EFFECTS OF ARTISANAL GOLD MINING ON AGRICULTURAL LAND USE IN KAREMO DIVISION, SIAYA COUNTY, KENYA

BY

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DECLARATION

Declaration by the student

I declare that this Thesis is my original work and has not been submitted for award of a degree in any other university. The work reported herein has been carried out by me and all sources of information have been acknowledged.

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DEDICATION

To my wife Lydia, my lovely daughters Joy, Hope and Patience, my mother Mary Otieno and my brother Maurice Achuo who has been our family pillar.

ABSTRACT

Artisanal Gold Mining (AGM) is an economic activity particularly in developing countries. The activity has various negative effects on agricultural productivity like loss of farm land as reported in Peru and Ecuador. In Ghana, AGM has absorbed the agricultural labour force as most households in the mining villages are actively involved in AGM activities. AGM is a common economic activity in Migori, Narok, Kakamega and Siaya Counties of Kenya. In Karemo division of Siaya County, AGM as an emerging economic activity has encroached on agricultural land leading to reduction in land acreage, soil erosion, loss of soil fertility and injuries to livestock. These effects have led to overall reduction in the quantity and quality of agricultural output. Although the low agricultural production is supplemented by income from gold sales, AGM is a short lived activity and the households often revert back to agriculture once gold is depleted. Post AGM rehabilitation strategies to mitigate the AGM challenges on agricultural land are inadequate. Thus, this study aimed to assess the effects of AGM on agricultural land use in Karemo division of Siaya County. Its specific objectives were to: establish the effects of AGM on agricultural land acreage; establish the relationship of hours spent by households on AGM and on agriculture and to establish the rehabilitation status of land under AGM. A cross-sectional descriptive research was used and a random sample of 384 households was drawn from 15,200 households using Fischer et al formula. Primary data on the extent of AGM on agricultural land area was collected using a household questionnaire; this was supplemented by interview schedule for key informants, photography and observation checklist. Secondary data on the history of AGM in Karemo division was collected from academic reports and government institutional reports. Data analysis was done using independent sample t- test to show whether there was a significant difference between land under agriculture and that under AGM. Pearson correlation was used to determine the relationship between hours spent on AGM and agricultural activities. Percentages were used to establish the rehabilitation status of land under AGM. The findings were presented in the form of tables, frequencies, percentages, pie charts, bar graphs and photography. The findings revealed that the acreage of land under AGM was significantly ($p<0.05$) larger than that used for agricultural purposes. A moderate negative significant correlation between hours spent on AGM and on agricultural activities ($r=-.550$, $p<0.01$) was reported. Also, there was a small attempt of land rehabilitation after AGM as revealed by a percentage of 25.5% of the households that either planted bananas and trees or refilled the abandoned mines. It was concluded that AGM activities in Karemo division had encroached into agricultural land and reduced its acreage, households spent more hours in AGM activities than agriculture and there was minimal rehabilitation of land after AGM. The study recommends that the households should rehabilitate mined parts of their farms for agricultural productivity. These findings are relevant to the policy makers in designing guidelines that would inform on post AGM productive land use.

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LIST OF ABBREVIATIONS AND ACRONYMS

AGM	:	Artisanal Gold Mining
FAO	:	Food and Agriculture Organization
ICMM	:	International Council on Mining and Metals
IIED	:	International Institute for Environment and Development
IRIN	:	Integrated Regional Information Networks
KNBS	:	Kenya National Bureau of Statistics
NEMA	:	National Environment Management Authority

DEFINITION OF OPERATIONAL TERMS

1. **Artisanal gold mining**- Artisanal and small scale gold mining refers to mining practiced by individuals, groups or communities often informally (illegally) in developing countries.
2. **Agricultural land-** is typically land devoted to agriculture through the systematic and controlled use of other forms of life, particularly the rearing of livestock and production of crops, to produce food for humans. It is the land resource upon which agriculture takes place due to its ability to produce agricultural products i.e. crops and animal products.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Artisanal gold mining (AGM) refers to informal mining activities carried out using low technology or with minimal machinery (Holloway, 1997). It is estimated that more than 100 million people rely on this sector for income, mainly in developing nations, (Telmer, 2009). AGM activities provide an important source of livelihood for both proximate and distant communities (Jennings, 1999). In such communities, mining serves as both a means of survival for impoverished farmers and as an engine for small business growth and agricultural expansion, complementing national, micro-, small-, and medium-size enterprise projects (Lange et al., 2007). AGM represents an important means of income diversification for many farmers, making it important to simultaneously address both agriculture and mining issues while improving people's lives. For example, in areas with distinct dry and rainy seasons, AGM provides farmers with income-generating opportunities during the dry season, while subsistence agriculture occupies them during the rainy season (Chupezi et al., 2009).

The contribution of small-scale mining may also produce domino effects if enhanced revenues and infrastructures are reinvested in the same locality (Heemskerk, 2015). AGM drives demand for goods and services through the generation of purchasing power (Busia, 2015). For instance, it is common knowledge that in small-scale mining communities, both men and women engage in income-generating activities such as the selling of food, of mining-related products, and of gold and other minerals. (Ingrid, 2006). Although these studies try to justify the importance of AGM i.e. by employing a significant proportion of the work force in many localities where they operate, the informal nature of this employment and lack of official records makes it difficult to quantify.

However, in Peru, research done on the institutional challenges for AGM and sustainability, found that AGM removes vegetation and soils, interrupts ecosystem service flows, and results in inevitable and often permanent farmland loss (Bebbington et al., 2009). According to Ghana's ministry of Mines and Energy, approximately 30% of Ghana's land is under gold concession to gold mining firms, and each year more arable land is diverted to this use (Agyei, 2008). The result of the socio-economic effect of mining on smallholder agriculture in the area includes displacement of people and land, increased migration into mining areas, environmental damages related to water quality, tailing management, noise and dust pollution as well as ecosystem disturbances, shortage of labour availability to agriculture, and contamination of crops as well as reduction in crop yields (Ashley, 2004). These studies however, have not addressed how AGM's encroachment on agricultural land acreage affects the other agricultural land uses in areas where it is newly discovered. These could include open hole that cause injuries to livestock, soil erosion, overall reduction in land acreage meant for agricultural practices and poor crop yields as a result of relatively infertile subsoil which overlies the top soil. This is a concern addressed by this study.

Majority of the people involved in AGM activities are men and women. The highest accumulation being between the ages of 25-45years (Agyei, 2008). The same age bracket constitutes the most active agricultural population; this has led to labour conflicts between agriculture and AGM. Where there exists large gold ores AGM plays a key role in the country's economic growth. Further, individuals directly involved in the AGM activities may experience quick financial earnings (Schmidt, 2012). However, without investing into adequate measures, the mining activities can adversely influence agricultural land. For example soil erosion is

common around mines hence limiting the agricultural land as the mined sites are no longer able to accommodate crop farming and cattle grazing (Wangari et al., 2012).

AGM is a rational economic choice for people seeking to escape poverty or improve their lives (Hilson, 2003). Artisanal miners mine because it brings them more income and faster economic returns than other livelihoods such as agriculture or because traditional livelihood activities are becoming less viable due to climate change and other reasons (Nyambe, 2009). In Uganda, for example, the average miner contributes almost 20 times more to the Gross Domestic Product (GDP) than animal farming, forestry or fishing (Hilson, 2003). However, the new labour exodus for the artisanal gold mines seems more intense given the lure of wealth driven by high international gold prices. The young men are also not returning home during the rainy season to work on the farm (Chupezi et al., 2009). Furthermore, their complete exodus from agriculture has negative implications for food production on the national scale in some countries and more generally in the developing countries (Laurent, 2011). This has led to over-reliance on excessive levels of food imports in such countries. These studies have addressed the overall problem of agricultural labour exodus towards AGM and the reasons for the same. However, they failed to look at the overall effects of demographic characteristics on AGM and agriculture. Such characteristics include the involvement of households in terms of gender, age, educational level, marital status, household-sizes and occupational status. The involvement of each of these characteristics in terms of number of man-hours allocation to AGM and agriculture has not been addressed, which is an objective of this study.

AGM further involves the excavation of underground shafts in pursuit of the gold ores (Jennings, 1999). Normally, the miners will make horizontal shafts as they follow the gold seams. If the shafts are not rehabilitated, crops with tap roots and that acquire their food from deep down the

soils will not flourish in such areas (Jenipher et al., 2003). Such areas are also susceptible to soil collapse hence not suitable for both settlement and agricultural production (Heemskerk, 2005). However, AGM is a temporary use of land, with the operating life of a mine lasting from a few years to several decades (Hilson, 2002). Current best practices in mine closure require the reclamation or rehabilitation of decommissioned mine sites, which involves returning the land and watercourses to an acceptable standard of productive use (Gavin, 2000). Although these studies attempt to address the need to rehabilitate mined lands so as to enable the continuity of other agricultural land uses, rehabilitation strategies have not been identified, which is an objective of this study.

Research done on the artisanal gold mining activities in Kenya, established that the activity is not as prominent as it is in other African countries such as South Africa and Ghana. This is because Kenya never had international gold explorers panning for its gold reserves. It has been discovered that AGM is only carried out in pockets of villages that do experience occasional gold booms (Ogola, et al., 1990).At the local level, the uncontrolled digging and abandoning of pits has caused destruction of land beyond economic and technical reclamation. Mine pits not only make land unfavorable for agricultural practices following closure, but also adversely impact livestock and wildlife resources. Some of the environmental impacts caused by AGM include diversion of rivers, water siltation, landscape degradation, deforestation, destruction of aquatic life habitat and widespread mercury pollution (Ogola, et al., 1990). The specific post AGM rehabilitation strategies however, have not been addressed by these studies. Such strategies could include; application of fertilizers, change of livestock grazing systems e.g. adopting zero grazing and refilling of abandoned holes, which is an objective of this study.

1.2 Statement of the Problem

AGM is an emerging economic activity in Karemo division, Siaya County. It has provided income diversification to local farmers as they are able to gain economically from both AGM and agricultural activities. Further AGM derives demand for goods and services through the generation of purchasing power. However, it is a temporary land use with operating life of a mine lasting for a few years to several decades. The uncontrolled digging and abandoning of pits can cause destruction of land beyond economic and technical reclamation. The labour exodus towards AGM also seems so intense, with negative implications for food production. The digging of underground horizontal shafts in pursuit of gold seams also make land susceptible to collapse hence not suitable for settlement and agricultural practices. Further, the heaps of soil and rock debris exposed from mines not only make the land ugly, but also limit other land uses in that; the exposed sub soils are relatively infertile, hence pasture and other agricultural crops cannot flourish. The abandoned open mines can also cause injuries to both livestock and human populace. Proper rehabilitation strategies therefore need to be put in place. Despite the numerous negative effects of AGM on agricultural land uses, it is very difficult to convince the households to abandon AGM. Both AGM and other agricultural uses therefore need to be carried out in a way that they complement each other.

1.3 Objectives of the Study

General objective

To assess the effects of AGM on agricultural land use within Karemo division of Siaya County

Specific objectives

1. To establish the effects of artisanal gold mining on agricultural land acreage.
2. To establish the relationship of hours spent by households in AGM and on agriculture.
3. To establish the rehabilitation status of land under artisanal gold mining.

1.4 Research Questions

1. What is the effect of artisanal gold mining on agricultural land acreage?

2. How many man-hours are spent on AGM and agriculture according to age and gender?

3. What rehabilitation strategies have been put in place by households to reclaim mined lands?

1.5 Justification of the Study

Land is a scarce resource that needs to be conserved for current and future generations. One of the causes of diminishing agricultural land is AGM. Overall, AGM in the developing world often interferes with livelihood foundations, forcing populations to relocate and farmers to develop alternative income strategies (Schueler et al., 2011). Siaya County, especially Karemo division, is limited in terms of employment opportunities. The availability of gold ore deposits is a blessing to the local inhabitants as it provides them with alternative employment opportunities. However most households have limited land acreages, which is shared between AGM,

agriculture and settlement. Since AGM provides quick financial returns compared to agriculture, most households are increasingly apportioning larger shares of their land to AGM. AGM is however, a temporary activity and the miners would always revert to their agricultural practices once gold gets depleted. AGM's activities reduce the ability of the land to sustain agricultural production if no rehabilitation measures are put in place. The integration of the two practices to allow the households to benefit from AGM and still retain the capacity for post AGM agricultural land use is required.

1.6 The Scope and Limits of the Study

The study covered all the eleven sub-locations within Karemo Division. It focused on the effects of AGM on agricultural land use because AGM affected nearly all the households land within Karemo division. Although AGM is practiced in several regions in Kenya e.g. Kakamega, Migori, Narok etc, Karemo division was chosen due to time constraints and limited resources. The other limitation during the study was the accessibility of some areas due to bad weather roads. Some households were also not willing to give information on their AGM activities for fear of victimization. However after clarification by the researcher and research assistants, they gave out the needed information, and the researcher was able to complete this work.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature was reviewed as per individual objectives i.e.; the acreage of land under AGM and agriculture, the relationship of hours spent by households in AGM activities and in agriculture and by assessing the rehabilitation status of land under AGM. Finally a conceptual frame work was developed to show the causes and influences of gold mining on agricultural land.

2.2. The effects of Artisanal Gold Mining on Agricultural Land Acreage.

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 (Bebbington, 2009). Since not all services can be maximized simultaneously, every land use decision involves trade-offs, often resulting in competing interests and substantial conflicts about the desired use of land among stakeholders (Rodriguez et al., 2006). Economic land use theory suggests that markets resolve such conflicts via differences in land rents that will lead to the most profitable land use allocation (Hollaway, 1997). However some of the profitable decisions may lead to degradation of land hence conflicts among land users (Hubacek et al., 2002).

AGM is a major economic activity in many developing countries. Its operations, whether small or large-scale, are inherently disruptive to the environment, producing enormous quantities of waste that can deleteriously impact for decades (Hoadley, 2004). The environmental deterioration caused by mining occurs mainly as a result of inappropriate and wasteful working practices and rehabilitation measures. Mining has a number of common stages or activities, each of which has potentially adverse impacts on the natural environment, society and cultural heritage, the health and safety of mine workers and community based in close proximity to

operations (Hentschel et.al, 2003).Some of the impacts of AGM include, displacement of local people from ancestral lands, marginalization and oppression of people belonging to lower economic classes. Tanzania, for example is endowed with abundant mineral resources of international value, including gold. However, mining has provided marginal contributions to the communities surrounding operations (Wangari et al., 2012). Despite the widespread documentation of increased mineral production within these regions, minimal analysis has been undertaken to determine the impacts associated with the expansion of AGM activities

AGM is an important component of the economy of many nations, particularly in the developing world. For example, 25% of Guinea's and 5.9% of South Africa's GDP as well as the majority of foreign revenues of these countries are mining related (Schueler et al., 2011). However, local livelihoods rarely profit from mining activities, because mining have widespread and drastic environmental and social effects on them (Wangari et al., 2012). AGM, for example, removes vegetation and soils, interrupts ecosystem service flows, and results in inevitable and often permanent farmland loss through soil erosion (Bebbington et al., 2009).

