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# THE PERCEPTION OF FARMERS IN AKYEM ADUKROM, EASTERN REGION OF GHANA, ON USING RECLAIMED MINED-OUT AREAS FOR CROP PRODUCTION

**Irene Jemilatu Yaro**
Environmental Protection Agency
P.O Box KF 725, Koforidua – Eastern Region, Ghana.
*irene.yaro@epa.gov.gh*

**Supervisor**
Thorunn Petursdottir
Soil Conservation Service of Iceland (SCSI)
*thorunnp@land.is*

## ABSTRACT

The gold mining sector in Ghana contributes substantially to the socio-economic development of the country. Unfortunately, gold mining also causes severe environmental and social problems such as ecosystem degradation that affects the livelihoods of farmers. According to Ghana's laws, mining companies are obliged to reclaim mined-out areas and make them safe for crop production. Currently, over 1 million ha of mined land have been reclaimed and handed back to the previous land users. However, some farmers seem reluctant to cultivate these reclaimed areas. To get an insight in how successful these reclamation activities are in practice, 20 farmers that are currently farming on reclaimed mined-out areas by the gold mine company "Managing Gods' Resources Limited" in Akyem Adukrom were interviewed about their experience and perception of cultivating the same area before mining and after reclamation and their involvement in the reclamation process. The result strongly indicated that even though in a few cases some crops seemed to be doing better on reclaimed areas than before mining, the reclaimed areas are not as fertile and productive as they were before mining. However, 16 farmers stated that reclaimed areas were as fertile as they were before mining and would recommend the cultivation of such lands to other farmers. The study indicated that some farmers were suffering from significant loss in yield but not all of them stated that to be a problem. The four farmers who perceived reclaimed lands to be contaminated and infertile, accounting for poor yields, were all part of the same cluster within the reclaimed area. None of the farmers was involved in the reclamation process. The results showed that the method applied in this study seems to be highly useful to monitor how successful the restoration activities are in practice and how the procedure can be improved further in order to secure as successful outcomes as possible.

**Keywords:** mining, mined-out areas, reclaimed lands, unmined areas, Ghana.

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# 1. INTRODUCTION

## 1.1 Background

Gold Mining in Ghana has gained unprecedented public attention. The sector is seen to have played a key role in the socio-economic development and growth of the country through the attraction of Foreign Direct Investment (FDI), creation of employment and overall poverty reduction (Akabzaa & Darimani 2001). With the commencement of the reforms to date, the mining sector has experienced a significant investment boom with an increased number of new mines coming on-stream, specifically in the gold sector (Akabzaa 2009). In 2012, about 13 large-scale mines and >1000 small-scale mines were operational in the country (Aubynn 2013). Currently, the mining sector accounts for up to 40% of Ghana´s gross foreign exchange earnings and 5.6% of the country´s Gross Domestic Product (Yelpaala & Ali 2005). Thereof, gold mining is the largest contributor accounting for approximately 80% of the country's mineral revenue and 95% of its total mineral exports (Garvin et al. 2009).

The mining industry in Ghana can be divided into two main sectors, large-scale mining and small-scale mining. The large-scale mining industry provides jobs for around 21,200 people of which 2% are expatriates (Aubynn 2013). According to Hilson (2001), the small-scale mining industry has been an employment engine for large numbers of unemployed people. An estimated 30,000 people are working on registered mine plots whilst about 170,000 people are engaged in illegal mining activities. The number of direct and indirect jobs created by the mining industry has thus aided in alleviating poverty in the country (Aubynn 2013).

Irrespective of the direct economic gains associated with mining, the industry also accounts for adverse environmental and socio-economic impacts which have deprived local communities of their main source of livelihood by excluding them from utilizing their natural resources (Akabzaa 2009). In some cases farmers are even forced to abandon their farms owing to environmental problems associated with mining activities (Asiedu 2013).

Exploitation of minerals involves the clearance of vegetation and trees of vast portions of land and construction of pits and dredges. The large quantities of waste generated and resources consumed in the large-scale mining process cause the most significant impacts. Waste generation during the ore excavation process is mostly in the form of waste rocks, and may contain concentrations of pollutants such as cyanide and mercury that are relatively toxic and could affect plant growth if such areas are used for crop production (Ogola et al. 2002). The risk posed here has been proved to be real as a study carried out by ActionAid Ghana (2006) at Obuasi in the Ashanti Region of Ghana clearly showed. It revealed that soils and water of an area where large-scale mining activities had taken place were contaminated with heavy metals. The situation has adversely affected food security in that area as plant growth is inhibited due to heavy metals embedded in the soils. According to Gupta and Gupta (1998), cultivation of crops on contaminated lands for human or livestock consumption creates a huge health risk as it could possibly lead to a build-up of these metals in edible plant parts which could be detrimental to human and animal life.

Although large-scale mining is the main source for soil and water contamination, surface mining is the biggest agent of destruction of forest ecosystems with the following land degradation (Asiedu 2013). In this report I will focus on the agricultural use of reclaimed small-scale mining areas and will hereafter thus only discuss small-scale mining in detail, leaving out further explanations of large-scale mining.

## 1.2 Small-scale mining

Small-scale or artisanal mining is the extraction of minerals using both rudimentary or simple tools and more sophisticated equipment at a low level of production with low capital investments by individuals or groups of persons. Only indigenous people > 18 years can get legal permission for operating small-scale mines (Aryee et al. 2003). Legally authorized miners thus have permission for their activities that secures their tenure on a mining concession for a period between 3 to 5 years. Parallel to these legal small-scale miners there is also a large group of thriving miners lacking legal authorization for their activities. These unlicensed small-scale miners, popularly known as 'galamsey' (Kessey & Arko 2013) do not have secured concessions but operate on the concessions of legal miners or in areas where mining activities are officially prohibited (Aryee et al. 2003).

Ghana's government has defined 25 acres as the maximum size of an area that can be utilized for small-scale mining (Hilson 2001). According to the country's laws, every mineral in its natural state found beneath or upon the surface, in water bodies or in the soil is the property of the state. The government has thus every right to grant areas with mineral deposits for legal mining activities with the exception of fragile areas like forest reserves, wetland areas, water bodies and areas close to residential settlements (Kessey & Arko 2013). Mining concessions are often located in forested areas and areas cultivated for crop production. Thus, mining companies usually pay compensation fees to the land users, who are mostly farmers (Aryee et al. 2003). The compensation sum is negotiated with the affected communities or individuals in terms of household structures and type and condition of the cultivated crops (Hilson & Haselip 2004)**.**

Mining activities, according to Akabzaa (2009) have resulted in the annexing of vast portions of land from communities, hence depriving the poor and marginalized of their surface land rights. Women have often borne the brunt of the negative impacts of mining when it comes to land issues. They are usually unfairly treated when it comes to issues of compensation for land and resettlement/relocation. Customarily, men are family heads and therefore compensation for farm crops and houses is usually paid to them. Thus, they exercise their discretion in the use of the money by sometimes abandoning their homes to live in the town centres, exhibiting irresponsible behaviours, only to return when the money is finished (Akabzaa & Darimani 2001).

The mining methods applied by legal and illegal small-scale miners are by no means different technologically (Aryee et al. 2003). In most cases the mineral deposits occur in the upper layer of the soil close to the surface. (Asiedu 2013). A new mining activity starts with vegetation clearance, done by heavy machinery. Then the topsoil layer of the cleared area is removed and stockpiled for future reclamation (Asiedu 2013). The overburden is also removed and stockpiled for processing. The overburden is then used to backfill excavations as mining advances (Kessey & Arko 2013).

Operational small-scale mining has substantially altered landscapes and caused severe land degradation (Hilson 2002). Surface mining is based on digging excavations, three to 12 meters deep, depending on the location of the ore (Kessey & Arko 2013). Processing of the ore involves washing (by gravity), sluicing, panning, and amalgamation (using mercury). Even though mercury is used for amalgamation, legal miners use a mercury retort device to prevent the fumes from escaping into the environment. However, illegal miners frequently dispose mercury

residues into the open environment, thus allowing it to escape into the atmosphere and to soil and water bodies with the ensuing risk of contamination (Kessey & Arko 2013).

In spite of all these concerns, the mining industry is nevertheless seen as an indispensable sector whose resources are required for socio-economic development. This makes it important for communities, mining companies and regulatory institutions to ensure that the connection between accrued benefits and conservation of environmental resources is based on ecologically sustainable principles (Tetteh 2010). As a result, the authorized mining industry in collaboration with the government of Ghana recommended mined land reclamation as a measure to reduce the negative environmental effects of mining as well as to re-establish lost ecosystem functions and services (Mikha et al. 2014). Mining companies therefore reclaim mined-out areas to ensure compliance with environmental regulations (Aryee et al. 2003). Cooperation of this type is known within most countries where mining is an important source for the national economy. The reclamation policies of the Czech Republic for instance also require that post-mined areas must be reclaimed and be suitable for their previous land use, in line with environmental regulations (Řehounková & Prach (2008).

### 1.3 Reclamation of small-scale post-mined areas

Reclamation of post-mined areas is a necessary remedy to ensure that the land use and morphology of a mined site are attuned with the current land use in the area or with its environmental condition as it was before the mining activities (Adu 2012). According to Yelpaala (2004), reclamation is widely used to refer to the rehabilitation or repair of damaged areas as a result of surface or underground mining activities. Adjei (2010) defines reclamation as a process to clean up a site that has sustained environmental degradation through anthropogenic and/or natural activities. Land reclamation is therefore important to return degraded mined areas to ecologically functional condition (Yelpaala 2004).

