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Original Research Article

The Influence of acreage of Land under Artisanal Gold Mining on Maize Crop Yields in Ikolomani Sub County, Kakamega Kenya

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Abstract: Artisanal Gold Mining has gained popularity as a source of livelihood for more than 13 million people in the developing world. However, it is characterized with massive land destructions posing a threat to food security. Despite this, many scholarly works on AGM have focused on its influence on livelihoods on a general perspective. There is need to narrow the scope of generalization and zero in on specific AGM parameters such as; acreage of land under AGM and asses its influence on maize crop yields. Ikolomani Sub County is endowed with high amounts of rainfall and fertile soils. Despite this, it has a food poverty index of 47% in comparison to the national food poverty rate of 45%. Notwithstanding the fact that, it has 500 households engaging in AGM on their farming land. Therefore this study focused on the influence of acreage of land under AGM on maize crop yields. A cross-sectional descriptive research design involving purposive, systematic, and random sampling was employed. A minimum sample size of 384 households was drawn from a study population of 500 households of farmers who engage in AGM. The results show that about 53.8 % ($r = 0.538$, $p < 0.05$) of the variation of maize crop yields can be explained by acreage of land under AGM. That arable land in Ikolomani is greatly degraded, compacted and occupied by AGM activities subsequently resulting to low maize crop yields. It can be recommended that enhanced control and management of AGM activities in Ikolomani Sub County could help mitigate against chances of decrease in the acreage of arable land and subsequent low maize crop yields.

Keywords: Artisanal gold mining, Acreage of arable land, Food security, Maize crop yields.

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INTRODUCTION

The rise in global demand and the price of gold have stimulated new gold mining activities by multinational companies and small-scale gold miners throughout the world (Burry & Creek 2009). For over the last 13 years leading to 2000, the price of gold has increased from $2500 / ounce to $1300/ounce in 2013 (World Gold Council, 2013). The high demand of gold as a resource has therefore resulted in shrinking of natural resources, an estimated 1000 km^2 of agriculture land or natural resource disappears annually (Koaliner & Roland 2013). Alongside this, illegal gold mining activities were identified as the cause of environmental problems such as water pollution, deforestation, poor soil fertility and limited access to land for agriculture productivity (Obiri *et al* 2019). These studies have succeeded in bringing to the fore the vulnerability state of farming land as a result of AGM activities on a general perspective. However, there is need to narrow the scope of generalization and zero in on specific AGM parameters; space occupancy and assess its influence on food crop yields.

Destruction of vegetation and farmland by miners affect agriculture and food security (Hayes 2008). In addition, surface mining removes vegetation and soils, interrupts ecosystems surface flows and results in investable and often permanent farmland loss (Bebbingtone & Burry 2009). In Peru and Ecuador AGM takes place alongside large scale formal mining leading to land use conflicts between AGM and other agricultural activities (ICMM, 2010). Furthermore,

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households lease out farmlands for AGM activates (Anoah, 2013).

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

In Kenya, agriculture is the backbone of the country as it accounts for 65% of the total GDP earnings. Despite this, the country is not food sufficient as witnessed in a performance deceleration from 6.1% in 2018 to 3.6% in 2019 in production of selected crops and pasture for livestock. For example, maize production reduced from 44.6 million bags in 2018 to 39.8 million bags in 2019 (GOK 2019). Notwithstanding the fact that the county is endowed with conducive climatic conditions for good agricultural production, rainfall performance is above average exhibiting a bimodal distribution with two distinct wet seasons averaging 1000-1200 mm for the long rains and 500-800 for the short rains (GOK 2019). Which is good for production of most of the staple crops in the country. On the other side, AGM is a collective term which covers formal and informal mining which is characterized by low capital intensity and high labour intensity and relatively simple methods for exploration, extraction and processing. It can involve men and women working on an individual basis as well as those working in family groups, in partnerships or as members of co-operatives or other types of associations (World Gold Council 2013). In Kenya, AGM is also a crucial player in the employment of the unskilled labour particularly in the rural areas of places such as Migori, Nandi, Vihiga, Kisumu and Siaya where it is gaining popularity over other sources of livelihoods (GOK 2019). This has culminated in the gross domestic product activities of mining and quarrying to increase from 545842 in 2015 to 673296 in 2019. Despite this, its contribution to the Gross Domestic Product cannot outmatch that of the agricultural sector which has increased sharply from 30.2% the year 2015 to 34.1% the year 2019 compared to mining and quarrying which stands at 0.9% the year 2015 and 0.7% the year 2019. This therefore awakens the need to ensure that AGM activities should exist in a sustainable manner alongside other sources of livelihoods particularly the major economic drivers of the economy such as agriculture.

