a range and combination of activities and choices that people decide to undertake to achieve their

livelihood goals. Livelihood strategies are dependent on assets endowments and policies, institutions and processes in place (DFID 1999).The livelihood strategy that applies to this study is AGM. The transforming structures and processes such as culture, laws and policies in the frame work are linked to the vulnerability context which in turn affects the l agriculture land as a livelihood assets available.

The Maslow's hierarchy is premised on the basis of categorizing individual needs into five categories (Maslow, 1943). These needs are hierarchical and begin with the physiological which refers to the lower level needs like food, shelter, breathing, water and excretion. These needs are needed by the human physical body so that it functions normally. Safety needs are those that provide security for the individual in terms of body, health, employment, and crime.

The individual ensures that all his material wealth is secure from external forces such as theft and vandalism. Love or belonging needs are those needs that make an individual to feel appreciated in family, community or fraternity. These needs include friendship, sexual intimacy, and family. Self-esteem needs are those that give the individual confidence, respect for others and respect from others. Self-actualization is the need that the individual has with regards to morality, creativity and spontaneity (Maslow, 1943).According to Maslow, (1943), after attaining a lower need one graduates to a higher need. Alderfer (1969) maintains a different position and argues that an individual can pursue more than one level need simultaneously. In responding to Maslow's weakness, Alderfer proposed a modification of the theory by highlighting three levels of needs instead of five.

These levels are: existence, relatedness, and growth (ERG). The ERG theory further proposed a frustration regression component. This component suggests that an already satisfied need can become activated when a higher need remains unfulfilled .Thus if a person is continually frustrated in his attempt to satisfy growth needs for instance relatedness needs can again surface as key motivators. Max Neef (1991) criticized the fact that sufficiently well-off people can achieve self-actualization arguing that poor people in reality may also be able to develop well their individual potential. For Jackson *et al* (2004), Maslow's theory overemphasized the individualistic nature of needs satisfaction and understates the importance of society, culture, and natural environment by treating these as secondary in importance to individual motivation. Alongside this, the assertions that only well-off people can achieve self-actualization is often

seen as problematic .The rationale of this theory to this study was that people are pushed by the basic survival needs to exploit the natural resources at their disposal. In regard to AGM, this results in shocks and stresses emanating from AGM activities which include; shrinking acreage of arable and grazing land due to land degradation making people more vulnerable to poverty because recovering from these shocks and stresses is an illusion. They end up being trapped in a vicious cycle of poverty in turn being driven to more AGM activities thereby more depletion of natural livelihood assets.

2.6 Conceptual Framework

The schematic diagram (Figure 2.1) represents the relationship between the study variables according to the study findings.AGM was the independent variable and was measured by the acreage of land under AGM and AGM monthly income.

Agricultural land was the dependent variable which was measured by the acreage of arable land, food crop yields and livestock grazing area .AGM activities in the study area influence the people's livelihood. The income from AGM influences the acreage of arable land. The assumption was that: increased income leads to increased AGM activities and reduced acreage of arable land. Removals of vegetation cover for excavating and mining gold and construction of AGM factories are AGM activities that lead to reduced acreage of arable land. Selling of gold is an AGM activity that determines the level of AGM income. Increased level of AGM income results in improved livelihoods.

The acreage of land under AGM influences food crop yields. The assumption was that: increased acreage of land under AGM can reduce land under food crops and hence reduced food crop yields. Decreased acreage of land under AGM can increase the land under food crops and hence increased food crop yields. Increased acreage of land under AGM can lead to reduced acreage of arable land and hence reduced food crop yields. Increased food crop yields results in improved livelihoods. The acreage of land under AGM can also determine livestock grazing area. The assumption was that the higher the acreage of land under AGM the more livestock grazing area is degraded reducing livestock grazing area The lower the acreage of land under AGM the lesser the acreage of land is degraded increasing livestock grazing area .The negative effects of AGM can be controlled by controlling AGM activities.

Intervening variables can be seen in terms of varying weather patterns, seasons and time. Adverse dry conditions over a long time can reduce the acreage of arable and livestock grazing feeds leading to reduced food crop yields and livestock grazing area and hence poor production from agriculture land. Wet seasons can increase food crop yields and livestock feeds availability hence improved agriculture production.

2.6.1 The Influence of AGM on Agricultural Land

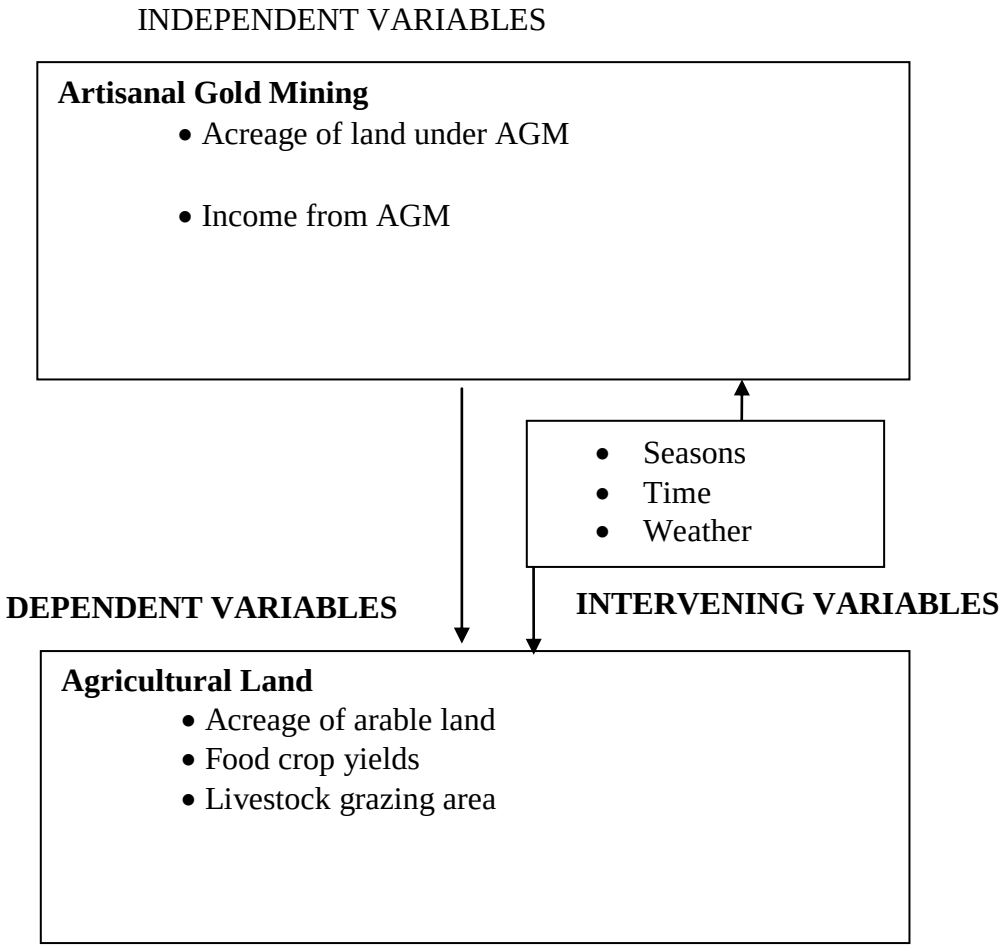

Figure 2.1: Conceptual Framework

Source : Author 2020

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter focused on research area and study population, research design, sample size calculation and sampling techniques, data collection methods, data analysis and validity and reliability , data collection tools and research ethics. Primary data on AGM and other economic activities in the study area was collected using different approaches including questionnaires, structured interviews and personal observation.

3.2Study Area

The study was carried out in Ikolomani Sub-County. The Sub-County lies between latitude 00º15'19''N to 0º6' 37''N and longitude 34º 37'37''E to34º48' 49''E. It is bordered by Lurambi Constituency to the North, Vihiga County to the south, Shinyalu Constituency to the east and Kwisero Constituency to the west. The Sub County covers an area of 146.2km^2 of which ; grazing land for livestock and cash crop area covers 51.8km^2; food crop land covers 55.3km^2 and residential settlement , natural resources covers 39.1 Km ^{2} respectively KC DP,2019).

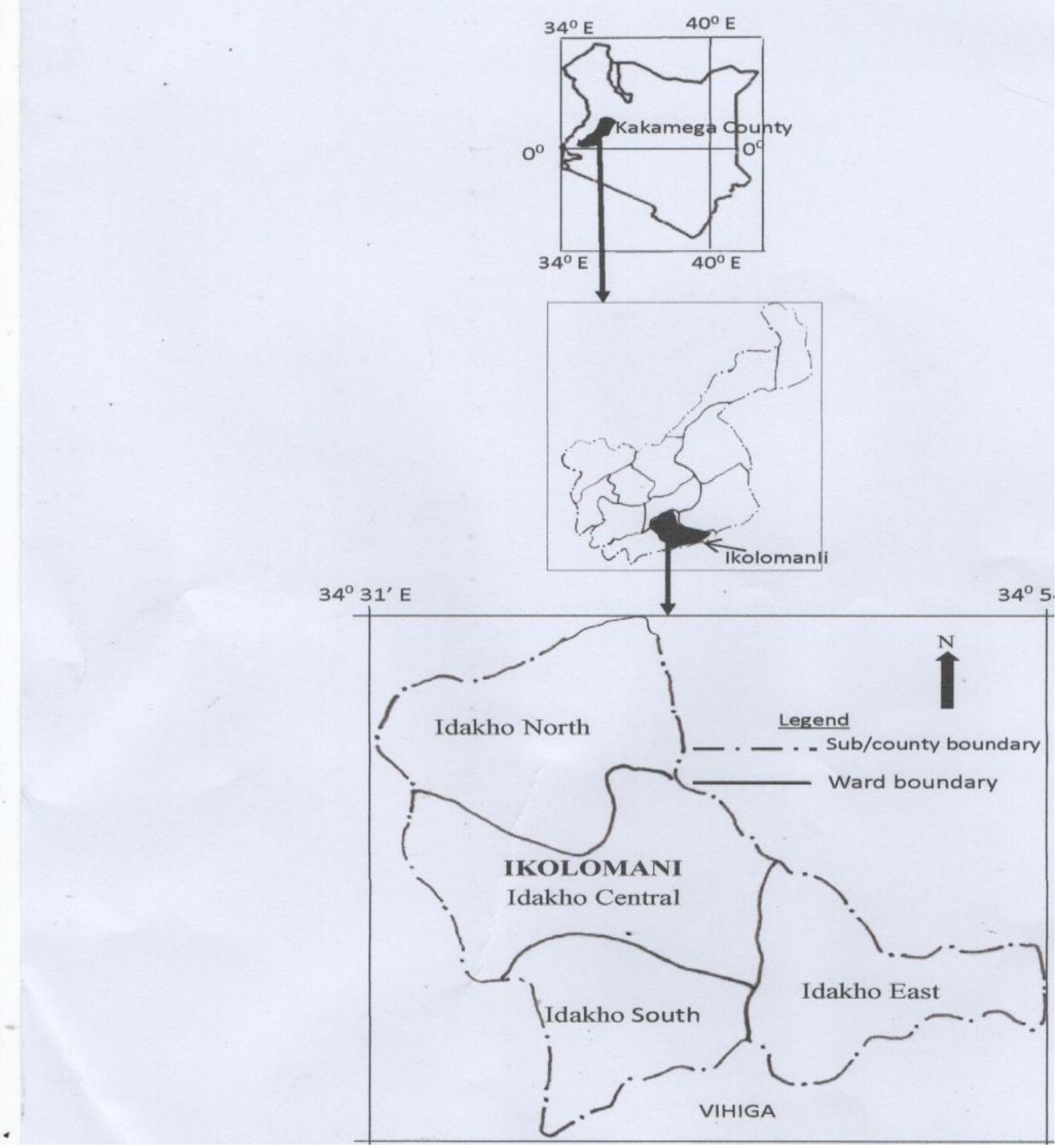

Figure 3.1:Map showing Ikolomani Sub County

Source: Kakamega County Development plan (2015).

3.2.1 Climate

The annual range of total rainfall in the study area is between 2214mm and 1280mm per year (source?). This rainfall is evenly distributed all year round with march and July receiving heavy rainfall while September and January receiving light rains. The temperature range is between 18℃ and 29℃.the hottest months are November, December, January and February. Other months have relatively lower and similar temperatures. This is conducive for high food crop production.

3.2.2 Geology and Soils

Ikolomani Sub County has massive sulphide hosted in sedimentary rocks of the Kavirondian sequence which are mudstones and grits. They form a stratiform layer within the strata of the mudstones and grits (Hitchen, 1997). The rocks of the region can be classified according to Rotich (2014) as; Upper division – feldspathic grits with pebble bands, Middle division – slates and mudstones, and Lower division – feldspathic grits and conglomerates. The system forms alternating units between mudstones and Grits but mudstones form the majority of the rock units (Hitchen, 1997). These rocks have been associated with the presence of gold in this area.

3.2.3 Population and Poverty Levels

Ikolomani Sub-County is dominated by the Luhya community. According to NPCR(2019) Ikolomani Sub-County has a population of 111743..This consists of 53219 males and 58524 females. Based on the area of 146.2 km^2 the Sub-county has an average population density of 764persons per square kilometer. The Sub County has a population of 26940 households. Out of this, a house hold population of 16437 engaged in crop and livestock production. This household population constitutes 950 households who engage in artisanal mining or had leased out their farms for AGM activities, thereby forming a basis for sampling during data collection.

3.2.4 Socio- economic Characteristics

The main economic activities in this Sub County include agriculture and mining. The average land holding acreage in the sub-county is 0.57ha. About 950 people in the Sub County are engaged in AGM and related activities on their farming land (KCDP 2019). We also have trade and commerce, transport and communication, pottery, and tourism.

The main crops grown in the sub-county are sugarcane, maize, beans, cassava, finger millet, and sorghum. Maize forms the staple food for the county. Cattle is reared by 53.2% of the population while 22.2%, 11.2% and 1.6% of the population rear sheep, goats and pigs respectively. Chicken rearing is pre-dominant with 92% of the households keeping them while 0.7% keep donkeys. About 19.15 million litres of milk are produced annually while 364, 000 kg of beef is also produced per year according to Kakamega County Economic Report (2015).

3.3 Research Design

This study employed a cross sectional descriptive design since AGM is already taking place within the study area and data could be obtained over a short period of time. It incorporated both quantitative and qualitative methods of data analysis. The unit of analysis was the household where AGM is practiced.

3.4Study Population and Sample Size

According to the NPCR (2019) Ikolomni Sub County has a population of 950 households who engage in artisanal gold artisanal gold mining or have leased out their farms for AGM activities, thereby forming a basis for sampling during data collection. According to Fishers *et-al* (1983) cited in Mugenda and Mugenda 2003, when a study population is greater than 10000 its minimum sample size is 384 at 95 % confidence level and 0.05 statistical significance. Therefore the study sample was drawn from a population of 950 households . Since the population was less than 10000 , the minimum sample size was guided by (Fishers *et –al*)1983 as ;

nf = n /1 + n/ N

Where ; nf = the desired sample size when the population is less than 10000 ,

n = the desired sample size when the population is more than 10000,

N = the estimate of the population size.

Therefore the desired sample size (nf) was ;

384/ 1 + 384 / 950 = 273

Table 3.1: Sample size calculation

No	Name of ward	Sub Locations	No of households Engaged in AGM	Proportional Sample Size
1	Idakho North	Shimanyiro	50	50 ×0.287 =14
		Shisero	53	53×0.287 =15
		Lunyerere	66	66 ×0.287 = 19
2	Idakho South	Eregi	89	89 ×0.287 = 26
		Lirhembe	88	88 ×0.287 = 25
		Makhokho	96	96 × 0.287 =28
3	Idakho Central	Malinya	105	105×0.287 = 30
		Musoli	54	54 ×0.287 = 16
		Mutaro	78	78 ×0.287 = 22
		Shikulu	69	69 ×0.287 = 20
		Shitoli	87	87×0.287 = 25
4	Idakho East	Shabwali	68	68 ×0.287 = 20
		Ivonda	47	47×0.287 = 13
Total	**Totals**		**950**	**273**

Where 0.287= 273/950

Source: Field 2020

3.5 Sampling Procedure

The study used stratified sampling technique for equal representation of the four words in Ikolomani Sub County .the wards were; Idakho North, Idakho South, Idakho Central and Idakho East. The wards were taken to be the sampling unit because the population of artisanal gold miners was evenly distributed in the Sub County KCIDP (2018- 2022) .Each ward consisted of Sub locations and had specific boundary. All the 13 Sub locations of the four wards were picked for equal representation. The list of 950 names of households engaging in artisanal gold mining was obtained from Ikolomani Sub County Petroleum and mining office. Simple random sampling was used to obtain 273 respondents from 950 artisanal gold miners' households. In the study each artisanal gold miner was assigned a random number based on the Sub location of

origin. The list of numbers was then randomized through a computer program Microsoft office excel to generate random numbers. The random numbers totaling to 273 were selected using the computer program based on specific sub locations as subject of study.