Land reclamation is a procedure that if properly managed can lead to ecological restoration of degraded ecosystems (Bradshaw 1996). Reclamation of damaged ecosystems will lead to minimized environmental impacts of the previously caused damage, increased vegetation cover, more stable slopes and soils, and improved soil and water conditions. It will also support the sustainability and viability of post-mined lands for present and future generations, and further efficient use of resources (Bradshaw 1996; Morrey 1999). According to Morrey (1999), different rationales and techniques need to be used for reclamation depending on the type of mining that has taken place. It is thus important to identify the utilization potential of the land as this will determine what type of technology should be applied (Mallo & Wazoh 2014). The type of mining activity (surface or hard rock) will then determine the reclamation method to be used (Asiedu 2013).

Substantial benefits can be derived from reclaimed mined lands. These can be categorized into land and water oriented benefits (Adjei 2010). Benefits derived for reclaimed terrestrial areas are for instance of agricultural origin (e.g. arable lands, hayfields and grazing areas), hunting, wood production, recreation, aesthetics, wildlife habitats and wetlands. Water-oriented benefits include for instance purification of water, re-establishment of natural stream flows, fishing and recreation (Adjei 2010; Tetteh 2010).

Reclamation of degraded mined areas has an impact on both men and women with respect to issues of livelihood. Once lands are reclaimed, landowners are given back their lands for their former land use that in most cases was farming (Tetteh 2010). Men and women have a role to

play in the use of reclaimed lands. Whereas men cultivate cash crops and staples such as cocoa, citrus, oil palm, cassava and plantain for household use and sell the surplus, women grow mostly vegetables such as okra, tomato, garden eggs, and pepper and sometimes crops like cassava, cocoyam, and plantain for home consumption and for sale. As homemakers, proceeds from the sale of farm products are used for the upkeep of the family (Akabzaa & Darimani 2001).

Throughout the last few decades Ghana's government has put a strong emphasis on achieving best practice in environmental management. That applies also to reclamation of post-mined areas as demonstrated by the reclamation bond that was established by the Environmental Protection Agency (EPA) in 2001. It provides financial assurance for on-going mining operations, created to ensure that mining companies implement their commitments as stated in their Environmental Impact Statements (EIS) as well as in their Reclamation Plans (Tetteh 2010). The bond should cover the cost of environmental damage and must be used to reclaim the mined-out area in case a mining company defaults in its environmental commitment of land reclamation (Asiedu 2013). In accordance with governmental regulations, legally authorized mining companies have reclaimed >1 million hectares of mined land in Ghana (Adjei 2010). Once lands are reclaimed and certified free of contamination, mining companies are mandated by law to hand them back to the local communities the areas previously belonged to, for cultivation or other types of utilization (Tetteh 2010).

Notwithstanding the fact that legally authorized mining companies have reclaimed several mined-out areas (certified free of contamination) and returned them to the local communities, some of the farmers seem reluctant to use the reclaimed areas for cultivation. They seem to believe that areas reclaimed after surface mining are 'polluted or waste lands' that have lost their fertility, unrelated to how the area was mined and reclaimed or if there was small-scale or large-scale mining (Tetteh 2010). Reclaimed post-mined areas should however be fully secured for cultivation as the areas are certified contamination free and their reclamation procedure is ecologically sound. Understanding the perception of farmers on using reclaimed areas for crop production would help unravel the strengths and weaknesses of reclaimed lands in relation to crop production which would help inform decisions about reclamation practices as well as help bridge the knowledge gap with respect to reclamation issues. The focus of this study was thus on assessing the perception of farmers about the use of reclaimed mined-out areas for crop production with particular attention to Akyem Adukrom in the Eastern Region of Ghana. This was done using reclaimed mined-out lands of the mining company "Managing Gods' Resources Limited'' (MGRL) located in the previously mentioned area.

MGRL is one of the medium scale authorized surface alluvial gold mining companies in the Eastern Region. Their operation does not entail the use of toxic chemicals. MGRL has taken keen interest in upholding its responsibility towards the environment by adhering to the best environmental management practices and contributing to a sustainable development effort through its reclamation practices. In the year 2000, 32 farmers had lost their arable lands due to the mining activities of MGRL in Akyem Adukrom. In 2000 the company started to reclaim post-mined areas. Currently the company has reclaimed about 97 acres and handed them back to the 27 farmers that previously used them for crop cultivation (Managing God's Resources Limited 2012).

### 1.4 Objectives

The main objective of this study was to assess the perception of farmers about the use of reclaimed mined-out areas for crop production at Akyem Adukrom in the Eastern Region of Ghana and compare it to their crop yields before mining and after reclamation.

The sub-objectives were the following:

- To investigate if the annual crop yield stayed the same after reclamation of the post-mined areas as it was pre-mining.
- To investigate if the farmers were growing the same main crops on the reclaimed areas as they did pre-mining.
- To assess if farmers/stakeholders perceived reclaimed areas to be as fertile and productive as they were pre-mining.
- To assess if stakeholders trust that reclaimed lands are free of contamination and thus safe for crop production.
- To assess if farmers were involved and conversant with reclamation techniques of mining companies and if stakeholders acknowledge these techniques were suitable for re-building of fertile agricultural lands.

## 2. METHODS

### 2.1 Historical context

MGRL is a wholly owned legalized Ghanaian medium scale gold mining company in the Eastern Region of Ghana. It acquired its concession from Bayat Mining Enterprise in 2000 and has since engaged in mechanized surface alluvial gold mining operations. The size of the concession is 72 $km^2$ (Managing God's Resources Limited 2012). The towns within the boundaries of the concession are Sagyimase and Akyem Adukrom in the East Akim Municipality (Fig 1).

Alluvial gold mining is the extraction of gold by dredging land surfaces and rivers (the same process as surface mining as explained in the introduction). The process entails the use of only water and gravity to recover the gold without the use of toxic chemicals such as cyanide and mercury. The only stage where mercury is used is during amalgamation. This is done in an enclosed room with a mercury retort device such that fumes do not escape into the open environment (Managing God's Resources Limited 2012). Mining is carried out concurrently with reclamation such that depleted areas are reclaimed with materials from newly opened areas as mining continues (Managing God's Resources Limited 2012).

Generally, the process of reclamation commences with backfilling of damaged areas with excavated materials and slope battering to ensure stability (Mallo & Wazoh 2014). In Ghana, particularly in the Eastern Region where alluvial surface gold mining operations are common, the reclamation techniques of MGRL are by no means different. Washed gravel (overburden) is used to backfill mined-out areas in the reclamation process before the stockpiled topsoil is used (Asiedu 2013). Filled out areas are allowed to settle naturally for a period of three to six months after a layer of topsoil or organic matter is spread over the surface to a depth of 150 mm and allowed to settle (Managing God's Resources Limited 2012). Re-vegetation starts with the planting of a leguminous cover crop with nitrogen fixing ability that is seeded over the whole

area and is periodically cut to mulch the land or smothered and worked in the soil (Asiedu 2013). Nitrogen based fertilizers may be applied to the soil to prevent nitrogen starvation (Asiedu 2013). Native tree species are planted over the entire area, which is interspersed with food crops. The use of species (local or exotic) specialized for chemical absorption and stabilization of contaminated soils is not needed as surface alluvial mining does not entail the use of heavy chemicals like cyanide (Managing God's Resources Limited 2012). As a way of strengthening community relations, MGRL claims it involves community members in its reclamation programme. The company states that community members are in charge of weeding, planting, fire protection and monitoring (Managing God's Resources Limited 2012).

## 2.2 Description of study site

Akyem Adukrom is in the East Akim Municipality of the Eastern Region of Ghana. The municipality is located in the central portion of the Eastern Region.

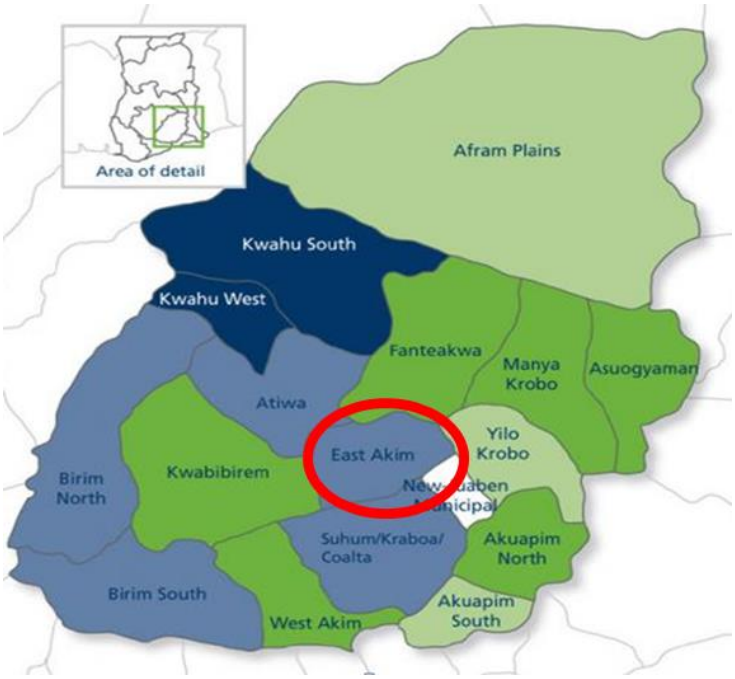


Figure 1. Map of Eastern Region showing the location of Akyem Adukrom in the East Akim Municipality. (Source: Managing God's Resources Limited 2012).