The Kenya mining legal framework of 2016 has legalized AGM in order to make it a sustainable venture through minimizing of environmental degradation. Livelihoods are anchored on environment in that, a livelihood is environmentally sustainable when it maintains or enhances the local and global assets on which livelihoods depend, and has net beneficial effects on other livelihoods (Wikipedia). Despite this, the bureaucracy involved in miners being allowed to engage in AGM is more time consuming making room for AGM sector to be porous to illegal mining. This therefore immensely leads to AGM impacting on other sources of livelihoods through land degradation and vegetation destructions leading to massive soil erosion (Odhiambo 2010). This is supported by KDCP (2018) that, the major contributors to environmental degradation are; poor waste management initiatives, lack of a designated waste disposal site, quarrying and poor land use practices, and degree of environmental enforcement of environmental laws which comparatively lead to reduced farm yields. For example in Kenya, land degradation is registered in AGM areas as a result of soil erosion, heavy mercury bio-accumulation in fishing waters and risk of human exposure through mercury vapor and fish consumption (Ogola *et al*., 2001).

In addition, AGM has resulted in the loss of farm land in Rongo (Odhiambo 2010). Apart from the impact mining activities have on the natural environment they also reduce farm labor or they make farm land vulnerable due to lack of labor (Otieno, 2017) .This, therefore, raises a question on how does AGM shape livelihood sustenance through crop yields?

Although AGM is not a major economic activity in Kenya, historically, making reference to the famous gold rush in Kakamega (1930s) which witnessed an influx of European gold prospectors who established the largest gold mine in Rostermine near Kakamega. The gold mine operated till its closure in 1952 (Ministry of Environment and Natural Resources) , this paved way for the indigenous scavenging for gold in the famous gold mine and on their private farms. This has seen gold become a major source of livelihood with majority of the populace being lured into it due to poverty and the need to make quick money (NEMA 2007). Notwithstanding the fact that Ikolomani Sub County is coupled with food security issues having a food poverty rate of 47% in comparison to the national food poverty rate of 45 % (GOK 2019. This has seen Ikolomani attract a lot of scholarly attention. For example, a study by Macharia *et al*., (2016) exposed the nature of conflicts associated with AGM in Ikolomani Sub County. Mulinya *et al*., (2020) further indicated the level of environmental degradation from mining in Ikolomani. Much as these studies directly address themselves to mining activities in the area, the food crop yields question has not received the much needed

attention and yet it remains at the core of AGM activities in Ikolomani.

Statement of the problem

AGM has gained popularity worldwide as a source of income due to the high demand for gold as a resource. In Ikolomani Sub County AGM is expanding due to the need for the populace to earn income. Most of the AGM activities are operating illegally, characterized with poor exploitation mechanisms, large land destructions and occupation as huge parcels of land are fenced off for AGM. The once arable land is gradually shrinking in acreage as it is replaced by heaps of stock piles, overburden and open excavated pits. This needs to be a revelation to why the area has registered low food crop yields having a food poverty rate of 47% in comparison to the national food poverty rate of 45% despite being endowed with high amounts of rainfall and fertile soils which could support agriculture. However the available reviewed literature did not reveal how the acreage of land under AGM has influenced maize crop yields in Ikolomani Sub County. Therefore, there was a need to conduct this study so as to examine the influence of acreage of land under AGM on maize crop yields. The study was therefore relevant because it has clearly brought out the relationship between, acreage of land under AGM and maize crop yields.

