International Journal of Development and Sustainability
ISSN: 2186-8662 – www.isdsnet.com/ijds
Volume 7 Number 1 (2018): Pages 1-20
ISDS Article ID: IJDS14100601

The impact of mining on farming as a livelihood strategy and its implications for poverty reduction and household well-being in Ghana

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Abstract

Despite the impressive contribution of the mining sector to national government revenue, foreign reserves and other infrastructural development many stakeholders still argue that the adverse effects of mining erodes the benefits of mining. Ghana has a long history of mining which many stakeholders contend has negatively impacted on the growth of other important sectors of the Ghanaian economy and also causing other social problems in mining communities. This study uses quantitative data analysis techniques to assess the impact of the mining activities on the ability of households to continue farming in spite of their displacement by the mine. The study also examines how the mine operations impact on the socio-economic wellbeing of households within the locale of the mine's operations. The study found that households that live within close proximity to the mining sites engage in less farming activities because large tracks of farmlands have been lost to the mining operations. At the broader community level, the study revealed that a household in a mining community is more likely to be poor compared to an identical household in a non-mining community. Conversely, mining operations rather reduce the probability of native households to be poor compared to non-native households.

Keywords: Ghana; Mining Communities; Farm Displacement; Environmental Degradation; Livelihoods; Farm Land, Household Poverty

Cite this article as: Assan, J.K. and Muhammed, A. (2018), "The impact of mining on farming as a livelihood strategy and its implications for poverty reduction and household well-being in Ghana", *International Journal of Development and Sustainability*, Vol. 7 No. 1, pp. 1-20.

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1. Introduction

Ghana has a long history of mining but many stakeholders are of the view that there are no commensurate benefits of mining to indigenous households in local communities located in the mining areas (Kapstein and Kim, 2011). In the 2012 budget, the Minister of Finance in Ghana indicated that many stakeholders in the mining industry believed that there is little or no evidence to show that the expansion in the mining sector since the early 1990s in Ghana has led to poverty alleviation and local economic development. This according to the Ministry of Finance was due to the lack of transparency and incentives to reform the extractive industry's value-chain" (Ministry of Finance Ghana, 2012). Rather, mining activities have been associated with increased environmental pollution and loss of agriculture livelihoods (Aragon and Rud 2012). Mining is usually characterized by various forms of displacement of people and their properties such as loss of shelter, land, forest cover and other livelihood activities.

The Ahafo Mining Project of Newmont Ghana Gold Limited started active mining in 2006 after several years of exploration and payment of compensation to all affected individuals and households. It is estimated that the total land coverage of the Newmont Mining Project is about 8,030 acres of farm lands of which about 4,854 acres were active farm fields destroyed belonging to about 3000 individuals in approximately 1,700 households (Newmont Ghana Gold Limited, 2006). Even though the affected households were resettled and paid a total of $14,309,030 initial compensation for the lost farms, many of the households are perceived to be unable to maintain and expand their new farms continuously due to the high cost of farm inputs and associated competition from the mine to utilize the limited farm lands and labour (PAB Development Consult 2008). It is also estimated that prior to the commencement of the mining project, about 97% of the displaced households identified farming as their main source of economic activity (Kintampo Health Research Center, 2011).

Mining activities are perceived to be negatively impacting on farming activities in the surrounding communities. This is because, apart from losing their farm lands, these farmers are not skillful enough to get employed in the mines, which are considered an alternative source of income. The counter argument however is that the displaced households have been duly compensated by the mining company including the payment of royalties to promote local community development. Additionally, the mining company has put in place the Livelihood Enhancement and Community Empowerment Program (LEEP), the Agricultural Improvement and Land Access Program (AILAP), and the Vulnerable People's Program to mitigate the potential social, economic and environmental impacts resulting from the development of the mining project (PAB Development Consult 2008). These projects were also intended to increase alternative livelihood opportunities in order to raise household income among persons affected by the mining activities. It was therefore expected that individuals might generate income from sources other than farming and would invariably contribute to decreasing poverty in communities directly impacted by the Ahafo mining project.

The main objective of the study is to examine the effects of mining on farming activities and the well-being of households within the operational proximity if the Ahafo Newmont Ghana Gold Mining Limited. The paper is structured as follows: section two presents a literature and an overview of mining in Ghana. Section three explores the background of the study area whilst section four explains the data analysis and variables used

for the study. Section five discusses the results from the data analysis and then section six provides some conclusions and policy implications.

2. Literature review

Similar to the situation in many other resource-endowed nations, mining in Ghana witnessed significant reforms and huge capital investment since the late 1980s following the Structural Adjustment Programs (SAP) that prescribed massive private sector-led investments into the mining sector in order to maximize tax revenues and other economic development (Akabzaa and Darimani 2001). To this end, Ghana's mining sector witnessed "significant institutional development and policy changes" to reflect the prescriptions of the SAP. For instance, the Ghana government established the Minerals Commission in 1984 and promulgated the Minerals and Mining code of 1986 and the Small-Scale Mining Law in1989. The government also established the Environmental Protection Agency in 1994 to enforce environmental regulations in Ghana including mining-related regulations (ibid. p. 3). Ghana is currently Africa's second largest producer of gold after South Africa. The country also produces substantial quantities of manganese, aluminum and diamonds. However, the mining industry is shrouded in controversies and contentious viewpoints among stakeholders because of the perceived environmental damages mining operations cause to the ecosystems and other livelihood activities operated with the communities in which they operate. (Kapstein and Kim, 2011).