The area falls within the tropical semi-deciduous rain forest belt of Ghana which has a few forest reserves including part of the Atiwa Forest Reserve (Fig. 2). The forest reserves make up about 15% of the entire surface area of the district. The area is also characterized by a double rainfall pattern. The first rainy season is usually from May to June and the second is often from September to October. Agricultural land use dominates with the majority of the people engaging in farming (crop production) as the main source of livelihood (Managing God's Resources Limited 2012). The population is comprised of farmers with a limited income due to the low output from small family farms. Non-farming sources of income are limited, with two-thirds of adults having no employable skills other than farming. Agriculture accounts for about 70% of the labour force. The major food crops farmers cultivate include cereals, plantain, yam, cocoyam, vegetables and cassava which are produced for both consumption and sale (Managing God's Resources Limited 2012). The main cropping systems adopted by farmers in this area

are mono-cropping and mixed cropping. "Cropping system" refers to the crops and crop sequences and the management techniques used on a particular field over a period of years (Adu 2012). The commonly practised cropping systems in Ghana are mono-cropping, mixed cropping, intercropping and crop rotation. Mono-cropping means that a field is used to grow only one crop season after season. Mixed cropping refers to the growing of two or more crops concurrently and intermixed without row arrangements. Intercropping refers to the growing of two or more crops simultaneously in alternate rows. Crop rotation means changing the type of crops grown in the field each season or each year or changing from crops to fallow (Adu 2012). Farmers have different reasons for practising different cropping systems. The reasons include among others that they have different farm sizes, soil types are different and fields may be on a slope or on flat land (Managing God's Resources Limited 2012).

The soils in the area are mainly of the Atiwa and Peki series. The Atiwa series are red, well drained, deep gravel-free silty loams and silty-clay loams, whereas the Peki series are brown or reddish yellow, moderately well drained, very shallow and rocky. These soils belong to the Forest Ochrosols soil group of the Ghanaian soil classification system. Generally, soil organic matter and plant nutrients are very high in the topsoil layer, but low in the subsoil. Soils in the area are classified by the USDA Soil Taxonomy and the FAO World Reference Base for soil resource classification systems as Ultisols and Acrisols, respectively (Managing God's Resources Limited 2012).

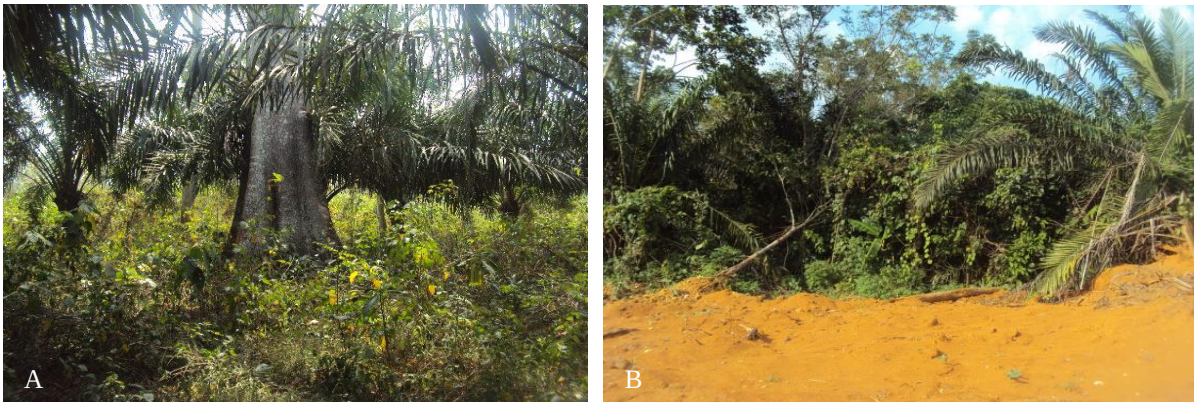


Figure 2. An unmined area in the Akyem Adukrom area (A) and an area cleared of vegetation ready to be mined (B). Photos were taken in July 2013.

In terms of topography and drainage of the area, the land has an undulating landscape rising up to about 350 metres above sea level with different rock formations which have different relief features such as flat valleys and steep-sided highlands. These are usually covered with iron pans, bauxite and kaolin (Managing God's Resources Limited 2012). There are also masses of granite rock which are known to contain several mineral deposits such as bauxite gold, kaolin and diamonds. The underlying rocks of the area are of the Birimian formations which are known to be the gold bearing rocks and also known to be rich in bauxite and diamond deposits (Managing God's Resources Limited 2012). Currently gold is being mined in areas where these rocks are found by MGRL. Small scale alluvial mining operations are also on-going in these same areas where these rocks are found by both legal and illegal miners (Fig. 3). The area is drained by the Birim, Pra, Densu and other rivers and streams (Managing God's Resources Limited 2012).

Figure 3**.** The landscape appearance during mining activities in Akyem Adukrom. Photos were taken in July 2013.

Mining companies are required by law to reclaim mined-out areas and hand them back to previous landowners. In most cases the reclaimed areas are utilized for crop production (Fig. 4) just as before mining.

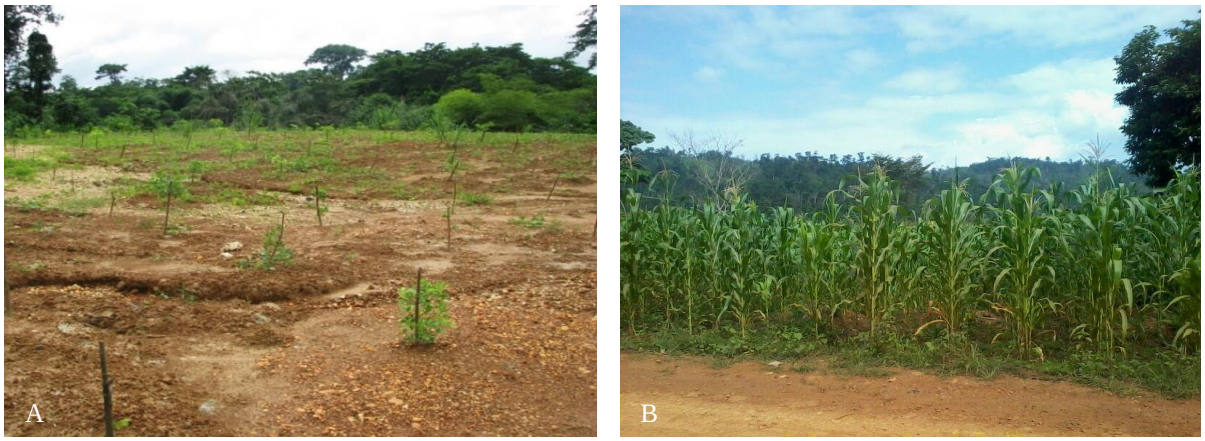


Figure 4. Newly reclaimed area in Akyem Adukrom that has to undergo several years of treatment before it's ready for cultivation (A) and an area that was reclaimed several years ago and is now utilized for crop production (B). Photos: July 2013.

### 2.3 Data collection and analysis

The study was carried out through interviewing to solicit opinions of stakeholders on the use of reclaimed mined-out areas for crop production (Fig. 5). A total of 23 respondents were interviewed for the study. The sample was comprised of 20 farmers that are cultivating areas mined and reclaimed by MGRL and three Agricultural Extension Officers with the Ministry of Food and Agriculture (MoFA) in-charge of Akyem Adukrom. Respondents were selected for the interviews using simple random sampling but corrected for gender balance beforehand. The interviews were conducted by using a semi-structured questionnaire (Rubin & Rubin 2011) with the aim of gathering information on cropping systems, types of crops cultivated on reclaimed lands, crop yields and use of agro-chemicals. The crop yields were measured in bags /baskets which were converted into kilograms.

Furthermore, the survey included questions on the respondent's perception of the fertility of the reclaimed areas in comparison to unmined areas, how safe they considered the reclaimed areas for crop production in regards to potential contamination, involvement in reclamation practices and based on their experience if they would recommend that other farmers grow crops on reclaimed mining small-scale/surface mining areas. A sample of the questionnaire is presented in Appendix 1.

Figure 5. Interviews with farmers using reclaimed lands for crop production. (Photos: S. Afari, July 2014).

In addition to the primary data that were obtained from the field interviews, an extensive review of literature was made as a source of secondary data to augment the primary data. The secondary data took into account project-related documents of MGRL such as environmental management plans and environmental reports, as well as existing literature on the mining sector and land reclamation. Data gathered from the field were analysed both qualitatively and quantitatively. The field interviews were analysed using Microsoft Excel 2010 software.

## 3. RESULTS

All the 20 farmers that participated in the research had cultivated crops on the reclaimed land for three years or less (Table 1). Eight of the farmers were female and twelve of them were male (Table 1). The average size of their arable land was 0.8 ha, ranging from 0.40 to 1.21 ha. All the farmers practiced mixed cropping. Farmers with 0.8 ha or more grew vegetables whereas farmers with 0.8 or less grew staples with the exception of farmers no. 9 and 13 (Table 1).

Of the eight women interviewed, three cultivated staples and five cultivated vegetables whereas four of the twelve men who were interviewed cultivated vegetables and eight cultivated staples (Table 1). The women grew staples on 0.5 ha on the average and vegetables on 0.9 ha on the average, whereas the men grew staples on 0.7 ha on the average and vegetables on 1 ha on the average (Table 1).