Purpose of the paper

The influence of acreage of land under AGM on maize crop yields in Ikolomani Sub County of Kakamega County. The study was confined to maize crop yields per season for two years 2018 and 2019. and the acreage of land under AGM per season for two years 2018 and 2019 seasons .The assumption of the study was that the acreage of land under AGM influences maize crop yields. The assumption was that: increased acreage of land under AGM reduce land under maize crop and hence reduced maize crop yields. Decreased acreage of land under AGM can increase the land under maize crop and hence increased maize crop yields.

MATERIALS AND METHODS

The study was carried out in Ikolomani Sub County. The Sub county lies between latitudes 00º15ˈ19ˈˈN to 0º 6ˈ 37ˈˈN and longitudes 34º 37ˈ37ˈˈE to34º 48ˈ 49ˈˈE (Figure-3). It is bordered by Lurambi Constituency to the North, Sabatia and Emuhaya Constituencies to the south, Shinyalu Constituency to the east and Kwisero Constituency to the west. The Sub County covers an area of 146.2 km^2 of which livestock and cash crop area covers 51.8 $km^2$and food crop land covers 55.3 km^2. The remaining area is covered by residential settlement and natural resources (KCDP, 2019).

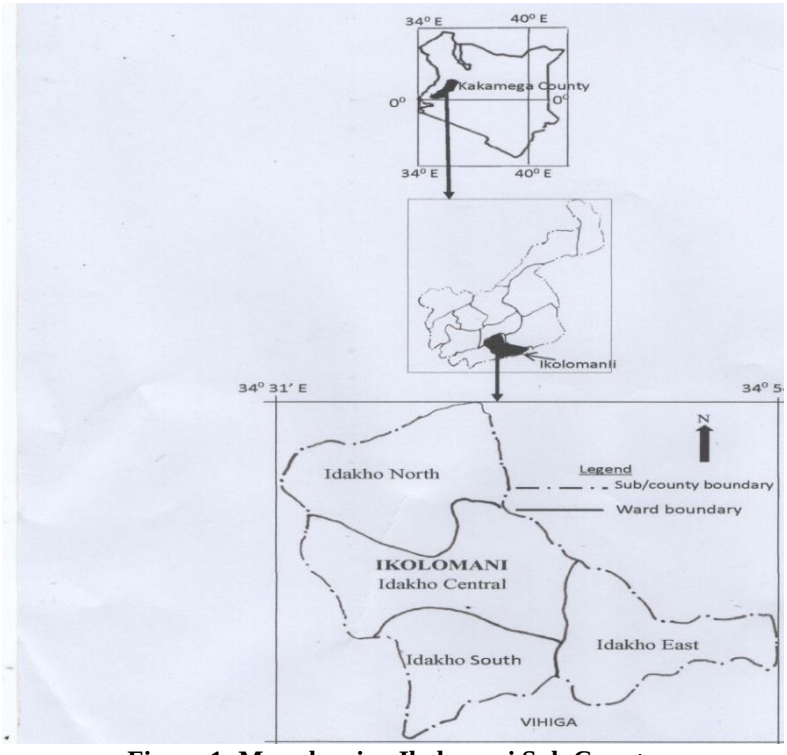

Figure 1: Map showing Ikolomani Sub County
Source: Kakamega County Development Plan 2015.

Socio Economic Characteristics

The Sub County has a total of 26940 households which constitutes four wards namely Idhakho North, Idakho South, Idakho Central and Idakho East.