The sad story of gold mining plays out on many levels. In large scale mechanized mining, there is often little regard for the agricultural land. The danger to biodiversity begins when roads are built for purposes of exploration and as land is cleared for settlement (Veiga et al., 2002). The ongoing operations of small scale unmechanized mining are also terribly destructive both to the land and to adjacent aquatic ecosystems (UNECA, 2003). And all too often, the spoils of the process continue to poison the environment long after commercial operations have ceased (Laurente, 2011). In short, mining without an awareness of issues related to the environment can result in drastic and permanent changes in the mining areas (Funoh, 2014).

Overall, AGM in the developing world often erode livelihood foundations, resulting in population relocation as farmers seek to develop alternative income strategies (Veiga, 2002). As a consequence, conflicts between communities and mining operators over land use rights are common in many regions worldwide and can become a serious threat to development and security (Schueler et al., 2011). Decentralised form of small-scale mining is however, better for the residents of countries who see little benefit from the large-scale mines run by international companies that repatriate most of their profits. In other words, it is a more equitable approach involving millions of small operators who, by grit, determination and ingenuity, are able to partake of their country's wealth (Ofosu-Mensah, 2014).

These studies have addressed the overall influences of both AGM and mechanized gold mining to the economy, biodiversity and farmland. However the influence and extent of AGM on individual household land was not addressed and merits attention in this study.

2.3 The Relationship between Hours Spent by Households in AGM and on Agriculture

AGM is a rational economic choice for people seeking to escape poverty or improve their lives (Busia, 2015). Artisanal miners mine because it brings them more income and faster economic returns than other livelihoods such as agriculture or because traditional livelihood activities are becoming less viable due to climate change and other reasons (Wall, 2000). In Uganda, for example, the average miner contributes almost 20 times more to the Gross Domestic Product (GDP) than farming, forestry or fishing (Hilson, 2003).

Majority of the participants (70%) in AGM activities are men, while women only account for 30%, and are involved in roles ranging from labour intensive mining methods to the processing aspects of AGM, including amalgamation with mercury in the case of gold extraction (Jenipher

et al., 2003). Since AGM is a labour intensive activity most of the households are always left too tired at the end of the day to attend to agricultural production (Hilson, 2003).

AGM may adversely affect agriculture indirectly when workers switch from one industry to the other (Schueler et al., 2011). Farmers may engage in artisanal mining seasonally, to supplement farm incomes, or leave farming for mining altogether (Laurente et al., 2011). In Africa, the declining viability of agriculture has led to a large decrease in agrarian activities and increased mining activities. The discovery of large mineral deposits and the perceived income opportunities they represent have also led to the abandonment of other agricultural land uses (Hilson, 2010).

Where there exist large gold ores such as South Africa, Guinea and Nigeria, mining plays a key role in the country's economic growth (Schmidt, 2012). Individuals directly involved in the gold mining activities may experience quick financial earnings, making them to abandon agricultural activities. However, without investing into adequate measures, the mining activities can result in adverse environmental and social impacts (Laurente et al., 2011).

The sexual division of labor within the AGM sector varies from region to region. In many countries, women carry out what are perceived to be 'lighter' tasks, such as crushing, sorting and carrying ore (Wall, 2000).

Women are less than 10 per cent of those involved in AGM in some parts of Asia; while in many African countries vary between 50 and 100 per cent depending on the location and type of mining (ILO, 1999). In Burkina Faso, approximately 90% of mineral processing activities are conducted by women (Gueye, 2001). Here, between 45,000 and 85,000 women work in gold mining alone and as many as 45% of all artisanal miners are women. Over 50% of Mali's AGM

workforce is comprised of women, who carry out an estimated 90% of mineral processing activities (Hinton et al., 2003). In Mongolia, women make up 40 per cent of AGM miners (Murray, 2003), and in Lao PDR, an estimated 80% of panners are women (Hinton et al., 2003). The lack of precise gender data notwithstanding, what is certain is that women play a much bigger role in ASM than in large-scale mining. Lack of attention to gender issues and limited social analysis mean that women are often treated as a homogenous group, whereas there may be enormous social differentiation amongst women associated with mining in a given context. For example, some may be financing mining activities as entrepreneurs while others may be living in chronic poverty and driven to hard manual labor reprocessing tailings or ore crushing. (Hentschel et.al, 2003)

In some contexts and types of mining women are limited to engaging in lower status and lower-paid activities. This stems from a combination of cultural perceptions of appropriate work for men and women and issues regarding women's access to assets (financial, knowledge, time, labor) to engage in mining. In some cases, cultural norms are reinforced by legislation, such as regulation that makes it illegal for women to work underground (Drechsler, 2001). Less direct legislation can also restrict women's participation and control over mining activities (e.g. the denial of legal title to land, or the lack of access to credit).Some countries have acted on these issues by changing their legislation to provide women with the same rights to working underground as men (Ranchod, 2001), whilst others have attempted to enact gender neutral legislation. The efficacy of these approaches remains to be seen, given the deeply-rooted nature of male dominance in many societies. While these studies try to explore reasons for gender parity in AGM around the world, reasons for abandonment of other agricultural land uses in favour of AGM have not been given consideration. This calls for attention in this study

In the recent years, AGM sector has experienced significant growth world-wide, predominantly in remote rural areas of developing world. This has occurred mainly due to widespread unemployment within Africa, Latin America and Asian countries in which it takes place (Hentschel et al., 2003). AGM is largely poverty driven and there is a correlation between Human Development Index (HDI) position of countries and proportion of the workforce involved in AGM (Hoadley, 2004). The redundancies caused by structural adjustment programmes. Inflation and modified patterns of trading and farming over the years have driven millions of people of varying skills and background to take up employment in the AGM sector (Tallichet et al., 2004).

Recent rises in the market prices of precious metals and stones, have further fuelled the sector's rapid expansion (Hentschel et al., 2003). In this respect AGM is typical of informal economic sectors in the developing world that offer employment to a significant part of labour market, make important contributions to production and rural income generations and provide a necessary survival strategy for hundreds of thousands of people (ILO, 2004). Generally AGM is extensively practiced as an alternative economic activity in times of stress (Hoadley, 2004). According to estimates of ILO (1999), nearly 13million people are directly employed in the AGM sector worldwide and an additional 100 million people depend on it for their livelihoods. Women comprise up to 50% of this workforce (ILO 1999). In Asia, the share of female employees in the sector amounts to 10%, while in Latin America it ranges from 10%-20%. The highest percentage of women in AGM is however, in Africa, where up to 50% of the labour force is female (Hinton et al., 2004). The participation of women can either be direct i.e. primary engagement in mining operations or indirect as panners, cooks, sex workers or as merchants (Heemskerk, 2003).

Studies done by Ogollah et al., (1990) in Migori district found out that women's involvement in small-scale mining was important. They were found in the aspects of carrying mineral deposits to washing sites, washing gold mineralization materials, concession owners, and gold dealers and cooking food for miners since they could not involve themselves in the physical strength aspect of the operations. Poverty and economic hardships were the factors that drove women to participate in small-scale mining in order to improve their living conditions. This also supported Hinton et al., (2003) assertion that, for most women, AGM symbolized an avenue to reduce strains of poverty.

The study discovered that limited employment opportunities or lack of jobs in rural areas, economic hardships/poverty, quick/high income earnings from AGM, low income earnings in agriculture, and supplementing income generated from other livelihoods were the driving factors that compelled and influenced people to combine and use their personal assets to enable them to engage in artisanal and small-scale mining

The above studies have addressed key issues for household involvement in AGM including; overall benefits of AGM to communities in developing countries, gender roles in AGM, reasons for household participation in AGM in developing countries and the influence of large scale mining on households' economic performance. However, the effect of household participation in AGM on agricultural land use was given minimal consideration and is an objective of this study.

2.4 The Rehabilitation Status of Land under Artisanal Gold Mining.

AGM is a temporary use of land, with the operating life of a mine lasting from a few years to several decades (Hilson, 2002). Studies done in Canada show that before the 1970s, it was common practice for mining companies to leave mine sites as they were when mining operations

stopped, which was frequently in a state of excavation (Dutta et al., 2005). Current best practices in mine closure require the reclamation or rehabilitation of decommissioned mine sites, which involves returning the land and watercourses to an acceptable standard of productive use. Reclamation activities often included removing or remediating any hazardous materials, reshaping the land, restoring topsoil, and planting native grasses, trees, or ground cover (Gavin, 2002).

AGM is a finite activity exploiting a non-renewable resource. The mineral deposits get overexploited and exhausted. As such, the livelihood potential associated with any AGM site is limited to the life of the resource, which is a function of the accessibility, scale and quality of the ore, the market, efficiency of production techniques, number of miners and the intensity of their labour (Woolard, 1999). AGM can only begin to contribute to national poverty reduction if the technical elements of efficient mining are managed in order to deliver economic development (Krappmann, 2006). Further, AGM can attract workers away from more sustainable livelihoods such as agriculture, and destroy the future potential of such areas if there is a resource found on agricultural land (Gavin et al., 2006).

Studies done in Peru show that, natural forest regeneration potential in degraded areas are inversely related to the intensity of previous mining operations and distance to forest fragments (Funoh, 2014). Soil texture in degraded areas is 95% sand, while clay soils are common in the adjacent reference forests; soil organic matter and cation exchange capacity are five and four times higher in the surrounding forests than in the abandoned mined areas respectively. Thus, soils in areas affected by mining do not have enough carbon to retain essential nutrients for plant growth- whether natural regeneration or reforestation seedlings (Woods, 2006).

In Ghana the AGM sector, at its current scale, is leading Ghana to an increased state of environmental degradation, with a cost that has yet to be quantified (Ashley, 2004). Ghana's list of mining related environmental degradations are extensive. They include the "release of toxic substances such as mercury for amalgamation process, pollutant discharge from abandoned mines, deforestation, wind and water erosion as well as sedimentation, loss of topsoil through mining and afterwards through erosion of the site (Schmidt, 2012). These examples are plentiful in Ghana where the state often has or choose not to have any control over land grabbing methods. Often times, acquiring a new plot of land for gold mining is as easy as bribing a law enforcement officer (Ashley, 2004). Further studies done in Ghana established that AGM results in deforestation 58% and substantial loss of farmland 45% within mining concessions, and widespread spillover effect as relocated farmers expand farmland into forests. These points to rapidly eroding livelihood foundations, suggesting that the environmental and social costs of Ghana's gold boom might be much higher than previously thought (Ashley, 2004).

Dust pollution from mining activities affects neighboring communities and also soil erosion is common around mines. Therefore, land use change became inevitable because the mined sites no longer can accommodate farming activities such as crop farming, cattle grazing and provision of ecosystem services such as pollination (Wangari et al., 2012). AGM can only begin to contribute to national poverty reduction if the technical elements of efficient mining are managed in order to deliver economic development (Krappmann, 2006). Hussein, (2007) did a research in Tanzania to assess how gold mining led to displacement of farmers, he found out that resettlement of communities was a highly complex process that required consideration of economic, social and cultural issues. The land that communities were moved to might appear

similar, but differences in soil fertility, water availability, access to roads and markets and a variety of other factors could have serious implications for the community's wellbeing.

These studies have addressed the need to rehabilitate mined lands for future settlement and agricultural production. However, the problems caused by small scale gold miners who mine in the tailings of mainstream artisanal miners have not been addressed. Further documentation of indicators of soil infertility and post AGM rehabilitation strategies are inadequate and merits attention in this study.

2.5 Conceptual framework

The AGM activities within Karemo Division of Siaya County have led to several negative effects on agricultural land use. Such effects include open holes that are inhibiting both crop production and pasture growth, widespread soil erosion from the unstable heaps of soil, injuries to both livestock and human populace and diversion of labour from agriculture to AGM. These conditions have led to loss of soil fertility, hence poor crop yields. The mined areas are also not suitable for settlement as a result of horizontal underground shafts that are made by the miners in pursuit of gold reserves. These have made the land in the area weak and susceptible to cave-ins. Rehabilitation strategies therefore need to be put in place to ensure the development of post AGM productive land use in the area. Such strategies can include use of fertilizers, change of livestock rearing systems, use of organic manure, filling up of abandoned AGM holes and planting of tress to rehabilitate mined AGM fields, as illustrated in Figure 2.1.