Nevertheless, mining is still one of the mainstays of the Ghanaian economy. In addition to providing substantial revenue to the national government, it also provides majority of the raw materials for other industries to produce most of the goods and services essential for daily life. For instance, in the year 2011, even though the mining sector contributed about 6.8% to Ghana's GDP, it accounted for about 40% of Ghana's foreign exchange earnings and about 14% of direct taxes to the government (Ministry of Finance Ghana 2012). A study by Kapstein et al. (2011) estimated the direct contribution of Newmont Ghana Gold Limited to the Ghanaian economy in the year 2009 as follows; 1.3% contribution to GDP; 9% to total gold export; 1% to domestic revenues and 4.5% to direct investment in Ghana (Kapstein and Kim, 2011).

Despite the impressive statistics of the positive contributions of the mining sector to Ghana's national economy, some stakeholders asserted that the benefits of mining are not felt locally within the Ghanaian society by ordinary citizens. They rather argued that the negative environmental and social impacts of mining far outweigh these macro-economic performances (Akabzaa and Darimani 2001). Also, mining operations are generally located in rural areas where majority of the inhabitants identify farming as their main source of livelihood. However, the nature of mining in Ghana is characterized by major socio-economic effects such as displacement of people and property, loss of arable lands, livelihoods and environmental pollution such as acid rain, contamination of ground water, air pollution, dust and noise pollution (Aragon and Rud, 2012).

In the mist of the mixed effects of mining sector on the Ghanaian economy, the policy environment in Ghana still favors huge capital investment into the mining sector. This is still influenced by the World Bank's policy of promoting private-led investment in the mining sector.

Table 1 below summarizes the investment flow into the mining sector between the years 2000 to 2010.

Table 1. Total Investments Inflow into the Mining Sector (2000—2010)

Year	Producing Companies US$m	Exploration Companies US$m	Support Service Companies US$m	Total US$
2000	29.91	179.40	22.47	231.78
2001	108.63	145.21	21.69	275.53
2002	110.50	186.44	18.65	315.59
2003	325.69	198.13	21.80	545.62
2004	407.58	207.36	23.39	638.33
2005	543.12	228.50	25.90	797.52
2006	330.36	232.90	23.48	586.74
2007	410.25	235.41	24.56	670.22
2008	466.75	270.72	27.83	765.30
2009	511.00	222.96	28.30	762.26
2010	508.20	231.00	30.80	770.00
TOTAL	**3,751.99**	**2,338.03**	**268.87**	**6,358.89**

Data source: (Ghana Chamber of Mines 2011)

2.1. Impact of mining on farming

Mining affects farming in different ways including loss of farm lands, competition for limited farm labor; increase cost of other farm inputs and environmental pollution which adversely affect the quality of farming in the mining area. Kapstein et al. (2011) revealed that the Ahafo Mining Project of Newmont Ghana Gold Limited occupied 16 square kilometers which is currently just about 2.1% of the overall mining lease area of 774 square milometers of land. This has resulted in the clearing of large tracks of land and forest for mineral extraction which is expected to continue for at least 30 years of the mine life (Kapstein and Kim, 2011). A recent panel survey by the Ahafo Mine Area Health and Demographic Surveillance Systems (AMAHDSS) indicated that about 69% of households engage in agriculture which is about 11% reduction from the 77% in the year 2006 (Kintampo Health Research Center 2011). This trend lends credence to the claim that mining activities reduce the amount of farming activities in communities they operate.

A similar study carried out by Duncan et al. (2009) in the western region of Ghana revealed that "between 1986 and 2006 agriculture lost 661.54 hectares (ha) representing 15.5 % reduction mainly due to the conversion of "101.24 ha into major pits, 28.62 ha into minor pits, 195.97 ha into mine waste dumps, 199.02 ha into settlements and 136.69 ha into roads" (Duncan, Kuma et al. 2009). This gives an indication that mining activities alter the land use patterns in mining areas which eventually limit the ability of farmers to access farm lands for farming purposes. Aragon et al. argue that since most mining projects are "located in rural areas where agriculture is the main economic activity, expansion in mining activities leads to: increase

pollution of air, water and land" that seriously affect farmers ability to produce- leading to significant impacts on yield reductions ranging from 30 to 60% depending on the type of crop (Aragon and Rud, 2012). A similar study by Hilson (2002) noted that small-scale mining activities in Ghana destroy vast tracks of forest which exposes fertile lands to erosion and other forms of degradations. Eventually, farmers lose their farm lands to these mining activities which can hamper the development of agriculture in the long run (Hilson, 2002).