Out of this, a house hold population of 16437 engaged in crop production with an average land holding acreage standing at 0.57 ha. This household population constitutes 500 households who engage in artisanal mining or had leased out their farms for AGM activities, thereby forming a basis for sampling during data collection.

Research Design

This study employed a cross sectional descriptive research design since AGM was already taking place over a wider area and data was obtained over a short period of time.

Study Population, Sampling and Data Collection

The study used stratified sampling for the four wards, two Sub locations were picked by the random sampling procedure from each ward giving a total of eight Sub Locations namely Shimanyiro, Shisero, Eregi, Lirhembe Malinya, Musoli, Makhokho, and Ivonda. Simple random sampling was used to obtain 384 respondents from the 500 artisanal gold miner's households who practice farming. Every artisanal miner from each Sub location of the eight Sub locations was given a number then the list of numbers was randomized through a computer program (Microsoft Office Excel). The random numbers totaling to 384 were then selected. The yields in maize were stratified into two seasons for the years 2018 and 2019 making a total of 4 seasons. This was because maize crop is planted and harvested twice per year. Purposive sampling was used to obtain key informants. Within the area of study who were interviewed. They included four artisanal gold mining opinion leaders, the area chiefs and assistant chiefs, village elders, four officers from the Petroleum and Mining and Agriculture departments. These were people who were conversant with artisanal gold mining activities, management and policy issues pertaining mining and agriculture in Ikolomani Sub County. Participatory rural appraisal tools were used. These tools included FGD whereby four groups of a minimum 14 adult males and females aged not less than20 years were selected with aid of local authorities. The groups had a discussion on the influence of acreage of land under AGM on maize crop yields for thirty minutes. This validated information on AGM acreage of land under AGM and maize crop yields

Data Analysis and Results Presentation

The questionnaires, interview schedules, field notes and photographs were first arranged and authenticated. Questionnaires were then coded for analysis. The quantitative data were analyzed using descriptive statistics such as percentages and frequencies. Frequency counts and percentages of the responses in form of statements were obtained so as to generate descriptive information about the respondents and to illustrate the general trend of findings on various variables that were under investigation. Using the SPSS Version 2016, Simple linear regression was used to determine the variation of maize crop yields as explained by the acreage of land under AGM. Qualitative data on acreage of land under AGM and maize crop yields were analyzed by creating patterns and themes then evaluating the usefulness of information in answering the research questions. Also data from Focus Group Discussions were analyzed thematically by extracting key themes significant to the research objective. Photo Express was used for digital photographs production. Microsoft word was used for processing the text. The analyzed findings were presented and discussed in form of summarized tables, graphs, charts, photographs and discussions. The findings are expected to provide awareness in Ikolomani Sub County on the influence of acreage of land under AGM on maize crop yields.

RESULTS AND DISCUSSION

The influence of acreage of land under AGM on maize crop yields

This chapter presents results, data analysis and interpretation of findings based on the objective of the study.

The study sought to establish the extent to which acreage of land under AGM influence maize crop using respondent's perceptions which was measured using a five point Likert scle as shown in Table-1.

Table-1: The statements used to find the extent to which acreage of land under AGM influence maize crop yields and percentages of total respondents using the Likert scale

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

The researcher sought to establish if the gold mining site was once used for farming. Respondents were asked if they agreed with this statement "that gold mining site was once used for farming". They provided a variety of responses in regard to the statement. The results as shown in the table 1 indicate that 87.3% of the respondents strongly agreed with the statement that gold mining site was once used for farming. Up to 11.6% agreed with the statement and 0.4% was neutral on the statement. This makes the statement valid and credible. Increased global demand for gold has increased mining both on large and small scales. High demand of resources results in shrinking of natural resources, an estimated 1000 km^2 of agriculture land or natural resource disappears annually as a result of increased resource demand (Koaliner & Roland 2013). The increased AGM activities are believed to have led to the shrinking of arable land and grazing space hence reduced food production. A respondent revealed that to have any meaningful maize crop yields they have reverted to the use of organic farm manure alongside the artificial fertilizers making farming a very expensive venture.