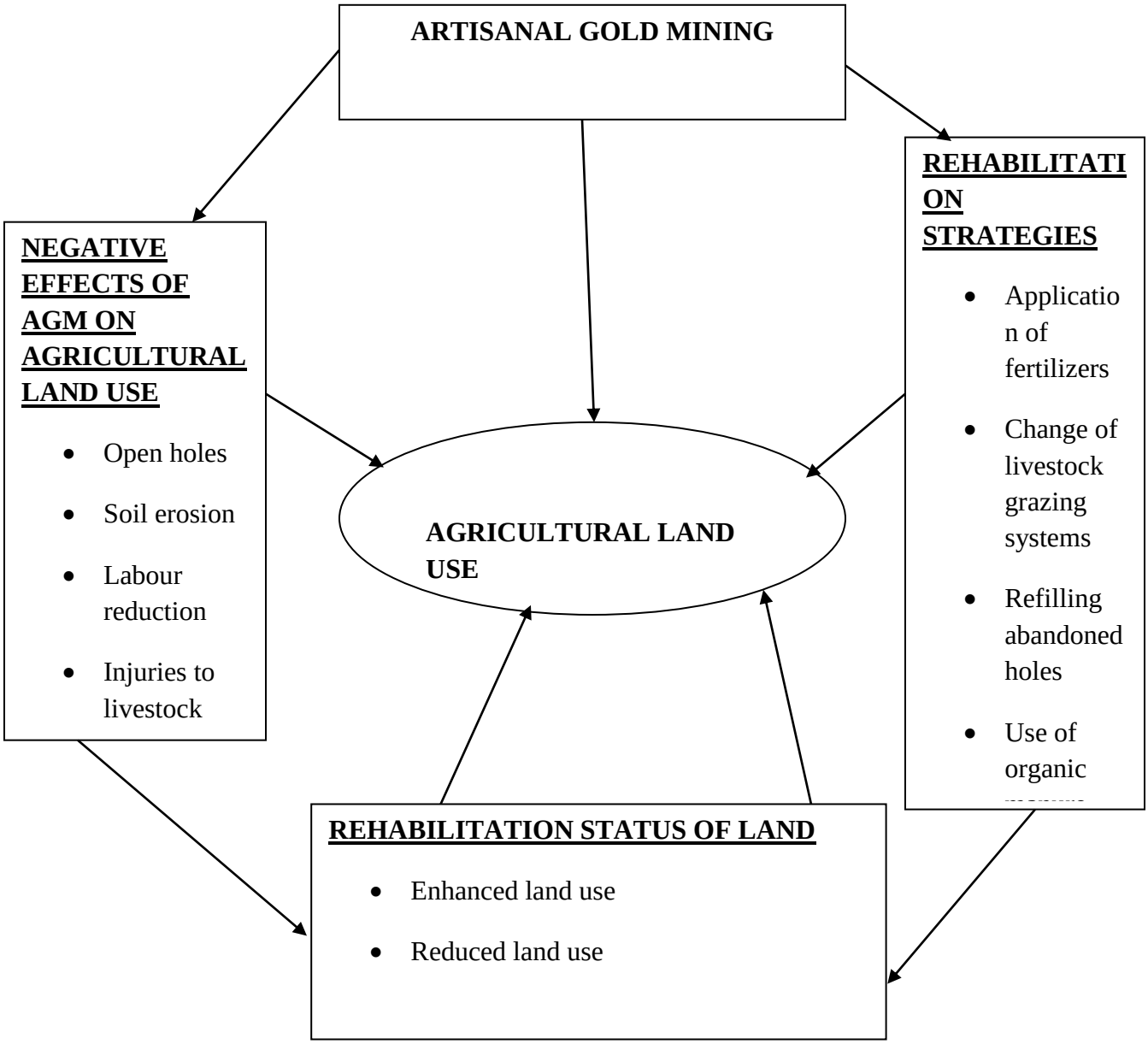


Figure 2.1: conceptual framework

CHAPTER THREE

METHODOLOGY

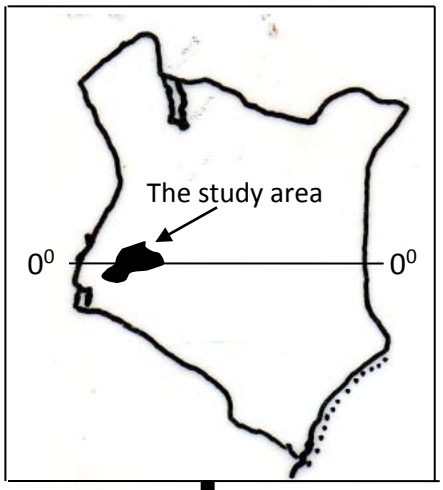
3.1 Introduction

This study analysed quantitative and qualitative data. While quantitative data can be used to test hypothesis, qualitative data seek in-depth understanding and also attempts to provide answers to why questions.

3.2 The Study Area

This study was conducted in Karemo division, which is in Siaya County. The division lies between latitude 0° 26’ to 0° 18’ north and longitude 33° 58’ east and 34° 33’ east. It had an altitude of 2,506 m above sea level and rainfall of between 1,170 and 1,450 mm. The mean annual temperature was 21^0C. The maps of the study area are presented in figures 1and 2 below;

Figure 3.1; Map of Kenya showing Karemo division



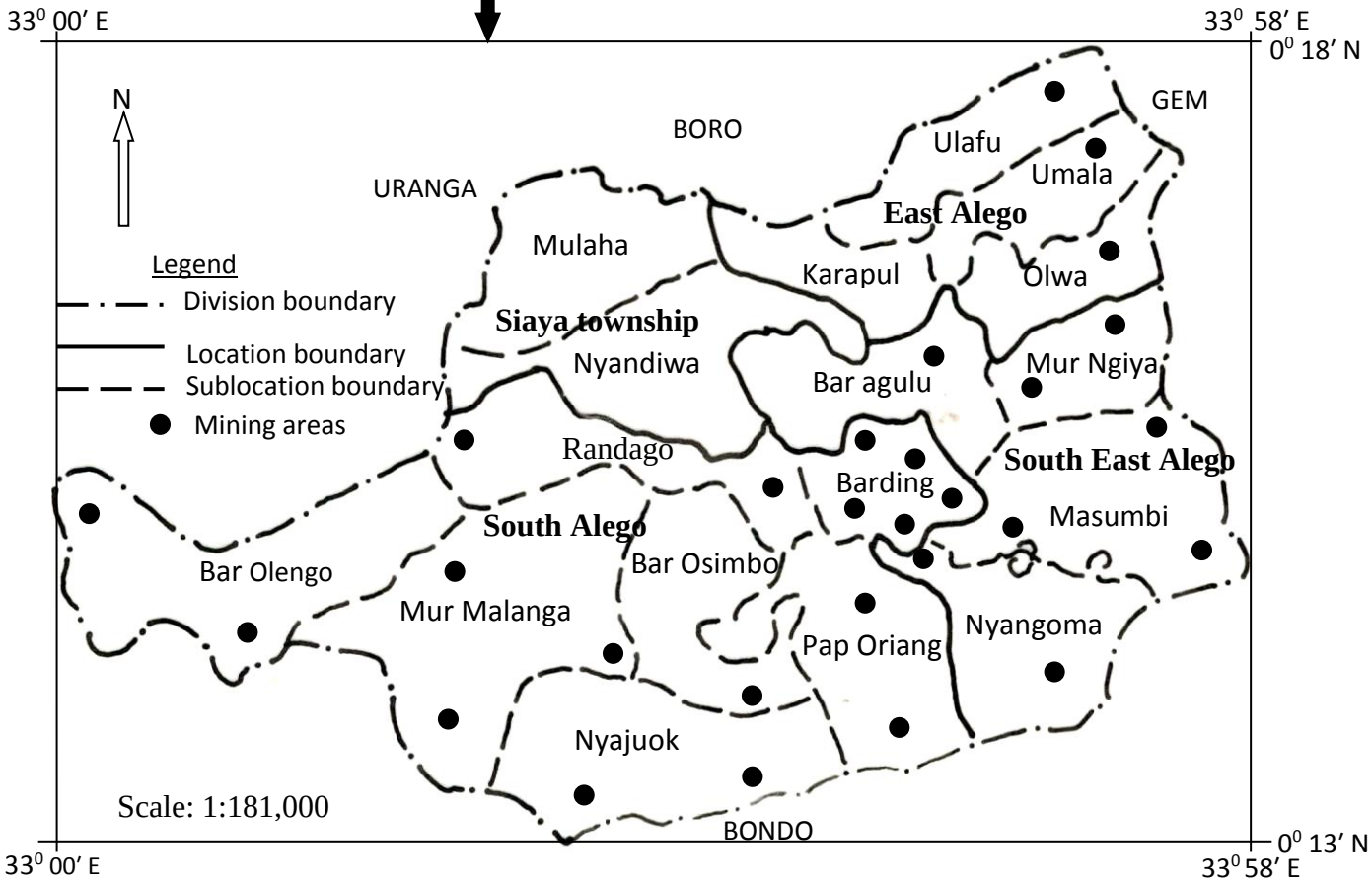


Figure 3.2; Map of Karemo division

The economic activities of the people of Karemo Division include subsistence gold mining, crop farming, livestock keeping, fishing, and small scale trading. Fishing is done in River Yala that passes to the southern part of the Division on its way to Lake Victoria, through Yala swamp. However the main economic activity before the emergence of AGM was subsistence agriculture whereby several crops were grown. There are small amounts of cotton, sugarcane and tobacco cash crops. Green vegetables such as kales and indigenous greens are grown with partial irrigation. Bananas, sweet potatoes, finger millet, and cassava do well when fed by rain and are grown widely as security crops that can withstand drought and feed families during famines. (Kenya Agricultural Research Institute - KARI Annual Report of 1996). These can also be sold for income, especially bananas. Maize is grown as a staple food and is cultivated twice a year.

Local breeds of mostly poultry and cattle characterize the livestock in Karemo Division. However, their crossbreds are becoming common. Due to decrease in land acreages as a result of AGM activities, the average family in the division has only around 3 cows. Most farmers also keep local chicken under free range system.

3.3 Research Design

The study employed a cross-sectional descriptive research since the artisanal mining was already taking place and data could be obtained over a short period of time. The data was collected over a period of three weeks. The study participants were individuals at the age of 18 and above, AGM workers and farmers in Karemo division. The reason for this selection was based on proximity to mining sites and intensiveness of AGM activities in these communities. The households were the units of analysis. A combination of simple random and purposive sampling techniques was used for the study. The simple random sampling was used to sample households to respond to questionnaires, using a sampling frame (Table 3.1). The purposive sampling

method was employed to select key informants i.e. agricultural officers and area administrative leaders. These people were selected purposively because they would be in a better position to share their knowledge as well as voice out their concerns and worries. A simple GPS system was used to measure land sizes.

SUB-LOCATION	NO OF HOUSEHOLDS	SAMPLE SIZE	CUMULATIVE SAMLPE
1. BARDING	1226	31	31
2. BAR-AGULU	1134	29	60
3. BAR-OSIMBO	892	23	83
4. BAR-OLENGO	1002	25	108
5. MASUMBI	1026	26	134
6. MUR-MALANGA	976	25	159
7. MUR-NG'IYA	1080	27	186
8. NYAJUOK	1300	33	219
9. NYANG'OMA	1400	36	255
10. OLWA	964	24	279
11. PAP- ORIANG'	1072	27	306
12. RANDAGO	924	23	329
13. ULAFU	1128	28	357
14. UMALA	1076	27	384

Table 3.1: Sampling Frame

3.4 Study Population and Sampling Procedure

The division has a total household population of 15,200 according to the 2009 population and housing census. It has a total area of 235.1 km^2. The division is sub-divided into fourteen sub locations'. The random sampling technique was used to select respondents, with the aid of a sampling frame. The respondents were adult males and females, since they are the once who practice mining and equally understand the influences of mining. The area under study had more than 10,000 people; hence the minimum sample size was guided by the formula: Fisher, (1935)

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

Where n = the desired sample size

Z = the standard normal deviate at the required confidence level (marginal error) at 95%

P=the proportion in target population estimated to have the characteristic being measured

q=1-p

d= level of significance

Hence $$n = \frac{(1.96)^2 \times (0.5 \times 0.5)}{(0.05)^2} = 384$$

Source; Fisher, 1935

3.5 Data Collection Procedures

Primary Data

The primary data that was obtained from the field included; age, sex, occupation, number of household members and educational levels. It also included data on acreage of land apportioned

to AGM, level of household involvement in AGM and the rehabilitation status of land previously under AGM. The instruments used in primary data collection included;

Questionnaire

The household questionnaire was used to capture information on the extent of AGM activities on agricultural land including, acreage of land apportioned to AGM, household involvement in AGM activities and the rehabilitation status of land previously under AGM. It was also used to capture information on the social, demographic and economic characteristics of the households.

Observations

Observation schedules were used to assess the extent of agricultural land degradation by AGM activities, the level of household involvement in AGM activities, and the rehabilitation status of land previously under AGM. The researcher also took photographs of the mined areas to enhance the quality of the study by showing exactly how AGM had led to agricultural land degradation in Karemo division.

Key Informant Interviews

This was applied to eleven key informants purposively selected including one chief, four assistant chiefs, four village headmen and two sub county agricultural officers. The village headmen, assistant chiefs and chief were interviewed on the history and extent of AGM in the division. The agricultural officers on the other hand were to provide expert information on the agricultural trends in Karemo division.

Secondary Data

This involved literature search on the effects of gold mining on agricultural land and its history in Karemo division of Siaya County. The information was obtained from academic reports, journals, periodicals, newspaper articles, textbooks, papers, government reports and the internet. The literature provided background to the understanding of the problem.

Measurement of Variables

The independent variable was AGM while the dependent variable was agricultural land use. They were measured by asking the stakeholders questions whose answers gave a clear picture of the situation as it was. Secondary data was read and interpreted to support the responses.

3.6 Methods of Data Analysis and Presentation

Data analysis was done using independent sample t- test to show whether there was a significant difference between sizes of land under agriculture and under AGM. Pearson product moment correlation was used to determine the relationship between numbers of hours spent on AGM and agriculture ($p < 0.05$). Percentages and bar-charts were also used to establish the rehabilitation status of land under AGM. Finally plates and percentages were used to illustrate the extent of AGM encroachment in agricultural land. The results were presented in the form of description, graphs, tables and photographs.

3.7 Reliability and Validity

Validity refers to the degree with which results obtained from data analysis actually represents the phenomena under study. It deals with how accurately the data obtained in the study represents the variables in the study (Bless, 2007). Validity was carried out using experts in the

department of Geography who assessed the instruments of data collection and approved them before data collection.

Reliability on the other hand refers to the degree to which research instruments yields consistent results after repeated trials (Mugenda, 1999). To assess the content reliability, the data collection tool was pre-tested in a few households to ensure that it was easily understood and conveyed the intended information. Since data was collected by the researcher himself, it was possible to ask structured questions in a standard format to give the same meaning among all study participants. Pretesting of the instrument was done among 20 households that were not part of the sample (Isaac et al., 1995). A test retest reliability method was then used to find correlation between the two results. Pearson product moment correlation coefficient value of 0.834 was obtained, which indicated that the instruments were reliable.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter contains an analysis of the socio demographic characteristics of the study population. It then gives the results and discussions on the effects of AGM on agricultural land use derived from the study population in Karemo Division based on each objective.

4.2 Demographic Characteristics of the Respondents

The study sought the gender, age, educational level, marital status and household sizes of the respondents. These were presented in Table 4.1 below

Table 4.1 Demographic Characteristics of the Respondents

Demographic Characteristics		Frequency	%
Gender	Males	261	68
	Females	123	32
	Total	**384**	**100**
Age	20-29 years	138	35.9
	30-39 years	159	41.4
	40-49 years	70	18.2
	50-59 years	17	4.4
	Total	**384**	**100.0**
Education level	None	17	4.4
	Primary	262	68.2
	Secondary	105	27.3
	Total	**384**	**100.0**
Marital status	Married	229	59.6
	Single	129	33.6
	Divorced	26	6.8
	Total	**384**	**100.0**
Household Size	1-5 members	145	37.8
	6-10 members	207	53.9
	11-15 members	22	5.7
	16-20 members	10	2.6
	Total	**384**	**100**

Table 4.1 indicates that majority of the respondents were male, 68% while the minority were female respondents, 32%. This indicates that males dominated the AGM projects in Karemo division. The low number of female participants was attributed to the labour intensity that was involved in AGM activities. These results concurred with Schueler et al., (2011) who found out that the majority of the participants in AGM activities are males. The female participants according to him were usually few and were mostly relegated to auxiliary jobs like selling food to the miners. Hinton et al., (2003) also established that approximately 30% of Artisanal miners are women who occupy roles ranging from labour intensive mining methods to the processing aspect of artisanal mining. This scenario was replicated in Karemo division where the majority of the miners were found to be men. The female participants were involved in minor AGM activities like scavenging for gold ores in the tailings of mainstream miners, grinding and washing the ground ores and selling food to the miners.