Apart from polluting farm lands which limit the quantity of farm lands available to farmers for farming, mining also strongly competes for the limited fertile lands and unskilled farm labor. This is because mining is associated with 'land grapping and increase cost of living' which invariably lead to increase in agricultural input prices and cost of production (Aragon and Rud 2012). Akabzaa and Darimani (2001) confirmed that expansion in mining operations leads to "widespread loss of land and pronounced community displacement in rural areas" and also withdraw significant percentage of the farm labor force from agriculture and other income generating activities by taking farm land away (Akabzaa and Darimani, 2001).

Another study undertaken by Bhattacharya (2012) revealed that "farm labor could be drastically reduced" in mining communities because most of the youth abandon their farming activities in favor of employment with the mining companies which eventually reduce agricultural productivity in these communities (Bhattacharya, 2012). A similar study conducted by Mishra and Pujara (2005) on the agriculture productivity in Valley coal field of Orissa Valley coal mining area in India indicated that; mining has displaced agricultural fields of all near-by villagers" which shifted the occupation of these villagers from being mainly farmers to other petty businesses. Eventually, the mining activities led to reduction in rice production among these villagers due to loss of farm lands and increased cost of farm inputs and scarcity of farm labor due to comparatively high wages from the mines (Mishra and Pujari, 2005).

2.2. Mining and poverty among indigenous mining communities

While the mining sector continues to dominate macro-economic performance in many resource-endowed nations, many stakeholders are still skeptical about the trickling down of these macro-level performances into improving the lives of indigenous communities. This is because mining operations are usually located in remote rural areas and despite investment in "physical and social infrastructure such as roads, schools, hospitals, electricity and water supplies" by the mining companies, these communities have been characterized by air and water pollution and other forms of environmental degradation resulting from mining operation (Akabzaa and Darimani, 2001).

Thus, despite the significant contribution of mining operations to the national economy, there is little or no trickling down effects on communities directly impacted by the mining operations. According to Akabzaa et al. (2001) mining operations in Ghana are usually characterized by forced acquisition of land from the peasant farmers under ambiguous regulations that often lead to no or little compensation to these farmers. For instance, apart from forced relocation and resettlement, the compensation packages do not usually take into account fallow lands and gestation periods of certain crops. Eventually, these mining communities become victims of other social problems such as unemployment, increased prostitution and drug usage, family disorganization and increased cost of living (ibid. p. 43).

Hilson and Banchirigah (2009) also indicated that the livelihoods of mining communities in developing countries are "structured around an assortment of agrarian activities and complementary subsistence occupations" whose impact on the environment is negligible compared to mining operations (Hilson and Banchirigah, 2009). However, when mining companies displace these companies, they attempt to diversify the economy of the local people which is often unsuccessful because of lack of the requisite capacity among the indigenous people to take advantage of the formal employment opportunities resulting from the mining operations (ibid. p. 177). Furthermore, Hilson (2004) in a related study revealed that even though the mining sector reforms in Ghana has contributed tremendously to macro-economic gains, the "associated growth has had detrimental impacts upon indigenous communities." This is because mining operations have caused serious environmental problems such as "land degradation, contamination, and chemical pollution" (Hilson, 2004).

Furthermore, the mining revenues are exported offshore which mainly benefit the multinational corporations at the expense of indigenous people. Mining communities are also characterized by protracted conflicts between the indigenous people and the mining communities. This is mainly due to the perceived exploitation of the mineral resources which do not benefit the indigenous people (Oxfam America, 2009).

Also, when mining royalties and other mining benefits are transferred to the local community level, it often leads to conflicts due to disagreements over entitlement rights and distribution mechanism to reach the rightful beneficiaries (Arellano-Yanguas, 2009). However, recent development in the corporate social responsibility sectors of mining companies have shown that with the requisite policies and programs, the mineral wealth could be used judiciously to improve the well-being of indigenous communities.

Nevertheless, a study by Pedro (2006) argues that mining has heterogeneous effects on mineral-rich nations and that it is inconclusive to attribute the underdevelopment of some mineral-rich nations to the extraction of the natural resources. He argued that while some mineral-rich countries have high growth rates and riches, others have negative growth and are poor. Poor performance in local communities can therefore be overcome if mining operations are appropriately reconciled with equitable growth objectives to reduce poverty while observing the highest environmental management and social standards (Pedro, 2006).

3. Study background: National context of mining and agriculture in Ghana

Mining and agriculture are two important sectors of the Ghanaian economy. The agriculture sector is noted for its competitive advantage in reducing poverty in Ghana because of the social stabilization and safety nets it provides to farmers during economic shocks. According to the Ghana Statistical Service, it is estimated that over 60% of the economically active population in Ghana engages in farming, which contributed 27% to Ghana's Gross Domestic Product (GDP) in 2011(Ghana Statistical Service, 2012).