3.5.1 Purposive Sampling

Purposive sampling was used to obtain key informants who were; four artisanal gold miner's four opinion leaders from the four wards of Ikolomani sub county. Also purposive sampling was used to obtain four officers from the ministry of petroleum and mining and four extension agricultural officers in the four wards of the sub county these key informants were interviewed .according to Mugenda and Mugenda (2003) , Urposive sampling technique allows the researcher to use cases that have the required information with respect to the objective of his or her study,

3.6 Primary Data

Primary data techniques included the following:

a)Questionnaire

Questionnaire was the major research instrument with both closed and open ended questions which were administered to households to collect information about the influence of AGM on livelihoods in Ikolomani Sub County. The questionnaires were self-administered by the four research assistants alongside the researcher to avoid misunderstanding of questions by the respondents and also because of the illiteracy levels in the rural areas. This method was appropriate because it allowed the researcher to understand and capture the respondent's point of view through probing of incidental information.

b)Key Informant Interviewing

Key informants within the area of study were interviewed. They included four artisanal gold mining opinion leaders, the four area chiefs and four assistant chiefs, four village elders these were people knowledgeable on how AGM is influencing agriculture land in the area of study. Four officers from the Petroleum and Mining and Agriculture departments were also considered according to Mugenda and Mugenda (2003) these were cases with required information with respect to the study objectives. Through these method: activities such as farming, livestock rearing and land occupation through AGM were identified, information on amounts of maize and

beans yields in the Sub County, the trends in livestock rearing and number of livestock reared, legal issues regarding mining and land degradation trends in the Sub Countybetween the years 2018 and 2019 and their influence on livelihood was obtained.

a) Focus Group Discussion

Participatory rural appraisal tools were used. These tools included FGD whereby a group of minimum 14 adult males and females aged not less than20 years were selected by purposive random selection with aid of local authorities. Four groups from the wards were generated for equal representation to have discussions on the influence of AGM income on acreage of land, influence of acreage of land under AGM on food crop yields and influence of acreage of land under AGM on livestock grazing area which lasted for thirty minutes. Information pertaining siltation of streams, migration of farmers whose land had be degraded to other areas and rampant spread of malaria was gathered which informed all the study objectives.

b) Observation and Photography

Observation and photography were used to understand agricultural land use patterns of people and various AGM activities associated with income generation. This helped the researcher to understand the influence of the acreage of land under AGM on food crop yields and livestock grazing area in the study area and even cross-checked the respondent's answers. Photographs taken were used to enhance the quality of the study as they represented the significant physical attributes relevant to the study.

3.7 Reliability and Validity of Data

Pre-testing of the research instruments was conducted to assess the reliability and validity of the research instruments. Pretesting helped to check for the strength and weaknesses of the instrument and whether they are in line with the problem under investigation. Pretesting of the instrument also found out the duration each questionnaire would take and to understand the respondent's ability and willingness to answer the question and its effect on the response rate. Basically, there are two types of pre testing techniques, reliability and validity.

3.7.1 Reliability of the Research Instrument

Reliability is the degree to which measures of a given phenomena are free from error and hence providing consistent data over time. The reliability of the research instrument was established

using a test and retest technique. Test retest reliability involved the researcher administering the test items to 10 % of the study sample. Therefore the questionnaires were administered to a group of 28 households engaging in AGM on their farming land twice. These households were not used in the main study. This was carried out based on (Borg (1987) assertions that, the size of a sample for the purpose of piloting testing can range between 5 % and 10 %. However Mugenda and Mugenda (2003) argue that, the pretest sample should be between 1 % and 10 % depending on the size of the sample, the larger the sample the smaller the percentage .This aimed at identifying any error to be eliminated and providing consistent data over time. From the result of the piloting, Pearson's Product Moment Correlation Method was used to obtain reliability coefficients of r = 0 .674, 0.780, and 0.698 which yielded an average reliability index, r = 0.706.Which indicated high internal reliability. Fraenkal *et al*(1993) argue that a reliable coefficient of not less than 0.7 is recommended for consistency levels. Internal consistency reliability was also used. Internal consistency reliability examines the ability of a given data to produce similar results when different samples are used to measure a phenomenon at the same period of time (McDaniel and Gate, 2010)

3.7.2Validity of the Research Instruments

Validity is the degree to which the researcher tries to measure efficiency of the research instrument (McDaniel and Gates, 2010).Content validity of the research instrument was carried out through *a* pilot test. The pilot study was done by administering the research instrument to 27 households who practice or leased out their farming land for AGM practices. Such questionnaire pre-testing helped to identify problems with the data collection instruments and possible solutions were realized. It also helped to check if questions were clear, well structured, had a logical sequence, meaning, this assisted in understanding and identification of any potential misunderstanding amongst respondents hence avoiding ambiguity and ensuring clarification of technical concepts. To determine if the instrument could measure what it is supposed to measure content validity was also conducted through opinions given by a panel of experts (McDaniel and gates, 2010). Therefore opinion from the supervisors and other research experts in the school of environment and earth science of Maseno University were given draft questionnaires to ascertain the suitability of the data collection instrument in obtaining information according to research objectives. This aimed to check questionnaire structure, sequence, meaning, and ambiguity.

3.8 Data Analysis Procedures

The questionnaires, interview schedules, field notes and photographs were first arranged and authenticated. Questionnaires were then coded for analysis. The quantitative data were analyzed using descriptive statistics such as percentages and frequencies. Frequency counts and percentages of the responses in form of statements were obtained so as to generate descriptive information about the respondents and to illustrate the general trend of findings on various variables that were under investigation using the SPSS Version 2016. Simple linear regression was used to determine the variation of dependent variables as explained by the independent variables of the study. Qualitative data were analyzed by creating patterns and themes then evaluating the usefulness of information in answering the research questions. Photo Express was used for digital photographs production. Microsoft word was used for processing the text.

3.9 Results Presentation and Discussion

The analyzed findings were presented and discussed in form of summarized tables, graphs, charts, photographs and discussions. The findings are expected to provide awareness in Ikolomani Sub County on the influence of AGM on agriculture land.

3.10 Ethical Considerations

Ethical consideration in research involves outlining the content of research and what was required of participants, how informed consent was obtained and confidentiality ensured. The researcher sought approval to conduct the research from the school of Graduate studies Board as well as the Ethics Review Committee both of Masen University. The researcher further sought approval from the local administration specifically from the Sub County Commissioner of Ikolomani Sub County to carry out the study. The study adhered to professional research ethics to avoid unnecessary misunderstandings, conflicts and ethical dilemmas. Participation in the study was voluntary and no sensitive information was collected. Informed consent was obtained from all participants (see Appendix 1).The researcher made various efforts to protect all participants' views and make clear and fair agreements prior to their participation. To protect the data, the results obtained were stored in the computer with a password which was only accessed by the researcher so as to ensure the security, confidentiality of data obtained from the participants.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents results, data analysis and interpretation based on objectives of the study. The chapter has been divided into four sections: Socio demographic characteristics of respondents, analysis of the influence AGM income on the acreage of arable land in Ikolomani Sub County, the analysis of the influence of acreage of land under AGM on food crop yields in Ikolomani Sub County and the analysis of the influence of acreage of land under AGM on livestock grazing area in Ikolomani Sub County.

4.2 Socio Demographic Characteristics of Respondents

This section sought to identify the demographic characteristics of respondents including gender, age and education level in Ikolomani Sub County.

This background information about the respondents is presented because it might be pertinent in interpreting the data that they provided. Besides these characteristics are important because they are known to influence variables of the study such as AGM activities, crop farming, and livestock farming. Markides (1997) argues that economic activity diversification is an entrepreneurial behavior whereby people are engaged in different economic activities for their livelihoods. According to Bryan (1994), these activities are influenced by gender, age and education level

4.2.1 Gender Composition of the Respondents

The researcher also sought to identify the gender composition of respondents in Ikolomani Sub County. Table 4.1 shows the overall percentage gender composition of the respondents in the eight Sub Locations of kolomani Sub County.

Table 4.1: Gender composition of respondents

Gender	Frequency	Percentage (%)
Male	206	75.46
Female	67	24.54
Total	**273**	**100.00**

Source: Field data 2020

While this research did not precisely focus on gender equity, as shown in Table 4.1 above, the findings show that majority of the respondents were male 206 (75.46%) followed by female 67 (24.54 %).This section sought to identify gender composition of the respondents in order to assess the economic activities by gender. Kring and Gordon, (1998) observed that there is a relationship between gender differences in personality, characteristics, and nature of activities they do. Markides (1997) argues that economic activity diversification is an entrepreneurial behavior whereby people are engaged in different economic activities based on gender for their livelihoods. According to Bryan (1994), these activities are influenced by gender, age, and educational level.

Gender influences the characteristics and nature of activities practiced by individuals and consequently productivity. The bigger percentage of the male population among respondents in the study area, can be explained on the basis of the fact that, AGM is an activity mainly carried out by men and that the household questionnaire targeted the household head.

In Luhyia communities and customs, the household head is usually the man. This fact is evident from the above findings that reflect males as the majority of respondents in this study.

4.2.2Age of Respondents

The researcher also envisaged to establish the age of the respondents. Age has been associated with productivity in economic activities such as farming. Table 4.2 shows the analysis of respondents by age in terms of frequency and percentage.

Table 4.2: The age breakdown of the respondents

Age group	Frequency	Percentage
Below 18	0	0.00
18 – 30	90	33.27
31-40	69	25.30
41 –50	82	30.03
Above 50	31	11.40
Total	**273**	**100.00**

Source: Field data 2020

The breakdown of respondents by age was as follows; 33.27 % were in the age bracket 18 - 30 years old ,25.30 % were in the age bracket 31-40 years, 30.03% were in the age bracket 41 - 50 years,11.40% were above 50 years old. We had no respondent below the age of 18 years. This is because land ownership is entitied to people who are 18 and above years. age bracket of above 50 years formed the minority group.This implies that most of the respondents were in their prime active ages (not too old nor too young) and were likely to be actively engaged in economic activities.

Age influences the type and nature of activities done by various individuals and hence productivity. Efforts to establish the respondent's age, has been associated with the type of economic activities carried out. Edgar & Geare (2004) posit that long-term experience, influences beliefs and attitudes that are substantially varied among age groups, which elicits various responses. According to Scott and Cook (1981) chronological age is one of the most important information about an individual. Inferences about a person's social behavior, anatomy, attitudes and occupation can be made based on age. Strong societal expectations such as role duty and type of tasks to be engaged in exist concerning the behaviors of different age groups. This is clearly supported by the fact from plate 4.1 which shows middle aged men using sluices to wash the gold slurry in Shisero Sub Location.

Plate 4.1: Middle aged men washing gold slurry using sluisess in Shisero
***Source: Field* 2020**

A study by FAO (2014) in the Ganges Valley, India sought to find out how age of respondents influenced the knowledge and understanding of the economic activities they practiced. Findings showed that age between 40 and 69 years old withat least 10 years engagement in their economic activities, demonstrated better knowledge and understanding of their activities. A broad age range of respondents and a requirement to have at least 10 years engagement in their economic activities were used to ensure that those who are more aged and had substantial experience would contribute their experiences to the study. The current study targeted respondents who have at least ten years engagement in economic activities of the study area. Majority of the respondents were in the age bracket of 30 to 50 years. These are the groups that are actively engaged or involved in activities such as AGM, farming and other meaningful economic activities.

4.2.3 Educational level of Respondents

The respondents were asked to state their education levels. Table 4.3shows the education level of the respondents who participated in the survey.

Table 4.3: Education level of the respondents

Level of Education	Frequency	Percentage %
Never went to school	16	5.9
Primary	87	31.9
Junior high school	100	36.6
Senior high school	19	6.9
Certificate	19	6.9
Commercial/Technical/ Vocational	11	4.0
Diploma	12	4.4
Higher National Diploma	1	0.4
University Degree	8	3.0
Total	**273**	**100.0**

Source: Field data 2020

The results indicated that majority of the respondents had either junior high school(36.6 %) or primary (31.6 %) education. Minority of respondents had university degree and higher national diploma respectively standing at (3.0 %) and (0.4 %). Those who never went to school constituted5.9%. According to (Table 4.3) education level influences the type and nature of occupation or economic activities carried out by the respondents. Educated respondents understand better the logistics involved in the economic activities such as capital input, income earned, acreage of input realized and related projections of their economic activities. This survey indicated that most respondents had at least Junior High School andSenior School level education and hence were able to accurately respond to questions regarding AGM and farming activities, the relationship that exists between them and their cost effectiveness. They were also able to read and comprehend the questionnaire well as Rosegrant and Cline (2003) posited.Education levels include level of knowledge and skills and this is one way of measuring competence (Veres *et al*., 1990). This implies that the respondents in the study area were also competent in the activities they were engaged in and definitely gave accurate and sufficient information in their responses.

4.2.4 Main Sources of Livelihood

The respondents were also asked to state the main sources of livelihoods. Table 4.4 shows the main sources of livelihood among the households across the Sub County. The main source of livelihoods to the respondents is given on the understanding of the type of economic activities practiced in the study area.

Table 4.4: The main sources of livelihood to the household

Source of livelihood	Frequency	Percentage
Crop farming	174	63.7
Livestock Farming	43	15.8
AGM	31	11.4
Formal employment	14	5.1
Trade	11	4.0
Total	**273**	**100.0**

Source: Field data 2020

The results indicated that those engaged in formal employment were 5.1%, crop farming 63.7% livestock farming 15.8%, AGM 11.4 % and trade 4.0%. This implied that the main source of livelihood in the Sub County is crop farming comprising of cash crops and subsistence crops followed by livestock rearing and AGM. Crop farming is the main source of livelihood represented by 63.7 %. It is mainly practiced on small acreage of land which necessitates the need to supplement their source of livelihood with other economic activities such as livestock keeping and AGM (GOK, 2013). Formal employment and trade formed the minority. As posited by Rosegrant and Cline (2003), the occupation of respondents is an indicator on the type of human or economic activities practiced in the study area as a source of livelihood

4.2.5 Relationship of the Respondent to Household Head

The researcher also sought to establish the relationship of the respondent to the household head. The household questionnaire targeted the household head, who was in a position to provide the most reliable information. Table 4.5gives details of the respondent's relationship with the household head.

Table 4.5: Relationship of respondent to the household head

Relationship	Frequency	Percentage
Head	207	75.8
Spouse	46	16.8
Son	7	2.6
Daughter	13	4.8
Total	**273**	**100.0**

Source: Field data 2020

The results in Table 4.5 show that 75.8% of the respondents were the household heads themselves, 16.8% were their spouses, 2.6 % were their daughters and 4.8 % were their sons.

The household heads were in a better position to provide the most reliable information. This is because they were the most experienced by age leadership ability as manager of the household. In their absence, the closest and knowledgeable immediate family member was in a position to give reliable information about the household. . The household spouses were in a better position to represent the household head and provide reliable information.

4.2.6 Acreage of Land Owned by Householders

The researcher also envisaged to establish the acreage of land owned by households. The household head was asked to state the acreage of land owned by household. Table 4.6 shows the acreage of land owned by respondents.

Table 4.6:Acreage of land owned by householders

Acreage of land	Frequency	Percentage
Below 1 acre	15	5.5
1 – 4 acres	167	61.3
5 - 10 acres	86	31.4
Over 10 acres	5	1.8
Total	**273**	**100.0**

Source: Field data 2020

Table 4.6indicates that, majority of the farmers owned below 1 - 4 acres (61.3 %). This was followed by 5 - 10 acres (31.4 %), below 1 acre (5.5 %), and over 10 acres (1.8 %). The acreage of land is believed to influence the economic activities practiced in the area. This indicates that majority of the people in the study area are small holder farmers owning between 1 – 4 acres. They practice subsistence crop farming but owing to low harvests resulting from extremely small farms, they supplement their sources of livelihood with other activities such as livestock keeping and mining (GOK, 2013). This can also be known as economic activity diversification. Ellis (1998) views rural livelihood activity diversification as the process by which households construct a diverse portfolio of activities and social support capabilities for survival in order to improve their living standards.

4.2.7 The main land use patterns

Respondents were also asked to give the main land use patterns on their farms. Table 4.7shows the main land use patterns by the residents of Ikolomani Sub County.

Table 4.7: The main land use patterns in the study area

Land use Patterns	Frequency	Valid Percent
Cash crop farming	18	6.59
Subsistence farming	189	69.2
Livestock keeping	8	3.0
AG M	56	20.7
Forestry	2	0.5
Total	**273**	**100.0**

Source: Field data 2020

The results indicate that subsistence farming is commonly practiced registering (69.2 %) followed by AGM mining ,cash crop farming and livestock keeping registering 20.7 % , 6.7 % and 2.9 % respectively. Forestry was not popular thereby having 0.5 %.Information on the main land use patterns in the Sub County can equally provide information on the type of economic activities practiced in the study area and how they are influenced by rapidly increasing population. The acreage of land is believed to influence the economic activities practiced in the area. This implies that the main economic activity is subsistence farming followed by mining. Land use indicates how the residents of Ikolomani Sub County respond effectively to viable economic activities (GOK, 2013).In Ikolomani Sub County subsistence food crop farming with farmers venturing into AGM activities to cope with hard economic times since artisanal mining offers quick money (Kitula 2006).This is supported by Plate 4.2 showing subsidence food crop farming; cultivation of maize intercropped with beans alongside gold mining in Malinya

Plate 4.2: AGM alongside Subsistence Farming in Malinya
Source: **Field data*2020***

Ratamtaki, (2008) acknowledges that diversification is not a new phenomenon among farmers and that sharing of farms with other gainful activities is on the rise in densely populated areas. She Further States that, farmers who have diversified are well placed in possessing general resources to run their households. Ikolomani being a densely populated area has similar features.

4.2.8 Portion of Land Preserved for Food Crop Farming

The researcher also sought to establish the percentage of land preserved for food crop farming by the respondents. Respondents were therefore asked to give the percentage of land preserved for food crop farming. Table 4.8shows the percentage of land preserved for food crop farming.