With regard to age, majority of the households (41.4%) were aged between 30-39 years, 35.9% were aged between 20-29 years, 18.2% were aged between 40-49 years and 4.4% were aged between 50-59 years. This could be explained by the fact that AGM is a very demanding activity that requires a lot of energy to carry out. The highest accumulation (77%) of those involved ranged between ages 20-39 years. This same age range also constituted the people that were expected to be involved in agricultural activities, thereby threatening the agricultural production within the division. This confirmed the findings of Schueler et al., (2011) that within the mining villages, majority of the household had switched to AGM activities to the extent of almost completely abandoning agriculture. Although, in Karemo Division, minimal agriculture was still being practiced alongside AGM but majority of the labour-force was focused on AGM.

Majority of the respondents (68.2%) had only achieved primary school education. 27.2% had secondary education, and 4.4% did not have formal education at all. Both secondary and primary levels of education are considered basic and this may explain the reasons for lack of rehabilitation of mined AGM fields. They are unable to project that AGM is a seasonal activity and they would return to agriculture once gold gets depleted. This concurred with Hilson, (2010) who reported that artisanal gold miners possessed minimal formal education and used rudimentary exploration and extraction techniques, thereby causing a lot of damage to farm lands. The gold rush and perceived quick financial gains from AGM may have discouraged the households of Karemo division from pursuing education which would have informed them on how to practice AGM and agriculture sustainably.

Concerning marriage, the results indicated that 59.6% of the respondents were married, 33.6% were single and 6.8% were divorced. Most households had 6-10 members as reflected by 53.7% of the respondents, followed by 1-5 members of a household as responded by 37.8%. The least response on household size was that of 16-20 (2.6 %.). These large household sizes coupled with the high unemployment levels pushed several households to engage in AGM activities so as to provide for their children. As a result little time was accorded to agricultural activities. This confirmed Hinton et al., (2003) findings that artisanal and small scale miners lived in poor rural settings of developing countries. Most were not formally trained in mining and had received little education in general. Mining however, allowed them to earn cash income for their households and supplemented meager farming revenues.

4.2.1 Occupational Status of the Households

The study sought the occupational status of the households so as to assess the level of formal employment attainment by the households within the division. The results were presented in Table 4.2 below

Table 4.2 Occupational Status

Occupational Status	Frequency	Percentage
Formal	38	10%
Informal	346	90%
TOTAL	**384**	**100%**

Table 4.2 reveals that majority of the households in Karemo division (90%) lacked formal employment and they majorly depended on AGM and subsistence agriculture. Those who were employed comprised of 10% of the population and they included teachers, nurses and other civil servants. This high unemployment levels revealed the reason for the high number of participants in AGM activities, as they had to fend for their families. As observed by Lahiri-Dutt, (2008), AGM employs more people than industrial mining. Often AGM is part of a diverse livelihood strategy at the individual and household levels, helping build resilience and enabling families to better cope with seasonal and extraordinary stresses. Most residents of Karemo division had therefore sought casual employment in AGM due to lack of formal employment opportunities.

4.3 Acreage of Land under Artisanal Gold Mining and Land under Agriculture

4.3.1 Sizes of Land Owned by Households

Sizes of land owned by the respondents was sought so as to find out if the households had enough parcels that could allow them to practice AGM and agriculture simultaneously. The results were presented as shown in Table 4.3.

Table 4.3: Sizes of Land Owned by Households

Land size	Frequency	Percent
0 - 1.9 acres	246	64.06
2 - 3.9 acres	129	33.59
4 and above acres	9	2.35
Total	**384**	**100.0**

Majority of the households, owned between 0-1.9 acres of land as reported by 64.06% of the households, followed by 33.59% who owned 2- 3.9 acres. Those with 4 acres or more only represented 2.35% of the households. As observed, most of the households cumulatively owned minimal sizes of land i.e. 1.9 acres and below. The same piece of land was shared between agriculture, settlement and AGM. This therefore calls for creation of awareness of land management practices so that the limited land is used sustainably. Schmidt, (2012) observed that artisanal miners were originally peasant farmers who owned between one to two acres of land. As a result of gold discovery, much of the land in most mining villages became dilapidated to the extent that no meaningful farming activities could be undertaken. In Karemo Division, most households predominantly practiced subsistence agriculture; however, with the onset of AGM in the area, the households have been increasingly apportioning large parts of their lands to AGM. This may jeopardize the fertility of their lands for future agricultural production hence food insecurity.

4.3.2 Nature of Household Land

The nature of household land reflected the distribution, demarcation, and structure of land under the activities of interest. The nature was therefore established on the basis of whether the land was one piece or several pieces. The results were presented as shown in Table 4.4.

Table 4.4 Nature of Land

Pieces of land	Frequency	Percent
One piece	244	63.5
More than one piece	140	36.5
Total	**384**	**100.0**

The results indicated that majority of the households, 63.5% owned one piece of land as compared to 36.5% who owned several pieces of land. This meant that both AGM and agriculture had to be practiced on the same piece of land. As a result, both human and livestock populace were endangered because AGM involves digging of holes to excavate the gold resource. Some of the holes are always very deep and can injure people and their livestock if they fell in them. Crop yields are also bound to decrease since the agricultural land is characterized by open pits, heaps of debris and relatively infertile subsoil. Further, pasture for livestock is also limited since the subsoil has covered the rich top soil that enhances pasture growth. This finding concurred with Bury, (2009) who observed that mining without an awareness of issues related to the environment could result in drastic and permanent changes in the mining areas.

4.3.3 Main Household Activity in Karemo Division

The study sought to find out the main activity that had occupied the largest portion of the households' land. These activities included AGM, crop farming and livestock rearing. The results are indicated in Table 4.5

Table 4.5: Main Household Activity

Activities	Frequency	Percent
crop farming	27	7.03
livestock farming	40	10.42
mixed farming	65	16.93
Mining	252	65.62
Total	**384**	**100.0**

Majority of the households (65.62%) had engaged larger parts of their lands under AGM. The second main activity was mixed farming (16.93%), with livestock farming consisting of 10.42%. 7.03% reported crop farming as their major household activity. The households' main reason for their engagement in AGM was the quick financial returns that they earned. A miner alluded that at times they were able to earn as high as kshs 10,000 per day from AGM. Some households were also categorical that with time, they would completely shift to AGM. In some instances, the household was only left with less than a quarter of their original land parcel. This confirmed the findings of Schueler et al., (2011) who found that in Ghana, farmers often relocated to AGM activities due to perceived income opportunities and changing climatic conditions. Although Karemo division has a favourable agricultural climatic condition, households have been swayed into AGM by perceived quick financial gains. However, the earnings from AGM are erratic can cannot be depended on for financial security and stability.

A photograph of an abandoned large tract of land was also taken (plate 4.1) to further illustrate the extent of encroachment of AGM on agricultural land.

Plate 4.1: Post Artisanal gold Mining Land Prone to Soil Erosion in Karemo Division

Source: Field Data, 2015

Plate 4.1 shows the state of land left after AGM had been abandoned and therefore soil erosion was taking place. AGM activities are however, still being carried out on the land. Several miners could be seen working in the tailings of the mainstream artisanal gold miners. This hindered the regeneration of the abandoned mined lands. This further hindered agricultural activity that was the primary occupation of the inhabitants. No crop could give yields in the area since the fertile topsoil had been covered by subsoil and rock debris. Livestock were also prone to injuries if they

fell in the deep holes. Further livestock pasture and grazing land was almost completely diminished.

4.3.4 Effects of AGM on Agriculture

Plate 4.2 below further gives a clear picture of the extent of AGM activities encroachment into agricultural lands.

Plate 4.2 Effects of Artisanal Gold Mining on Agriculture in Karemo Division

Source: Field Data, 2015

From plate 4.2 the extent of AGM encroachment on agricultural land within Karemo division is clearly demonstrated. The household originally possessed three acres of land. However, due to the discovery of AGM on their land, the household was only left with less than a quarter of an acre to share between settlement and subsistence agriculture. The area that was cultivated could

not provide enough food to sustain the household for a whole season. Eminent food shortage was therefore evident in the area. This confirmed the findings of Bury, (2009) who established that there was always little regard for agriculture once gold was discovered in an agricultural land. The same scenario was replicated in Karemo division where miners disregarded agriculture and extended their AGM activities into the farm lands.

4.3.5 Trends of AGM Activities in Karemo Division

To illustrate the trends of AGM activities in Karemo division, a comparison was done on acreage of land allocated to agriculture and AGM per household over the last 5 years. This was illustrated by Figure 4.1

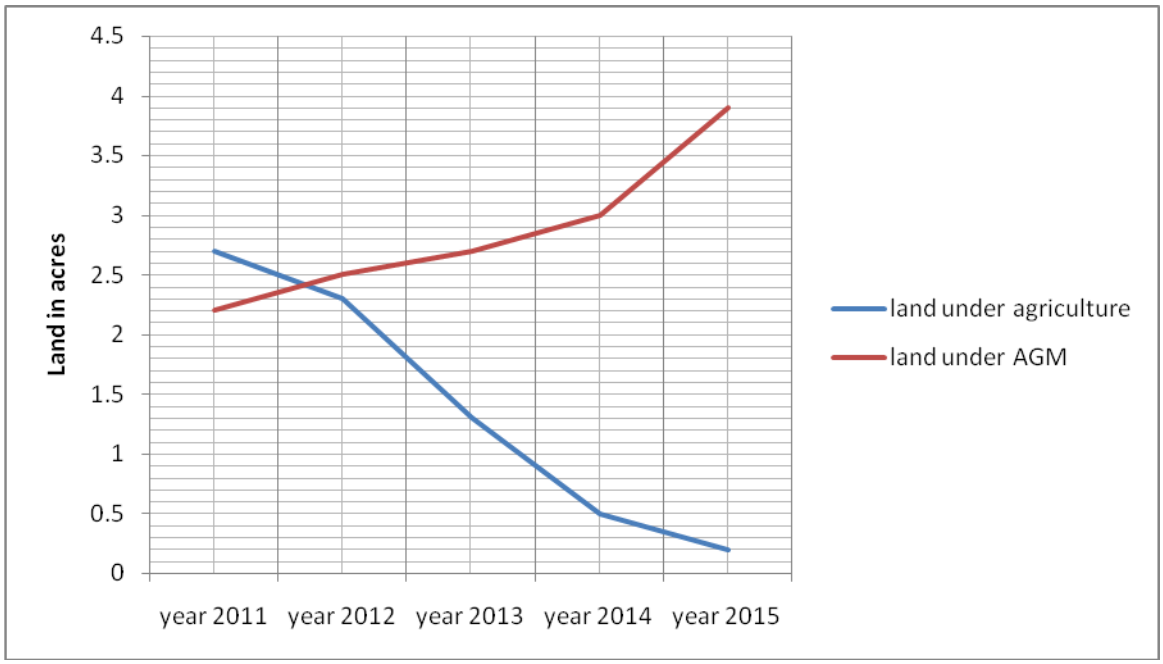


Figure 4.1: Land Used for Artisanal gold Mining and Agriculture in Karemo Division between 2011 and 2015 (Source: Ministry of Agriculture, Siaya County)

The above figure shows a worrying trend of diminishing agricultural activities with increased participation in AGM activities. While in 2011 the main activity of the residents of Karemo

division was agriculture, with an average allocation of land of above 2.5 acres per household, in 2015 household allocation had gone down to averagely 0.5 acres per household. AGM on the other hand had increased in terms of land acreage from 2.2 acres in 2011 to approximately 3.7 acres in 2015. This trend was coupled with the fact that the some of the abandoned AGM lands were not rehabilitated hence leaving behind a huge trail of AGM in the area. As established by Schueler et al., (2011), land use conflicts are becoming increasingly apparent from local to global scales and AGM is an extreme source of such a conflict. In Karemo division there is a decrease in land acreage apportioned to agriculture. This is despite the fact that the area reported favourable agricultural climatic conditions. This is posing an evident risk of food security within the division.

4.3.6 Effects of AGM on Livestock Production

An open ended questionnaire on the effects of artisanal mining on livestock rearing was summarized and the responses presented in the chart as shown below in Figure 4.2

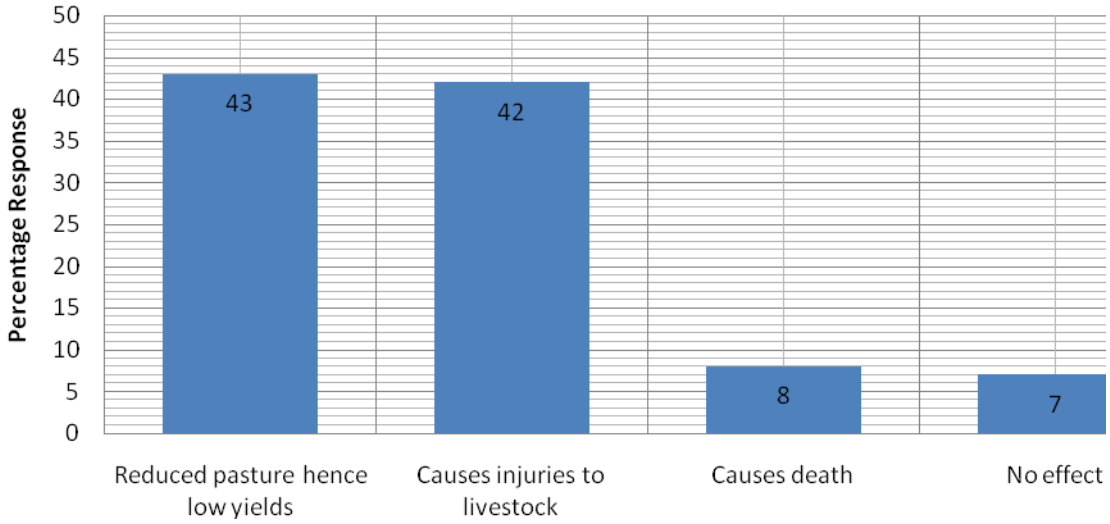


Figure 4.2 Effects of Artisanal gold Mining on Livestock Production

Figure 4.2 presents the effects of AGM on livestock production in Karemo division. The greatest threat was reduced pasture and hence low production, as was reported by 43% of the households. 42% reported that it caused injuries to their livestock especially when their livestock fell into the abandoned mines. 8% reported that AGM caused death to their livestock. Very few respondents (7%) saw that it had no effect on livestock production. These were those who never practiced AGM in their farms, those who had rehabilitated their lands alongside those who practiced zero grazing. As a result of the negative influences of AGM on livestock, majority of the households reported a reduction of the number of livestock reared especially cattle. Averagely there was only approximately three heads of cattle per household. The Artisanal miners also polluted water sources as they washed their gold powders in streams. Most of these streams were found to be seasonal and during dry seasons, several stagnant pools of water would be witnessed along the streams, both the miners and livestock shared these pools. Since mercury is used in the extraction of gold, it could be affecting livestock health. However, Nyambe, (2009) found that AGM had a positive effect on livestock production since it provided market to the farmers. He explained that AGM provided financial capability to populace hence the purchasing ability. His study however did not look at the negative influences of AGM on livestock production. In Karemo division, such negative effects including loss of pasture fields, injuries and death from open holes and breeding sites for disease vectors alongside polluted.