In contrast to the significant contribution of agriculture to Ghana's GDP, the mining sector contributes just about 6.8% despite Ghana's long history of mining (Ghana Chamber of Mines 2011). It is also estimated that the mining sector contributed about 43.4% to Ghana's total export in 2009 (Kapstein and Kim, 2011). The government of Ghana also stated in the 2012 Budget Statement that even though mining is still the leading

sector of the country's economy, accounting for about 23.5% of direct taxes in 2010, the "economic and social benefits that the sector provides" are not commensurate with people's expectations. Most Ghanaians are of the view that the cost of environmental degradation by mining operations is higher than the benefits Ghanaians derive from mining. This is attributed to "lack of transparency and incentives to reform the extractive industry's value-chain" (Ministry of Finance Ghana, 2012).

Often times, apart from taking up farm lands for mining purposes and the associated environmental pollution, the mining firms also "compete with farmers for scarce local inputs, such as unskilled labor" that would have been used by the rural farmers to increase agriculture productivity (Aragon et al., 2012). Hilson (2004) also indicated that despite the success of gold mining at a macro level in Ghana, there is no commensurate benefit to the local communities located in mining areas. Thus, there is little or no evidence that shows that expansion in the mining sector since the introduction of the Structural Adjustment Programs (SAP) in Ghana has led to poverty alleviation or to local economic development. Rather, mining activities have increased environmental pollution and loss of agriculture livelihoods (Hilson, 2004).

3.1. Geographical context of the study

The Ahafo Project of Newmont Ghana Gold Limited is located in the Brong Ahafo Region of Ghana. It is located between the cities of Sunyani, the Brong Ahafo regional capital, and Kumasi, the second largest city in Ghana. The mining area covers a 70 kilometer of land area across these two cities. Newmont acquired the mine lease in February 2003 with operating rights spanning 30 years. However, active gold mining commenced in the Ahafo Gold Project in June, 2006 after several years of successfully completing all the necessary exploration activities and compensation to effected farmers in the Asutifi and Tano North districts of the Brong Ahafo Region.

The Ahafo Project is located in two administrative districts of the Brong Ahafo Region (Asutifi and Tano North districts). About 70% of the resident population in this area are farmers who produce maize, cassava, plantain, cocoyam, yam, rice, and vegetables for consumption and cocoa, palm oil, citrus, and coffee for cash. According to the Ahafo South Resettlement Action Plan, the average size of farm fields destroyed by the mine is 0.34 hectares (Newmont Ghana Gold Limited, 2006).

Newmont Ghana Gold Limited started surface mining in Ghana in 2006 in the Asutifi District of the Brong Ahafo Region of Ghana and over 3,000 hectares of farm lands were destroyed in establishing the mining project. This resulted in the displacement of over 8,000 small scale farmers. Many of the affected households lost their primary livelihoods through displacement and resettlement which have deprived them access to farm lands. Also, prior to the mine, agriculture had employed 77.6% of the district's population, contributing to 51% of total household income in the mine take area (Newmont Ghana Gold Limited, 2010).

A baseline study conducted by the Kintampo Health Research Centre in 2004 also revealed that 97% of displaced persons identified farming as their main source of livelihood. However, current employment data from the Ahafo Mining Area Health and Demographic Surveillance Systems (AMAHDSS) in 2011 revealed that about 25% of individuals over 14 years of age are actively engaged in farming while 45% engage in other sectors to take advantage of the mining operation, and about 30% were identified as unemployed.

4. Data and methods

The dataset used for the study was extracted from the Ahafo Mine Area Health and Demographic Surveillance Systems (AMAHDSS) which was instituted by Newmont Ghana Gold Limited to provide longitudinal data on households that might be impacted by the operations of the mining company. This panel study was contracted to the Kintampo Health Research Center in Ghana to implement which started actual data collection in 2010. There are ten communities originally covered by the AMAHDSS. However, for the purpose of this paper, I extracted relevant data from six (6) cluster communities comprising 4132 individual household heads within the ages of 16 and 60 years. These six communities were selected and clustered based on their distance to the main mining site and the extent to which the mine impacts the respective communities. The table below summarizes the distribution of households sampled for the study among the six communities.

Table 1. Distribution of Households among the Six Communities Sampled for the Study

S/No.	Name of Community	Distance to Mine	Number of Households	Sex			
				Male	Percent	Female	Percent
1.	Ntotroso/Gyedu	6km	744	452	61%	292	39%
2.	Kenyasi (1&2)	8km	1,668	1,007	60%	661	40%
3.	Wamahinso	9.5km	233	126	54%	107	46%
4.	Hwidiem	15km	624	394	63%	230	37%
5.	Acherensua	17km	443	282	64%	161	35%
6.	Nkaseim	28km	420	281	67%	139	33%
Total		**NA**	**4132**	**2542**	**62%**	**1590**	**38%**

Note: NA=not applicable

4.1. Statistical analysis

Even though the database is a panel study intended to provide longitudinal information such as births, deaths, migration, health and other socio-economic information of all targeted households within the mining area, the paper employed a cross-sectional analysis using the baseline year of 2011. We used a statistical software package (STATA, 12) to run Ordinary Least Squared (OLS) and Probit regression models to test the two hypotheses of the studies. First, the OLS technique is used to assess the association between mining and household propensity to engage in farming as indicated in *Hypothesis 1*. Second, we used both OLS and Probit models to assess association between mining and household propensity to be poor as indicated in the *Hypothesis 2.* In both cases, we interacted *"mining"* which is the key explanatory variable, with the other explanatory variables to assess the effects of mining across the various groups.