Table 4.8: The percentage of land preserved for food crop farming

Portion of land preserved for crops	Frequency	Percent
Below 20%	187	68.5
20% - 50%	29	10.6
51% - 75%	28	10.4
Above 75%	29	10.5
Total	**273**	**100.0**

Source: Field data 2020

Results in Table 4.8 indicate that less than 69.1% of the respondents had less than 20 % of their land preserved for food crops. 20% - 50% had 10.4%, 51% - 71% had 10 % and more than 75 % had 10.4 % of their land preserved for food crops. This implies that majority of the respondents had less than 20% of their land preserved for food crops leaving the rest, 80% for other economic

activities and that minority of the respondents had between 51% - 75% of their land under food crops, leaving between 49% - 25% for other activities. Omwoyo (2015) posits that crop farming is the most important and widely practiced activity in Kenya. It is the main activity for 76 % of the population and the main source of livelihood in Kenya. Determining the proportion of land under crops provides the basis on which we compare economic activities of an area. Acreage of land under crops could also be affected by rainfall variability patterns in an area. The high rainfall in the study area is a justification for the dominance of crop farming in the area. The dense population and the small farms acreages also dictates the nature of households to take farming as a basic activity to source for family food.

4.2.9 Types of Food Crops Grown by Householders

Respondents were asked to give the food crops grown on their farm in order of their importance. Table 4.9 shows the type of food crop combination grown by the respondents in order of their importance.

Table 4.9: The type of food crops grown by householders

Types of food crop combinations grown	Frequency	Percent
Cowpeas, millet, maize, beans, potatoes	1	0.4
Maize	1	0.4
Maize, millet	1	0.4
Maize, bananas, beans	1	0.4
Maize, beans	170	62.3
Maize, beans, cassava	3	1.1
Maize, beans, cassava, banana	1	0.4
Maize, beans, cassava, potatoes	11	4.0
Maize, beans, cassava, yams	9	3.3
Maize, beans, potatoes	7	2.6
Maize, beans, banana	8	2.9
Maize, beans, banana, cassava	6	2.2
Maize, beans, bananas	12	4.4
Maize, beans, bananas, cassava	8	2.9
Maize, beans, bananas, yams	18	6.6
Maize, beans, potatoes	6	2.2
Maize, beans, yams	3	1.1
Maize, beans, yams, bananas	1	0.4
Maize, yams, beans, bananas	2	0.8
Maize, beans, bananas, yams	1	0.4
Sorghum, cassava	1	0.4
Yams, beans, maize	1	0.4
Total	**273**	**100.0**

Source: Field data 2020

Results in the Table 4.9indicate that the main combination of crops grown in the study area in order of importance were maize and beans represented by 62.3%, followed by maize, beans, bananas, yams represented by 6.6%, maize, beans and bananas represented by 4.4%, maize, beans, cassava, and potatoes represented by 4.0%. Single crops maize, the combinations of yams, beans, maize ; sorghum ,cassava ; maize, beans, bananas, yams ; maize, millet ;were least grown (0.4 %).

Maize is the main crop in the study area as it appears in almost all the combinations and leading in combinations as they appear. Omwoyo (2015) posits that maize is the most important and widely consumed food crop in Kenya. It is the staple food crop for 96% of the population with 125 kg per capita consumption and provides 40% of the calorific requirements in Kenya. Beans is the second most important crop in the area as it also appears in almost all the combinations as maize. In western regions of Kenya, beans is intercropped with maize grown in two seasons. Other crops are grown in smaller quantities and are mainly to supplement the two major crops. According to focused group discussions, the major crops cultivated are maize, beans, cassava, sweat potatoes, bananas, and yams. This confirms the information given in Table 4.10

4.2.10 Percentage of Area Preserved for Livestock Grazing

Respondents were asked to give the percentage of space preserved for livestock grazing. Table 4.10 shows the percentage of space preserved for livestock grazing.

Table 4.10: The percentage of the area preserved for livestock grazing

Area Preserved for grazing	Frequency	Percentage
Less than 20%	262.6	96.2
Between 51% and 75%	10.4	3.8
Total	**273**	**100.0**

Source: Field data 2020

Results from the Table 4.10 indicate that 96.2% of the householders preserved less than 20% of their area for livestock grazing and the minority 3.8% preserved between 51% - 75%. This implies that very few households had spacious grazing land, despite this through observation animals kept were seen tethered to avoid them getting injured in the abandoned mines. Also most farmers had embrace zero grazing as a form of livestock rearing. The findings agrees with Odhiambo (2010) that farmers had embraced post AGM copying strategies such as livestock tethering and zero grazing .Very few households had big spacious land which allowed them to

preserve between 51% - 75% of their land for grazing. Considering the fact that 61.4% of the householders own between less than1 - 4 acres of land through observation the number of livestock kept was high. This was an indicator/evidence of activities leading to overgrazing in the area. The small acreages of land, less than 1 – 4 acres had to be shared between crop farming and animal keeping.(KKIDP 2018-2019) This evidently indicated overgrazing in the area.A study carried out in Mongolia by Yusri *et al*. (2012) examined the influence of the portion of land preserved for livestock and overgrazing on land degradation. He concluded that, imbalances could likely cause reduced rainfall culminating in the spread of desert conditions. The study area has majority who have preserved very small portions for grazing. Table 4.11. Through observation in Makhokho an extensive acreage of land was exposed bear with no vegetation or grass cover for livestock having been converted for an AGM factory. The owner said that on a daily basis he has to buy napier for his livestock making it very expensive for him.

4.2.11 Type of livestock kept in order of importance

The researcher also sought to find out the type of livestock kept by households in order of importance. Respondents were therefore asked to give the type of livestock kept in order of importance**.** Table 4.11 shows the type of livestock kept in order of importance.

Table 4.11: The type of livestock kept in order of importance.

Livestock combination	Frequency	Percentage
Cows, chicken, goats	10	3.6
Cows, chicken	9	3.3
Cows, chicken, sheep	1	0.3
Cows, goats	9	3.3
Cows, goats, sheep, chicken	11	4.0
Cows, goats, pigs	1	0.3
Cows, goats, pigs, chicken	3	1.1
Cows, rabbits	1	0.3
Cows, goats, sheep	20	7.4
Cows, sheep, goats, pigs, chicken	9	3.3
Cows, sheep, goats, pigs	26	9.5
Cows, sheep, pigs, chicken	39	14.4
Cows, pigs	2	0.7
Cows, sheep	55	20.3
Goats, sheep	52	19.1
Goats, sheep, chicken	22	8.1.
Goats, sheep, pigs	2	0.7
Sheep, pigs, goats, chicken	1	0.3
Total	**273**	**100.0**

Source: ***Field data 2020***

Results as seen on Table 4.11 indicate that cows and sheep were the main combination of animals in order of their importance (20.3%), followed by, goats, and sheep (19.1%), cows, sheep, pigs and chicken (14.4%), cows, sheep, goats and pigs(9.5%)Among the least combinations we have sheep, pigs, goats and chicken (0.3%), cows, goats and pigs(0.3 %)and cows and rabbits (0.3%).

Cows were the main animals kept as they appeared in the majority of the combinations followed by chicken, goats, and sheep. The importance of cattle is attributed to their productivity and value. Goats are the most affordable to keep as they can feed on any vegetation and can be kept on relatively small farms. Pigs were the rarest species kept. Focused Group Discussions reported that, the farming practices embraced by most farmers are; mixed farming whereby alongside food and cash crop cultivation, they also engage in livestock rearing (KCIDP 2018-2022). The animals reared are cows, sheep, goats, pigs, and chicken. (KCIDP 2018 -2022) This report is consistent with the major findings shown in Table 4.11 .

4.2.12 Portion of land preserved for AGM

Respondents were also asked to give the percentage of their land preserved for AGM. Table 4.12 shows the percentage of their land preserved for AGM.

Table 4.12: The portion of land preserved for AGM

Acreage of land	Frequency	Percentage
Less than 20%	58	21.1
Between 20% and 50%	29	10.8
Between 51% and 75%	134	49.0
More than 75%	52	19.1
Total	**273**	**100.0**

Source: Field data 2020

The results indicate that between 51% - 75% had the biggest portion of land preserved for AGM (49%), followed by less than 20% represented by 21.1 %, more than 75% represented by 19.% and 20 – 50% was represented by 10.8 %. This implies that the majority of the householders have preserved almost half of their land for AGM. This is an indicator that AGM is a major activity in the study area.

This finding supports (NEMA, 2008) which posited that AGM was one of the major sources of livelihood and that the populace in Ikolomani Sub-County is lured into gold mining due to

poverty and need to make quick money. Like Ikolomani, in places such as Peru and Ecuador AGM takes place alongside farming activities which are the main competing economic activities. Mining leads to land use conflicts between AGM and other agricultural activities (ICMM,2003).

4.2.13 Major Income Generating or Economic Activities percentages by 'Yes' respond

Respondents were also asked to give their major income generating activities in order of their importance. They were to rate each economic activity by a Yes or No response .Table 4.13shows the major income generating or economic activities in order of importance based on the yes response only.

Table 4.13: The major income generating or economic activities

Economic activities	Percentage by 'Yes' of respondents
Artisanal gold mining	98.5%
Livestock earnings	97.1%
Petty trading	87.7%
Cultivation of food crops	86.4%
Fishing	86 .1%
Hunting	80.2 %

Source: Field data 2020

The results in the Table4.13 indicate that the major income generating or economic activities were as follows; Artisanal gold mining represented by(98. 5%)of the respondents, livestock earnings represented by (97.1%) of the respondents, cultivation of food crops represented by (86.4%) of the respondents, fishing represented by (86.1%) of the respondents and hunting represented by (80.2%) of the respondents.

AGM is rated as the leading income generating economic activity, followed by livestock earnings and cultivation of food crops. Hunting and fishing were rated as the lowest earners. This finding is consistent with a study in Kenya, by Kibukho (2015) which revealed that 70.2% of all AGM miners practiced mining as the principal economic activity and that mining income is used to support livelihoods by meeting most basic needs, with purchase of food being the dominant use represented by 95.99%. This was supported by Artisanal Gold Mining Opinion Leader 2 from Malinya (AGMOL 2, M) who noted that,

> *'AGM is paying them good monetary returns particularly when they lease out their land and the miners access the gold ore. This means we get contraction fee and an additional amount of money. We therefore have no much regard for agriculture land"*

In Ikolomani AGM is one of the major sources of livelihood as indicated in Table4.14 , it is the leading income generating activity. This is supported by Plate 4.3 showing 0.1 grams of gold on a pan before the amalgamation process in Musoli Sub Location.

Plate 4.3: Gold in Shisero Sub Location before the amalgamation process

Source: Field 2020

This is attributed to the fact that gold is very valuable. Though mined in small quantities, it is able to bring more income than other economic activities practiced in the area. This was in agreement with Artisanal Gold mining Opinion Leader 3 from Shisero, (AGMOL 3 S) who observed that ,

> "*Here in Shisero we have the market for gold readily available in the shops which have agents for the Asians, Somalis, Arabs and even Chinese. When we deliver our gold payments are done instantaneously. We are paid Kshs 4600 for 1 gram of gold delivered to the black market. These payments are much higher than when we deliver the gold to banking institutions in Kisumu or Kakamega*."

These views are in support of the findings of a study conducted in Ghana in which Ontoyin and Agyamang (2014) reported that, artisanal gold mining was a source of income for the poor populace, it is accompanied with much destructions to farm land. In Ikolomani Livestock earnings are the second income generating activity. This is mainly through the sale of milk and

livestock sales. Cultivation of food crops follows. Food crops are mainly for subsistence. Very little surplus for the market is realized. Hunting was the least popular.

4.3 The Influence of AGM Income on the Acreage of Arable Land

This section sought to investigate the extent to which AGM income influences the acreage of arable land in Ikolomani Sub County. The perceptions of the extent to which AGM income influences the acreage of arable land in the study area were measured using a five point Likert scale. The practices were rated as 1. To a very small extent, 2. Small extent, 3. Moderate extent, 4. Large extent, and 5.To a very large extent. Table 4.14 provides the results of the statements used to find the extent to which AGM income influences the acreage of arable land and percentages of total respondents using the Likert scale.

Table 4.1 4: The statements used to find the extent to which AGM income influences the acreage of arable land and percentages of total respondents using Likert scale.

Statement	1	2	3	4	5
Gold mining is a widespread economic activity in the Sub County	0%	0%	0.4%	8.8%	90.8 %
Gold mining creates a reliable and alternative job opportunities for inhabitants in the Sub County.	0%	0%	1.0%	4.8%	94.2 %
You have engaged in AGM for more than five years.	0%	0%	1.2%	12.1%	86.4%
To what extent do you practice AGM on your farm?	0%	0%	0	3.3%	96.7%
AGM is the main economic activity in the Sub County	0.7%	0%	2.2%	8.4%	88.7%
AGM has been growing in importance over other economic activities over the years in the Sub County.	1.5%	0%	1.1%	2.9%	94.5%
The land area preserved for AGM for income generation has been increasing over time in the Sub County.	5.9%	1.5%	0%	1.5%	91.1%
Income from AGM is used in enhancing the acreage of arable land.	52%	38.7%	7%	2.2%	6.3%
The acreage of arable land has been decreasing since 2018 in the Sub County.	1.8%	0.7%	2.2%	1.8%	93.5%
The decrease in the acreage of arable land is attributed to expansion of AGM activates for income generation in the Sub County	1.8%	0.4%	0%	1.1%	96.7%
The acreage of arable land has been increasing since 2018 in the Sub County.	96.1%	1.8 %	1.2%	0.5%	0.4%
The increase in acreage of arable land since is attributed to contraction of AGM activities in the Sub County	96.4.%	1.4 %	1.1%	0.6 %	0.5%

Source: Field data 2020

Respondents were asked to state: “To what extent gold mining is a widespread economic activity in the Sub County”. The results from the table indicate that 90.8% agreed to a very large extent,8.8% agreed to a large extent and 0.4 agreed to a moderate extent that gold mining is a widespread economic activity in Ikolomani Sub County. On the basis of the strength that the majority agreed to a very large extent and the minority agreed to a moderate extent, it implies that gold mining is an important economic activity in Ikolomani Sub County. AGM in Ikoloman Sub County pays the households who have leased their portions of land to miners and also it pays other workers affiliated to the gold miners. Through observation the researcher was able to see both women and men working at various stages of ore extraction to the actual selling of gold. This was evident in AGM mining centres or factories in areas such as Malinya and Shitoli. Women were hired to do lighter jobs like crushing the gold ore manually and washing of the gold slurry using pans .Whereas young energetic boys were hired at day time and during the night periods to dig vertical pits and horizontal underground channels .All these roles attracted lucrative pays as one young boy was heard saying that he prefers being hired at night because he earns Ksh 500 compared to day time when he only earns Ksh 300 to dig pits and underground tunnels This finding is consistent with the study by CASM(2005) which observed that AGM is a widespread economic activity which provides significant livelihoods for rural communities in Africa and serves as a means of reducing poverty. Like many other scholars, MacDonald (2002) posits that mining is regularly practiced and exists in many African countries such as Ghana, Kenya, and Nigeria. The extraction of precious minerals such as gold and diamond has impacted on the socioeconomic lives of people in these countries and communities involved directly or indirectly in the mining sector (Hilson and Banchirigah 2002). Kenya is one of these countries in Africa where AGM is practiced as an important economic activity.

Respondents were also asked to state; to what extent they agreed with the statement Gold mining creates reliable and alternative job opportunities for inhabitants in the study area. The results from Table 4.14indicate that 94.2% agreed to a very large extent, 4.8% agreed to a large extent and 1.0 agreed to a moderate extent that gold mining has created job opportunities in Ikolomani Sub County. On the basis of the strength that the majority agreed to a very large extent and the minority agreed to a moderate extent, it follows that gold mining creates and provides alternative job opportunities in Ikolomani Sub County. This finding is consistent with Ontoyin and Agyamang (2014) who corroborated that, AGM has helped to reduce the rate of unemployment

in the lives of the average people and that it has contributed to livelihoods in many parts of the world. ILO (2008) reports that AGM sector generates a large number of informal employment particularly in developing countries.

A study by CASM(2003) in Ghana, observed that AGM employs and engages more people than large scale mining in most developing countries. According to Francis *et al*. (2015) AGM is seen to generate employment opportunities in Africa contributing to livelihood enhancement and asset acquisition-AGM provides employment both directly and indirectly in Ikolomani Sub County. This was evident by observation which showed that we had other subsequent jobs which emanated alongside AGM. We had gold brokers or agents; we had women engaging in petty business like selling of cocked meals to miners. In addition we had jobs directly linked to mining like crushing of gold bearing rocks using grinding machines In Ikolomani Sub County though gold is found in small amounts, it is valuable and earns higher returns compared to other sources of livelihood. The miners revealed that they were able to earn more money from the sale of 1gram of gold when they sold it to the banks as compared when they sold to agents who only offer 4600 for 1 gram of gold.

Respondents were asked to state to what extent they agreed with the statement that 'you have engaged in AGM activities for more than five years'. A variety of responses were raised to address the statement. Table 4.14 provides the results of the survey. The results in the table indicate that 86.4% agreed to a very large extent, 12.1% to a large extent and 1.5% to a moderate extent with the statement that they have engaged in AGM activities for more than five years. This provides evidence that majority of the household heads have engaged in AGM activities in Ikolomani Sub County for more than five years time. Hence are able to provide adequate and accurate information about AGM activities.