A photograph of an animal grazing in an abandoned AGM field, was taken to demonstrate the dangers posed to livestock by AGM activities as shown in plate 4.3

Plate 4.3: An animal grazing in abandoned AGM field.

Plate 4.3 demonstrates the dangers posed by the abandoned mines to livestock. The farmer used tethering as a means of grazing probably to stop the animal from falling in the abandoned mines. The cow could still be seen maneuvering dangerously between the abandoned mines. Some of the ditches were found to be too deep, and this might explain the responses of the households that AGM causes death and injuries to livestock. Jul-Larson et al., (2006) established that current practices in mine closure require the rehabilitation or reclamation of decommissioned mines through returning of land and water courses to acceptable standards of productive use, which was not the case with Karemo households who to a large extent failed to reclaim the abandoned mines.

4.3.7 Effects of AGM on Crop Production

Response on the effects of AGM on crop farming was also sought and the results presented in figure 4.3.

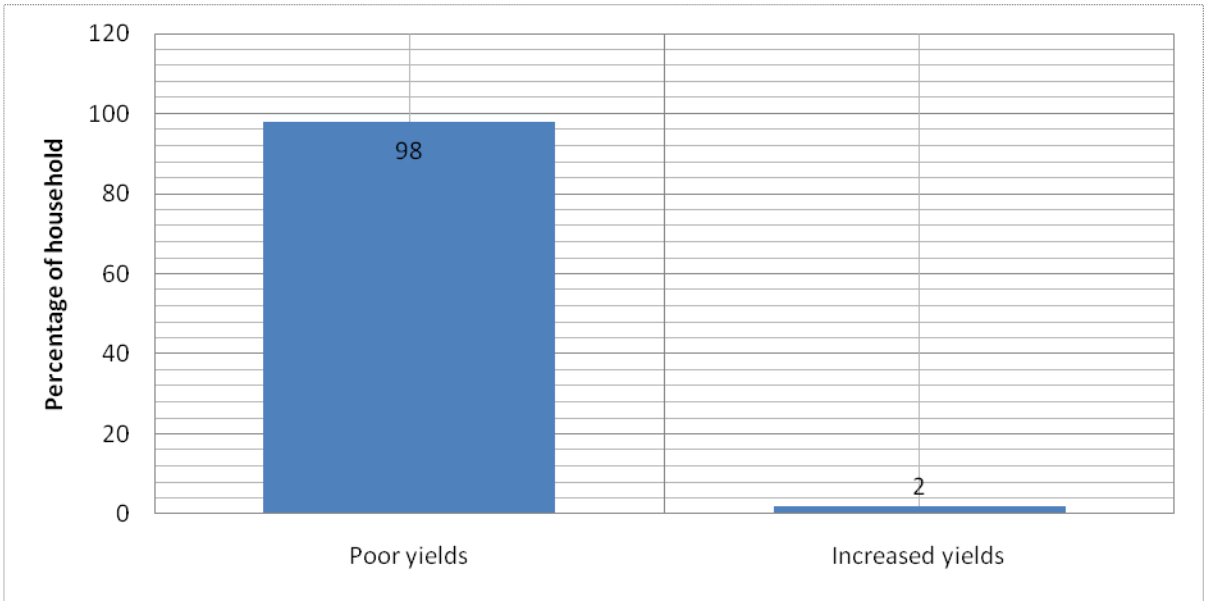


Figure 4.3 Effects of Artisanal Gold Mining on Crop Yields

The results indicate that AGM leads to reduced yields due to the encroachment into the land meant for farming. 98% of the households reported that their crop yields reduced in lands previously under AGM while 2% reported increased yields. These comprised those who did not practice AGM in their lands together with those who had rehabilitated their lands and were applying fertilizers. The poor production could be explained by the dilapidated state of the land meant for agriculture. Top soils have been replaced with the relatively infertile sub soil. The open holes and heaps of debris were also limiting mechanization. This concurred with Veiga, (2002) who found out that there were reduced crop yields in the mining villages since some miners would still scavenge for gold in the tailings of the mainstream artisanal miners. This according to him had hampered the rehabilitation process of the mined lands. This situation was confirmed in Karemo division where mostly women, children and some men could be seen scavenging for gold in the abandoned mines, thereby prolonging the regeneration period of the land.

4.3.8: Crop Yield Trends in Karemo Division

The trend of maize and beans yields between 2011 and 2015 was obtained to illustrate the effects of diminishing land acreage being apportioned to agriculture in the division over the years. The data was presented in table 4.6.

Table4.6: Crop yields in Karemo division in kgs between 2011 and 2015.

Year	Mean Acreage under Agriculture	Beans in Kgs	Maize in Kgs
2011	2.7	1458	2187
2012	2.3	1242	1863
2013	1.3	702	1053
2014	0.5	270	405
2015	0.2	108	162

Source: Ministry of Agriculture, Siaya County agricultural office.

Table 4.6 indicates a decreasing yield of maize and beans; the major agricultural crops produced in the division. From year 2011 to 2015, there was a sharp decrease in average crop yields in Karemo division. While 1458 and 2187 bags of beans and maize respectively were realized in 2011, only 108 and 162 bags of the same were realized in 2015. However, the production remained stable and what decreased was the land acreage. This proved that the area remained agriculturally viable. As pointed out by Hilson, (2003), in Sub-Saharan Africa, farmers always branched out into non-farm activities in order to secure a better livelihood. He pointed out that the central difference between agriculture and AGM was seen in the form of income generation. This was confirmed in Karemo Division where households were lured into AGM activities mainly due to the immediate monetary returns. The Karemo households were categorical that they could comfortably cater for their basic needs from the AGM proceeds even if they only practiced minimal agriculture.

4.3.9 Comparison between Land under Artisanal Gold Mining and Agriculture

To confirm that AGM was encroaching on agricultural land, comparison between land under gold mining and agriculture was done using a one sample t-test. Crop farming and livestock farming were combined to represent farming, while mining was given a second code. The results for the means between farming and mining were presented as shown in Table 4.7

Table 4.7 Mean of land under farming and AGM in acres

Farming or Gold Mining	Mean in acres
Mining	3.9
Farming	0.2

The results indicate that majority of larger tracts of land, as shown by a mean of 3.9 acres was used for mining activities while smaller tracts of land (Mean of 02 acres) was engaged in farming activities, either livestock or crop farming combined. This was an indication that AGM exceeded agricultural activities, and majority of the households in Karemo division preferred mining to agriculture, and has apportioned larger parts of their lands to AGM as compared to agriculture. This finding contradicts Hubacek, (2002), who established that families in the mining villages were always torn between deciding on whether to put their lands under AGM or agriculture. In Karemo Division, most of the conventional farmers had almost fully relocated to AGM. However this activity was finite as the gold resource was non renewable. Proper land management strategies therefore needed to put in place to ensure future agricultural productivity once gold got depleted.

It was also necessary to establish whether this difference was statistically significance using an independent sample t-test. This was done on the assumption that the two different forms of land use were completely independent and had no relationship in terms of purposes of use. The results indicate that there was a significant difference ($p < 0.05$) between land use under artisanal gold mining and agriculture. This implied that the mean of land use under AGM far much outweighed the mean of land use under agricultural activities, an indication that most of the residents could be moving from agricultural activities and venturing in AGM activities. Garvin, (2006) found out that, AGM could attract workers away from more sustainable livelihoods, such as farming, and could destroy the future potential of such areas if there was a resource found on agricultural land. The people of Karemo Division were also over depending on AGM thereby abandoning their traditional agricultural activities.

4.4 Number of hours spent by households on AGM and on agriculture.

This objective involved establishing relationship between the number of hours spent by household on AGM and on agriculture. This was achieved by asking the households to state their preferred economic activity, whether they mined gold in their farms, the activities they were involved in, how they detected gold in their farms, the number of their households that participated in AGM, hours spent on mining and on agricultural activities.

4.4.1 Preferred economic activity

The preferred economic activity was sought between livestock rearing, crop farming and AGM. The results are presented in Table 4.8 as shown below.

Table 4.8: Most preferred economic activity by the households of Karemo division.

Activity	Frequency	Percent
Livestock farming	51	13.3
Crop farming	27	7.0
AGM	306	79.7
Total	384	100

The results indicate that 79.7% of the households regarded AGM as their most preferred economic activity, followed by livestock farming, 13.3% and finally only 7.7% of the households preferred crop farming. This is explained by the perceived quick financial returns that are derived from AGM as compared to both livestock and crop farming. This is further caused by the high rate of formal unemployment that was recorded in the division. As a result the households' next option for providing for their immediate needs was only through participating in AGM activities. The households complained of reduced pasture in the area as reported earlier in figure 4.3, due to increased AGM activities. This has led to low production from their livestock, a factor that is discouraging the households from venturing into livestock farming. They further explained that no meaningful agriculture can take place in the area, due to the dilapidated nature of the agricultural land that is characterized by open pits, heaps of debris and sub-soil. These findings partly contradicted with Hollaway, (1997) who found out that people engaged in AGM due to decline in the viability of agriculture as a result of climate variability or due to potential for high profits or gold-rush type situations. The residents of Karemo division although are pushed into AGM because of the potential for higher earnings, the climatic conditions in the area favour agriculture.

4.4.2 Household involvement in AGM

The households were also asked to state how many of their household members were involved in AGM activities. The results were presented in Table 4.9.

Table 4.9 Number of households participating in AGM

Number of household members participating in AGM	Frequency	Percent
Participate in artisanal gold mining activities	367	95.6
Do not participate in artisanal gold mining activities	17	4.4
Total	384	100

Table 4.9 shows that majority of the households, (95.6%) participate in AGM and only 4.4% do not participate in gold mining activities. This implies that AGM is the main economic activity in the area that is being undertaken by the majority of the households in Karemo division. This could have a negative impact on agriculture since AGM is a labour intensive activity. Further this shift towards AGM can lead to food insecurity within the division. This finding concurs with Schueler et al., (2011), who stated that in Africa, the declining viability of agriculture has led to a large decrease in agrarian activities and increased mining activities. The discovery of large mineral deposits and the perceived income opportunities they represent also leads to the abandonment of farmland. The people of Karemo division have equally abandoned agriculture in favour of AGM activities. However, there is no indication that agriculture is no longer viable since the climate and soils in the area favours agricultural production.

4.4.3: Number of people participating in AGM per household

The extent of AGM participation per household was also sought so as to inquire how many people per individual household participated in AGM. The results were presented in table 4.10

Table 4.10: Number of household members that participated in AGM

No of household mining	Frequency	Percent
None	17	4.4
1-2	105	27.3
3-4	104	27.2
5 and above	158	41.1
Total	384	100.0

Table 4.10 indicates that most of the households (41.1%) had at least five members participating in AGM. Cumulatively 95.6% of the households reported that at least a member of their household participated in AGM. Only 4.4% of the respondents reported that none of their household members participated in AGM. This meant that most of the available labour force had been diverted to AGM, thereby almost neglecting agriculture. According to Laurente, (2011), AGM was mainly practiced in poverty stricken areas of developing countries where it provided millions of job opportunities to the world's poorest people. This confirms the present study where majority of the household members are involved in AGM activities probably due to the high unemployment rates.

4.4.3 AGM activities in Karemo division

The study also sought to know the kind of activities the miners were engaged in. The results were presented in Table 4.11.

Table 4.11: AGM activities in Karemo division

Activity	Number	Percentage
Mining the ore	185	48.18%
Grinding the ore	72	18.75%
Carrying the ore	60	15.62%
Washing the ore	50	13.02%
Do not mine	17	4.43%
Total	**384**	**100%**

From Table 4.11, it was evident that majority of the households, (48.18%) participate in mining gold ore. This is because extracting the ore from the ground is the most demanding activity that requires many people. Mining of the ore is mainly done by men, and it involves digging of vertical open shafts until the gold ore deposits are reached. At times several boulders would be encountered (plate 4.4) which makes the activity to very tedious and energy consuming. Those who are involved in this activity will be too exhausted at the end of the day to engage in any meaningful agricultural activities. Unfortunately, it is not guaranteed that gold deposits would be found in the dug hole, since the miners do not have any sophisticated tool for exactly locating the gold ores. The miners therefore sometimes spend a whole week digging one hole, only to abandon it when no gold was found. This is illustrated in plate 4.4

Plate 4.4: Artisanal gold miners removing rock debris from a gold pit in Karemo division

Source: field data, 2015

As demonstrated the process of ore extraction is quite energy demanding and can only be carried out by energetic men. This scenario resembled the findings of Agyei, (2008) who found out that in Ghana, majority of the people involved in artisanal gold mining activities were men, majorly being between ages of 25-45years due to the high labour intensity involved.

Women were mainly involved in carrying, grinding, washing the ore or selling food to the miners. Other women scavenged for remnants of gold ores in the tailings of the mainstream miners, as shown by plate 4.5 below.

Plate 4.5 Women scavenging for gold ores in Karemo division

Source: Field data, 2015

Plate 4.5 shows women picking gold ore deposits from soils scooped from a gold hole. The men can be seen in the background digging a hole to extract the ore. Comparatively the men's activity was more demanding of the two. This finding concurred with Hinton (2003) who stated that majority of the participants in AGM activities were men, 70%, while women only accounted for 30%, and were involved in roles ranging from less labour intensive mining methods to the processing aspect of artisanal mining.