4.2. The econometric model

To test the two hypotheses, the following econometric models have been developed;

Hypothesis 1:

[1] $FARMING_{hc} = \alpha - \beta1MINING_{hc} - \beta2NATIVE_{hc} + \beta3MINE\ WORKER_{hc} + \beta4FARMER_{hc} + \beta5TRADER_{hc} + \beta6FOOD\ FARMING_{hc} + \beta7CASH\ FARMING_{hc} + \beta8MALE_{hc} + \beta9HOUSEHOLD\ SIZE_{hc} + \varepsilon$

Hypothesis 2:

[2] $POOR_{hc} = \Phi0 + \Phi1MINING_{hc} + \Phi2NATIVE_{hc} + \Phi3MINE\ WORKER_{hc} + \Phi4FARMER_{hc} + \Phi5TRADER_{hc} + \Phi6FOOD\ FARMING_{hc} + \Phi7CASH\ FARMING_{hc} + \Phi8MALE_{hc} + \Phi8HOUSEHOLD\ SIZE_{hc} + \varepsilon$

From the econometric model in *Hypothesis 1*, the main outcome variable is "*FARMING"* which is used to define whether a household owns a farm or not. Household ownership of farm (both food crop and cash crop farms) is used as proxy to indicate the extent to which a household still engages in farming despite the mine displacement. From *Hypothesis 2,* the main outcome variable *"POOR"* is used to classify households as either being poor or not poor based on the income bracket they fall in and the kind of household assets they possess.

Both models are explained by three main explanatory variables; the first explanatory variable is *"MINING"* which is used to classify communities used in the study area as either been a mining community impacted by the mining activities or not impacted. This classification is primarily based on the proximity of each community to the main mining pits and processing plant site. For *Hypothesis 1*, it is expected that a household living within the mining communities will be less likely to own a farm compared to households living outside the mining community (area). Likewise, a household within a mining community is more likely to be poorer than households living outside the mining communities as indicated in *Hypothesis 2.* The second explanatory variable *"NATIVE"* basically classifies households as either being indigenous of the mining area or non-indigenous (migrants). It is also expected that natives of the mining communities will have less farms and will be poorer as predicted in the two hypotheses. The third explanatory variable is *"MINE WORKER"* which categorizes households into either mine employees or non-mining employees. For *Hypothesis 1*, it is expected that households who gain employment with the mining company will engage less in farming activities compared to households who are not employed with the mining company. However, in *Hypothesis 2*, households working with the mining companies are expected to be less poor than households who are not employed with the mining company.

"FARMER", "TRADER", "FOOD FARMING", "CASH FARMING", "MALE", and *"HOUSEHOLD SIZE*" are used as control variables in the study. The subscripts*"α*", *"β"* and Φ are parameters to be estimated for the various variables while *"h"* is a subscript representing the household head and "c" is a subscript for subject's community of residence. The error term is represented by *ε.*

4.3. Outcome variables

There are two main outcome variables in the study, namely; *"FARMING"* and *"POOR."* The first outcome variable *"FARMING*" is used to define whether a household owns a farm or does not own a farm. Farm ownership is used as proxy to indicate the extent to which households still engages in farming despite the mine displacement. This is the main outcome variable to test *Hypothesis 1* which posited that households in

mining communities are associated with less farming activities compared to households living in non-mining communities. *"FARMING"* is a dichotomous variable (0=households who do not own a farm; 1=households who own a farm). There are 4,132 household heads reported in the study with 1,124 (27%) indicating that they do not own a farm, and 3,008 representing 73% reported that they own a farm.

The second outcome variable is "POOR" which is used to classify households as either poor or not poor based on the income bracket they fall in and the kind of household assets they possess. This indicator is used as the outcome measure to test *Hypothesis 2* which theorized that a household in a mining community is more likely to be poor than a household that lives outside a mining community. The variable "POOR" is also dichotomous variable (0=households are not poor; 1=households are poor). A total of 4,132 households have been assessed with 1,362 (33%) identified as not to be poor while 2,770 (67%) are reported as poor.

4.4. Explanatory variables

There are three main explanatory variables of the study namely; *"MINING"*, *"NATIVE" and "MINE WORKER"*. The first explanatory variable *"MINING",* is a dichotomous variable which is used to classify communities used in the study area as either being directly impacted by the mining activities or not impacted. The classification is mainly based on the proximity of each community to the main mining pits and processing plant site. Communities that are located within 10 kilometers radius are deemed to be affected by the mining activities and are represented by one [1] while communities that are 10 or more kilometers radius away from the mine site are classified as not impacted directly by the mining activities and are therefore represented by zero [0]. Out of the 4,132 observations, 1,487 household heads (representing 36%) were not directly impacted by the mining operations while 2,645 observations (representing 64%) households are identified to be directly impacted by the mining operations.