Respondents were asked if they have ever visited the gold mining site in the Sub County. A variety of responses were raised in regard to the question. The results as shown in the table 1 indicate that 87.5% of the respondents strongly agreed with the statement, 12.1% agreed and 0.4% were neutral on the statement. This makes the statement valid and credible. Majority of the respondents have visited the mining site.

This implies that they have been at the site, either as workers or residents of the area. This implies that they know and understand the activities that take place at the mining site. Through observation the respondents have adequate knowledge about the mining activities. Knowledge of the activities that take place at the mining site implies that they understand and can give concrete and credible information about mining in the area.

The researcher also envisaged to find out if the gold mining site was once used for maize crop farming. Respondents were therefore asked if the gold mining site was once used for maize crop farming**.** A variety of responses were raised in regard to the question. The results as shown in the table 1 indicate that 89.7% of the respondents strongly agreed with the statement, 9.9% agreed, and 0.4% were neutral on the statement. This makes the statement valid and credible. This rural community is largely made up of poor peasant farmers whose traditional activities were subsistence farming mainly growing maize as their staple food (GOK, 2013). Gold mining practices started in 1930s when gold was discovered in Rosterman, Ikolomani Sub County (GOK, 2013). Since subsistence farming existed before the discoveries of gold were made, then it follows that the gold mining area was once used for food crop farming. Based on this argument, then it follows that the initial gold mining and the subsequent expansion of AGM activities have helped in reducing maize crop yields. By observations made by the researcher much acreage of land initially used for crop production had been encroached on by the constructions of mining factories; for mining activities such as; crushing of gold, washing of the gold ore, drying of the gold slurry, smelting houses and make shift structures which are consuming much acreage of land hence having a direct impact on maize crop yields. This is evidenced by figure 2 showing a make shift structure that has been constructed in arable land in Makhokho, thereby reducing acreage of arable land consequently leading to reduction in maize crop yields.

Figure-2: A photograph showing a make shift structure constructed on arable land in Makhokho Source: Field 2021

Respondents were also asked to comment on the statement that, the methods used in the gold mining activity have had an effect on maize crop yields. Respondents provided a variety of responses in regard to the statement. Table 1 provides the results of the responses. The table indicates that 95.6% of the respondents strongly agreed with the statement, and 0.4% were neutral on the statement. This confirms the statement valid and credible. This means that the methods used in AGM activities have an effect on maize crop yields. Excavating for gold involves destruction of trees and crops.

This surface mining method reduces farmlands and hence reduction on maize crop yields. This finding is consistent with studies such as Schuelar & Schroder (2011) in Ghana, which posited that surface mining resulted in deforestation (58%), a substantial loss of farmland (45%) within mining concessions and widespread spillover effect as relocated farmers expand farmlands into forests. Kumah (2006) eludes that surface mining in developing countries, negatively affects livelihoods as farmers switch to alternative strategies of income. Destruction of farmlands through surface mining negatively affects agriculture and food security. The above studies are in line with what was

observed in Ikolomani as much land was under AGM concessions, trees had been cleared in AGM mining areas such as Malinya and Shisero making the land susceptible to erosion hence rendering it less fertile for optimum maize crop production.

Respondents were also asked to comment on the statement that the average seasonal yields of maize per acre reduced between 2018 and 2019 in the sub county. Table 1 indicates that 89.0% of the respondents strongly agreed with the statement, 10.7% agreed with the statement and 0.4% were neutral on the statement. This confirms the statement as valid and credible. There was a reduction in average seasonal yields of maize between 2018 and 2019. This reduction could be attributed to increased AGM activities in the area. A discant reported that, ‘‘here in Shisero most households engaging in AGM have their acreage of arable land being replaced by mining activates or degraded through mining thereby reducing on maize crop yields’’. Studies such as, Kumah (2006); Schuelar &Schroder (2001) have demonstrated that surface mining methods in developing countries have negatively affected farming lands and hence food crop yields. The reduction in maize yields between 2018 and 2019 can be strongly associated with the expansion of AGM activities in Ikolomani Sub County.