According to GOK (2012), AGM as a practice in Ikolomani has been going on since the discovery of gold in Rosterman, Kakamega County by colonial government in the 1930s. The mine was closed upon exhaustion of the mineral deposit, giving way to AGM Practices by the local communities to date. Since then, the practice has been passed on from generation to generation. This is a long period of engagement in AGM activities in Ikolomani.

The researcher also sought to establish to what level of extent, the household heads had practiced AGM activities on their farms. A variety of responses were raised to address the statement. Table 4.14provides the results of the survey.

The results in the table indicate that 96.7% of the respondents' rating was to a very large extent and 3.3% to a large extent on the statement to what level of extent they practiced AGM activities on their farms. That provides evidence that majority of the household heads have engaged in AGM activities for quite a long period of time .Hence are able to provide adequate and accurate information about AGM activities. This is a fact that is supported by findings of Telmer (2009) that communities around the large gold mining areas in Kenya are actively involved in AGM activities. Being very valuable, it has attracted a large number of people, who have been practicing the activity on a large extent. The fact that the portion of land preserved for AGM is between 51% - 75%, supports this finding in Ikolomani Table 4.12.The growth in importance of AGM is slowly overtaking other economic activities. Increasing population is contributing to reduced farm acreages. This is reducing farm yields and hence the importance of crop farming as a source of livelihood. As a result more people are switching to AGM as an alternative source of income as asserted by (Ontoyin & Agyamang , 2014).

In addition respondents were asked to state if AGM was the main income generating activity in Ikolomani Sub County. A variety of responses were raised to address the statement. Table 4.15 provides the results of the survey. The results in the table indicate that 88.7% of the respondents' rating was to a very large extent, 8.4% to a large extent and 2.2% to a moderate extent on the statement AGM is the main economic activity in the sub county. That confirms the statement that AGM is the main economic activity in the sub county. Globally AGM has been seen to contribute highly to economies of many countries. In Mongolia, mining including AGM, is the largest contributor to the national economy (World Bank,2006).In Latin America, the AGM sector is rapidly growing into a principal sector of the economy (Bebbington and Burry,2008). In Kenya, AGM has enhanced the gold mining sector, making it second to South Africa on the continent (Talent *et al*., 2011). In Kenya studies such as Kibukho (2015) posit that over 70% of AGM activities were practiced as principal economic activities to support livelihoods. The fact that AGM is the main economic activity in Ikolomani, implies that it has over taken the traditional farming activities and so to speak, it has impacted on the acreage of arable farming land. The researcher was able to observe that mining activities had taken up household 's arable

land that most of the once arable land which was used to cultivate food crops such as maize and beans was beefing up with many people beyond the land's carrying capacity in the name of miners leaving no room for arable land.

The researcher also sought to find out the rate of growth in importance of AGM over other economic activities in the sub county over the years. A variety of responses were raised to address the statement. Table 4.14 provides the results of the survey. The results in the table indicate that 94.5% of the respondents' rating was to a very large extent, 2.9% to a large extent 1.1% to a moderate extent and 1.5 to a very small extent on the statement AGM has grown in importance over other economic activities over the years in the sub county. That confirms the credibility of the statement that AGM has grown in importance over other economic activities over the years in Ikolomani Sub County. Ogutu (2006) posited that in the African gold mining areas, AGM activities conducted for income generation by the local communities are on the rise, threatening the existence of traditional economic activities like farming and increased environmental damage. A replica was observed in Ikolomani as many mining areas in Makhokho, Shisero had their vegetation covers greatly destroyed particularly trees .This is because trees were constantly being used to support weak mining shafts, construct the make shift structures for miners and used for their fuel needs.

In Cameroon, increased AGM practices have been reported due to increased withdrawal of foreign companies as a result of dwindling deposits (Laplaine, 2009). According to the MMIR (2012), gold rose to be Kenya's most important mineral earning 13.9 billion with AGM contributing significantly. Most AGM activities in Kenya, as in Cameroon, started growing in importance as a result of withdrawal of foreign mining companies citing reduced deposits, a case of Rosterman (lkolomani) and Macalder Nyanza mines (Otieno, 2017).

Respondents were asked to state, if they agreed with the statement that "The land area preserved for AGM for income generation has been increasing over time in the sub county. A variety of responses were raised on the statement. Table 4.14provides the results of the survey. The results in the table indicate that 91.1% of the respondents agreed with the statement to a very large extent, 1.5% to a large extent 1.5% to a small extent and 5.9% to a very small extent. This makes the statement "The land area preserved for AGM for income generation has been increasing over time in the sub county" to be valid and confirms the credibility of the statement. The rising

practice of AGM means that there is continuous search for this valuable mineral and hence expanding the land area preserved for the activity. The expansion impacts negatively on other resources in particular arable farming lands.

Anoah (2014) in Ghana asserted that, expansion of land under AGM has affected rural livelihood by lowering agricultural activities and other economic activities. Researchers in Africa have also documented biodiversity loss and reduced crop yields as a result of expansion of land under AGM (Emberson *et al.*,2001). In Kenya, studies such as Ogola *et al*, (2003) cited land degradation as a result of expanding AGM activities. Argon and Juan (2012) posits that food production levels continue to drop as more people opt to expand their AGM activities for income generation.

The researcher also sought to establish if "The income from AGM is used in enhancing the acreage of arable land." Respondents were asked if they agreed with the statement. A variety of responses were raised on the statement. The results in the table 4.14indicate that 6.3% of the respondents agreed with the statement to a very large extent, 2.2% to a large extent 0.7% to a moderate extent. 38.7% to a small extent and 52% to a very small extent. This makes the statement that the Income from AGM is used in enhancing the acreage of arable land in the Sub County to be invalid and does not confirm the credibility of the statement. In Ghana, AGM income has mainly been used to enhance living standards as asserted by Ontoyin and Agyamang (2014) that AGM has made the miners to take care of their health, build their own houses and own taxi cabs.

According to Yeboah, (2013) AGM has contributed to improved living standards of local communities in Africa in terms of better housing and improved diet. AGM also provides income for day today survival especially during economic crises (Talent *et al*., 2011). These studies support the fact that AGM income is not used to increase acreage of arable land in Ikolomani Sub County instead the converse is happening in Ikolomani since households heads revealed that they do not hesitate in leasing out their land as it attracts good money. They revealed that when a contractor arrives he gives a contraction fee and then pays the remaining fee according to how they had stricken an agreement. The remaining amount is paid when the contractor accesses the actual gold bearing ore.

Respondents were asked if they agreed with the statement that "The acreage of arable land has decreased in the Sub County". Various responses were made on the statement. The results in the Table 4.14 indicate that 93.5% of the respondents agreed with the statement "The acreage of arable land has decreased in the Sub County" to a very large extent, 1.8% to a large extent 2.2% to a moderate extent. 0.7% to a small extent and 1.8% to a very small extent.

This makes the statement valid and confirms its credibility. This confirms the fact that increased AGM activities are expanding the land preserved for AGM practices. This is consistent with Bebbingtone and Burry (2009) that in Peru and Ecuador AGM is conducted alongside large scale formal mining. Increased income from gold has led to expansion of the land under AGM leading to land use conflicts (Elis *et al*., 2008). In West Africa, increased surface mining in AGM areas has resulted in deforestation as substantial loss of farm land as a result of AGM expansion, this forces displaced farmers forcing farmers to clear forests to expand their farmlands (Schuelar and Schroder 2011). Increased income from AGM has contributed to increased number of people venturing in the activity and hence its expansion. This has further led to negative impacts on the traditional sources of livelihoods such as agriculture land in developing countries (Ellis *et al*., 2008).

Respondents were asked if they agreed with the statement that "The decreasing acreage of arable land has been attributed to expansion of AGM activities in the Sub County."Various responses were made on the statement. Table 4.14 provides the results of the survey. The results in the table indicate that 96% of the respondents agreed with the statement "The decreasing acreage of arable land has been attributed to expansion of AGM activities in the Sub county." to a very large extent, 1.1% to a large extent, 0.4% to a small extent and 1.8% to a very small extent. This makes the statement valid and confirms its credibility of the statement that the decreasing acreage of arable land has been attributed to expansion of AGM activities in the Sub County. This is well supported by Plate 4.4 showing potential arable land compacted due to motorcycles and human traffic to an AGM factory in Ivonda Sub Location.

Plate 4.4: Compacted land due to motorcycles and human traffic to an AGM factory in Ivonda Sub Location
Source: Field 2020

This finding is consistent with findings of studies such as Bebbington and Burry (2009) who asserted that AGM and its expansion, removes vegetation and soils and results in the loss of farm land. Farm land in this case is the arable land. Kumah, (2006) posits that destruction of vegetation and farm lands by AGM activities affects agriculture negatively in developing countries. Schuelar and Burry, (2011) associates surface mining with increase in population and relocation of farmers. Ikolomani arable land was also observed to be vulnerable as many immigrants flocked the area in search of gold from nearby counties such as Kisumu, Nandi and Vihiga (agents and miners).This was evident to be putting pressure on land.

Also respondents were asked to rate the statement that; "The acreage of arable land has been increasing in the Sub County". The results in the table indicates that 0.4 % of the respondents agreed to the statement "The acreage of arable land has been increasing in the Sub County", to a very large extent 0.5% to a large extent 1.2 % to a small extent 1.8 % and 96 .1% to a very small extent. This makes the statement invalid and does not confirm its credibility. The acreage of arable land did not increase between this periods if anything it decreased. This lends credence to Ocansey (2013) that the chemicals used in mining process had destroyed the fertility of farming lands resulting in less arable land. By observation, it was evident that mining activities such as washing of gold slurry, crushing of gold ores, drying and smelting of the gold had taken much acreage of arable land in Ikolomani Sub County.

Lastly respondents were required to rate the statement that "The increase in acreage of arable land is attributed to contraction of AGM activities in the Sub County". The results in the table 4.15 indicate that 0.5 % of the respondents agreed with the statement" The increase in acreage of arable land since 2018 to the present is attributed to contraction of AGM activities in the Sub County" to a very large extent,0.6 % to a large extent 1.1% to a moderate extent 1.4 % to a small extent and 96.4 % to a very small extent. This makes the statement invalid and does not confirm the credibility of the statement". The increase in acreage of arable land since 2018 to the present is attributed to contraction of AGM activities in the Sub County". If anything then many farm owners in Ikolomani have sold off their degraded parcels of land to gold prospectors and migrated to the nearby settlement schemes of Lugari (GOK 2006).

The researcher also carried out simple linear regression analysis to examine the influence of AGM income on the acreage of arable land in Ikolomani Sub County. Figure 4.1 shows the results of the regression. The results are indicated by scatter plots of the simple linear regression to test the relationship between average monthly AGM income and the acreage of arable land.

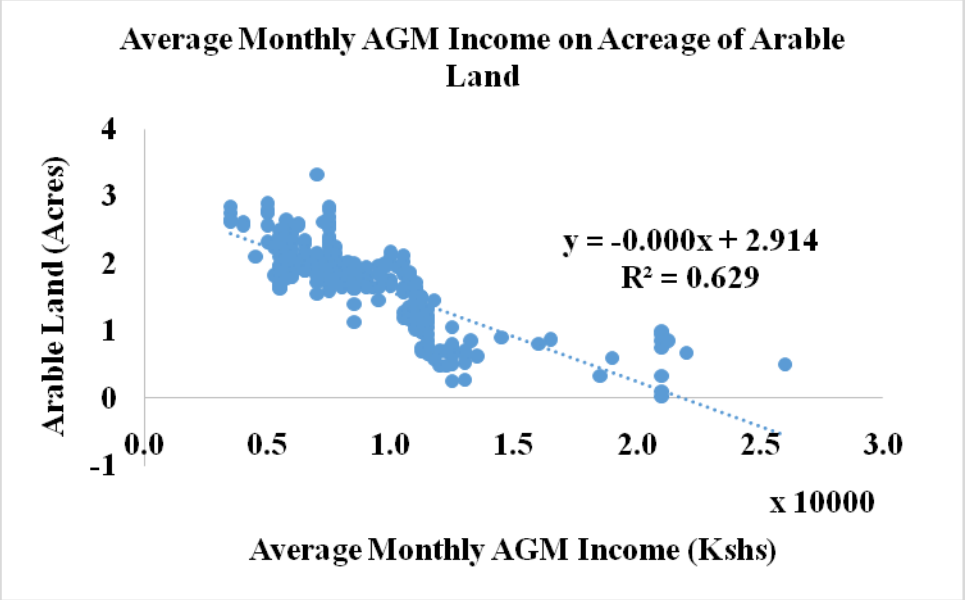

Figure 4.1: Scatter Plot simple linear regression results showing the influence of average AGM income on the acreage of arable land

Figure 4.1 shows that about 63% variation of the acreage of arable land in acres can be explained by average monthly income from AGM. This implies that AGM income has a big influence on

the acreage of arable land in Ikolomani Sub County. The results imply that AGM income has influenced expansion of AGM activities which have seen the reduction of arable land as a result of expanding the proportion of land preserved for AGM practices. Ontoyin and Agyamang (2014) posits that in Africa AGM has enhanced the livelihoods of poverty ridden communities leading to its expansion. This expansion has always impacted negatively on the available acreage of arable land .Increasing population as a result of an influx of miners from the nearby counties like Vihiga and Kisumu in need of income has stimulated the need for construction of make shift structures for settlement purposes in areas where gold prospects is ongoing thereby reducing the acreage of arable land. (KKDIP 2018 – 2022) This findings are consistent with research conducted in Cameroun by Funnoh (2006) which posits that mining is an activity that employs many people in rural areas because the barriers to entry are minimal, with low technology, capital and limited specialized skills needed.

Miners can earn higher incomes in mining than through other traditional activities. Artisanal mining can contribute to poverty reduction and provides many opportunities. This has led to its expansion and greatly reduced the acreage of arable land in areas it is practiced (Arah 2014).The increase in population and expansion of acreage of land under AGM are mainly realized as a result of the lucrative income from AGM activities in Ikolomani Sub County.

The 37 % variation of acreage of arable land can be explained by factors not considered in this analysis. These factors could entail; conversion of arable land is highly due to population growth, economic booms and the construction of transport and infrastructure (Thorapong 2011).Shrestha *et al*(2012) reported land fragmentation due to rapid urbanization in the Phoenix metropolitan area, urban land expansion and the resulting arable land loss. Daoquam *et al*(2014) reported that arable land loss has put food security at risk in China. He also resonated that, arable land conversions occur near built up areas, city centers and major roads. Daoquam *et al*(2015) alluded that the prime farmland protection policy is an essential part of land planning that has a significant positive effect on arable land preservation. However this study did not focus on these factors.

When the regression analysis is compared to the findings in Table 4.14, 93.5% of the respondents said that ‘to a very large extent’ the decrease in acreage of arable land is attributed to expansion of AGM activities in the Sub County. Plausibly, the two findings confirm that

average monthly AGM income to a very large extent influence the acreage of arable which have seen the reduction of arable land as a result of expanding the proportion of land preserved for AGM practices. This finding is consistent with a study by Mac Donald (2002) which posits that in Africa, AGM has enhanced the livelihoods of poverty ridden rural communities. It employs and engages more people than large scale gold mining leading to its expansion. This expansion has always impacted negatively on the available arable land. Because of the quick money offered by AGM, most of the miners get money after selling gold through the black market. This has made the miners to have little or no regard for farming activities. AGM practices are characterized with large land occupation and destruction posing a threat to other sources of livelihood particularly farming practices. The income from AGM is responsible for its expansion resulting in destruction of agricultural land, hence arable land (Schuelar and Schroder2011).Some miners have sold off their parcels of land to gold prospectors and migrated to the Lugari settlement scheme for better and more spacious land for agriculture (GOK, 2006).

More findings in the study area through observation indicated that, mining sites in the study area are greatly degraded through massive soil erosion. This is because when miners settle in an area to begin mining, they clear the trees, grass leaving the soil exposed to the agents of soil erosion. Therefore land under gold prospection and mining loses its fertility at a fast rate making it poor and not able to sustain Crop farming. This therefore reduces on the acreage of once arable land in the study area and renders it derelict and a waste land (Hayes 2006).Similar results by Sheriff and Bashiru (2018) also revealed that; the uncontrolled digging and turning over of top soil that is rich in plant nutrients by miners caused destruction of land beyond economic and technical reclamation making the land unfit for agricultural use..

Moreover focused group discussion on specific objective one of the study; to examine the influence of AGM income on the acreage of arable land revealed that: most land in the Sub County is under gold concessions by AGM miners, and that most farmers have opted to engage in AGM or lease out their land to gold mining activities. This has greatly reduced on the acreage of land under farming. Most farmers are of the opinion that they get food and quick money when they lease out land for gold mining unlike when they depend on farming. This is because farming is unpredictable with weather patterns which are not favorable, making them not to be sure about farming of food crops such as maize and beans. That farming is susceptible to weather changes.

In Ikolomani the young populace is engaged in AGM whereby they carry out activities such as; drilling and blasting the rocks containing gold ore. The young boys carry the ore for crushing and even to the nearby streams for washing. They work in gold mining sites. Young girls wash the crushed ore and carry water for washing. They also engage in petty business of selling food staff to gold miners. Therefore most young populace is not available to offer labour for farming practices. This discourages farming activities and more engagement in AGM activities which minimizes on the acreage of cultivation land.