4.4.4 Methods of Detecting Gold in Karemo Division

The study further sought to know how the households detected gold in their farms. The results were presented as shown in Table 4.12

Table 4.12 Methods of detecting gold

Ways of Detecting Gold	Frequency	Percent
Discovered when digging toilet	18	4.7
Used local gold experts	61	15.9
Trial and error	244	63.5
Do not know	61	15.9
Total	384	100

Most households (63.5%) detected gold using trial and error, 15.8% used local gold experts and 4.6% realized it when digging toilet. The high application of the trial and error technique in discovering gold explains the dilapidated nature of agricultural land in Karemo division. Further it was realized that even the "local gold experts" lacked proper machinery for detecting gold, and their predictions would at times fail. These findings concurred with the Jenipher et al., (2003), who stated that AGM is an informal mining activity carried out using low technology or with minimal machinery. In Karemo Division the lack of gold detection equipment had contributed to the massive destruction of agricultural land. Many holes are dug in pursuit of gold only to be abandoned when none is found.

A photograph of several households participating in AGM during the day was also taken to illustrate the extent of household involvement in AGM within the division. This was presented in plate 4.6

Plate 4.6 Households participating in AGM during day time in Karemo division

Source: Field data, 2015

Plate 4.6 shows a photo of members of several households panning for remains of gold ores in the tailings of mainstream artisanal gold miners. The photo was taken at 9am in the morning in one of the mining sites, a time when the households were expected to be attending to their farms. Both men and women could be seen actively involved in AGM activities. This implied that AGM had completely engaged the households of Karemo division and thus relegating agriculture as the main activity in the region. This contradicted Heemskerk, (2005) who found out that AGM was the second leading employer after agriculture in developing countries. In Karemo division AGM was found to be the leading employer.

4.4.6 Time of Mining

The study further sought to know the time the households participated in the gold mining activities. This was classified as day, day and night, or don't mine. The results are presented as shown in Table 4.13.

Table 4.13: Time of Mining

	Frequency	Percent
Day	271	70.6
Day and night	96	25
Don't mine	17	4.4
Total	**384**	**100.0**

The majority of the artisanal gold miners, 70.6%, participated in the activity during day. 25% participated during day and night and 4.4% did not participate in AGM. During the day, both men and women participated in AGM. This explains the high response accorded to day time. Only men participated in AGM during day and night, while women were restricted to day time only due to security reasons. Others maintained that their family values and roles do not allow them to engage in AGM at night. The men on the other hand would dig the holes at night and come back to remove the ore during day time. The women would then pound and grind the ore. Others would scavenge for gold ores from the soils scooped from the gold holes. Finally both men and women would participate in washing the soils to extract gold. These activities are so demanding that very little time is spared for agricultural engagements. This concurred with the findings of Emel et al., (2012) who found out that within the mining villages especially in the developing countries, very little time was spared for agriculture during gold booms within the mining villages.

4.4.7 Hours spent in mining

The number of hours that the households took to mine was also paramount to their engagement in artisanal mining activities, and therefore the study sought to find out about this. The hours were classified in three categories, which were; 1-6 hours, 7-12 hours and those that did not participate in AGM. The results were summarized as shown in table 4.14.

Table 4.14: Hours spent in AGM

	Frequency	Percent
Do not mine	17	4.43
1-6 hours	105	27.34
7-12 hours	262	68.23
Total	**384**	**100**

The results indicate that majority of the households (68.23%), spent between 7-12 hours daily in AGM activities. This implied that AGM had taken majority of the time of the households of Karemo division, thereby leaving very minimal time for agricultural engagements. AGM being a labour intensive activity means that the households would be too exhausted at the end of the day to engage in agriculture. Those who work for the longest hours were the main stream artisanal miners who excavated the holes. They would therefore excavate the holes at night and sleep during morning hours as the day time miners remove the ores. The night shifters would then return during the afternoons to collect their share of the ore. This therefore left them with very minimal time to practice agriculture. This contradicted Laurente, (2011), findings that AGM complimented agriculture within the mining villages by providing the money for accessing both agricultural inputs and labour. In Karemo division there was a near complete shift from agriculture to AGM. Most of the remnants of farmers complained that with the onset of mining in the area, it had become very expensive to hire casual labourers, since they earned more from

AGM compared to agricultural wages. This could have negative impacts on food security in the long run within the division.

4.4.8 Hours spent in agriculture

The study also sought to find out the level of the household involvement in agricultural activities. This was done by first finding out the average time spent by households on agricultural activities per day. The results were presented as shown in Table 4.15.

Table 4.15 Average agricultural time per day

Hours	Frequency	Percent
1 hour	45	11.7
2 hours	203	52.9
3 hours	93	24.2
4hours	26	6.8
5hours	17	4.4
Total	**384**	**100.0**

Table 4.15 shows that averagely, residents of Karemo division spend two hours in agricultural activities, as reported by 52.9% of the respondents. 24.2% spend one hour, 6.8% spend four hours and 4.4% spend 5 hours. This shows a near complete shift in economic activity from the people who were predominantly agriculturalists. The scenario explains the almost complete venture into AGM by the residents of Karemo Division, as they were involved in the gold rush, and gave very little consideration to agriculture, since to them AGM was more rewarding. Two hours was deemed too little to do any meaningful agriculture. This concurs with Hilson, (2003) that AGM is a rational economic choice for people seeking to escape poverty or improve their

lives. According to him, artisanal miners mine because it brings them more income and faster economic returns than other livelihoods such as agriculture or because traditional livelihood activities are becoming less viable due to climate change.

4.4.9 Relationship Between Hours Spent on AGM and Agriculture

To show this relationship, Pearson product moment correlation was carried out to determine whether there was a relationship between numbers of hours spent on AGM and agricultural farming. The results were presented as shown in Table 4.16

Table4.16: relationship between hours spent on AGM and agriculture

Correlations			
		Numbers of hours spent on AGM	Number of hours on agriculture
Numbers of hours spent on AGM	Pearson Correlation	1	-.550**
	Sig. (2-tailed)		.000
	N	100	100
Number of hours spent on agriculture	Pearson Correlation	-.550**	1
	Sig. (2-tailed)	.000	
	N	100	100

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

Table 4.16 indicates that there is a moderate negative significant correlation between hours spent on AGM and on agricultural activities ($r=-.550$, $p<.01$). More time is spent on AGM activities thus leaving minimal time for agricultural activities. This contradicted the findings of Schueler et al., (2011), that AGM and agriculture were positively mutually related. The shift of agricultural labour coupled with the damage to both crop land and grazing fields was causing a decrease in

agricultural productivity in Karemo division. Further, more time was being spent on AGM activities compared to agriculture.

4.5 Rehabilitation status of the land under AGM

4.5.1 Elements of rehabilitation

The study sought to identify indicators of rehabilitation within the division so as to assess the level of land rehabilitation awareness and its extent in Karemo division.

First the percentage of households that still farmed their abandoned AGM lands was sought. The results were presented in 4.4 below

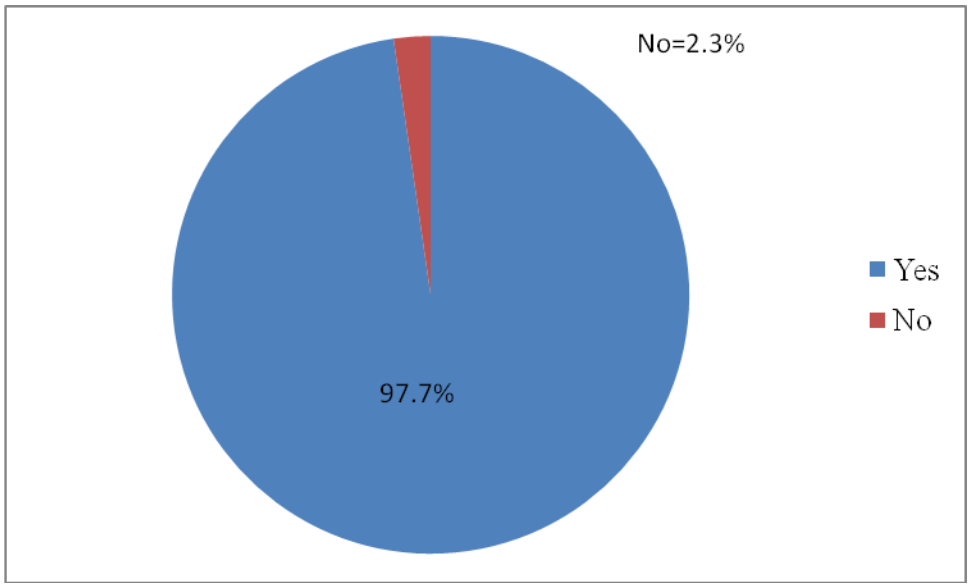


Figure 4.4: Percentage of households that still farm abandoned AGM land

Figure 4.4 indicates that majority of the residents 97.7% were found to be still farming the parcel of the land that had AGM, while 2.3% had completely abandoned the mined lands. This illustrates the limited nature of the households' land within Karemo division. As indicated in table 4.3, majority of the households possessed only two acres of land. They therefore need to rehabilitate their mined lands so as to ensure post AGM land use in the area.

The method of land cultivation used in abandoned AGM fields was also sought and the results presented in figure 4.5

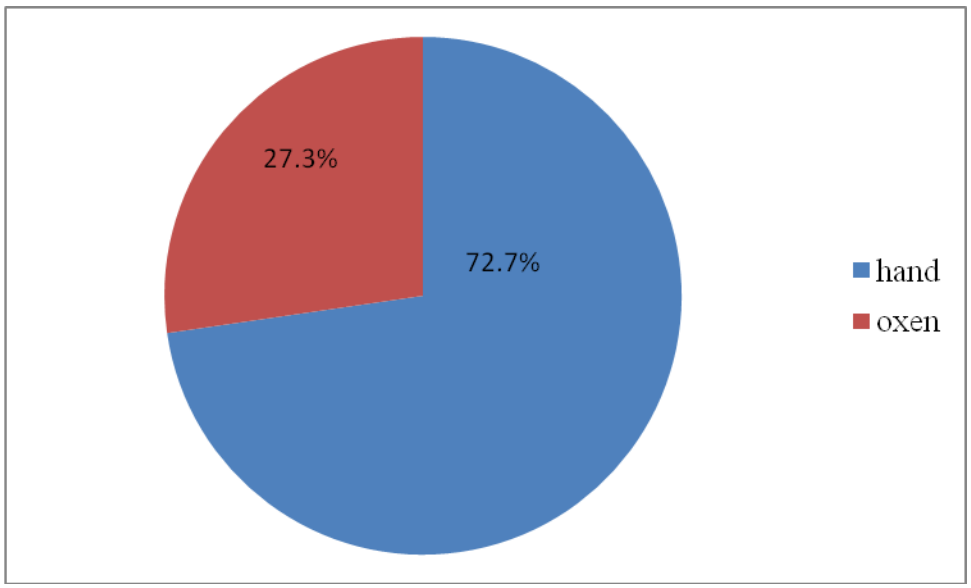


Figure 4.5: Method of cultivation used by households in abandoned AGM farms

Most of households, 72.7%, still use hands to plough while the rest used ox plough 27.3%. The use of hands is as a result of many open holes that can neither allow ox plough nor mechanization. Those who used ox plough had their lands rehabilitated, naturally regenerated or never participated in AGM at all. The pronounced use of hands may limit the agricultural output since only limited land can be cultivated as opposed to if ox plough would have been employed. This confirmed Krappmann, 2006 findings that, AGM can only begin to contribute to national poverty reduction if the technical elements of efficient mining are managed in order to deliver economic development.

The number of households that either rehabilitated their lands or attempted some level of rehabilitation was also sought and the results presented in figure 4.6 below:

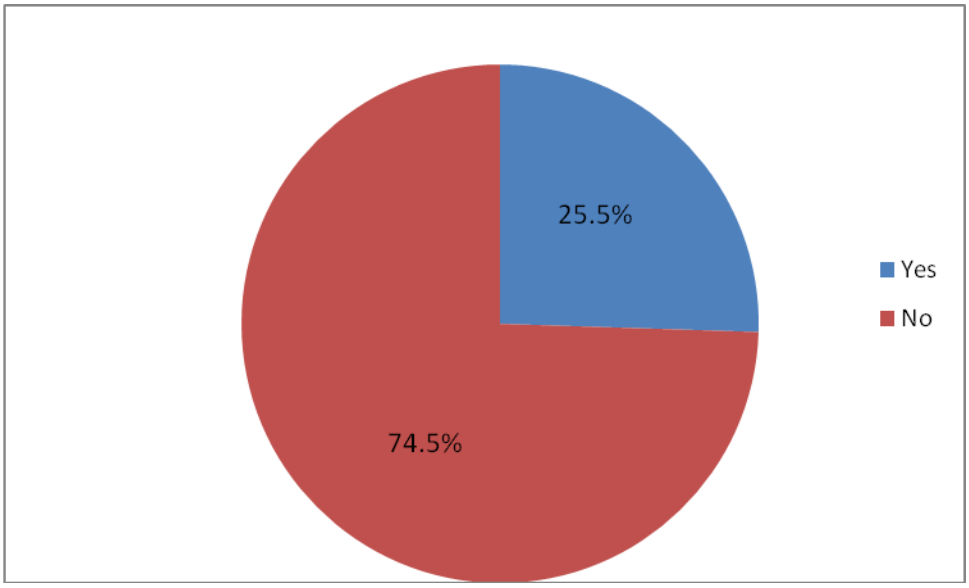


Figure 4.6: Percentage of households that rehabilitated their lands

The rehabilitation of land previously under AGM was not pronounced as indicated by a response rate of only 25.5%. Most households (74.5%) had not rehabilitated the abandoned mines either because of the costs involved, due to gold rush or because of low level of education attainment. On completion of gold reserves in their farms, they simply moved to the neighbouring farms where new reserves had been discovered. As pointed out by Rodriguez at al., (2006) most AGM activities took place in remote areas where the government or local authorities had little control. Rehabilitation efforts were therefore left at the mercy of the miners.