The second main explanatory variable "NATIVE" classifies households as either native to the mining area or non-natives. It is a dichotomous variable that identifies households as either native because of their indigenous roots in the area while all other households are identified as non-natives or migrants. The variable "native" is distributed such that 2,879 households (representing 70%) of the observations are natives while 1,253 (30%) observations are identified to be non-natives.

The third explanatory variable "MINE WORKER" categorizes the 4,132 observations into two group; the first group is represented by [1] which constitutes 838 (20%) of the total household heads observed who were identified to be actively employed with the mining company at the time of the observation. The second category is represented by [0] which constitutes 3,295 (80%) of the 4,132 households observed who did not have active employment with the mining company at the time of the observation.

For *Hypothesis 1*, it is expected that household heads who gain employment with the mine will be less likely to own a farm compared to households who are not employed with the mine. This is because employment with the mine is considered more lucrative than farming so households who get employed with the mines are more likely to abandon their farming activities. However, for *Hypothesis 2*, it is expected that household heads who gained employment with the mine will be less likely to be poor compared to those who are not employed with the mine.

Table 2. Definitions and Summary Statistics of Variables used in the Study (N=4132 households)

Variable	Definition	Categories	Observations	Share (%)	Mean	Standard Deviation
Outcome Variables:						
Farming	Whether household head owns a farm or not	0=household has no farm 1=household has a farm	0=1124 1=3008	27% 73%	0.64	0.48
Poor	Whether household head is classified as poor or not	0=not poor 1=poor	0=1362 1=2770	33% 67%	0.67	0.47
Explanatory Variables:						
Mining	Villages whose proximity is within 10 kilometers to the mining site.	0= outside mining zone 1= inside mining zone	0=1487 1=2645	36% 64%	0.640	0.48
Native	Whether subject is a native of the mining area or migrant	0=migrant 1=native	0=1253 1=2879	30% 70%	0.70	0.46
Mine worker	Whether subject is a mine employee or not	0= not employed in mine 1=employed in mine	0=3295 1=838	80% 20%	0.20	0.40
Controls Variables:						
Farmer	Whether household head identifies farming as his or her main occupation	0=subject is not farmer 1=subject is a farmer	0=2586 1=1546	63% 37%	0.37	0.48
Trader	Whether household head identifies trading as his or her main occupation	0=subject is not a trader 1=subject is a trader	0=2744 1=1388	66% 34%	0.34	0.47
Food Farming	Whether household has a food crop farm	0=subject has no food farm 1=subject has a farm	0=1150 1=2982	28% 72%	0.72	0.45
Cash Farming	Whether household head has a cash crop farm	0=subject has no cash farm 1=subject has a cash farm	0=1970 1=2162	48% 52%	0.52	0.50
Male	Subject's sex	0=female 1=male	0=1590 1=2542	38% 62%	0.62	0.49
Household size	Number of individuals in household	NA	4132	NA	5.44	3.15

Note: N=Number of Observations; NA=Not Applicable;

4.5. Results of regression analysis of the effects of mining on farming and poverty

Table 3. Regression Results of the Effects of Mining on Farming and Poverty among 4132 Households in Communities Surrounding the Mining Activities of Newmont Ghana Gold Limited, 2011

Explanatory Variables:	**Outcome Variables:**									
	Hypothesis 1: Farming			**Hypothesis 2: Poor**						
	OLS			**OLS**			**Probit**			
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7] dF/dx**	**[8]- x-bar**	**[9] dF/dx**	**[10]- x-bar**
Mining	-0.04 (0.10)	0.004 (0.004)	-0.79** (0.02)	0.03 (0.08)	0.03 (0.07)	-0.08 (0.08)	-0.03 (0.08)	0.64	-0.08 (0. 09)	0.64
Native	-0.02 0.03	-0.002 (0.002)	-0.07** (0.01)	-0.10** (0.02)	-0.11** (0.13)	-0.14** (0.03)	-0.10** (0.02)	0.70	-0.14** (0.03)	0.70
Mine worker	-0.15** (0.01)	-.009 (0.01)	-0.13** (0.02)	-0.16** (0.01)	0.11** (0.13)	-0.13** (0.02)	-0.16** (0.01)	0.20	-0.13** (0.02)	0.20
Interaction of mining with;										
Native *Mining	NA	NA	0.06** (.018)	NA	NA	0.07 (0.03)	NA	NA	0.06* (0.04)	0.48
Mine workers*Mining	NA	NA	0.13** (0.02)	NA	NA	-0.03 (0.03)	NA	NA	-0.03 (0.02)	0.13
Food farming*Mining	NA	NA	0.93** (0.01)	NA	NA	0.09** (.01)	NA	NA	0.09** (.01)	0.45
Cash farming*Mining	NA	NA	0.05** (0.01)	NA	NA	0.02 (0.03)	NA	NA	0.02 (0.03)	0.33
Controls:										
Male	^	0.003 (0.002)	^	^	-0.12** (0.02)	^	^	^	^	^
Household size	^	0.0003 (0.003)	^	^	-0.02** (0.002)	^	^	^	^	^
Farmer	^	-0.01 (0.01)	^	^	0.11** (0.03)	^	^	^	^	^
Trader	^	-0.01 (0.01)	^	^	-0.08** (0.01)	^	^	^	^	^
Food Farming	^	0.95** (0.02)	^	^	0.09** (0.02)	^	^	^	^	^
Cash Farming	^	0.04 (0.02)	^	^	-.003* (0.03)	^	^	^	^	^
Constant	0.80** (0.07)	0.02** (0.05)	0.82** (0.01)	0.76* (0.06)	0.83** (0.06)	0.77** (0.06)	NA	NA	NA	NA
R^2	0.02	0.97	0.64	0.03	0.08	0.03	0.02	0.67	0.02	0.67
Test of all interaction variables	NA	NA	F= 1802.9 P>F= 0.0000	NA	NA	F= 2.88 P>F= 0.15	NA	NA	X^2= 190.34 P> X^2=0.000	NA