Quick money is earned through AGM activities. Middle men come from as far as Nairobi to the site every evening to buy the commodity. They are paid Kshs 4600 for 1 gram of gold. This has made the miners to have little or no regard for farming activities for they get some money which they use to purchase food and the excess is used for drinking alcohol.

Mining sites are greatly degraded through massive soil erosion. This is because when miners Settle in an area to begin mining, they clear the trees, grass leaving the soil exposed to the agents of soil erosion. Therefore land under gold prospection and mining loses its fertility at a fast rate making it poor and not able to sustain plant growth. This therefore reduces on the acreage of once arable land and renders it derelict/waste land. This is supported by plate 4.5 showing a degraded landscape in Shisero which cannot be utilized for arable farming not unless it is rehabilitated.

Plate 4.5: A degraded landscape in Shisero

In conclusion it comes out clearly that AGM income has led to reduction in acreage of arable land in Ikolomani Sub County as supported by Table 4.14 and Figure 4.1 which shows that AGM income has influenced the acreage of arable land by 63 %.This is because of , AGM pits occupying much of acreage of arable land ,exposure of the parent rocks due to extensive soil erosion, construction of factories for AGM on arable land, immigrant's pressure on land, poor exploitation mechanisms which make the land to cave in., compaction of land by motorcycles and human traffic in AGM mining areas and large lands being under gold concessions rendering them unproductive for arable purposes. In the context of sustainability therefore AGM is not a sustainable source of livelihood as its exploitation leads to destruction of agriculture land. like acreage of arable land.

4.4 The Influence of Acreage of Land under AGM on Food Crop Yields

This section investigated the extent to which acreage of land under AGM influences food crop yields in Ikolomani Sub County. Respondents were asked to respond to a number of statements aimed at determining the relationship between the acreage of land under AGM and food crop yields. Table 4.15 shows the statement used to find the extent to which acreage of land under AGM influences food crop yields and percentage of total respondents using Likert scale.

Table 4.15: The statements used to find the extent to which acreage of land under AGM influence food crop yields and percentages of total respondents using the Likert scale

Statement	1	2	3	4	5
The gold mining site was once used for farming.	0%	0.7%	0.4%	11.6%	87.3%
You have paid a visit to the gold mining site in the sub county.	0%	0%	0.4%	12.1%	87.5%
The gold mining site was once used for food crop farming.	0%	0%	0.4%	9.9%	89.7%
The methods used in the gold mining activity have had effects on the food crop yield.	0 %	0%	0%	4.4%	95.6%
The average seasonal yield of maize per acre reduced between 2018 and 2019.	0%	0%	0.4%	10.7%	89.0%
This reduction was mainly believed to be caused by gold mining activities.	0%	0%	0.4%	7.4%	90.1%
The average seasonal yields of beans reduced per acre reduced between 2018 and 2019.	0%	0%	0.4	7.4	91.9
This reduction was mainly believed to be caused by gold mining activities.	0%	0%	0.4%	8.1%	91.5%
	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree

The researcher sought to establish if the gold mining site was once used for farming. Respondents were asked if they agreed with this statement "that gold mining site was once used for farming. They provided a variety of responses in regard to the statement. The results as shown in the table 4.15indicate that 87.3% of the respondents strongly agreed with the statement that gold mining site was once used for farming. Up to11.6% agreed with the statement and 0.4% was neutral on the statement. This makes the statement valid and credible.

Increased global demand for gold has increased mining both on large and small scales. High demand of resources results in shrinking of natural resources, an estimated 1000 km^2 of agriculture land or natural resource disappears annually as a result of increased resource demand (Koalinea and Roland 2013). The increased AGM activities are believed to have led to the shrinking of arable land and livestock grazing area hence reduced food production. A respondent revealed that to have any meaningful food crop yields they have reverted to the use of organic farm manure alongside the artificial fertilizers making farming a very expensive venture.

Respondents were asked if they had ever visited the gold mining site in the Sub County. A variety of responses were raised in regard to the question. The results as shown in the table 4.15 indicate that 87.5% of the respondents strongly agreed with the statement. 12.1% agreed and 0.4% were neutral on the statement. This makes the statement valid and credible. Majority of the respondents \had visited the mining site. This implies that they have been at the site, either as workers or residents of the area. This implies that they know and understand the activities that take place at the mining site. This corroborates Rosegrant and Clne (2003) that the more frequently the people engage in an activity the more they gain knowledge pertaining he activity. Through observation the respondents have adequate knowledge about the mining activities. Knowledge of the activities that take place at the mining site implies that they understand and can give concrete and credible information about mining in the area.

The researcher also envisaged to find out if the gold mining site was once used for food crop farming. Respondents were therefore asked if the gold mining site was once used for food crop farming**.** A variety of responses were raised in regard to the question. The results as shown in the table 4.15 indicate that 89.7% of the respondents strongly agreed with the statement,9.9% agreed, and 0.4% were neutral on the statement. This makes the statement valid and credible.

This rural community is largely made up of poor peasant farmers whose traditional activities were subsistence farming mainly growing maize and beans as their staple food (GOK, 2012). As seen earlier, 69.2% of the respondents in Ikolomani are subsistence farmers, it confirms that food crop farming is one of the principal economic activities in the area.

Gold mining practices started in 1930s when gold was discovered in Rosterman, Ikolomani Sub County (GOK, 2012). Since subsistence farming existed before the discoveries of gold were made, then it follows that the gold mining area was once used for food crop farming. Based on this argument, then it follows that the initial gold mining and the subsequent expansion of AGM activities have helped in reducing crop yields. By observations made by the researcher much acreage of land initially used for crop production had been encroached on by the constructions of mining factories. The mining factories engaged in; crushing of gold, washing of the gold ore, drying of the gold slurry, smelting houses and make shift structures. These were consuming much acreage of land hence having a direct impact on food crop yields. This is evidenced by Plate 4. 6 Showing a make shift structure that has been constructed in arable land in Makhokho, thereby reducing acreage of arable land consequently leading to reduction in food crop yields.

Plate 4.6: A make shift structure constructed on arable land in Makhokho.

Source: Field 2021

Respondents were also asked to comment on the statement that, the methods used in the gold mining activity have had an effect on food crop yields. Respondents provided a variety of responses in regard to the statement. Table 4.15provides the results of the responses. The table

indicates that 95.6% of the respondents strongly agreed with the statement, and 0.4% were neutral on the statement. This confirms the statement valid and credible. This means that the methods used in AGM activities have an effect on food crop yields. Excavating for gold involves destruction of trees and crops. This surface mining method reduces farmlands and hence reduction of crop yields. This finding is consistent with studies such as Schuelar and Schroder (2011) in Ghana, which posited that surface mining resulted in deforestation (58%), a substantial loss of farmland (45%) within mining concessions and widespread spillover effect as relocated farmers expand farmlands into forests. Kumah (2006) eludes that surface mining in developing countries, negatively affects livelihoods as farmers switch to alternative strategies of income. Destruction of farmlands through surface mining negatively affects agriculture and food security. The above studies are in line with what was observed in Ikolomani as much land was under AGM concessions, trees had been cleared in AGM mining areas such as Malinya and Shisero

Respondents were also asked to comment on the statement that the average seasonal yields of maize per acre reduced in the Sub County. Table 4.15 indicates that 89.0% of the respondents strongly agreed with the statement, 10.7% agreed with the statement and 0.4% were neutral on the statement. This confirms the statement as valid and credible. There was a reduction in average seasonal yields of maize between 2018 and 2019. This reduction could be attributed to increased AGM activities in the area. A discant reported that,

> *"Here in Ikolomani most households engaging in AGM have their acreage of arable land being replaced by mining activates or degraded through mining thereby reducing on food crop yields."*

Studies such as Schuelar, and Schroder (2011) in Ghana and Kumah (2006) have demonstrated that surface mining methods in developing countries have negatively affected farming lands and hence food crop yields. Anoah (2014) alluded that , artisanal mining has led to reduction in food crop yields The reduction in maize yields between 2018 and 2019 can be strongly associated with the expansion of AGM activities in Ikolomani Sub County (KKIDP 2018-2022).Respondents were asked to rate the extent to which they agreed with the statement that reduction on the average seasonal yields of maize per acre in the study area was mainly caused by gold mining activities**.** Respondents gave various responses in regard to the statement. Table 4.15 provides the results of the responses.

As shown in the table 4.15 the results of the survey indicate that 90.1% of the respondents strongly agreed with the statement, 9.5% agreed and 0.4% were neutral on the statement. This confirms the statement as valid and credible. This finding is similar to Odhiambo (2010) who connotes that AGM has resulted in loss of farmland and hence reduced crop yields in the area. This is likely to be the scenario in most areas that practice AGM in Kenya.

Mining has been associated with land grabbing in mining communities, leading to decreased food crop yields (Argon and Juan 2012). Maize being the main subsistence food crop in the area, its changes in yields are strongly associated with expansion of AGM in the study area. Equally, many studies have associated surface mining with destruction of farmlands and hence reduced food crop yields. (Ocansey 2013). This is supported by Plate 4.7 showing heaps of overburden and tailing from the excavated pits consuming chunks of arable land in Malinya Sub Location. This has a direct influence on food crop yields in Ikolomani Sub County.

Pate 4.7: Large land concessions for AGM reducing acreage of arable land in Makhokho Sub Location.
Source: Field 2020

Respondents were asked to rate the extent to which they agreed with the statement that the average seasonal yields of beans per acre reduced between 2018 and 2019**.** Respondents gave various responses in regard to the statement. Table 4.15 provides the results of the response. As shown in

the table, the results of the survey indicates that 91.9 % of the respondents strongly agreed with the statement that the average seasonal yields of beans per acre reduced between 2018and 2019**.** About 7.3% agreed with the statement and 0.4% were neutral on the statement. This confirms the statement as valid and credible. The same reason that was attributed to reduction in maize yields can also be associated with reduction in the yields for beans. Odhiambo (2010) connotes that increased AGM activities has reduced existing farmlands and reduced crop yields in the area. In most AGM areas. Mining has been associated with decreasing farmland in mining areas, leading to decreased food crop yields (Argon *et al*2012). Beans as one of the subsistence food crops in the area, changes in yields time to time are strongly associated with expansion of AGM in the study area.

The researcher also sought to establish the relationship between gold mining activities and reduction on beans yields. This was realized by finding out the extent to which the respondents agree with the statement that, "the average seasonal yields of beans per acre reduced as a result of gold mining activities". Respondents gave various responses in regard to the statement. As shown in the table 4.15, the results of the survey, indicates that 91.5% of the respondents strongly agreed with the statement that the average seasonal yields of beans per acre reduced as a result of gold mining activities, 8.1 % agreed with the statement and 0.4% were neutral on the statement. This confirms the statement as valid and credible. As mentioned above maize and beans are the major crop combination in the study area. Reasons for reduction of maize is likely to be the same as that of beans as stated above. That is reduction on the acreage of arable land as a result of expansion of AGM activities. This finding is in support of studies such as Schuelar and Juan (2011) and Kumah (2006) in Ghana which connotes that land under AGM are rendered less fertile and therefore are not likely to support nutritive values of food crops such as beans.

In addition, the study carried out regression analysis to test the effect of acreage of land under AGM on maize yields. This was based on 2018 season 1,and season2 and 2019 season 1 and season 2 based on specific objective two.

4.4.1 Influence of Land under AGM on Maize Yields

Regression analysis to test the effect of acreage of land under AGM on maize yields in 2018 season 1 was carried out.

Figure 4 .2 shows the influence of acreage of land under AGM on maize yields in 2018 season 1.

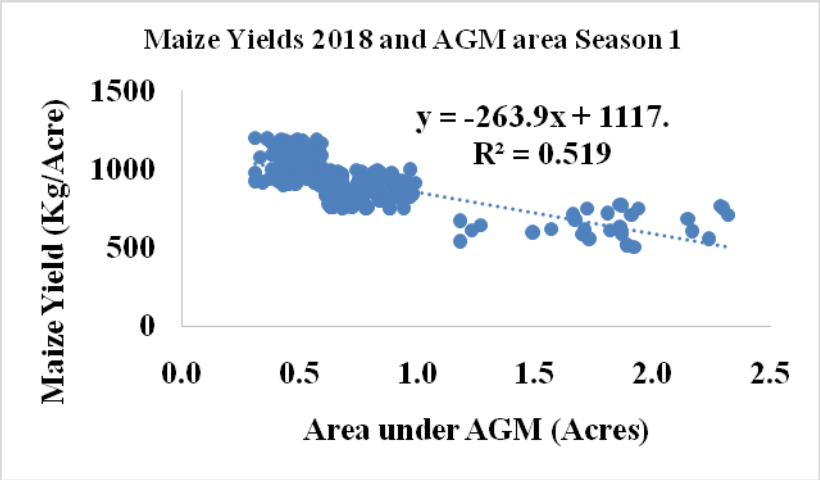

Figure 4.2:Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on maize yields in 2018 season 1

Figure 4.2 shows that , 52% variation of maize yields in 2018 season 1 can be explained by acreage of land under AGM. Whereby, surface mining in the developing world often erodes livelihood foundations, forcing populations to relocate and farmers to develop alternative income strategies (Kumah, 2006). Hayes (2008) alluded that, the destruction of vegetation and farm lands by miners affect agriculture and food security. This connotes the findings by Bebbington and Burry (2009) who asserted that, AGM removes vegetation and soils, interrupts ecosystem service flows and results in inevitable and often farm land loss. Relocation of farmers, destruction of farm lands and farm loss have a corresponding negative influence on food crop yields In Ikolomani massive land degradation was observed in AGM areas .This is supported by plate 4. 5which shows a potential arable land that has been degraded through AGM

Nonetheless 48% variation of maize yields in 2018 season 1 can be explained by factors not considered in this analysis. These factors could be climatic factors. Where by variations in annual rainfall, average temperature, global increase of atmospheric Co_2 and fluctuations in sea level are some major manifestations of climate change which negatively impact maize yields (Raza 2009).Climate change is the result of global warming. It has devastating effects in plant growth and crop yield which can affect directly/indirectly and socio economically reduce crop yields by up to 70% (Boyes 1982).

Regression analysis to test the effect of acreage of land under AGM on maize yields season 2 , 2018 was carried out The acreage of land season 2 2018 was regressed against the maize yields season 2 , 2018. Figure 4.3 shows the results of the influence of acreage of land under AGM on maize yields in 2018 season 2.

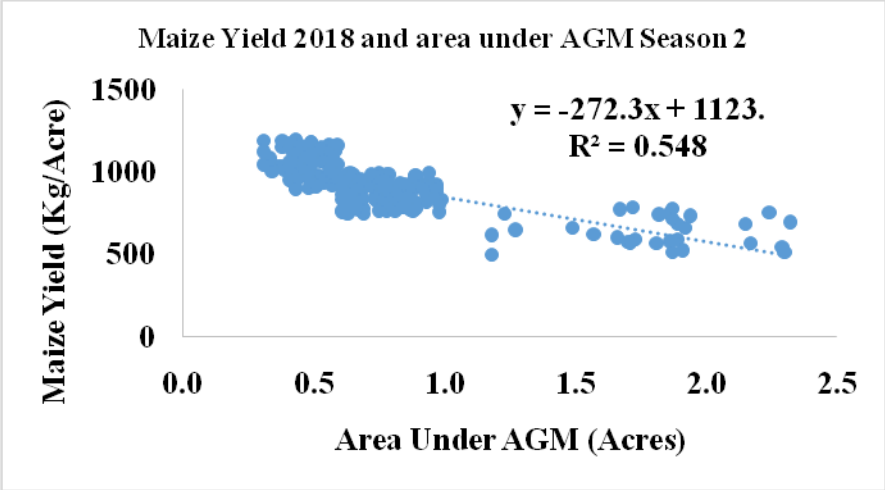

Figure 4.3: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on maize yields in 2018 season 2

Figure 4.3 shows that 55% variation of maize yields in 2018 season 2 can be explained by acreage of land under AGM. By observation it was clearly seen that vegetation cover was greatly degraded in areas of Makhokho and Eregi .Vegetation clearance therefore deprives the soil from the humus that is essential for determining its fertility. A respondent revealed that the soils were no longer fertile as a result of massive deforestation and reduction in acreage of arable land to AGM activities. This lends credence to (Schueler and Juan 2010) that Substantial loss of farm land is registered in mining areas forcing farmers to relocate to forests .This also corroborates the findings of Akabzaa and Daramani (2001) mining concessions destroy farmlands as well as vegetation in Ghana. When farm land is degraded soil fertility is compromised hence food crop production is compromised.

However 45% variation of maize yields in 2018 season 2 can be explained by factors not considered in this analysis. These factors could constitute drought which refers to a situation in which the amount of available water through rainfall and or irrigation is insufficient to meet the evapotranspiration needs of the crops (Kunaraswany 2006). The impending climate change adversities are known to alter the abiotic stresses like a variable temperature regimes and their

associated impacts in water availability leading to drought, increased diseases and pests incidence and extreme weather events at local and regional scale (Kunaraswany 2006).