Four farmers had cultivated solely cocoa before mining but after reclamation they all changed to a mixed cropping system of staples (Table 1). Farmer number 2 cultivated citrus trees before mining but changed to a mixed cropping system of staples after mining, and farmer 18 changed from cultivating vegetables before mining to staples after reclamation (Table 1).

One of the farmers that previously cultivated cocoa stated:

*"We had to change the crop type because deep rooted crops like cocoa are not good for mined-out land. As for cocoa, if the soil is deep, it is good, the roots can go down. Crops like cassava and cocoyam do well on reclaimed lands because their roots are able to get nutrients near the soil surface" (*Farmer, Akyem Adukrom, 21/07/2014).

**Table 1.** An overview showing: gender, years of cultivation on reclaimed lands, land size, opinions of farmers about reclaimed/un-mined lands, cropping systems and types of crops cultivated by farmers. Ge = gender, Yrs = years of cultivation on reclaimed lands, Ha = land size, In = farmers' involvement in reclamation practices, C = opinions on contamination, SF = opinions on same fertility/productivity of reclaimed areas as un-mined, Re = recommending other farmers to cultivate on reclaimed areas, AC = agro-chemical usages ($y^{=}$ = used in same amount on both lands, $y^{+}$ = higher usage of agro-chemicals in comparison to before or after mining), U = un-mined areas, R = reclaimed areas.

| | | | | | | | | | | **Staples** | | | | | | | | **Vegetables** | | | | | | | | | | | | **Citrus/fruits** | | | | | | **Cash crop** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **No** | **Ge** | **Yrs** | **Ha** | **In** | **C** | **SF** | **Re** | **AC** | | **Cassava** | | **Maize** | | **Coco yam** | | **Plan tain** | | **Okra** | | **Garden eggs** | | **Pepper** | | **Cabbage** | | **Toma toes** | | **Ginger** | | **Tange rine** | | **Orange** | | **Squash** | | **Cocoa** | |
| | | | | | | | | U | R | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** | **U** | **R** |
| 1 | m | 2 | 1.21 | y | y | Y | y | y | $y^{+}$ | | | | | | | | | x | x | x | x | x | x | | | | | | | | | | | | | | | | |
| 2 | f | 1 | 1.21 | n | y | Y | y | y | $y^{+}$ | | | | | | | | | | x | | x | | x | | | | | | | x | | x | | | | | | | |
| 3 | m | 3 | 1.21 | n | y | Y | y | y | $y^{+}$ | | | | | | | | | x | x | x | x | | | x | x | | | | | | | | | | | | | | |
| 4 | f | 2 | 0.97 | n | y | Y | y | y | $y^{+}$ | | | | | | | | | x | x | x | x | | | | | | x | | | | | | | | | | | | |
| 5 | f | 3 | 0.87 | n | y | Y | y | y | $y^{+}$ | | | | | | | | | | | x | x | x | x | | | | | x | x | | | | | | | | | | |
| 6 | m | 3 | 0.87 | n | y | Y | y | y | $y^{+}$ | | | | | | | | | x | x | x | x | | | x | x | | | | | | | | | | | | | | |
| 7 | m | 2 | 0.81 | n | y | Y | y | y | $y^{+}$ | | | | | | | | | x | x | x | x | x | x | | | | | | | | | | | | | | | | |
| 8 | f | 3 | 0.81 | n | n | N | y | y | $y^{+}$ | | | | | | | | | x | x | x | x | x | x | | | | | | | | | | | | | | | | |
| 9 | f | 1 | 0.61 | n | y | Y | y | y | $y^{+}$ | | | | | | | | | | | x | x | x | x | | | | | x | x | | | | | | | | | | |
| 10 | m | 3 | 0.81 | n | y | Y | y | y | $y^{+}$ | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | m | 2 | 0.81 | n | y | Y | y | y | $y^{=}$ | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | m | 2 | 0.75 | n | y | Y | y | $y^{+}$ | y | | x | | x | | | | | | | | | | | | | | | | | | | | | | | | x | x | |
| 13 | m | 2 | 1 | n | y | Y | y | $y^{+}$ | y | | x | | x | | | | | | | | x | | | | | | | | | | | | | | | | | x | |
| 14 | m | 1 | 0.74 | n | n | N | n | $y^{+}$ | y | | x | | x | | x | | | | | | | | | | | | | | | | | | | | | | | x | |
| 15 | f | 2 | 0.69 | n | y | Y | y | $y^{+}$ | y | | x | | x | | x | | | | | | | | | | | | | | | | | | | | | | | x | |
| 16 | f | 2 | 0.66 | y | n | Y | n | y | $y^{+}$ | x | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | f | 3 | 0.4 | n | y | Y | y | y | $y^{+}$ | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | m | 2 | 0.51 | n | n | Y | n | y | $y^{+}$ | | | | x | | x | | x | | | x | | x | | | | | | | | | | | | | | x | | | |
| 19 | m | 2 | 0.51 | n | y | Y | y | y | $y^{+}$ | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | f | 2 | 0.4 | n | y | Y | y | y | $y^{+}$ | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | |

## 3.1 Annual crop yield before mining and after reclamation

Four male farmers cultivated vegetables (Fig. 6). Farmer no.1 harvested 85% more garden eggs and 8% more pepper after reclamation than he did before mining but 17% less okra. The other male farmers harvested less of all the three vegetables after reclamation than before mining. Their annual yield reduction was on the average -14% for okra, -10% for garden eggs and -17% for pepper (Fig. 6).

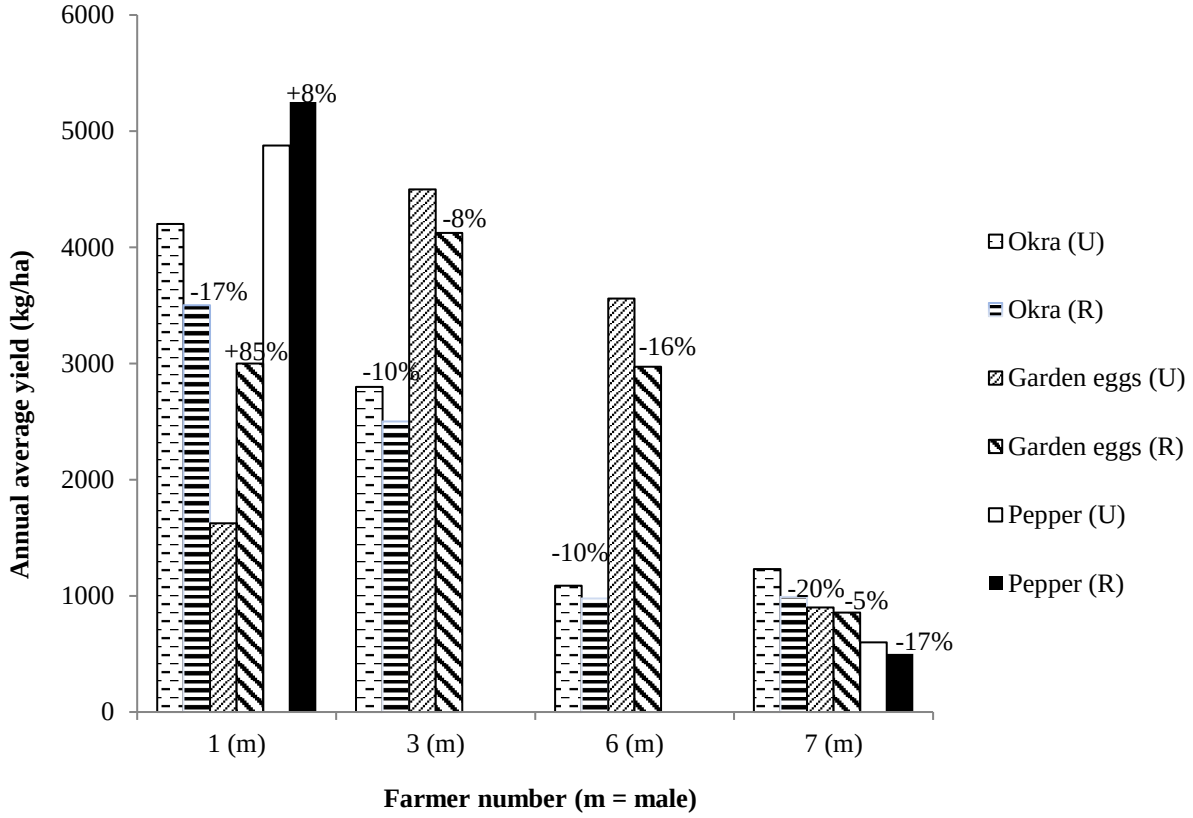


Figure 6. Annual production of vegetables (kg/ha) cultivated by male farmers before mining and after reclamation. The percentages indicate an increase or decrease in annual yield. (U = un-mined and R = reclaimed land).