NOTES:

- *For definition of variables see Table 1*
- *All regressions were ran with robust standard errors (in parenthesis) under each coefficient and clustering by community*

- **p≤0.05; ** if p≤0.01*
- *^ variable is intentionally excluded in regression*
- *NA= not applicable*
- *For probit regressions, dF/dx is for discrete change of dummy variable from 0 to 1*
- *x-bar is the mean of the sample, the point at which marginal effects are calculated.*
- *OLS = Ordinary Least Squares*

Table 2 presents definitions and summary statistics of the variables used in the study. This provides preliminary assessment of all the variables by identifying the type of variables; the kind of distribution and variance of the variables and the mean and standard deviations of each of the variables.

4.6. Hypothesis 1: The effects of mining on household propensity to farm

The OLS regression results in columns [1] to [3] of Table 4 estimate the effects of mining on farming. The first column [1] presents the association between farming and the three main explanatory variables (MINING, NATIVE, and MINE WORKER) without controls. In column [1] all the regression coefficients for the three explanatory variables are negative which suggest a negative association between farming and households living in mining communities, indigenous households and mine employees compared to their corresponding counterparts. The results in column [1] for instance suggests that a household in a mining community has a four percentage points lower probability of owning a farm than an otherwise identical household in a non-mining community (p=0.725). The estimates in column [1] also suggest that an indigenous household in a mining area has two percentage points lower probability of owning a farm compared to a non-indigenous household (p=0.587). Also, there is an indication in column [1] that a household head employed with a mining company is fifteen percentage points less likely to own a farm compared to a household that does not have employment with the mine (p=0.000).

In the second model (column [2]), additional variables such as the gender of the individual, household size and occupation of the individual have been controlled for in the regression estimation. The new model suggests that controlling for these additional variables presents a positive association between farming and household living in a mining community. For instance, unlike in the first model, the coefficient in column [2] suggests that a household in a mining community is 0.4 percentage points more likely to own a farm compared to a counterpart household in a non-mining community (p=0.337). However, controlling for additional variables did not change the coefficients for the variable "NATIVE". The estimation coefficient of the "NATIVE" variable in column [2] still suggests that an indigenous household in a mining community is 0.2 percentage points lower probability to engage in farming (p=0.204) which is similar to the results obtained in column [1] for the same variable. Further, the estimation coefficients for "MINE WORKER" in column [2] shows that a household head employed with the mining company is 0.9 percentage points lower probability of owning a farm compared to a counterpart household head who is not a mine employee (p=0.231).

In column [3], the variable "MINING" has been interacted with the other key explanatory variables. This is intended to demonstrate if the parameter estimates will differ across the various groups. While the coefficients for the original variables in the interaction model are negative, those of the interaction terms are positive. The first coefficient in column [3] for the original variable (MINING) shows that a household in a

mining community is 7.9 percentage points less likely to own a farm compared to a counterpart household in a non-mining community (p=0.000). For indigenous households, the model suggests that an indigenous household is 0.7 percentage points less probability to owning a farm compared to a non-indigenous household (p=0.000). Likewise, a household employed with the mine is 1.3 percentage points less likely to own a farm compared to a household that does not work with the mine (p=0.000).

However, in column [3], the coefficient for the interaction term (NATIVE*MINING) suggests that a native household had 0.6 percentage points higher marginal probability of owning a farm than a non-native household (p=0.001). A household employed in the mines on the other hand had 1.3 percentage points marginal probability to own a farm than a non-mining employee household (p=0.000). The model interacted mining separately with food farming and cash farming households to estimate the marginal effects of mining on food and cash farming respectively. The coefficient for food farming indicates that a household who owns a food farm had 9.3 percentage points higher marginal probability of owning a farm than a household that does not own a food farm (p=0.000) while a household who owns a cash crop had 0.5 percentage points more marginal probability to own a farm than a counterpart household that does not own a cash crop farm (p=0.000).