Types of crops grown in the abandoned mined fields were also sought. The results were presented in figure 4.7

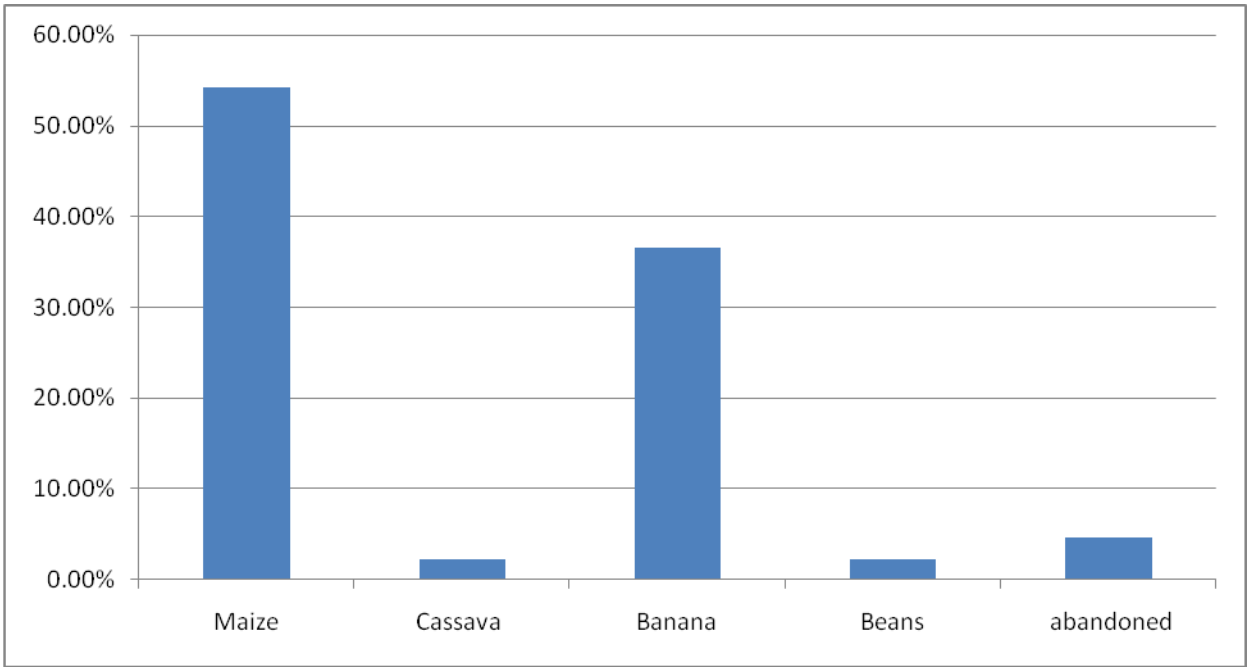


Figure 4.7: Crops grown in abandoned AGM fields

Most of the households (52.4%) had also planted maize in the abandoned AGM lands. 2.3% had planted cassava and beans, 36.5% bananas while 4.7% had completely abandoned the mined fields. Maize was mainly planted as a staple food, hence the high number of responses. Bananas were mainly preferred in the abandoned fields since they helped in reclaiming the opens holes. The households would plant them in the abandoned holes so that they trap rain water and eroded soils. Out of the farmers, 70.3% used fertilizers while 29.7% did not apply any fertilizer. The high rate of fertilizer application is an indication of the effects of AGM on soil fertility. With the exposure of subsoil from the mines, the fertility of soils in the area is compromised and therefore more fertilizer has to be applied. However, the high number of households using fertilizer could be an indication of the availability of funds, probably from AGM. Fertilizers are usually expensive especially in rural setups with high unemployment rates like Karemo division. These findings concurred with Woods, 2006 who found out that, soils in areas affected by mining do

not have enough carbon to retain essential nutrients for plant growth- whether natural regeneration or reforestation seedlings (Woods, 2006).

The methods of cattle grazing used by the households in abandoned AGM fields was also sought and the results presented in figure 4.8

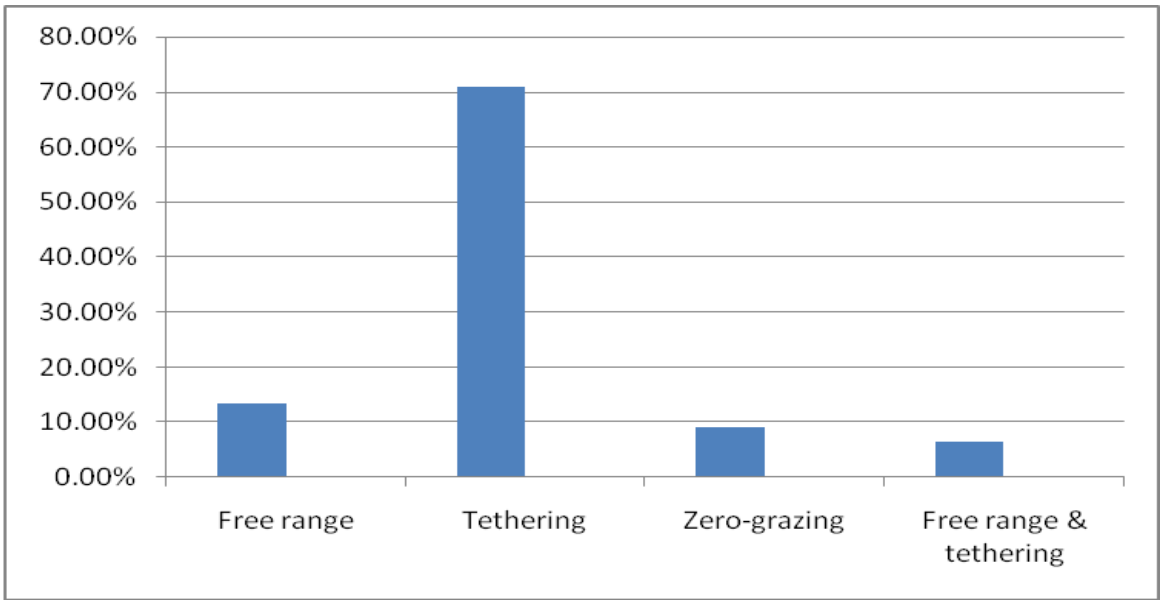


Figure 4.8: Methods of cattle grazing used in abandoned AGM lands

Majority of the households (70.8%) that reared livestock employed tethering as a means of grazing. 13.5% practiced free range, 9.1% zero grazing, while 6.5% combined both free range with tethering. Tethering was mainly used as a precautionary measure to prevent the animals from straying into abandoned mined areas that had unrehabilitated open holes. As reported in figure 4.2, 42% of the households had reported that AGM caused injuries to their livestock. As expressed by Bebington, (2009) AGM, for example, removes vegetation and soils, interrupts ecosystem service flows, and results in inevitable and often permanent farmland loss through soil erosion. This situation was confirmed in Karemo division where animals could be seen grazing dangerously in abandoned AGM fields (plate 4.3). Further the households that predominantly

used free range system as a method of rearing livestock, had been compelled to change to either tethering or zero grazing to avoid injuries to their livestock from abandoned open pits.

The households were finally asked to suggest possible measures that could be instituted to help in curbing agricultural land loss. The results were presented in figure 4.9 below

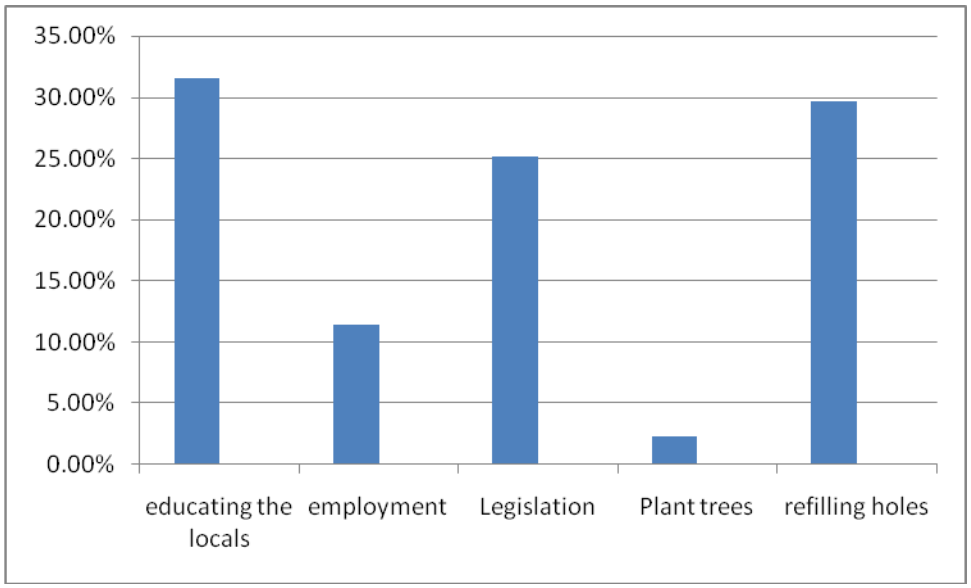


Figure 4.9: Recommended measures to be put in place to rehabilitate agricultural land

The households were also interviewed on whether there were any measures that could be put in place to ensure rehabilitation of the abandoned AGM land. 31.5% suggested educating the locals, 11.4 % suggested provision of employment opportunities by the government, 25.1% proposed enactment of strict legislation, and 2.3% proposed planting of trees in abandoned fields, while 29.7% recommended refilling of abandoned holes. An interview with the are assistant chiefs and village headmen confirmed that the households did not bother about rehabilitating abandoned mines, and since there were no regulations in place, they were unable to compel them to rehabilitate the mined lands.

4.5.2 Unrehabilitated land

Plates 4.7 and 4.8 below, shows pictures of some of the abandoned unrehabilitated AGM lands. Within the division, a number of mined lands were left unrehabilitated. The households gave a number of reasons including lack of enough soil to cover the pits, lack of time, gold rush among other reasons.

Plate 4.7 Land left after AGM in Karemo division

Source: Field data, 2015

Plate 4.7 shows a pit left after AGM activities without any measure of rehabilitation. The pit was very deep and was dangerous to the area residents or any animal in the area. This was a sign that there were no measures that had been taken into consideration to ensure that land was rehabilitated on completion of AGM activities. The condition of the pit shows that it had taken quite some time since it was mined. Alongside the pit, top soil had also been overlain by the subsoil. Rock debris also overlaid the agricultural land, making it impossible for the pasture to sprout that would have provided livestock feeds. The hole was also very large and wide almost 50m in diameter, such that it could form some temporary dam during rainy season. This would be further dangerous to human and livestock, since it would act as breeding site for disease vectors. Animals and people could also drown if they fell in it. These findings concurred with Gavin, (2002), who stated that gold was a finite resource, whose many deposits were short lived and exhaustible over a short period of time. In Karemo division most households that had depleted gold in their lands, moved to work in the neighbouring lands. Very few of them cared to reclaim their lands.

Plate 4.8: Bare land undergoing soil erosion after AGM in Karemo division

Source: Field data, 2015

Plate 4.8 above further displays a tract of land previously under AGM, with various pit holes which are prone to erosion. The land that was once under agriculture has been left bare with poor sub soil that could not support crop farming left exposed at the top. Some of the abandoned holes were very deep and posed a lot of danger to both livestock and human populace. The miners also made underground shafts as they followed gold seams and layers; as a result the land in the area has serious cracks and posed dangers of cave-ins. This indicated that even future settlement in the area may not be possible. This confirmed Hinton et al., (2003) findings that usually, artisanal and small-scale miners lived in poor rural areas of developing countries. Most were not formally

trained in mining and had received little education. In addition, they used rudimentary exploration and extraction techniques. This was also the case in Karemo division where artisanal gold miners were found to have very minimal knowledge on land reclamation. They could not comprehend that gold was a non renewable resource that would soon get depleted and they would get back to practicing agriculture.

An interview with households on the types of crops grown in the area revealed that some minor practices of land rehabilitation were carried out but on a very small scale. Most of the households concentrated on AGM rather than rehabilitation. Some planted bananas as a rehabilitation measure while others planted other trees although on a very small scale. An area residents who participated in the activity was quoted saying,

"There is very little land rehabilitation taking place. We have no time for such activities since we have not had support from the government. If we spent time on rehabilitation then we would not earn our daily income from AGM." These sentiments were shared by quite a number of the households.

This implied that the residents avoided carrying out land rehabilitation due to the time it could take, coupled with lack of support from the government.

4.5.3 Rehabilitated land

A small number of households (25.5%) had rehabilitated their lands on the completion of gold mining in their farms. This was done by planting bananas and trees in the mined fields or refilling the abandoned pits. Plate 4.9 shows a farm that was once under AGM but had been reclaimed back for agricultural productivity.

Plate 4.9 Bananas planted in abandoned holes in Karemo division

Source: Field data, 2015

Plate 4.9 indicates that there was some form of land rehabilitation by one of the participants in AGM activities. The household had planted bananas in the abandoned pits, so as to help refill them. Water would also accumulate in the pits and the banana plants were meant to help in draining it. Maize was also planted in the same field, but without any fertilizer application. Since sub soil was still exposed in the farm, the crops were not healthy which indicated the expected poor harvests. This was a common practice which was observed in parts of Karemo division where residents attempted land rehabilitation. These findings concurred with Bury, (2009) who stated that mining without an awareness of issues related to the environment could result in

drastic and permanent changes in the mining areas. Although there was some level of land rehabilitation in Karemo division, its rate was still minimal and more households needed to be informed on the need to rehabilitate mined lands.

Another evident effect of AGM on agricultural land use is the increased cases of soil erosion which are common in abandoned mined areas. This has led to increased use of chemical fertilizers on crop production in by the households (70.3%) that have rehabilitated their lands. This suggests to the infertility levels of the mined lands. This concurs with Schueler et al., (2011) who explained that in Ghana lands surrounding AGM areas had been rendered bare and susceptible to increased erosion and loss of viability to agricultural activities. Even though the results in table 4.16 indicated that 31% of the participants reported education on rehabilitation as a measure, none of them was aware of some of the mining acts that catered for land rehabilitation. The Mining Act Cap 306 which accommodates quarries and any form of mining in Kenya. As stipulated in section 35 of the act, all those who undertake mining have an obligation to rehabilitate the mined areas on abandonment. Additionally, section 47 gives the rights under the lease in terms of making excavations. Part V of the act deals with accidents and the inspection with section 69 stipulating the obligation of those mining to remedy their dangerous practices.

An interview with a resident on whether he was aware of the quarrying act after being educated on land rehabilitation as one of the measures was quoted.

> *"We are not seriously educated on forms of rehabilitation. We are only advised to do some rehabilitation but we don't know how. We were told there are acts for it but we do not know those acts."*

These findings indicated that there was no formal education on land rehabilitation. The respondent did not have the knowledge of the act in the constitution and are therefore under no obligation to carry out land rehabilitation.

To prove their lack of awareness on proper rehabilitation efforts, plate 4.10 below was taken in one of the farms where a household was found planting trees on an abandoned mine field.

Plate 4.10: Eucalyptus trees being planted in former AGM field in Karemo division

Source: Field data, 2015

The plate indicates an attempt to rehabilitate an abandoned AGM field. Although it was a great step towards reclaiming the land for agricultural purposes, the method employed was not appropriate since the trees planted were found to be capable of even further degrading the land further. Eucalyptus trees are heavy consumers of water that will deny nearby crops of soil moisture. Since the soils in the area had been degenerated, a better strategy could have been employed. The household was however, oblivious of their actions due to their illiteracy levels.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of the findings, conclusion and recommendations and the areas for further research.