Five female farmers cultivated vegetables before mining and after reclamation (Fig. 7). Farmer no. 9 harvested 39% more garden eggs, 50% more pepper and 57% more ginger after reclamation than she had before mining but the other women had smaller harvests after reclamation than they had before mining. Their annual yield reduction was on the average -40% for okra, -41% for garden eggs and -37% for pepper (Fig. 7)

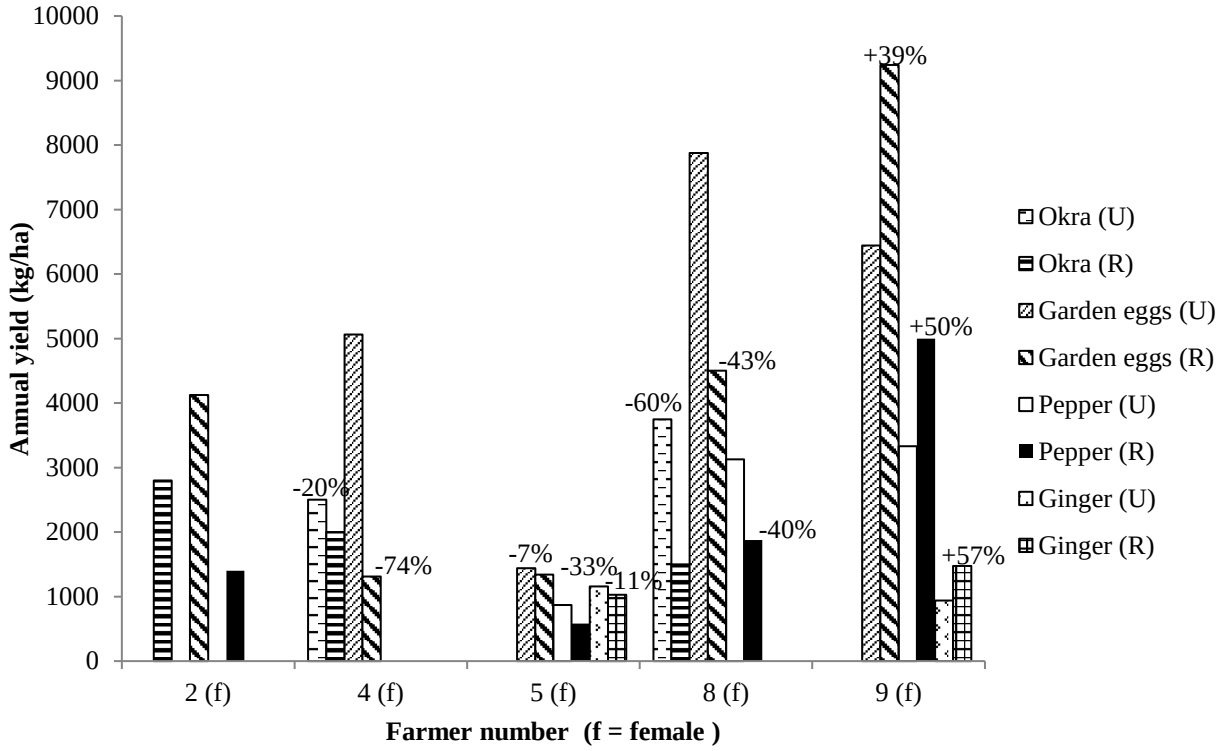


Figure 7. Annual production of vegetables (kg/ha) cultivated by female farmers before mining and after reclamation (except for farmer no. 2 who cultivated citrus trees before mining). The percentages indicate an increase or decrease in annual yield. (U = unmined and R = reclaimed land).

The farmers that changed from cultivating cocoa, citrus or vegetables to the cultivation of staples after reclamation harvested from 830 kg/ha to 1962 kg/ha of cassava, from 189 kg/ha to 605 kg/ha of maize and from 328 kg/ha to 1047 kg/ha of cocoyam (Fig. 8)

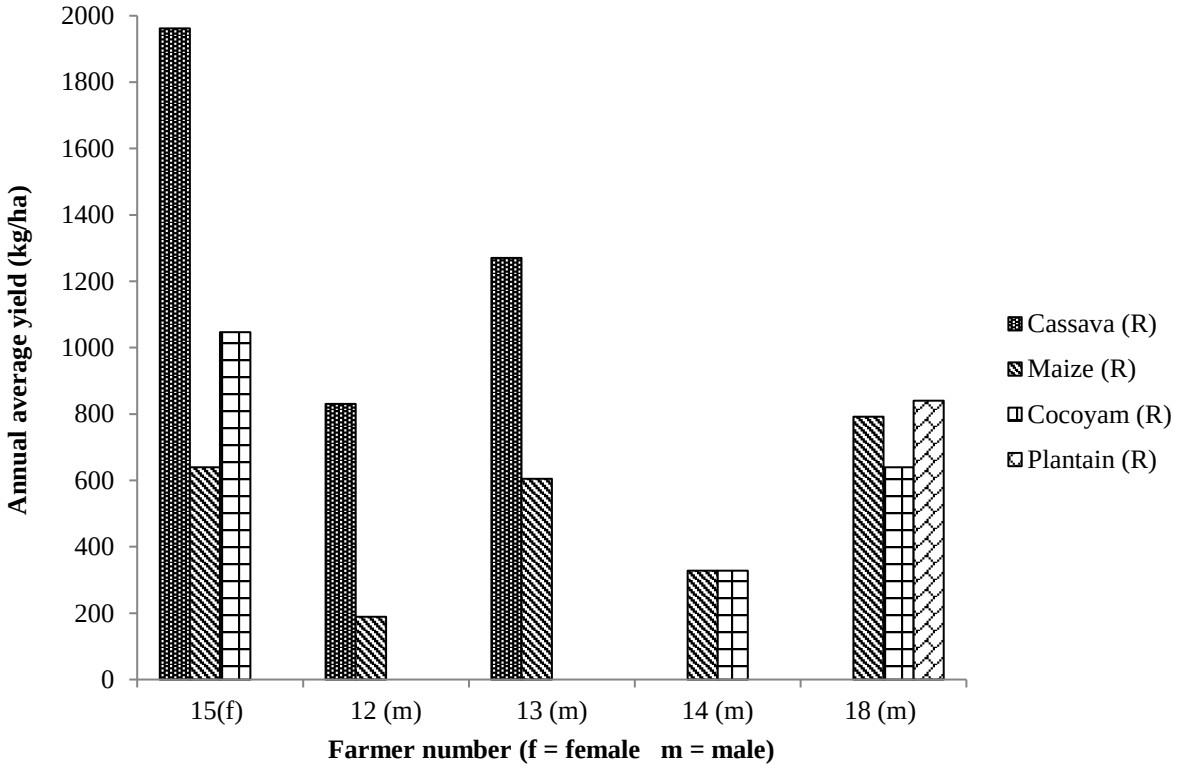


Figure 8. Annual yield (kg/ha) of the farmers who changed their cropping system after mining. (U = unmined and R = reclaimed land).

Two female and four male farmers cultivated staples before mining and after reclamation (Fig. 9). Farmers no. 20 and 11 harvested on the average 88% more cassava and 50% more maize after reclamation than they had before mining but the other staple farmers gained the same or less harvest after reclamation than they had before mining. Their annual yield reduction was on the average -6% for cassava, -35% for maize and -55% for cocoyam (Fig. 9)

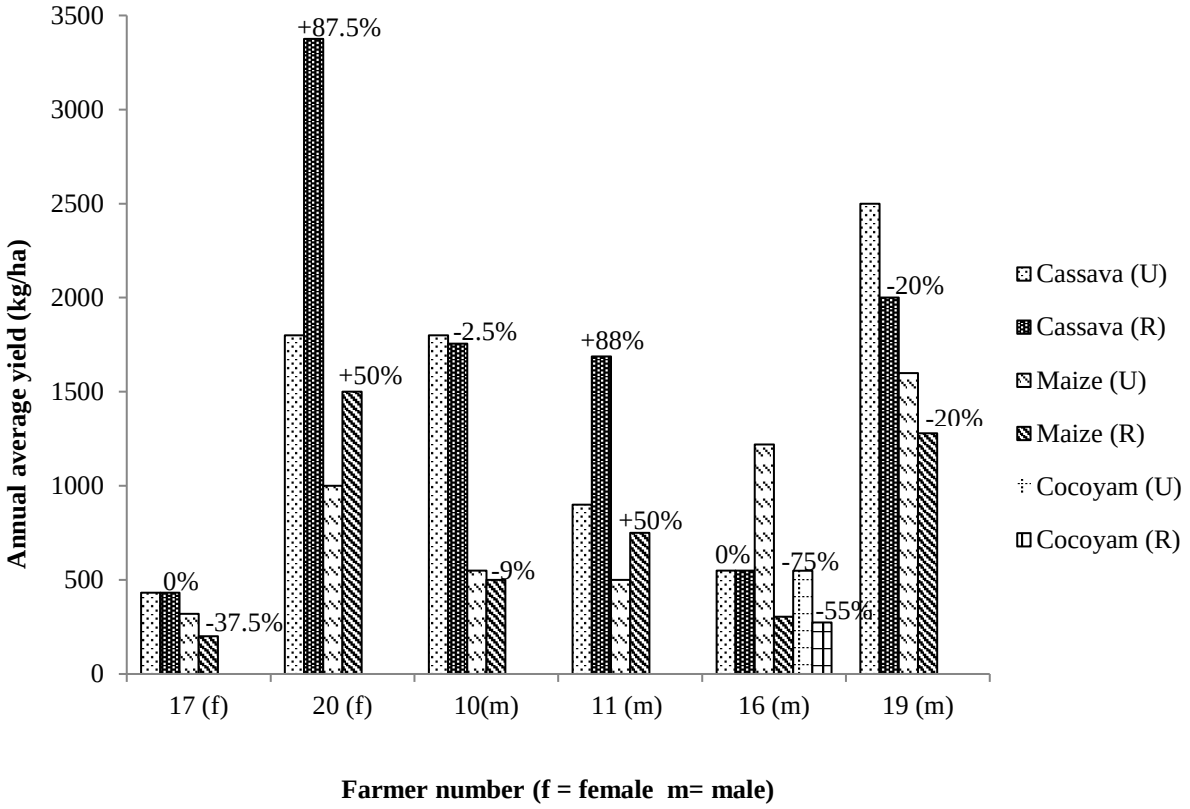


Figure 9. Annual production of staple crops (kg/ha) before mining and after reclamation. The percentages indicate an increase or decrease in annual yield. (U = unmined and R = reclaimed land).