Respondents were asked to rate the extent to which they agreed with the statement that reduction on the average seasonal yields of maize per acre in the study area was mainly caused by gold mining activities. Respondents gave various responses in regard to the statement. Table 1 provides the results of the responses as shown in the table 1 results of the survey indicate that 90.1% of the respondents strongly agreed with the statement, 9.5% agreed and 0.4% were neutral on the statement. This confirms the statement as valid and credible. This finding is similar to Odhiambo (2010) who connotes that AGM has resulted in loss of farmland and hence reduced crop yields in the area. This is likely to be the scenario in most areas that practice AGM in Kenya. Mining has been associated with land grabbing in mining communities, leading to decreased food crop yields (Aragon & Juan 2012). Maize being the main subsistence food crop in the area, its changes in yields are strongly associated with expansion of AGM in the study area. Equally, many studies have associated surface mining with destruction of farmlands and hence reduced food crop yields. This is supported by figure 3 showing heaps of overburden and tailing from the excavated pits consuming chunks of arable land in Malinya Sub Location. This has a direct influence on maize crop yields in Ikolomani Sub County.

Figure-3: Large land concessions for AGM reducing acreage of arable land in Makhokho Sub Location Source: Field 2

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

Influence of acreage of land under AGM on Maize crop yields

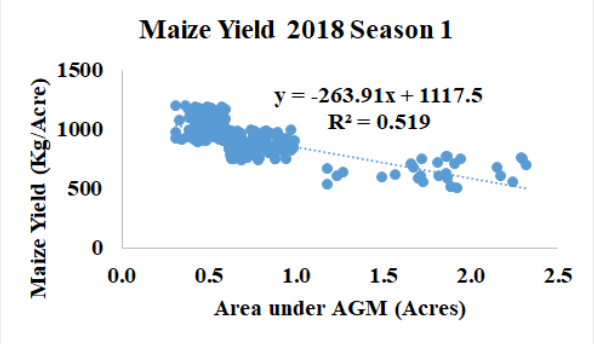

Figure-4: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on maize yields in 2018 season 1

Figure-4 shows that 52% variation of maize yields in 2018 season 1 can be explained by acreage of land under AGM. Whereby, surface mining in the developing world often erodes livelihood foundations, forcing populations to relocate and farmers to develop alternative income strategies (Kumah, 2006). Hayes (2008) alluded that, the destruction of vegetation and farm lands by miners affect agriculture and food security. This connotes the findings by Bebbington & Burry (2009) who asserted that, AGM removes vegetation and soils, interrupts ecosystem service flows and results in inevitable and often farm land loss. Relocation of farmers, destruction of farm lands and farm loss have a corresponding negative influence on food crop yields In Ikolomani massive land degradation was observed in AGM areas. A respondent observed that most potential land in Shiero had been degraded greatly and replaced by pot holes making it not economic viable in terms of agricultural productivity.

Nonetheless, 48% variation of maize yields in 2018 season 1 can be explained by factors not considered in this analysis. These factors could be climatic factors. Where by variations in annual rainfall, average temperature, global increase of atmospheric CO_2 and fluctuations in sea level are some major manifestations of climate change which negatively impact maize yields (Raza 2009). Climate change is the result of global warming. It has devastating effects in plant growth and crop yield which can affect directly/indirectly and socio economically reduce maize crop yields by up to 70% (Boyes 1982).