Regression analysis to test the effect of acreage of land under AGM on maize yields 2019 season 1 was carried out. The acreage of land under AGM was regressed against maize yields 2018 season 1.The regression results were sought to give the effect of the acreage of land under AGM on maize yields in 2019 season 1. Figure 4.4 shows a scatter plot of simple linear regression results of the influence of acreage of land under AGM on maize yields season 1

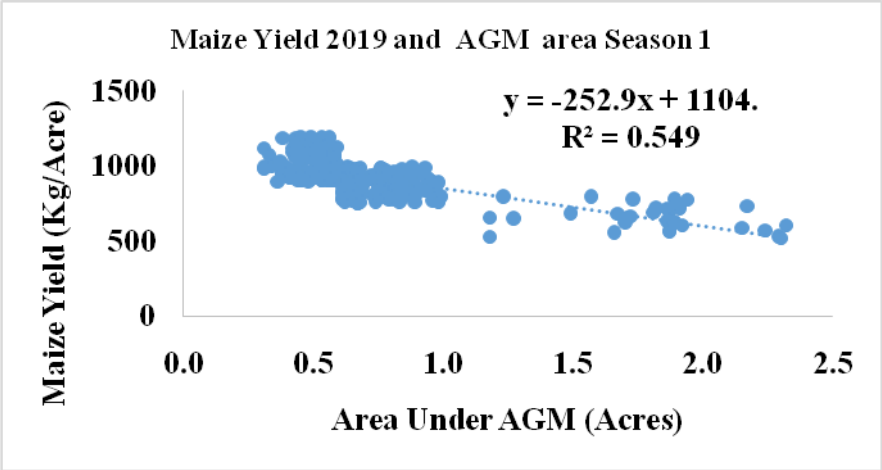

Figure 4.4: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on maize yields in 2019 season 1

Figure 4.4 shows that 55% variation of maize yields in 2019 season 1 can be explained by acreage of land under AGM. In Ikolomani large land of under gold concessions reducing the acreage of arable land this has a direct impact on food crop yields. A respondent revealed that after leasing out his land for AGM he has resorted to buying food staff for his family as his yields have reduced to only two sacks of maize and 30 kgs of beans from a previous yield of 5 bags of maize and one bag of beans in the subsequent seasons. This findings is in line with Francis *et al*2016 that farmlands, forests and water resources are most vulnerable to adverse effects of AGM. This is also in agreement to the findings by Tenkorang *et al* (2013) that posited that leases for surface mining displaced the original owners from large arable land needed for food crop cultivation. This clearly shows that when acreage of arable land is reduced to mining activities food production reduces accordingly.

In addition to this 45% variation of maize yields in 2019 season 1 can be explained by factors not considered in this analysis. These factors could constitute floods which entail stressful conditions to plants, mainly depending on water depth and its duration. Soil water logging damages most crops with the exception of rice, flooding has become frequent in many lowlands and cultivated areas every year and causes a lot of damage to human beings including losses in crop yield and food stuff (Tandzi 2019).

Regression analysis to test the effect of acreage of land under AGM on maize yields 2019 season 2 was carried out .The acreage of land under AGM was regressed against maize yields 2019 season 2. The regression results were sought to give the effect of the acreage of land under AGM on maize yields in 2019 season 2 Figure 4.5 shows a scatter plot of simple linear regression results of the influence of acreage of land under AGM on maize yields 2019 season 2

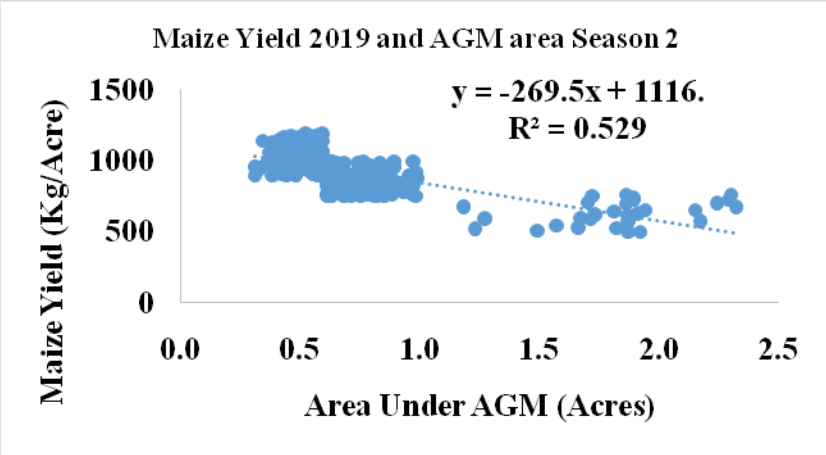

Figure 4.5: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on maize yields in 2019 season 2

Figure 4.5 shows that 53% variation of maize yields in 2019 season 2 can be explained by acreage of land under AGM. By observation areas of Malinya and Eregi were characterized with massive land degradation and extensive erosion .This deprived soil of essential macro and micro nutrients for maximum food production. This in line with Hagos and Geta2016 who posited that land disturbance and soil erosion, vegetation and biodiversity loses were the serious threats of traditional gold mining leading to reduction in cultivable areas for cereal crops .

In Ikolomani we also had mined areas suffering extensively from soil compaction which considerably reduced on the acreage of arable land this is supported by plate.. The findings are in

line with Sheriff *and* Bashiru (2018) who connoted that AGM led to soil depression thereby reducing the acreage of arable land consequently leading to reduction in agricultural productivity.

On the other side 47% variation of maize yields in 2019 season 2 can be explained by factors not considered in this analysis. These factors could constitute diseases and pests, plant diseases are caused by different micro –organisms such as viruses, bacteria and fungi. In addition, various soil borne and above ground insect pests also affect crop production(Tandzi 2019)

When the regression analysis results for figures 4.2 to 4.5 are compared to the findings in Table 4.16, 89.0 % of the respondents said that 'they strongly agree' that the average seasonal yields of maize per acre reduced between 2018 and 2019 . About 90.1 % of the respondents strongly agree that this reduction was mainly believed to be caused by gold mining activities. Plausibly, the two findings confirm that acreage of land under AGM influence maize yields in 2018 and 2019 seasons 1 and 2. This implies that acreage of land under AGM influences Food crop yields in Ikolomani Sub County. In Kenya a study conducted by Ogola *et al.*, (2001) asserted that; land degradation is registered in AGM areas as a result of soil erosion. This affects productivity of land and hence food production. Land degradation directly impacts negatively on maize crop production. Findings from focus group discussions reveal that; the soils in Ikolomani have been deprived of the humus content as a result of more vegetation being destroyed to pave way for AGM activities. This therefore reduces maize crop yields.

Secondly, Young people have been attracted to mining due to an allure of striking it rich by making quick money. This has deprived farming activities of human labour, thereby reducing on maize crop yields. This corroborates with the findings by Francis *et* al (2016) that economic hardships poverty situations of people and quick income earnings from AGM were the major factors that influenced people to combine and use their personal assets to engage in AGM .This has gone hand in hand to deny farming human labour hence low agricultural productivity.

Moreover, the focus group discussions based on the influence of the acreage of land under AGM on food crop yields revealed that; In Ikolomani , Most of the land under AGM is degraded through extensive soil erosion, the soil is rendered less fertile hence not being able to sustain

maximum food production. Most farmers are registering dwindling maize crop yields as a result of much land being taken over by AGM activities.

Mushrooming settlements by miners are taking up the once potential acreage of land for food crop production and therefore the acreage of land under food crop production has been shrinking as it is taken up by miners for mining and settlement purposes. This connotes the findings by Sheriff and Bashiru (2018) that agricultural productivity can be threatened or compromised by AGM activities.

In Ikolomani it was revealed by a respondent that an increase in acreage of land under AGM has led to more income which farmers are using to purchase farm inputs such as fertilizers and improved seed varieties. The soils have been deprived of the humus content as a result of more vegetation being destroyed to pave way for AGM activities. This therefore reduces on food crop yields. The active populace has been made vulnerable by diseases such as malaria as a result of pools of water dotting the AGM landscape. This has deprived farming activities of human labour, thereby reducing on food crop yields. Planting, weeding and harvesting of maize is labour intensive, if proper land management and harvested is not done in time the yields are likely to drop.

4.4.2Influence of Land under AGM on Beans Yields

Regression analysis to test the effect of acreage of land under AGM on beans yields 2018 season 1 was carried out .The acreage of land under AGM season 1 2018 was regressed against beans yields 2018 season 1.The regression results were sought to give the effect of the acreage of land under AGM beans yields in 2018 season 1. Figure 4.6 shows a scatter plot of simple linear regression results of the influence of acreage of land under AGM on beans yields season 1.Figure 4.6 shows the influence of acreage of land under AGM on beans yields in 2018 season 1.

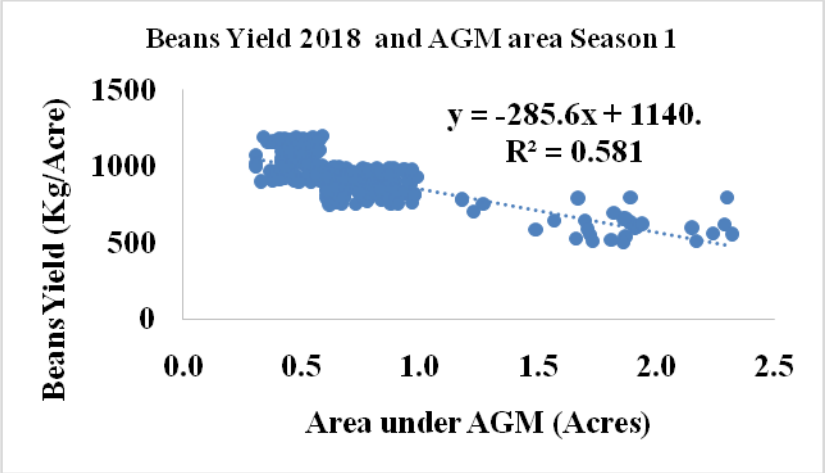

Figure 4.6: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on beans yields in 2018 season 1

Figure 4.6 shows that 58% variation of beans yields in 2018 season 1 can be explained by acreage of land under AGM. Sheriff and Bashiru (2018) resonated that the uncontrolled digging and turning of top soil that is rich in plant nutrients by miners cause destruction of land beyond economic and technical reclamation making land unfavorable for agricultural use. Food security can be threatened or compromised by AGM factors such as loss of agricultural land. (Yaaba and Ato 2017) .

On the contrary 42% variation of beans yields in 2018 season 1 can be explained by factors not considered in this analysis. These factors could constitute rainfall variability , (Semoka 2003) noted that the impact of rainfall on crop production can be related to intra seasonal rainfall distribution in the area, but more subtle intra seasonal variability in rainfall distribution during crop growing periods can also cause substantial reductions in food crop yields. Dry spells lasting for one to two weeks during critical period of growing season can reduce crop yields significantly .(Semoka 2003).

Regression analysis to test the effect of acreage of land under AGM on beans yields 2018 season 2 was carried .The acreage of land under AGM season 1 2018 was regressed against beans yields 2018 season 2.The regression results were sought to give the effect of the acreage of land under AGM beans yields in 2018 season 2 Figure 4.6 shows a scatter plot of simple linear regression results of the influence of acreage of land under AGM on beans yields season 2.Figure 4.7 shows the influence of acreage of land under AGM on beans yields in 2018 season 2

Figure 4.7 shows the results of the influence of acreage of land under AGM on beans yields in 2018 season 2

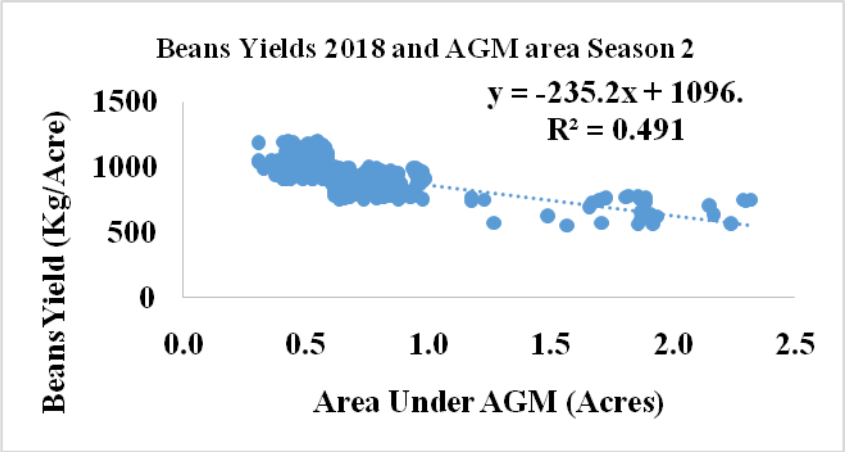

Figure 4.7: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on beans yields in 2018 season 2

Figure 4.7 shows that 49 % variation of beans yields in 2018 season 2 can be explained by acreage of land under AGM. This is because AGM tends to destroy vegetation and farmlands (Teschner 2012).This connotes findings by Yanoah (2008) that chemicals used in mining process had destroyed the fertility of farm lands resulting in less arable land. Besides this 51% variation of beans yields in 2018 season 2 can be explained by factors not considered in this analysis. These factors could entail, limited access to new technologies, that many farmers lack access to irrigation facilities and mainly depend on rain fed agriculture which is in adequate and unreliable (Alberto 2013), many farmers are limited in (Integrated management of nutrients and pests) innovations in agriculture, like genetic improvement of variables, fertilizer technology, adaptive microbial technology, pesticide's, farm machinery agronomic and management practices are not up to date. It has been reported that 1 kg of nutrient fertilizers produces 8 Kgs of grain (Rehman 2017) In addition, fertilizers are commonly believed to be very important in crop production since they contribute up to 50 % of crop harvest product (Rehman 2017).

Regression analysis to test the effect of acreage of land under AGM on beans yields 2019 season 1 was carried .The acreage of land under AGM season 1 2019 was regressed against beans yields 2019 season 1.The regression results were sought to give the effect of the acreage of land under AGM beans yields in 2019 season 1 Figure 4.8 shows a scatter plot of simple linear regression

results of the influence of acreage of land under AGM on beans yields season 2.Figure 4.8 shows the influence of acreage of land under AGM on beans yields in 2019 season 1

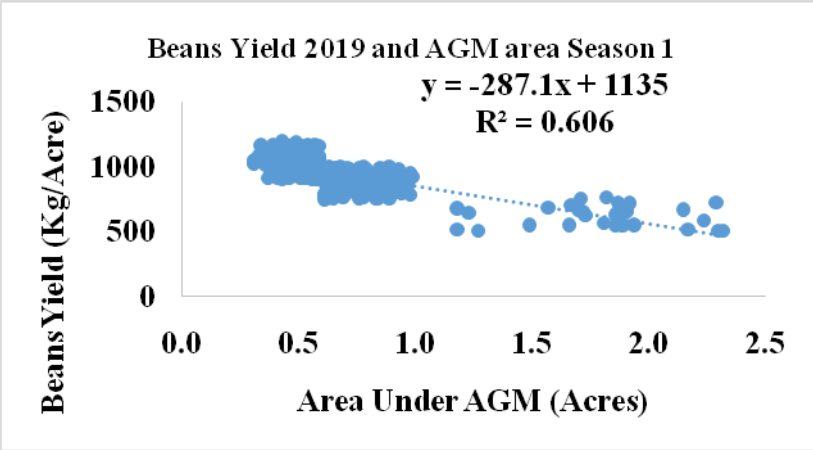

Figure 4.8:Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on beans yields in 2019 season 1

Figure 4.8 shows that 61% variation of beans yields in 2019 season 1 can be explained by acreage of land under AGM. Whereby mining impacts on agricultural land and food security (Ocansey 2013).This finding agrees with (Kitula 2006) that mining practices have caused serious land degradation impacting on food productivity. On the contrary 39 % variation of beans yields in 2018 season 1 can be explained by factors not considered in this analysis. These factors constitute; climate change,we have heat stress which refers to high temperature regimes due to climate change affecting the percentage of seed germination, photosynthetic efficiency crop phenology, reproductive, biology, flowering times, pollen viability and pollination population(kunaraswany 2006). We also have the cold stress experiences by plants from 0 to 25 ^{0}c which lead to major crop losses .Various types of crops in tropical or sub-tropical origin are injured or killed. Nonfreezing low temperatures are associated to poor germination, stunted growth, and reduced leaf expansion and wilting hence low food crop yields.

Regression analysis to test the effect of acreage of land under AGM on beans yields 2019 season 2 was carried .The acreage of land under AGM season 2 2019 was regressed against beans yields 2018 season 2 The regression results were sought to give the effect of the acreage of land under AGM beans yields in 2019 season 2 Figure 4.9 shows a scatter plot of simple linear regression

results of the influence of acreage of land under AGM on beans yields season 2, 2019.Figure 4.9 shows the influence of acreage of land under AGM on beans yields in 2019 season 2

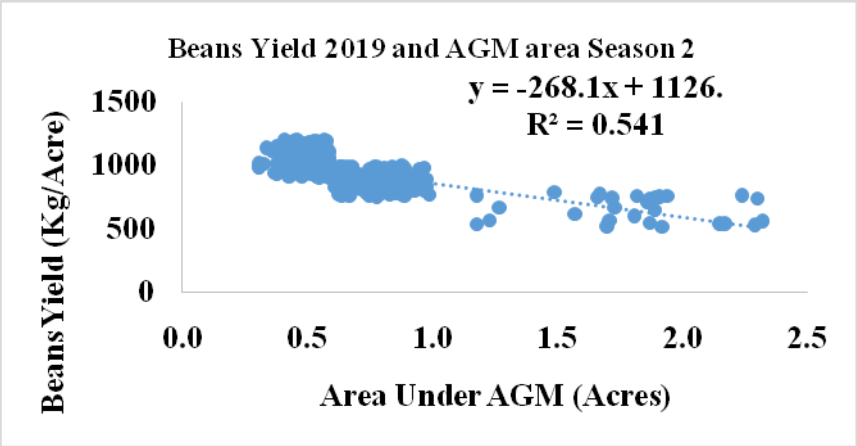

Figure4.9: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on beans yields in 2019 season 2

Figure 4.9 shows that 54% variation of beans yields in 2019 season 2 can be explained by acreage of land under AGM. According to Francis *et al* (2016) farmland is vulnerable to adverse effects of AGM activities leading to low agricultural productivity. Tenkorang (2013)resonated that leases for surface mining displaced the original owners from large arable land needed for agricultural productivity .On the contrary 47% variation of bean yields in 2019 season 2 can be explained by factors not considered in this analysis. These factors constitute diseases and pests. Plant diseases are caused by different microorganisms such as viruses, bacteria and fungi .These comparatively cause reduction in food crop yields.