Of two main staple crops and three main vegetable crops cultivated, cassava was the only species that increased on the average in yield after reclamation compared to before mining (Fig. 10). The average reduction (kg/ha) in the annual production varied from 2% to 28% for pepper, maize, garden eggs and okra respectively.

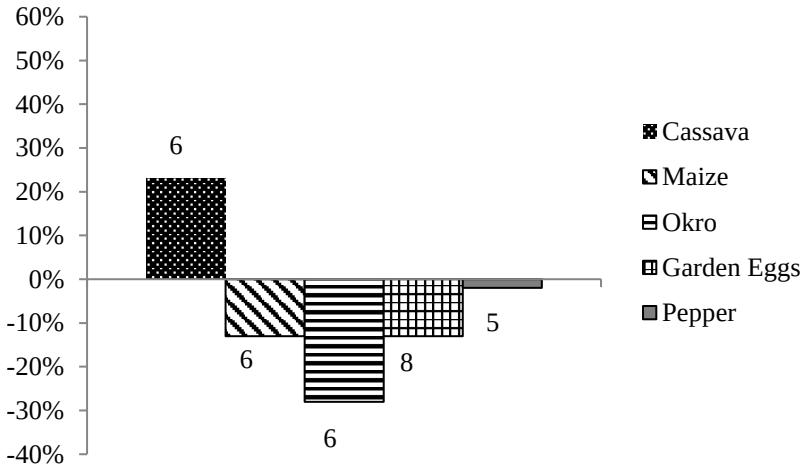


Figure 10. Percentage changes in annual average crop yield (kg/ha) of farmers practicing the same cropping system before mining and after reclamation. The number on each bar represents the number of farmers behind this average yield.

None of the farmers interviewed applied fertilizer to their crop fields before the land was mined nor after it was reclaimed (Table 1). They claimed that the mining company practiced concurrent and progressive reclamation and thus the reclaimed land was just as rich and productive as it was before it was mined.

All the farmers interviewed used agro-chemicals to control weeds, pests and diseases on their crop fields both before mining and after reclamation. However, the amount used varied on both unmined and reclaimed lands. The vast majority of the farmers (75%) used more agro-chemicals on the reclaimed lands than they did before the land was mined in comparison to four farmers (20%) that claimed they used less agro-chemicals to control weeds on reclaimed lands. One farmer used same amount of agro-chemicals before and after mining (Table 1).

### 3.2 Stakeholder opinions on fertility/productivity of reclaimed lands compared to unmined areas

The majority of the farmers (80%) said reclaimed lands were as fertile and productive as unmined areas (Table 1). They stated that crop yields were just as high as or even higher than before mining. They also stated that toxic chemicals were not used in the mining activities within their area, and that reclamation techniques of the mining company had helped to maintain soil fertility and plant growth. It was described by one of the farmers in the following way:

*"The crop yield on the reclaimed land is higher than before mining. The roots of the crops get enough space to penetrate well into the soil. For example, the size of the tuber of cassava is bigger than on unmined land because the soil of the reclaimed lands are loose so the tuber can easily enlarge"* (Farmer, Akyem Adukrom, 21/07/2014).

However, four farmers (20%) said reclaimed lands were not as productive/fertile as unmined areas. They claimed that the annual yield was lower than before mining and the reclaimed areas were contaminated/polluted with toxic chemicals (Table 1).

In addition, all three Agricultural Extension Officers interviewed stated that reclaimed lands were in general as fertile/productive as unmined areas because the mining company (MGRL) does not use toxic chemicals in its operations.

An Extension Officer had this to say about the fertility/productivity of reclaimed lands:

*"The land has not lost its fertility because toxic chemicals are not used in mining. The mining company does not use chemicals so the soils are fertile"* (Agricultural Extension Officer, Akyem Adukrom, 21/07/2014).

### 3.3 Opinions on soil contamination

According to the analysis of the responses to the questionnaire on whether reclaimed lands were safe (free of contamination) for crop production, the vast majority of farmers (80%) believed the reclaimed lands were safe and free from contaminants and thus good for crop production (Table 1). Toxic chemicals such as mercury and cyanide were not used in mining and hence the lands were not polluted like other areas. On the other hand, four farmers (20%) said the reclaimed lands were polluted and not safe for crop production because they suspected toxic chemicals were used in mining. These four farmers were located within the same area.

As stated by a farmer who perceived the reclaimed lands were contaminated and hence not good for crop production:

*"I suspect the company uses toxic chemicals in their operations so the crops cannot grow well. With tuber crops, when you take them out of the ground, it looks as if it is already cooked. So you realize immediately that there is something wrong with the soil"* (Farmer, Akyem Adukrom, 21/07/2014).

Three Agricultural Extension Officers interviewed also mentioned that the soils of the reclaimed areas were free from contaminants because the mining operations of MGRL did not entail the use of toxic chemicals.

### 3.4 Involvement of local community in land reclamation

On farmers' involvement and knowledge in reclamation process of MGRL, two farmers (10%) said they knew how the mined-out area was reclaimed but none of them was involved in the reclamation process (Table 1). They said they had no knowledge of how the mined-out areas were reclaimed. However, 16 farmers (80%) were convinced that the reclamation techniques of mining companies were suitable for the re-building of fertile agricultural lands and stated that they would recommend to other farmers that they use reclaimed lands for crop production (Table 1).

On the other hand, the four farmers (20%) located within the same area mentioned that reclamation techniques of mining companies were not suitable for re-building of reclaimed lands because such methods could not clean contaminated soils (Table 1). They therefore did not recommend the use of reclaimed lands by other farmers. As stated by one of them:

*"The land is polluted, the reclamation methods cannot clean up contaminated soil. I won't recommend reclaimed lands for other farmers"* (Farmer, Akyem Adukrom, 21/07/2014).

Similarly, all three Extension Officers interviewed indicated that concurrent and progressive reclamation techniques of mining companies improved soil fertility for plant growth. One Agricultural Extension Officer had this to say about reclamation being suitable for re-building of fertile lands.

*"The company practices good methods of mining by practicing current reclamation so the lands are fertile for crop production. I recommend farmers to use these lands"* (Agricultural Extension Officer, Akyem Adukrom, 21/07/2014).

# 4. DISCUSSION

## 4.1 Stakeholder opinions on fertility\productivity of reclaimed compared to unmined areas and the observed crop yields

Farmers' and stakeholder views on fertility/productivity of reclaimed lands compared to unmined areas varied. Opinions gathered from 80% of farmers and three Agricultural Extension Officers interviewed revealed that reclaimed lands were as fertile and productive as unmined areas. The reasons assigned were that crop yields were high for cassava, garden eggs, ginger and pepper on the reclaimed lands, and that the good reclamation practice (concurrent reclamation) of MGRL had helped maintain the fertility of the soil and thus high crop yields. Secondly, the soils had not been contaminated with toxic chemicals like other areas. The mining activities of MGRL did not entail the use of toxic chemicals such as cyanide which could contaminate as well as affect soil fertility and plant growth.

The methods used in reclamation will determine whether crops can thrive well on reclaimed soils or not. The amount of topsoil and type of leguminous species used enriches the soil to support plant growth. Concurrent or progressive reclamation ensures that topsoil is not stockpiled for a longer period leading to deterioration of soil nutrients (Tetteh 2010). Progressive or concurrent reclamation is best suited for surface alluvial mining which is common in Ghana. This method allows for reclamation following the exhaustion of minerals in one portion of the concession while other sectors are being mined. Materials from newly opened areas are usually transported and used to reclaim already mined areas (Asiedu 2013).

Views gathered from respondents showed that 20% of farmers mentioned that reclaimed lands were not as fertile and productive as unmined areas. The main reasons were that crop yields were low because of poor or bad reclamation practices and secondly, the soils were contaminated. Polluted or contaminated soils could also account for poor yields by inhibiting plant growth. As indicated by Ogola et al. (2002), plant growth on mined land in the Migori Gold Belt, Kenya, was impeded due to toxic compounds and heavy metals embedded in the soils. Poor reclamation practices could also contribute to poor yields. In instances where topsoil is stockpiled for a long period, the biological vitality of the soil might get lost because the interior of soils is starved of water and oxygen. Plants grown on such soils might not thrive well, resulting in low yields. The relocation or stockpiling of topsoil results in the reduction of the concentration of a range of nutrients which are essential for plant growth (Adu 2012). It is also likely that in the process of reclaiming the mined-out areas, the topsoil was not evenly distributed, accounting for topsoil deficit in some areas and resulting in poor yields for some of the farmers since the 20% of farmers who recorded low yields on their farms were located in the same area.

Owing to the above, the lands of the 20% of the farmers from the study who registered low yields might have been contaminated by activities of illegal miners since the farm lands were within the same location. It is commonplace to find illegal miners on the concessions of authorized medium and large scale mines. These illegal miners in their operations end up leaving mercury residues in the open environment, thus allowing the mercury to escape into the atmosphere, soil and water bodies, thereby contaminating such soils and water bodies (Kessey & Arko 2013).