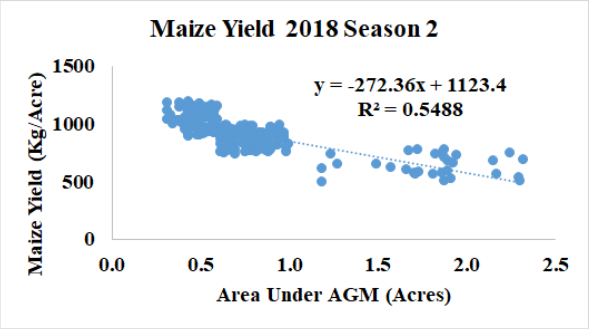

Figure-5: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on maize yields in 2018 season 2

Figure-5 shows that 55% variation of maize yields in 2018 season 2 can be explained by acreage of land under AGM. By observation it was clearly seen that vegetation cover was greatly cleared in areas of Makhokho and Eregi . Vegetation clearance therefore deprives the soil from the humus that is essential for determining its fertility. A respondent revealed that the soils were no longer fertile as a result of massive deforestation and reduction in acreage of arable land to AGM activities. This lends credence to (Schueler & Schroder 2011) that Substantial loss of farm land is registered in mining areas forcing farmers to relocate to forests .This also corroborates the findings of Akabzaa & Daramini (2001) mining concessions destroy farmlands as well as vegetation in Ghana. When farmland is degraded soil fertility is compromised hence food crop production is compromised.

However 45% variation of maize yields in 2018 season 2 can be explained by factors not considered in this analysis. These factors could constitute drought which refers to a situation in which the amount of available water through rainfall and or irrigation is insufficient to meet the evapotranspiration needs of the crops (Kunaraswany 2006).

The impending climate change adversities are known to alter the abiotic stresses like a variable temperature regimes and their associated impacts in water availability leading to drought, increased diseases and pest's incidence and extreme weather events at local and regional scale (Kunaraswany 2006).

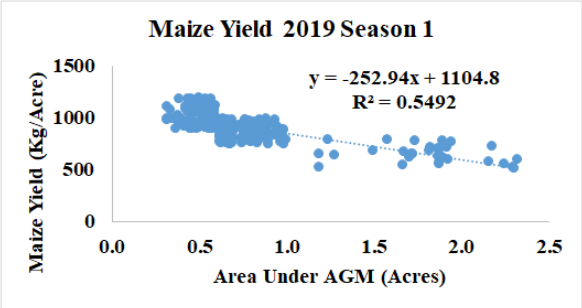

Figure 6: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on maize yields in 2019 season 1

Figure-6 shows that 55% variation of maize yields in 2019 season 1 can be explained by acreage of land under AGM. In Ikolomani large land of under gold concessions reducing the acreage of arable land this has a direct impact on food crop yields. A respondent revealed that after leasing out his land for AGM he has resorted to buying food staff for his family as his yields have reduced to only two sacks of maize from a previous yield of 5 bags of maize in the subsequent seasons. This findings is in line with Agyemang *et al*., (2015) that farmlands, forests and water resources are most vulnerable to adverse effects of AGM. This is also in agreement to the findings by Tenkorang *et al*., (2013) that posited that leases for surface mining displaced the original owners from large arable land needed for food crop cultivation. This clearly shows that when acreage of arable land is reduced to mining activities maize production reduces accordingly.

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

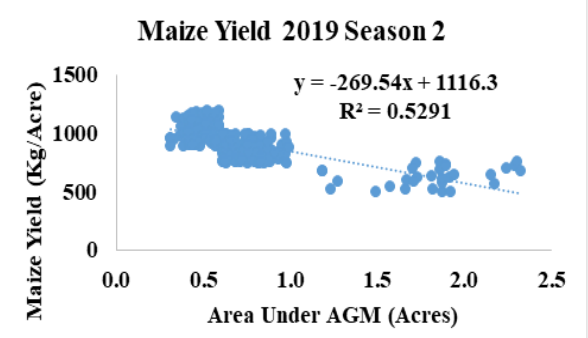

Figure-7: Scatter plot of simple linear regression results showing the influence of acreage of land under AGM on maize yields in 2019 season 2

Figure-7 shows that 53% variation of maize yields in 2019 season 2 can be explained by acreage of land under AGM. By observation areas of Malinya and Eregi were characterized with massive land degradation and extensive erosion .This deprived soil of essential macro and micro nutrients for maximum food production. This in line with Hagos *et al*., (2016) who posited that land disturbance and soil erosion, vegetation and biodiversity loses were the serious threats of traditional gold mining leading to reduction in cultivable areas for cereal crops .