When the regression analysis results are compared to the findings in Table 4.15, 91.9% of the respondents said that 'they strongly agree' that the average seasonal yields of beans per acre reduced between 2018 and 2019 .About 91.5 % of the respondents strongly agree that this reduction was mainly believed to be caused by gold mining activities. Plausibly, the two findings confirm that acreage of land under AGM influence beans yields in 2018 and 2019 seasons 1 and 2. This implies that acreage of land under AGM influences Food crop yields in Ikolomani Sub County. In Kenya a study conducted by Ogola *et al.*, (2001) asserted that; land degradation is registered in AGM areas as a result of soil erosion. This affects productivity of land and hence food production. Land degradation directly impacts negatively on food crop production. Findings from focus group discussions reveal that; the soils in Ikolomani have been deprived of the humus

content as a result of more vegetation being destroyed to pave way for AGM activities. This therefore reduces on food crop yields. Secondly, Young people have been attracted to mining due to an allure of striking it rich by making quick money (NEMA 2008). This had deprived farming activities of human labour, thereby reducing on beans yields. This agrees with the findings by Francis *et* al (2016) that economic hardships poverty situations of people and quick income earnings from AGM were the major factors that influenced people to combine and use their personal assets to engage in AGM .This has gone hand in hand to deny farming human labour hence low agricultural production.

Moreover, the Focus Group Discussions based on the influence of the acreage of land under AGM on food crop yields revealed that; Most of the land under AGM is degraded through extensive soil erosion, the soil is rendered less fertile hence not being able to sustain maximum food production. Most farmers are registering dwindling beans yields as a result of much land being taken over by AGM activities. Mushrooming settlements by miners are taking up the once potential acreage of land for food crop production and therefore the acreage of land under food crop production has been shrinking as it is taken up by miners for mining and settlement purposes. This connotes the findings by Sheriff and Bashiru (2018) that agricultural production can be threatened or compromised by AGM activities.

The soils have been deprived of the humus content as a result of more vegetation being destroyed to pave way for AGM activities. This therefore reduces on beans yields. A respondent also revealed that the spread of malaria is rampant .This was evident by pools of water covering the land scape in AGM areas of Ikolomani Sub County. This made the farming populace to be exempted from productive activities as they seek medication. Harvesting of beans is labour intensive, if not harvested in time the yields are likely to reduce.

In conclusion , it is evident that, the acreage of land under AGM has led to a reduction in food crop yields in Ikolomani Sub County as supported by Table 4.17 and Figures 4.2- 4.9 which shows that AGM acreage of land has influenced food crop yields by 55%. This has been attributed to; AGM factories occupying once arable land thereby reducing food crop yields, soil erosion has resulted to loss in soil fertility, immigrants are putting pressure on arable land by increasing the carrying capacity of the land, compaction of arable land making it poorly aerated

for increased agricultural production, collapsing or carving in of arable land rendering farming practices difficulty hence reduced food crop productivity. Lack of labour for farming activities. as they opt for AGM ones. This is also as a result of mercury related sickness and malaria. In the context of sustainability, livelihood assets such as land and human assets are affected by AGM activities. Measures should be put in place to ensure that the exploitation of gold through AGM strikes a balance to minimize damages rendered to other livelihood assets.

4.5 Influence of Acreage of Land under AGM on Livestock Grazing Area

This section sought to investigate the extent to which acreage of land under AGM influences the livestock grazing area in Ikolomani Sub County. The perceptions of the extent to which acreage of land under AGM influences livestock grazing area in the study area were measured using a five point Likert scale. The practices were rated as 1. To a very small extent, 2.Small extent. 3. Moderate extent. 4. Large extent and 5.To a very large extent. Table 4.16 provides the results of the statements used to find the extent to which acreage of land under AGM influences livestock grazing space and percentages of total respondents using the Likert scale

Table 4.16: The extent to which acreage of Land under AGM influences livestock grazing area and percentages of total respondents using the Likert scale

Statement	1	2	3	4	5
The gold mining site was once used for livestock grazing.	0	0	0	9.4%	99.6%
The methods used in gold mining activities have a big influence on livestock grazing area	0	0	0	7.4%	92.6%
These methods used in gold mining activities are responsible for the reduction of livestock grazing area.	0	0	0	0.7%	99.3%
The activities of gold miners are contributing to reduction in the number of livestock reared in the sub county					
	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree

The study envisaged to establish if gold mining site was once used for livestock grazing in Ikolomani Sub County. As shown in the Table.4.16, the results of the survey, indicates that 99.6% of the respondents strongly agreed with the statement, the gold mining site was once used

for livestock grazing and 0.4% agreed with the statement. This confirms the statement as valid and credible that the gold mining site was once used for livestock grazing. Results in the main land use patterns revealed that 75% of the land was preserved for farming and 3% for livestock. This implies that the land preserved for grazing was far much smaller as supported by the above finding. This finding is not consistent with the UNEP, (2004) report which asserted that about 29% of the world's pastures and rangelands have been degraded but the proportion is still high at 73% in dry areas. Steinfield *et al.*,(2006) posits that livestock is the world's largest user of land resources. However the findings of this study are in line with Wangari (2012) which elucidated that, mining activities destroy both farming and grazing land in developing countries. This explains the reason for the small space of grazing land in mining areas.

The researcher also envisaged to find out the relationship between gold mining methods and the livestock grazing area. Respondents were asked to comment on the statement "that the methods used in gold mining activities have a big influence on the livestock grazing area". Respondents provided a variety of responses in regard to the statement. As shown in the table 4.16the results of the survey, indicates that 92.6 % of the respondents strongly agreed with the statement that, the methods used in gold mining activities have a big influence on the livestock grazing area 7.4% agreed with the statement and 0.4% were neutral on the statement. This confirms the statement that the methods used in gold mining activities have a big influence on livestock grazing area valid and credible. The methods used in Ikolomani are mainly are mainly surface mining and panning of alluvial gold as supported by plate 4.2.These methods are responsible for reduction of livestock grazing land.

Steinfeld *et.al*,(2006) alluded that livestock is the world's largest user of land resources with grazing land and cropland representing 80%.Wassenaar *et al.*,(2006) posits that AGM and its associate activities is one of the contributors to the degradation of pasture lands. Hagos and Geta, (2016) observed that grazing land under AGM areas has been degraded. Hence AGM activities have subsequent influence on the acreage of grazing land. The studies above demonstrate the fact that AGM methods and activities are responsible for reduction of livestock grazing area. This study has come up with similar results. By observation, it was noted that, livestock grazing area had been replaced by stock piles, overburden and open pits which hindered the free range grazing mode of livestock rearing. Therefore farmers were embracing

tethering and zero grazing to mitigate against the reduction of grazing area in Ikolomani. Sub County.

Respondents were asked to comment on the statement "The activities of gold miners are contributing to reduction in the number of livestock reared in the sub county. "Respondents provided a variety of responses in regard to the statement. Table 4.16 provides the results of the responses. As shown in the table, the results of the survey, indicates that 99.3 % of the respondents strongly agreed with the statement that the activities of gold miners are contributing to reduction in the number of livestock reared in the sub county. 0.7 % agreed with the statement. This confirms the statement as valid and credible. Mining activities are a contributor to reduction of livestock reared in the study area. As seen above AGM methods and its related activities are responsible for the reduction in livestock grazing area This is supported by plate 4.8 which shows cows grazing in an AGM landscape covered by stock piles and non-bio generable sacks in Shimanyiro Sub Location

Plate 4.8: Cows grazing in an AGM land scape covered by stock piles and non-bio generable sacks in Shimanyiro Sub Location.
Source: Field 2020

As the grazing land reduces, the land carrying capacity becomes higher and hence the need to dispose of the excess numbers. This confirms the statement that mining activities are a contributor to reduction of livestock reared in the study area. In extreme cases open pits in the mining areas cause livestock deaths through accidents.

The pits make land unfavorable for agricultural activities and adversely impact on livestock and wildlife resources (Kitula, 2006). Ontoyin and Agyamang (2014) alluded that AGM has affected farming and led to livestock deaths.

In addition the researcher also carried out regression analysis to test the effect of acreage of land under AGM on livestock grazing area based on specific objective three. To determine the influence of acreage of land under AGM on livestock grazing area. Figure 4.10 shows a scatter plot of simple linear regression result showing the influence of acreage of land under AGM on average livestock grazing area.

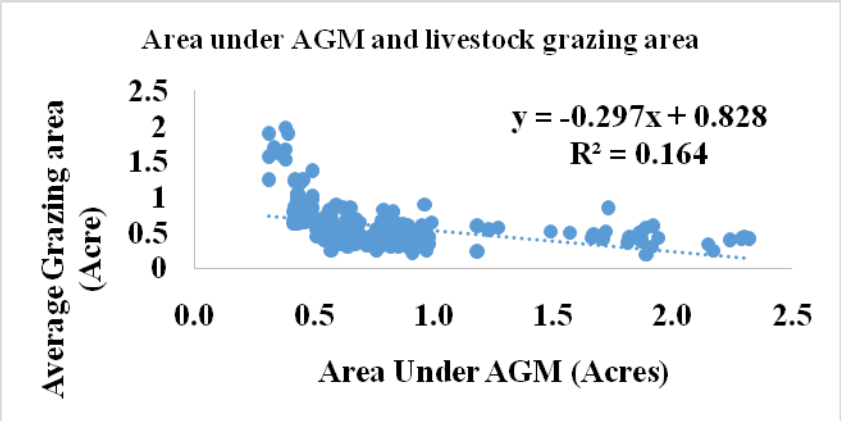

Figure 4.10: Scatter plot of simple linear regression results showing the influence of Acreage of land under AGM on livestock grazing space

Figure 4.10 shows that 16 % variation of average acreage of grazing land can be explained by acreage of land under AGM. This implies that the acreage of land under AGM influences the acreage of grazing land in Ikolomani Sub County. This findings supports Wassenaar *et al*(2006) which reported that in Africa, pasture land is degrading due to AGM. Pasture land is being converted into other uses like crop land, urban areas and AGM activities. According to Hagos and Getal 2016, in Africa AGM land disturbances and loss of biodiversity particularly woodlands and grasslands commonly leads to tension between miners and local communities. The situation as reported in other parts of Africa is seemingly the same in Ikolomani Sub County.

On the contrary 84 % variation of the average acreage of grazing land can be explained by factors not considered in this analysis. These factors could entail; Roads and trails. Krueger *et*

al(1982) reported that steep slopes, dense vegetation and rocks often act as barriers to cattle movements reducing access to some feeding sites. Climate change and range land disturbances influenced by climate change will affect the entire ecosystem services that range land provide including forage for wildlife and livestock production. (Karl *et al* 2009). Physical properties of soil such as texture and porosity affect the nutritive quality of forage more or less indirectly. Poorly aerated soils greatly limit or decrease the absorption of essential elements, especially phosphorus .Chemical properties of the soil may determine the nutrients that the plant are able to absorb (Zhang 2018).Gnskopp *et al*(2000) alluded that, forage improvement by burning or fertilizing in combination with water and trails can improve livestock distribution. Bailey *et a*l (2004)connoted that, land treatments such as burning, bush removal weed control seeding and fertilization can result in changes to feeding sites that increase the rate of nutrient capture. Weed and bush control often improve the yields and accessibility of forage. Hence increasing the acreage of grazing land. Improved access in addition to improved forage quality and quantity attract grazing animals this results in increased grazing use (Mebrate *et al* 2019).However these factors were not the focus of this study.

When the regression analysis result for figure 10 is compared to the findings in Table 4.16, 92.6 % of respondents said that they strongly agree that the methods used in gold mining activities have a big influence on the acreage of grazing land. About 99.3% of respondents strongly agree that these methods used in gold mining activities are responsible for the reduction of livestock grazing area. Apparently the two findings confirm that acreage of land under AGM influence the average acreage of grazing land in Ikolomani Sub County.

More over the focused group discussion on the influence of the acreage of land under AGM on the acreage of grazing land revealed that; AGM has led to an accumulation of Stock piles (soil, rocks) all over the landscape which over time is invaded by alien grass species which cannot be utilized by animals for grazing purposes.

In Ikolomani, underground streams are diverted by miners as they drill holes. In so doing the water is pumped to the surface causing much of the surface land to be flooded with water. Flooded land surface discourages livestock grazing for it interferes with the growth of grass. This is evidenced by plate 4.9Showing flooded grazing land by underground water pumped to the surface by miners in Eregi.

Plate 4.9: Flooded grazing land by underground water pumped to the surface by miners in Eregi.
Source: Field 2020

In Ikolomani miners use pumping machines with generators and blasting machines. These machines make a lot of noise. This scares off animals from enjoying natural grazing in their ecosystem. This was evident in the most factories visited by the researcher through hearing and observation.

Soil erosion is also rampant in areas under gold concession by miners in Ikolomani Sub County. This is because land is exposed and rendered bear hence vulnerable to the agents of erosion such soil is deprived of its essential mineral elements for they are washed away by water which is the main agent of soil erosion in mined areas thereby inhibiting the growth of grass. This implies that AGM activities lead to reduction on livestock grazing area.

Also according to Focused Group Discussions, siltation of streams where miners carry out the washing of gold bearing rocks is greatly reducing on the availability of clean drinking water for livestock use and that miners use mercury for amalgamation of gold in gold processing. The use of mercury is greatly contaminating water for livestock drinking. This agrees with the findings by Yaaba and Ato (2017) that AGM workers and livestock are exposed to cyanide and mercury which make them vulnerable to all manner of health risks .

A respondent reported that during dry periods when mining is at its pick most miners who smock bang (cannabis sativa) are not careful on how to dispose the remnants which occasionally burn the grass in mining areas. This limits on the availability of grass for livestock.

By observation, previously livestock grazing area was covered by heaps of non-bio generable sacks which are used to sale and carry crushed gold ores for washing in factories and on the nearby streams. A farmer reported that he was not comfortable with the sacks on his grazing pace as they were very dangerous when consumed by livestock for they have caused. Constipation which has resulted to livestock death .This is supported by plate4.6. He confessed that occasionally he tries burning them but the rate of disposal of the sacks from AGM activities is high rendering his efforts futile.

Respondents also revealed that it has been challenging on rearing of livestock as many of them have had accidents and died in abandoned mined pits and caved in landscapes as a result of mining This is in line with (Tenkkorang 2013) that artisanal mining area are characterized with many abandoned open pits which pose a threat to livestock grazing .This is supported by plate4.10 showing an abandoned mine pit that pause danger to livestock in Lirhembe

Plate 4.10: An abandoned mined pit in Lirhembe

The respondent further resonated that they are however trying to utilize such destroyed land by planting Napier grass for their animals. This is supported by plate 4.11 showing Napier grass

planted in a once grazing space that has curved in as a result of AGM in Musoli in Ikolmani Sub County.

Plate 4.11: Napier grass planted in a once livestock grazing area that had curved in as a result of AGM in Musoli in Ikolmani Sub County.

In conclusion , the findings revealed that, the acreage of land under AGM has influenced livestock grazing area in Ikolomani Sub County as supported by Table 4.16 showing the extent to which creage of land under AGM influence livestock grazing area and Figure 4.10 which shows that the acreage of land under AGM has influenced livestock grazing space by 16 %. The low percentage is because grass produces sterile fillers which regenerates at a fast rate after any form of land degradation from anthropogenic activities (FIS ,2021). Nonetheless acreage of land under AGM in Ikolomani Sub County has led to ;AGM factories occupying once grazing area, Abandoned open pits have degraded grazing area, stock piles and overburdens occupy once grazing area Non generable sacks cover grazing space, siltation and mercury contaminated streams, noise from gold ore crushing machines that scare grazing animals, flooded grazing fields and grass being set on fire by miners who smoke. In the context of sustainability AGM is rendering other livelihood assets not viable and therefore AGM should embrace modern environmental mining methods.

4.5.1 Information Provided by the County Natural Resources Management Officer

In addition to this we had the County Petroleum and mining Officer revealing that: The sub county lacks formal legalities in the AGM sector which affects workers safety and health. Their activities are not well structured and regulated. This is due to laxity in the law enforcers who are compromised by hand outs in the form of money. Therefore the miners do not pay a lot of attention to the requirements of bodies such as NEMA. There is lack of financial assistance to help on reclaiming mined land which is derelict. There is lack of training. The miners are not exposed to knowledge pertaining safe methods of mining. UNEP has been urging governments to set up structures to reduce the level of mercury, a toxic metal used by miners to extract gold and also to improve the hygienic conditions in the mines. Miners suffer from poor ventilations, lack of safety equipment, improper use of chemicals and obsolete equipment's.