5.2 Summary of the research findings

Summary of the research findings were made as per the objectives of the study

5.2.1 Effects of AGM on land agricultural land use

The results revealed that most of the households engaged a larger portion of their lands in AGM and cumulatively 63% had two acres and below. The main activity used in the land by the households was AGM, as indicated by 65.6% of the respondents as compared to the acreage of land that had been set aside for agricultural purposes. There was also a moderate negative significant difference between the land used for artisanal gold mining and that used for agricultural activities. Majority of the respondents (N=252) with large tracts of land (mean of 2.86 acres) engaged their land in AGM activities, as compared to fewer people (n=132), with smaller tracts of land that engaged their lands in faming activities.

A sample t-test carried out for land use between agriculture and AGM also indicated that there was a significant difference between land use under AGM and agriculture ($p<0.05$). This implied that land under AGM was done in large tracts and with majority of the respondents as compared to land allocated for agricultural activities.

5.2.2 Households' involvement in agriculture and in AGM

Majority of the households that participated in AGM were male (68%), compared to (32%) of the female population. Most of the participants cumulatively fell between the ages 20-49 years. 68% of these households had only attained primary education. Household involvement in agriculture was also found to be at a very low level as compared to AGM. Majority of the residents, even though participated in agriculture, had not given it a priority and did it as an additional source of income. For instance, the results revealed that 95.6% of the households participated in AGM and only 4.4% did not participate in gold mining activities. Most of the AGM activities were practiced during the day with majority of the households spending between 7-12 hours daily in AGM activities. On the contrary, only an average of two hours was spent on agricultural activities as reported by 52.9%. Most of the households, 79.7% preferred AGM, with a reason of getting quick cash returns as compared to agricultural activities which they claimed required a lot of patience in order to get some cash.

5.2.3 Rehabilitation status of the land under agriculture

Rehabilitation status of the land under agriculture was found to be inadequate, though majority of the households (97.7%) were found to be still farming the parcel of the land that had AGM. Most households 72.7%, used hands to plough while the rest 27.3% used ox ploughs. There was inadequate and rudimentary rehabilitation of the land after AGM. This was revealed by the rehabilitation methods employed by the households, for example, the planting of eucalyptus trees in regenerating lands would only degenerate even the land further. Tethering was the most considered form of grazing by 70.8% of the households. This was meant to prevent the animals from getting injured in the abandoned mines. It was further noted that there were no proper measures that were put in place to rehabilitate the land as reported by 50.5% of the respondents,

with 31.5% stating that sometimes the community was educated to carry out rehabilitation, though only 29.7% practiced refilling the holes.

5.3 Conclusions

From the study findings, various conclusions can be made based on the objectives of the study. First, AGM has preoccupied most of the residents 65.6%. This has taken position of the large acreage of land thus leaving to very small size of the land to be used for agricultural purposes. Due to the large participation in the activity, most of the households, even those whose land is capable of larger production in agricultural purposes have ventured in AGM activities. Very small land in the area is therefore left for agricultural purposes. Most residents also own one piece of land as opposed to several pieces. They are therefore torn between subdividing their one piece between settlement, AGM, crop farming and livestock rearing.

Most households of Karemo division were engaging in AGM activities. There was no age or sex disparity when it came to AGM. While men involved themselves in active mining, women were involved in other auxiliary jobs like carrying, grinding, washing the ore and selling food to the artisanal miners. These activities were labour demanding such that there was minimal time spared for agricultural activities. This shift in labour was diminishing agricultural production and leaving a lot of gaps on food security in case of gold depletion or reduction in prices. The limited level of education attainment in most households was also found to a possible cause of land degradation in the area. Since majority of the households had only attained primary level of education, inculcation of sustainable AGM practices was a mirage within the division.

Finally, it was evident that there were no appropriate measures put in place to ensure land rehabilitation. This was largely attributed to the gold rush and the low literacy levels as exhibited

by the research findings that 68.2% of the residents had only attained primary level of education. Lack of rehabilitation was also evidenced by the grazing method being employed i.e. tethering, which was meant to prevent the animals from injuring themselves in the abandoned mines. Further it was evident that the there are no strict legislations to deter locals from leaving open abandoned mines.

5.4 Recommendations

Based on the study findings, the following recommendations are made.

Karemo households consider AGM as a major employment venture. It is therefore almost impossible to implore upon them to avoid mining it once they realize its existence in their farms. However, part of the money earned from AGM should be used to both rehabilitate the mined lands and enhance agricultural productivity through refilling of mined holes, purchase of fertilizers and mechanization.

Most households spend majority of their time in AGM as compared to agricultural activities. AGM was also practiced by all household members irrespective of age and sex. Agricultural production is therefore negatively affected in Karemo division. The study therefore recommends that households should divide labour proportionally between the two activities. This can be done by dividing roles between household members. This will ensure that households both benefit from quick AGM money and are also food secure in case of depletion of gold reserves.

Land rehabilitation measures must also be put in place to ensure post AGM productive land use. This can be achieved through enforcement of the existing legislation of laws like the Mining ACT and NEMA laws to compel the households to rehabilitate mined lands. Education to the

households should also be done by the ministry of agriculture and NEMA to sensitize the households on the need to reclaim their lands.

5.5 Suggestion for further studies

The following are suggestions for further studies.

i. A study should be carried out on the effects of artisanal gold mining on water quality in the area.
ii. The study also suggests a comparative study on the economic performance of agricultural production and artisanal gold mining in Karemo division.
iii. A study should also be carried out on social dynamics influencing AGM activities in Karemo division.

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APPENDIX I

LETTER TO RESPONDENTS

Maseno University,

Private Bag,

Maseno – Kenya.

Dear respondent,

My name is Chrispine Odhiambo Otieno. I am pursuing my masters of Arts in Geography at Maseno University – Kenya.

I am undertaking research on **"Effects of Artisanal Gold Mining on Agricultural Land in Karemo Division, Siaya County".**

This research is part of my academic work for the award of Master of Arts in Geography. I kindly request you to respond to the questions in the attached questionnaire. I assure you that the answers given by you will be confidential.

Thank you.

Chrispine Odhiambo Otieno

MA/NS/00136/2013

0719378313

Otienopine@gmail.com

APENDIX II: HOUSEHOLD SURVEY QUESTIONNAIRE

Effects of Artisanal Gold Mining on agricultural land in Karemo Division, Siaya County, Kenya

SECTION A: Demographic Information **Questionnaire No.: ____**

Date: _____ **Location: _____**

1. What is your gender? Male ☐ Female ☐
2. How old are you? _____ years
3. What is your level of education?

None ☐

Primary ☐

Secondary ☐

Tertiary ☐

Others specify.....

4. What is your marital status?

Single ☐ Married ☐ others specify.....

5. What is the size of your household?.....
6. What is your employment status? ☐ Formal employment ☐ informal employment

SECTION B: ACREAGE OF LAND UNDER AGM AND UNDER AGRICULTURE

7. How much land does your household own in acres?.....

8. What is the nature of your household land?

One piece ☐ several pieces ☐

9. If several pieces, what is the most dominant activity in your farm?

i) Crop farming ☐ ii) livestock farming ☐ iii)gold mining ☐ iv)mixed farming ☐

v) Others specify.....

10. What acreage of land is apportioned to each of the above mentioned activities?

i) Crop farming.....

ii) Livestock farming.....

iii) Gold mining.....

iv) Others specify.....

11. When did AGM activities commence in your farm?.....

12. What is the effect of AGM on animal production?

.....

.....

.....

.....

13. What is the effect of AGM on crop production?

.....

.....

.....

.....

SECTION C: HOUSEHOLD'S INVOVEMENT IN AGRICULTURE AND IN AGM ACTIVITIES

14. Do you mine gold in your farm? YES ☐ NO ☐

15. If YES, How do you detect gold in your farms?

.....

.....

.....

16. How many members of your household participate in gold mining activities?

.....

.....

17. When do you participate in mining? Day time ☐ Day and night ☐ Don't participate ☐

18. On average, how many hours do your household spend on AGM activities per day?

.....

19. On average how many hours does your family allocate to agricultural activities per day?

.....

20. Between agriculture and AGM, which one does your household prefer? AGRICULTURE ☐ AGM ☐

21. Why to question 19 above?

.....

.....

.....

SECTION D: REHABILITATION STATUS OF LAND UNDER AGRICULTURE

22. Do you still farm the parcel that had AGM?

23. If YES, what do you use to cultivate the land previously under AGM?

Hand ☐ Ox plough ☐ tractor ☐

24. If NO to question 22 above, what do you do with the abandoned mined farms?

25. Do you rehabilitate the abandoned pits? Yes ☐ No ☐

26. If YES to question 24 above, why?

.....

.....

27. If No to question 24 above,give reasons why

.....

.....

28. Which crops do you grow in the abandoned mined fields?

Maize ☐ cassava ☐ bananas ☐ beans ☐

Other specify.....

29. Why in question 27 above?

.....

.....

30. Do you use fertilizer to increase your yields? Yes ☐ No ☐

31. If YES, in question 31 above why?

.....

.....

32. Which method of cattle grazing have you employed in the mined areas?

Free range grazing ☐ tethering ☐ zero grazing ☐ others specify.....

33. Why in Q32?

.....

.....

34. Are there any measures being put in place to prevent agricultural land loss?

a. Yes

b. No

35. If yes in Q34, which ones?

.....

.....

.....

SECTION E: QUESTIONS GUIDE FOR THE KEY INFORMANTS

Effects of Artisanal Gold Mining on agricultural land

36. Are you aware of the existence of gold mining in this area? YES☐ NO☐

37. If YES, when did gold mining activities commence in this area?

38. How have the mining activities affected the agricultural land in the area?

39. How have the mining activities contributed to the economy of the locality?

40. Are there any adverse effects of mining in the area? YES ☐ NO ☐

41. If yes, which ones?

42. What measures have the locals put in place to mitigate the adverse effects of AGM?

43. In your opinion, are the mitigation measures in place adequate? YES ☐ NO ☐

44. What other measures could be considered by the locals in order to foster sustainable gold mining?

45. Would you recommend a continuation of gold mining in light of the possible effects to the agricultural land in the area? YES ☐ NO ☐

46. Explain your response in Question 51 above.

APENDIX III: OBSERVATION CHECKLIST

The following will be the observation checklist during the field study

- Methods used in gold mining
- The techniques and tools uses in gold mining
- Gender roles in AGM
- Acreage of land apportioned to both AGM and agriculture
- Acreages of unrehabilitated land.
- Extent of land rehabilitation on completion of AGM.
- Number of people participating in AGM.

APPENDIX IV: TOOLS OF ANALYSIS

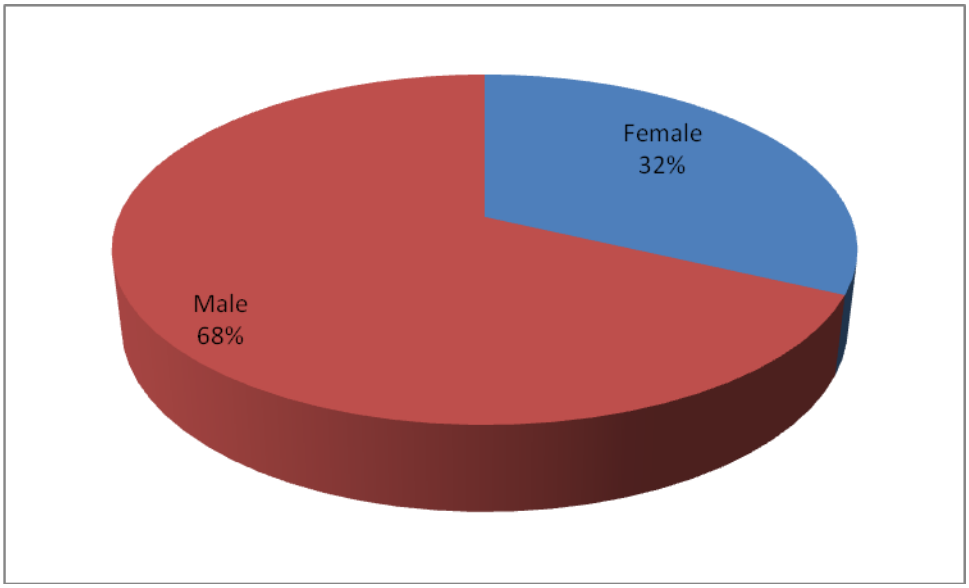
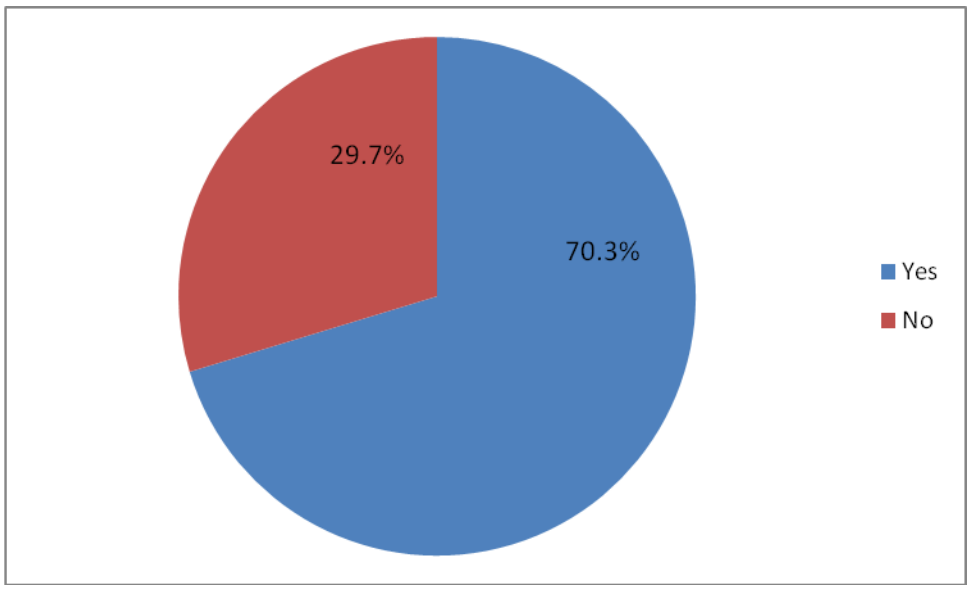


Figure 4.1: Distribution of respondents by Gender, Source: Survey data, 2015

t-test for Land use between Agriculture and Artisanal Gold Mining

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference
land use	Equal variances assumed	24.661	.000	9.127	382	.000	.84776
	Equal variances not assumed			8.322	207.752	.000	.84776



Percentage of households that applied fertilizer in abandoned AGM fields