On the flip side, opinions of farmers on annual crop yields on both reclaimed and unmined areas were in contrast to their assertions that reclaimed lands were as fertile as unmined. Annual crop yields were looked at based on farmers with the same crop types on unmined and reclaimed lands which were basically staples and vegetables. The results indicated that, generally, crop yields were high on the unmined areas compared to the reclaimed areas for most of the crops (Figs. 6, 7, 9 and 10).

The higher annual yields recorded on unmined lands could be attributed to high organic matter content of the soils due to leaf and grass litter fall. These are usually left on the soil surface to decompose to improve the soil quality, which will obviously improve plant growth and crop yields. On the other hand, the lower yields on the reclaimed lands compared to the unmined areas could be attributed to the amount and quality of top soil used for reclamation. Topsoil when stockpiled for long periods deteriorates in soil nutrients. As indicated by Adu (2012), the relocation or stockpiling of topsoil results in the reduction of the concentration of a range of nutrients which are essential for plant growth.

Also, the difference in crop yields on both unmined and reclaimed lands could be the result of the use of agro-chemicals for crop production. Most agro-chemicals can affect crops directly by causing increases or decreases in crop yields. All the farmers interviewed used agro-chemicals on their crop fields (Table 1). The amount or quantity of agro-chemicals used however varied, with some farmers using more or less on the reclaimed and unmined lands (Table 1). The quantity of agro-chemicals used could affect crop yields positively or negatively. Lower rates of agro-chemical use could lead to increases in yield and a high rate of application of agro-chemicals could decrease crop yield by causing wilting, yellowing and scorching of the foliage of crops (Glover-Amengor & Tetteh 2008). In the unmined areas, where there is a high density of trees, their canopies reduce the amount of sunlight that reaches the ground and suppress weed growth; thus less agro-chemical application is required in these areas. However, in reclaimed areas, a vast amount of vegetation is cleared during mining activities, leaving the land barren with more weeds which demand the application and use of more agro-chemicals which could affect crop yields if the concentration is high. Increasing agro-chemical concentration in soils reduces soil microbial activity, which could affect yield and productivity (Glover-Amengor & Tetteh 2008).

Nonetheless, four farmers recorded high yields for crops such as cassava, garden eggs, ginger and pepper on the reclaimed land. The increased yields for crops grown on reclaimed lands could be due to the following reasons: in the first place, soil type plays an important role in crop production. Different soil types benefit different crops through their unique physical, chemical and biological properties (Adu 2012). Thus different crops thrive well on different soils. Generally, root and tuber crops and vegetables thrive well on sandy or silty loam soils that are loose, open and well drained to ensure easy percolation. For instance cassava and ginger require adequate root room to expand so the best soils are (friable) loose and open soils (Ojo et al. 2011). Pepper and garden eggs also require the same growing conditions (well drained soils). The turning of the soil during reclamation could have changed the structure of the soil making it loose and well drained (increase in pore spaces), which is suitable for the cultivation of roots and tubes and vegetable. Asiedu (2013) maintained that reclamation changes soil structure and therefore crop selection is an important factor when using reclaimed lands for crop production.

Secondly, the harvesting frequency or pattern of crops could influence crop yield. Harvesting frequency of crops, especially vegetables, could contribute to an increase or decrease in yield. Harvesting fruits early, especially twice a week (between 3 to 4 days) within the harvesting

period could increase yield by preventing much loss rather than once a week and at the final harvest, which is the normal practice of farmers (Ojo et al. 2011).

Also, the use of some pesticides for vegetable production could affect crop yields. As indicated by Glover-Amengor and Tetteh (2008), the application of lower rates of concentration of some pesticides increases the yield of vegetables such as garden eggs, okro, pepper, and tomatoes whereas higher rates of concentration decrease yields. The high yields of garden eggs and pepper on the reclaimed lands could be attributed to the application of lower rates of concentration of pesticides.

### 4.2 Involvement of local community in land reclamation

On farmers' involvement in the MGRL reclamation process, views from interviews with respondents revealed that none of the respondents was involved in the reclamation process, even though 10% said they knew how the areas where reclaimed. In Ghana, per the mining regulations, the concessioners are responsible for the reclamation of mined areas. Thus, the concessioner has to ensure that the area is reclaimed by no means with or without the involvement of affected people or communities. However, as a result of conflicts between affected communities and mining companies on reclamation related issues, it has become necessary therefore to involve communities in the reclamation process, especially on issues such as species selection, tree planting, weeding, protection, and establishment of nurseries.

The non-involvement or refusal of community members to participate in the reclamation process of MGRL was a result of conflict or misunderstanding between community members and the company on issues relating to inadequate compensation and the fulfilment of Corporate Social Responsibility (CSR). According to the company's reclamation plan, the company states that community members are in charge of weeding, planting, fire protection and monitoring. For instance in Sagyimase, due to good community relations between MGRL and the community, community members participate in the reclamation programmes and are contacted periodically through meetings and workshops to make their inputs in the reclamation plan. This has strengthened community relations and enhanced a deeper understanding of issues relating to reclamation.

Community involvement or participation in reclamation ensures knowledge sharing, sense of ownership, job creation, trust and confidence, peaceful co-existence and overall reclamation success. Higgs (1997) asserted that, restoration success depends on identification of stakeholder needs and interests which entail cultural and social issues of communities. Community participation is therefore fundamental in reclamation/restoration practice. For instance, the involvement of community members in the reclamation programmes of AngloGold Ashanti Iduapriem Mine Limited (Ghana) contributed to the company being adjudged as having the best reclaimed mine in 2007 (Tetteh 2010). Community members were responsible for weeding, nursery establishment, fire control, maintenance and monitoring of invasive species. In addition, community members were consulted periodically to solicit their views and inputs into the reclamation programme. Visits to reclamation sites were conducted three times a year to ascertain progress of work and to solicit for inputs and comments. All casual workers were recruited from the community. This collaboration with the community brought peace and tranquillity between the company and the community (Tetteh 2010).

On the other hand, lack of community participation in reclamation activities of ActionAid Ghana (Non-Governmental Organization- NGO) in the Ga West Municipality of the Greater

Accra Region of Ghana generated some conflicts between some community members and the NGO. The NGO reclaimed farmlands which had been devastated by sand winning in the area to support the food situation problem in the area and to enhance global food security issues; however, the reclamation process did not involve those affected (Adjei 2010).

Even though the majority of farmers (80%) in the present study recorded low annual yields on the reclaimed lands and were not involved in reclaiming the land, they were still convinced and acknowledged that reclamation techniques of mining companies are suitable for re-building of fertile agricultural lands. The three Agricultural Extension Officers also concurred that reclamation was suitable for re-building of agricultural lands. They therefore recommended the cultivation of such lands to other farmers.

Different mining companies have different rationales or objectives for reclaiming mined areas. Reclaimed areas are used for different purposes. The important thing is to identify the potential of the land and ensure that the land use and morphology of the site is compatible with the current land use in the area or with the pre-mining environment (Adu 2012). In Ghana, most of the mining concessions are found in and around farming areas. Thus, reclamation objectives and techniques are geared towards making lands compatible with current land uses such as farming. Reclaimed areas have mostly been used for farming purposes. As indicated by Tetteh (2010), reclamation is considered to be successful and agreed upon only when the land use is in conformity with the current land use of the area without any greater management input as compared to other lands used in that way.

Likewise, these farmers might have concurred with the issue of reclamation because they were guaranteed of getting their lands back since reclamation was a surety for getting one's land returned. Once lands are reclaimed, mining companies are mandated by law to hand them back to landowners. Traditionally, land is ascribed with spiritual values and viewed as sacred. Hence, to part with it means delinking the ancestral ties and therefore the farmers and the land are not entitled to the streams of benefits generated from it. Also, future generations would have a means of living since land is handed over from ancestral generations to their descendants (Adjei 2010). Based on these beliefs, farmers prefer to have their lands even if the lands are not productive so that they can hand them over to other generations. Secondly, it is prestigious to have farmland in the traditional setting. Men are responsible for farming and therefore as a 'man' your prestige and respect lies in the fact that you have farm land.

In contrast, 20% of farmers said reclamation techniques of mining companies were not suitable for re-building of agricultural lands. Reclamation techniques of mining companies could not clean up contaminated or polluted soils for crop production. They therefore did not recommend the use of reclaimed lands by other farmers. In Ghana, the mining sector is considered as one of the major generators of hazardous waste such as mercury, lead and arsenic acid which could be dangerous to plants, animals and humans alike. The soil is the major reservoir of all these effluents which contribute to polluting or contaminating these soils (Adu 2012). Contaminated soil takes a much longer period to regenerate even when it is cleaned. This is because of the complex nature of the soil. Contaminants or pollutants in the soil at the end of the day interfere with the chemical and physical properties of the soil, thereby affecting available soil nutrients and rendering it unsuitable for plant growth (Adu 2012).

Nonetheless, the lack of farmer involvement in the reclamation programme of MGRL might have contributed to 20% of farmers disagreeing with the fact that the reclamation techniques of mining companies were suitable for re-building of fertile agricultural lands. It is possible that

some kind of friction existed between the company and the community such that farmers could not discuss problems concerning their reclaimed lands, especially with the issues of soil contamination and crop yields, let alone participate in reclamation programmes. Generally, if the farmers had participated and had knowledge about the reclamation, they could have come out with better recommendations which could be useful for other farmers. Participatory approaches are important for building trust and confidence, knowledge sharing and the necessary rapport among stakeholders (Tetteh 2010).