As an activity, AGM uses a lot of water, AGM has caused pollution of streams through mercury use, caused buildup of SiO_4, poor sanitation on mining areas as miner's crowd in mining sites. Water is likely to be polluted from human waste. This water is to serve as drinking water for both livestock and human life. Besides streams are highly affected by siltation, AGM miners carry the crushed gold ore for washing in the nearby streams. Erosion is among the factors contributing to reduction in vegetation compositions. AGM activities are accompanied by environmental degradation which has resulted into abandoned mine pits , pools of stagnant water and sacks which are used to carry the crushed ore prowling on the grazing surface limiting grazing animals. Most miners risk their lives in unregulated black markets that accounts for upto a quarter of the world gold as the gold is sold to middle men who pay Kshs. 4600 for 1 gram of gold.

CHAPTER FIVE
SUMMARY, CONCLUSIONAND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of findings, key conclusions based on the study findings, recommendations and areas of further research.

5.2 Summary of Findings

The influence of artisanal gold mining income on the acreage of arable land was the first investigation based on specific objective one. Majorly the expansion of AGM activities were seen to be responsible for decreased acreage of arable land. The regression model summary for the influence of AGM income on acreage of arable land produced r^2 = 0.63, Meaning that AGM income indicated 63% of the variance in changes of acreage of land The analysis on the influence of acreage of land under AGM on food crop yields revealed that , the acreage of land under AGM influenced food crop yields in Ikolomani Sub County. The overall regression model produced r^2= 0.55.This shows that the acreage of land under AGM indicated 55 % of the variance in food crop yields. Which was statistically significant. From these results it is concluded that the increased acreage of land under AGM led to the decrease in food crop yields. The analysis of the acreage of land under AGM and its influence on the livestock grazing area indicated the following results; Linear regression analysis between the study variables, produced r^2 = 0.16, Meaning that acreage of land under AGM indicated 16 % of the variance in livestock grazing area Expansion of AGM activities, lead to the decrease in livestock grazing area.

5.3 Conclusion

The study attempted to assess and analyze in detail the influence of artisanal gold mining on agriculture in Ikolomani Sub County of Kakamega County. Majorly it was observed that the expansion of AGM activities for income generation was responsible for decreased acreage of arable land in the study area. The regression model summary produced r^2 = 0.63, Meaning that AGM income indicated 63% of the variance in changes of acreage of arable land. This is because of; AGM pits occupying much of acreage of arable land ,exposure of the parent rocks due to extensive soil erosion, construction of factories for AGM on arable land, immigrant's pressure on land, poor exploitation mechanisms which make the land to cave in., compaction of land by motorcycles and human traffic in AGM mining areas and large lands being under gold

concessions rendering them unproductive for arable purposes. This therefore confirmed the credibility that AGM income influenced the acreage of arable land.

The analysis on the influence of acreage of land under AGM on food crop yields revealed that , the acreage of land under AGM influenced food crop yields in Ikolomani Sub County. For regression analysis, the overall regression model $r^2 = 0.55$ %. The acreage of land under AGM indicated 55 % of the variance in food crop yields. Which was statistically significant. This has been attributed to; AGM factories occupying once arable land thereby reducing food crop yields, soil erosion has resulted to loss in soil fertility, immigrants are putting pressure on arable land leading to increased carrying capacity of the land, compaction of arable land making it poorly aerated for agricultural productivity, collapsing or carving in of arable land rendering farming practices difficulty hence reduced food crop production. Lack of labour for farming activities as they opt for AGM ones. This is also as a result of mercury related sickness and malaria. From these results it is concluded that the increased acreage of land under AGM led to the decrease in food crop yield

The analysis of the acreage of land under AGM and its influence on livestock grazing area indicated the following results; the regression model summary produced $r^2= 0.16$. Meaning that area of land under AGM indicated 16 % of the variance in changes of livestock grazing area. Which was statistically significant. This is because of ; AGM factories occupy once grazing area, Abandoned open pits have degraded livestock grazing area, stock piles and overburdens occupy once grazing area Non generable sacks cover grazing area, siltation and mercury contaminated streams, noise from gold ore crushing machines that scare grazing animals, flooded grazing fields and grass being set on fire by miners who smoke. From these results it is concluded that the increased acreage of land under AGM led to the decrease in livestock grazing area.

5.4 Recommendations

Enhancing the control and management of AGM activities in the study area could help reduce the chances of decrease in the acreage of arable land. It will also help in curbing environmental damage brought about on agricultural land by uncontrolled AGM activities. Alongside this Practicing improved farming methods, intensifying crop

production and diversifying crop production could help solve the problem of reduced crop yields. Finally,

Rehabilitation of potholes and depressions in mining areas. Measures such as controlling expansion of AGM activities, could help the problem brought about by reduced acreage of grazing land as a result of expansion of AGM activities. Controlling the expansion of AGM activities will also ensure its sustainability for future.

5.5 Areas of Further Research

Further research should be conducted in the study area employing alternative set of variables. For example, "The effect of Artisanal Gold Mining on water quality in Ikolomani Sub County.' Another important area of research is to establish mitigation and copying strategies against the effect of AGM activities on the acreage of both arable and grazing land.

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APPENDICES

APPENDIX 1: CONSENT FORM

Maseno University Ethics Review Committee

P.o box, private bag

Maseno Kenya.

Content and purpose of the study

The researcher provided adequate and clear explanations on the purpose of the study to each respondent. The purpose of the study was to investigate the relationship between artisanal gold mining (AGM) and agriculture in Ikolomani Sub County of Kakamega County. The study sought respondent's permission to participate in the study while assuring them that their participation was voluntary and confidential. Information from the other sources or authors to support this research was acknowledged in the form of reference. The researcher sought permission from the local administration officers to carry out research in their areas of jurisdiction. In addition to this, the researcher also sought the consent of community.

Statement of voluntarism

The researcher is a student undertaking a degree course in master of Arts in geography at Maseno University carrying out a research on; an assessment of the influence of artisanal gold mining on agriculture in Ikolomani Sub-County Kakamega County Kenya. The information you provide will be treated with confidentiality and entirely used for purposes of this study.

Risks and benefits of the study

The risks that were involved in the study included; Possibilities of accidents such as falling in excavated open pits.

APPENDIX 2: PARTICIPANTS CONSENT FORM

GRACE ANDEYO ONOKA.

MASENO UNIVERSIY,

DEPARTMENT OF GEOGRAPHY AND
NATURAL RESOURCE MANAGEMENT,
SCHOOL OF ARTS AND SOCIAL SCIENCES.
P.O BOX. PRIVATE BAG,
MASENO KENYA.

TO RESEARCH PARTICIPANTS:

Dear Respondents

RE: PARTICIPANT'S CONSENT FORM.

You are required to participate in a research study on ''the influence of artisanal gold mining on agriculture in Ikolomani Sub County Kakamega County Kenya. 'All your responses and information will be treated with utmost confidentiality and your identity remain anonymous. You are free to ask any questions before agreeing to take part.

I have been briefed on what the study is all about. I am assured that the information I give is confidential and I therefore agree to participate in the above study.

……. **…….**

Signature Date

APPENDIX 3: HOUSEHOLD QUESTIONNAIRE

MASENO UNIVERSITY

FACULTY ENVIRONMENT AND EARTH SCIENCES

Questionnaire No……. Date ……

INTRODUCTION

The researcher is a final year postgraduate student at Maseno university, undertaking a master's programme in Geography. The purpose of the study for which the questionnaire is designed, is to carry out an assessment of the influence of artisanal Gold mining on agriculture in Ikolomani, Sub County, Kenya. All the information provided in this questionnaire is strictly for academic purposes and not for any other purpose.

Your identity will not be associated with the information you provide. The information will strictly be treated with utmost confidentiality and only be used for analytical purposes of the study. Please answer all questions as honestly as possible. Give your responses by putting a tick (√) or number (1, 2, 3 etc) in the appropriate space that corresponds with your response.

SECTION A

1.0Background information about the respondent (Bio Data)

1. Name of respondent ……

3. Gender of the respondent [ ] 1. Male 2. Female

4. Age of the respondent [ ] 1. Below 18 2. 18 – 30 3. 31-40 4. 41 -.50

5. above 50

5. Marital status [ ] 1. Single. 2. Married 3. Widowed 4. Divorced

6. Relationship to the household head. [ ] 1. Head 2. Spouse 3. Son. 4. Daughter 5.

Others; Specify……

7. Educational background of the respondent [ ] 1. Never 2. Primary 3. Junior High School 4. Senior High School 5. Certificate 6. Commercial/Technical/ Vocational 7. Diploma 8. Higher National Diploma Secondary 9. University Degree.

8. Main source of livelihood to the household [ ] 1. Crop farming 2. Livestock

Farming [ ] 3. Formal employment [ ] 4. Trade [ ]5. Remittance [ ] 6 . Mining

Others. Specify……

9. What is the main land use? [ ] 1. Cash Crop farming 2. Subsistence farming

3. Livestock keeping 4. Mining 5. Forestry

10. Number of children [ ] 1) None 2) 1 – 2 3) 3 - 4. 4) 5 and above

LAND USE PATTERNS IN THE STUDY AREA (IKOLOMANI)

The following questions intent to establish land use patterns in the study area.

1. What is the acreage of your land? 1. Below 1 acre [ ] 2. 1 – 4 acres [ ] 3. 5 - 10 acres [ ]

4. Over 10 acres

2. What percentage of this land have you preserved for crop farming 1. Less than 20% [ ]

Between 20% and 50% [ ] 3. Between 51% and 75% [ ] More than 75% [ ]

3. Which crops do you grow on this farm. Arrange in order of importance.

……

……

4. What percentage of this land have you preserved for livestock grazing? 1. Less than 20% [ ]

Between 20% and 50% [ ] 3. Between 51% and 75% [ ] More than 75% [ ]

5. What type of livestock do you keep on your farm. Arrange in order of importance.

……

……

6. What portion of land have you preserved for artisanal gold mining? 1. Less than 20% [ ]

Between 20% and 50% [ ] 3. Between 51% and 75% [ ] More than 75% [ ]

7. Are the following income generating activities major in the Sub County ?

i) Livestock rearing Yes[ ] or No [ ]

ii) Cultivation of food crops. Yes [ ] or No [ ]

iii)Petty trading Yes [ ] or No [ ]

iv) Artisanal gold mining. Yes [ ] or No [ ]

v) Fishing Yes [ ] or No [ ]

vi) Cultivation of cash crops Yes [ ] or No [ ]

vii). Hunting. Yes [ ] or No [ ]

For each economic activity respond by YES or NO.

THE EFFECT OF ARTISANAL GOLD MINING IN COME ON THE ACREAGE OF ARABLE LAND.

The statements below are aimed at finding the extent to which artisanal Gold mining income influences acreage of arable land. Please tick the most appropriate response on how you agree with each statement using the scale given in the table.

1 **To a very small extent**	2 **Small extent**	3 **Moderate extent**	4 **Large extent**	5 **To a very large extent**

S/No	**Item**	**1**	**2**	**3**	**4**	**5**
1	Gold mining is a widespread economic activity in the sub county					
2.	Gold mining creates a reliable and alternative job opportunity for inhabitants in the sub county.					
3.	You have engaged in AGM for over five years .					
4.	To what level of extent do you practice AGM on your farm?					
5.	AGM is the main economic activity in the sub county.					
6	AGM has been growing in importance over other economic activities over the years in the sub county					
7	The land area preserved for AGM has been increasing over time in the sub county.					
8	Income from AGM is used in enhancing the acreage of arable land.					
9.	The acreage of arable land has been decreasing since 2018 in the Sub county.					
10	This decrease in acreage of arable is attributed to expansion of AGM activities in the Sub county.					
11	The acreage of arable land has been increasing since 2018 in the Sub county.					
12	This increase in acreage of arable land since 2018 to the present is attributed to contraction of AGM activities in the sub county.					

13 On average what was your monthly income from gold mining according to this table?

Estimate the monthly income from gold mining

Income 2017	**Income 2018**

14 What was the acreage of arable land according to the table below

Estimate the acreage of arable land in acres

2018 First season	
2018 Second season	
2019 First season	
2019 second season	

THE INFLUENCE ACREAGE OF LAND UNDER AGM ON FOOD CROP YIELDS

The statements below are aimed at finding how the acreage of land under AGM influences food crop yields. To what extent do you agree with the following statements. Please tick the most appropriate response on how you agree with each statement using the scale given in the table.

1 Strongly disagree	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly agree**

S/No	**Item**	**1**	**2**	**3**	**4**	**5**
13.	The gold mining site was once used for farming					
14.	You have paid a visit to the gold mining site in the sub county.					
15.	The gold mining site was once used for food crop farming					
16.	The methods used in the gold mining activity has had effects on the food crop yield					
17.	These methods used by gold miners are responsible for the reduction of food crop yields in the sub county					
18.	The average seasonal yields of arable land reduced between 2018and 2019					
21.	This reduction was mainly believed to be caused by gold mining activities.					
22.	The average seasonal yields of beans on your arable land reduced between 2018and 2019.					
23.	This reduction was mainly believed to be caused by gold mining activities.					

24. Which portion of land in acres have you apportioned for artisanal gold mining activities?

Estimate the average maize yield per acre in kgs in the following seasons.

22018	FIRST SEASON	
2018	SECOND SEASON	
2019	FIRST SEASON	
2019	SECOND SEASON	

Estimate the average beans yield per acre in kgs in the following seasons.

2018	FIRST SEASON	
2018	SECOND SEASON	
2019	FIRST SEASON	
2019	SECOND SEASON	

……
……
……

THE ACREAGE OF LAND UNDER AGM AND ITS INFLUENCE ON LIVESTOCK GRAZING AREA.

The statements below are aimed at finding how the acreage of land under AGM influences on livestock grazing area. To what extent do you agree with the following statements? Please tick the most appropriate response on how you agree with each statement using the scale given in the table.

1 Strongly disagree	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly agree**

S/ No	**Item**	**1**	**2**	**3**	**4**	**5**
24.	The gold mining site was once used for livestock grazing.					
25.	The methods used in gold mining activities have a big influence on livestock grazing area					
26.	These methods used in gold mining activities are responsible for the reduction of the livestock grazing area					
27.	The activities of gold miners are contributing to reduction in the number of livestock reared in the sub county.					

28. Estimate livestock grazing area in the following seasons.

2018	FIRST SEASON	
2018	SECOND SEASON	
2019	FIRST SEASON	
2019	SECOND SEASON	

29. What do you think can be done generally to solve the problems of harmful effects of the AGM on livestock grazing area ?

……
……..……

THANK YOU FOR YOUR COOPERATION

APPENDIX 4; OBSERVATION CHECKLIST

The following will be the observation checklist during the field study.

Methods used in AGM.

The techniques and tools used in AGM

Food crops cultivated in farms.

Land occupancy by AGM activities

Abandoned mined areas

Livestock reared by residents

Deforested landscapes

Pools of stagnant water

Acreage of land apportioned to food crop and livestock grazing

APPENDIX 5: Focus Group Discussion Guide

It was developed and comprised of a set of open – ended questions prepared on specific topics on

The influence of AGM on livelihoods in the study area.

TOPIC	**DISCUSSION**
General Information	**Research team and the respondents : please introduce yourselves and tell us your age and level of education**
Purpose	**To gather information on the influence of AGM on livelihoods in Ikolomani Sub County.**
Methodology	**FGD** **Please feel free to give as much information as possible on the topics we are about to discuss.** **It is not an exam all answers will be correct'** **Do you have any question you would like to ask before we begin, if not please ask at the end of the session?**
GENERAL TOPIC	**QUESTIONS** **Describe how AGM income is influencing on the acreage of arable land in Ikolomani Sub County?** **Describe how the acreage of land under AGM is influencing on food crop yields in Ikolomani Sub County?** **Describe how acreage of land under AGM is influencing on livestock grazing area in Ikolomani Sub County?**

APPENDIX 6: Key Informant Interview Schedule

1What is the influence of AGM income on the acreage of arable land?

2) What is the influence of acreage of land under AGM on food crop yields in the Sub County?

3)What is the influence of acreage of land under AGM on the acreage of arable and livestock grazing space ?

4) What is the state of law enforcement on AGM in the Sub County?

5)Does the County government assist in addressing these effects on agriculture in the Sub County?

7)What other institutions help in addressing these challenges in the Sub County?

8) What are some of the efforts made by these institutions .

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

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FROM: Secretary - MUERC

DATE: 9th January, 2020

TO: Grace Andeyo Onoka
PG/MA/NS/0000119/2014
Department of Geography
School of Environment and Earth Sciences
Maseno University
P. O. Box, Private Bag, Maseno, Kenya

REF: MSU/DRPI/MUERC/00712/19

RE: Assessment of the Influence of Artisanal Gold Mining on Livelihoods in Ikolomani Sub-County, Kakamega County, Kenya. Proposal Reference Number MSU/DRPI/MUERC/00712/19

This is to inform you that the Maseno University Ethics Review Committee (MUERC) determined that the ethics issues raised at the initial review were adequately addressed in the revised proposal. Consequently, the study is granted approval for implementation effective this 9th day of January, 2020 for a period of one (1) year. This is subject to getting approvals from NACOSTI and other relevant authorities.

Please note that authorization to conduct this study will automatically expire on 8th January, 2021. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 15th December, 2020.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach the MUERC Secretariat by 15th December, 2020.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

MASENO UNIVERSITY SECRETARY 09 JAN 2020 ETHICS REVIEW COMMITTEE

Dr. Bonuke Anyona,
Secretary,
Maseno University Ethics Review Committee.

Cc: Chairman,
Maseno University Ethics Review Committee.