In Ikolomani we also had mined areas suffering extensively from soil compaction which considerably reduced on the acreage of arable land this is supported by plate 8.

Figure-8: A photograph showing compacted land due to motorcycles and human traffic to an AGM factory in Ivonda Sub Location
Source: Field 2020

The findings are in line with Sheriff & Bashiru (2018) who connoted that AGM led to soil depression thereby reducing the acreage of arable land consequently leading to reduction in agricultural productivity. In Ikolomani Sub County mushrooming settlements by miners are taking up the once potential acreage of land for food crop production and therefore the acreage of land under maize crop production has been shrinking as it is taken up by miners for mining and settlement purposes. This connotes the findings by Sheriff & Bashuru (2018) that agricultural productivity can be threatened or compromised by AGM activities.

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

When the regression analysis results for figures 4,5,6 and 7 are compared to the findings in Table 1, 89.0 % of the respondents said that ‘they strongly agree’ that the average seasonal yields of maize per acre reduced between 2018 and 2019 . About 90.1 % of the respondents strongly agree that this reduction was mainly believed to be caused by gold mining activities. Plausibly, the two findings confirm that acreage of land under AGM influence maize yields in 2018 and 2019 seasons 1 and 2. This implies that acreage of land under AGM influences maize crop yields in Ikolomani Sub County. In Kenya a study conducted by Ogola *et al*., (2001) asserted that; land degradation is registered in AGM areas as a result of soil erosion. This affects productivity of land and hence food crop production. Land degradation directly impacts negatively on maize crop production.

A discant observed that as a result of increase in acreage of land under AGM, AGM activities such as crushing of the mineral ore, washing, digging of the pits and carrying the ore to crushing factories have intensified. This has attracted young people to AGM since they are paid good money. This has deprived farming activities of human labour, thereby reducing on maize crop yields. He further noted that, in Ikolomani, it is not easy to find farm laborers as most of them prefer being engaged in mining activities which pay well. This corroborates with the findings by Agyemang *et al*., (2015) that economic hardships poverty situations of people and quick income earnings from AGM were the major factors that influenced people to combine and use their personal assets to engage in AGM. This has gone hand in hand to deny farming human labor hence low maize crop productivity. This is because maize cultivation is labour intensive particularly through land preparation, planting, weeding to harvesting. The active populace in Ikolomani has also been made vulnerable to diseases such as malaria as a result of pools of water dotting the AGM landscape. This means that labour provision is hampered hence reduction on maize crop yields production.

CONCLUSION

In conclusion, it is evident that, the acreage of land under AGM has led to a reduction in maize crop yields in Ikolomani Sub County as supported by Table 1 and Figures 4, 5, 6 and 7 which shows that AGM acreage of land has influenced maize crop yields by 53.75 %. This has been attributed to; AGM factories occupying once arable land thereby reducing on maize crop yields, soil erosion has resulted to loss in soil fertility, immigrants are putting pressure on arable land, compaction of arable land making it poorly aerated for agricultural productivity, collapsing or carving in of arable land rendering farming practices difficult hence reduced maize crop productivity. Lack of labour for farming activities as they opt for AGM ones. This is also as a result of mercury related sickness and malaria. In the context of sustainability, maize crop yields have been negatively affected by the acreage of arable land in Ikolomani Sub County. Mitigaive AGM activities

measures should be put in place to ensure that the exploitation of gold through AGM strikes a balance to minimize damages rendered to arable land on which maize crop cultivation is anchored.

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