### 4.3 Gender effects

In most traditional societies, gender plays a vital role in determining who in the household provides what. In Ghana, women are in charge of domestic chores including food preparation and therefore are responsible for the provision of ingredients for cooking while men are responsible for cultivating food crops and hence decisions on land ownership is within their domain. With respect to the use of reclaimed lands for crop production, traditional gender roles could influence decisions on land ownership and the types of crops men and women cultivate. From the results, eight out the twelve men interviewed cultivated staples such as cocoyam, cassava and maize from which they made a living, whereas five out of the eight women interviewed cultivated vegetables such as tomatoes, garden eggs, okra, and pepper for home consumption and sale to support the family (Table 1). As stated by Akabzaa and Darimani (2001), as homemakers, women would more often than not ensure that proceeds from the sale of farm products are used for the upkeep of the family (Akabzaa 2009). It is therefore possible that the traditional system of men having more right to landownership than women influenced decisions on land such that the men had more land for crop production than the women. Information on these traditional gender roles and responsibilities on using reclaimed lands for crop production is essential for any land restoration project.

## 5. CONCLUSION/RECOMMENDATIONS

Reclamation of post-mined areas as a measure to reduce environmental degradation and for re-building of fertile agricultural lands has been accepted worldwide and is gaining momentum. Over the years, stakeholders and mining companies have been concerned about the implementation of best reclamation practices that support the sustainability and viability of post-mined lands.

This study is therefore a response to the pursuit for solutions on issues related to the reclamation of mined land. It illustrates strongly that even though in a few cases some crops seemed to be doing better on the reclaimed areas than before mining, the reclaimed areas are not as fertile and productive as they were before mining. However, 16 farmers saw the reclaimed areas to be as fertile as they were before mining and would recommend the cultivation of such lands to other farmers. The study indicated that some of the farmers were suffering from a significant loss in yield but not all of them saw that to be a problem. The four farmers who perceived the reclaimed lands to be contaminated and infertile accounting for poor yields were all part of the same cluster within the reclaimed area. None of the farmers was involved in the reclamation process. The method applied in this study seems to be highly useful to monitor how successful the restoration activities are in practice and should therefore be researched further on a bigger scale in order to secure successful outcomes as much as possible. This therefore calls for the need to implement new approaches in monitoring and evaluating the socio-ecological progress of reclamation activities. Additionally, stakeholder involvement or participation in restoration

programmes will provide local communities with the knowledge and capacity to deal with issues related to sustainable land management. This will facilitate the adoption of attitudes more respectful to the environment, thereby improving the restoration procedure and leading to adaptive management of reclaimed areas as well as supporting improved livelihood within the farming societies.

It was also clear from the study that traditional gender roles of who provided what in the household might have influenced the type of crops men and women cultivated on reclaimed lands. Information on these traditional gender roles and responsibilities on the use of reclaimed lands is essential for land restoration.

Based on the findings of this study, the following recommendations are made, inter alia;

- Mining companies could practice the "laying down" topsoil method rather than stockpiling topsoil in reclamation to enhance soil fertility. Laying down topsoil means spreading topsoil in many small piles over an area rather than having a huge heap of topsoil at a particular location. Laying down helps retain the biological vitality of the soil while stockpiling creates a deep pile of soil that starves the interior of water and oxygen (Adu 2012).
- Species that are capable of extracting heavy metals from contaminated/polluted soil could be included in reclamation practices that have crop production as an end use objective to avoid poor plant growth and a toxic level of heavy metals in the food chain.
- Soil analysis and monitoring should be conducted regularly, especially in areas that have registered a high concentration of heavy metals, to ascertain the safety for crop production.
- Selection of crops is necessary on reclaimed lands with crop production as the end use objective since different crops might perform differently on reclaimed soils.
- Participatory restoration approaches could be used for all restoration and sustainable land management in the area.
- Surveys should be conducted regularly to monitor the biophysical condition of the soil through the farmers' perception of its fertility and the results used for adaptive management practices for improved soil restoration.

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# APPENDICES

**Appendix 1**

**Questionnaire /Interview Guide for farmers using certified reclaimed mined-out areas for crop production**

This questionnaire/interview guide seeks to collect data on the perception of farmers on the use of reclaimed mined lands for writing a project work at the UN University Land Restoration Training Programme. The information provided from this interview will only be used for academic purpose, therefore will be treated confidentially. None of it will be used for any other purpose.

Please, draw a circle around "Yes" or "No" and write your responses in the spaces provided.

Name of farmer _____

Gender : Male _____ Female_____

1. How many years have you grown crops on this reclaimed land?_____
2. What is the size of your farm?_____
3. What type of cropping system do you practice on your farm?
   _____
4. What are the 3 main crops you grow on this reclaimed land?
   _____
   _____
   _____
5. Are there reasons for growing these crops on this land?
   _____
   _____
   _____
6. What 3 main crop types did you grow before mining?
   _____
   _____
   _____
7. Do you normally apply fertilize to your crop fields? **Yes / No**

   If Yes: Why do you apply fertilizer?
   _____
   _____
   _____

If No: Why don´t you apply fertilizer?

8. Did you apply fertilizer to your crop fields before the area was mined? **Yes / No**

   If Yes: Was the annual amount comparable to what you now use annually? (Number of bags/kg)

   _____

   _____

   _____

   If No: Why didn´t you use fertilizer before the area was mined?

   _____

   _____

   _____

9. Do you normally use agro chemicals in your crop production? **Yes / No**
   If Yes: Why do you use agro-chemicals?

   _____

   _____

   _____

   If No: Why don´t you use agro-chemicals?

   _____

   _____

   _____

10. Did you use agro chemical before the area was mined? **Yes / No**

    If Yes: Why did you use agro-chemicals?

    _____

    _____

    _____

    If No: Why didn´t you use agro-chemicals?

    _____

    _____

    _____

If Yes: Is the amount you used then comparable to what you use today? **Yes / No**

_____

_____

_____

11. What is your crop yield for the 3 main crops you cultivate? (in terms of bags, sacks)

a) Before mining:

Crop 1:_____

Crop 2:_____

Crop 3:_____

b) After mining

Crop 1:_____

Crop 2:_____

Crop 3:_____

12. What is the average weight of the basket or bag for the 3 main crops? (5kg, 10 kg etc.)

Crop 1:_____

Crop 2:_____

Crop 3:_____

13. If you perceive the crop yield is less on the reclaimed area than it was before mining, in your opinion what could be the main reasons?

_____

_____

_____

14. Do you know how the mined-out area you grow your crops on was reclaimed? Please describe:

_____

_____

_____

15. Were you involved in reclaiming the land you now use for crop production? **Yes / No**

If Yes: What was your role?

_____

_____

_____

16. Do you believe the soil of reclaimed areas that are mined and reclaimed by legally authorized companies is free of contamination? **Yes / No**

    If Yes: Why do you believe it´s free of contamination?

    _____

    _____

    _____

    If No: Why don´t you believe it´s free of contamination?

    _____

    _____

    _____

17. Do you believe that reclaimed areas that were mined and reclaimed by legally authorized companies are as fertile /productive as they were before they were mined? **Yes / No**

    If Yes: Why do you believe the areas are as fertile/productive as before mining?

    _____

    _____

    _____

    If No: Why don´t you believe the areas are as fertile /productive as before mining?

    _____

    _____

    _____

18. Based on your experience, would you recommend other farmers to use reclaimed land (that has been certified free of toxics) for crop production? **Yes / No**

    If Yes: Why would you recommend other farmers to use reclaimed land?

    _____

_____

_____

If No: Why would you not recommend other farmers to use reclaimed land?

_____

_____

_____

***Thank you for your time***

**Appendix 11**

**Questionnaire for Agricultural Extension Officers**

This questionnaire is designed to help assess the perception of farmers about the use of reclaimed mined-out areas for crop production (a case study of Akyem Adukrom in the Eastern

Region of Ghana). Information gathered will be used for writing up a project at the UN University Land Restoration Training Programme. The information provided from this interview will only be used for academic purposes and therefore will be treated confidentially. None of it will be used for any other purpose.

Please write your responses in the spaces provided.

1. In your opinion, what are the 3 main crops the farmers here grow on reclaimed land:

   Crop 1:_____

   Crop 2:_____

   Crop 3:_____

2. In your opinion, what is the main cropping system on reclaimed lands

   _____

   _____

   _____

3. In your opinion, do farmers cultivate other types of crops after reclamation than they did before the land was mined? **Yes / No**

   If Yes: Why do you think they grow other types of crops now than before mining?

   _____

   _____

   _____

4. In your opinion, what is the average annual yield of the 3 main types of crops grown on reclaimed lands.

   Crop1:_____

   Crop 2:_____

   Crop 3:_____

5. Do you believe the soil of reclaimed areas that were mined and reclaimed by legally authorized companies is free of contamination? **Yes / No**

   If Yes: Why do you believe the soil of these areas are free of contamination?

   _____

_____

_____

If No: Why do you believe the soil of these areas is not free of contamination?

_____

_____

_____

6 Do you believe that reclaimed areas that are mined and reclaimed by legally authorized companies are as fertile /productive as before they were mined? **Yes / No**

If Yes: Why do you believe they are as fertile/productive as before?

_____

_____

_____

If No: Why do you believe they are not as fertile /productive as before?

_____

_____

_____

7 Based on your experience, would you recommend farmers to use reclaimed land (that has been certified free of toxics) for crop production? **Yes / No**

If Yes: Why would you recommend them to use the reclaimed areas?

_____

_____

_____

If No: Why would you not recommend them to use the reclaimed areas?

_____

_____

_____

***Thank you for your time.***