4.7. Hypothesis 2: The effects of mining on household propensity to be poor

The estimation of the effects of mining on the propensity of a household to be poor is analyzed using both OLS and Probit regressions as shown in columns [4]-[10]: The first OLS regression model in column 4 of Table 4 is limited to the effects of mining on the probability of a household to be poor without any control variables. The coefficient suggests that a household in a mining community is associated with three (3) percentage points higher probability of being poor than otherwise identical household that was not in a mining community (p= 0.733). However, the coefficient for the "NATIVE" variable suggests that an indigenous household has 10 percent lower probability of being poor compared to a counterpart household that is non-native to the mine area (p= 0.009). Also, a household working with the mining company has sixteen (16) percent lower probability of being poor than an identical household that does not work with the mine (p=0.000).

In column [5], additional variables have been introduced as controls in the regression estimation which shows similar results like the estimation in column [4] where no controls were introduced. For instance, a household in mining community is still 3percent points higher probability of being poor compared to a counterpart household in a non-mining community (p=0.698) while a native household has 11percent point lower probability of being poor than a non-native household (p=0.000). The regression coefficient for "MINE WORKER" variable suggests that a household employed with the mine is 11 percent lower probability to be poor compared to a household that had no employment with the mine at the time of the observation (p=0.001).

The model in column [6] is estimated by interacting the variable "MINING" with all the key explanatory variables to estimate the likelihood of a household to be poor among the various groups. The regression coefficient for a household living in a mining community suggests 8 percent points lower probability of being

poor compared to an identical household living outside a mining area (p= 0.364). Furthermore, the coefficient for a native household with the interaction term shows a 14 percentage points lower probability of being poor compared to a non-native household (p=0.005) while a household working with the mine has a 13 percentage points lower probability to be poor than a household that are not employed with the mining company (p=0.003).

However, in column [6] all the interaction terms except that of "MINE WORKER" variable reveal a positive probability of being poor across the various groups. For instance, the coefficient for interacting "MINING" with "NATIVE" suggests that a native household who live in a mining community has 7 percentage point higher probability of being poor (p= 0.092). Also, the coefficient for interacting "MINING" with "MINE WORKER" indicates that a household that lives in a mining community and has employment with a mining company has 3 percentage point lower probability of being poor than a counterpart household who lives outside mining community (p=0.363). Similarly, interacting "MINING" with "FOOD FARMING" suggests that a household that engages in food crop farming in a mining community has 9 percentage point higher probability of being poor (p= 0.000) while a household that engages in cash crop farming in a mining community has 2 percentage point higher probability of being poor than an identical household who lives outside a mining area (p=0.433).

Probit regression analysis is used in columns [7]-[10] to estimates the likelihood of a household to be either poor or not in a mining community over the sample mean of households observed in the study. The probit regressions help produce more accurate predictions of the probability that mining will affect a household to be poor within a narrow range of explanatory variables. In columns [7], the probit regression estimation is done without the interaction terms which shows that a household in a mining community has a 3% less likely to be poor than an identical household living outside the mining area (p= 0.724) while a native household is 10% more likely to be poor than a non-native household when (p<0.0001). Also, a household working in the mine is 16% less likely to be poor than a household that does not work with the mine when (p<0.000).

In columns [9] and [10], the interaction term variables have been introduced into the probit estimation which shows that a household that lives in a mining community has 8% lower probability to be poor (0.383) while a native household that live a mining community has 14% lower probability to be poor than a non-native household (p= 0.000). Also, a household who lives in a mining community and has employment with the mine has 13% lower probability to be poor than an identical household that lives outside a mining community (p= 0.000). However, the coefficients for all the interaction terms in column [9] except that of households working with the mine suggest positive likelihood to be poor among the various groups. For instance, interacting mining with native household suggest that a native household that lives in a mining community has 6% higher probability to be poor than a native household that lives outside mining community (p= 0.052) while a household that lives in a mining community and has employment with the mine has 3% lower probability to be poor than a counterpart household that lives outside a mining area (0.201). Similarly, a household that lives in a mining community and engages in food crop farming has 9% higher probability to be poor than an equivalent household who lives outside mining community (p=0.000).

Also, a household that lives in a mining community and engages in cash crop farming has 2% higher probability to be poor than an identical household in a non-mining community (p= 0.357).

5. Discussion

5.1. The effects of mining on farming

The findings confirm that being a resident of a mining community is associated with between 4% and 7.9% lower probability to own a farm. Hence, *Hypothesis 1* is accepted as true since the findings adequately support the expectation that a household living in a mining community is associated with low farming activities than a counterpart household in a non-mining community. The reduction in farming activities among households in mining communities is attributable to the 4,854 acres of active farm fields that were destroyed as a result of the Newmont mining project (Newmont Ghana Gold Limited 2006). Also, even though the 1,700 households displaced by the mining activities were duly compensated and assisted to establish at least two acres of new farms, it was not enough to enable them continue to engage in farming to the levels similar to the pre-mining era. This finding is also consistent with the study conducted by Duncan et al. (2009) which revealed that between 1986 and 2006 "agricultural lands lost 661 hectares representing 15.5% reduction" as a result of mining land taken in the Bogosu-Prestea mining area in Southwestern Ghana (Duncan et al., 2009).

Additionally, Aragon et al. (2012) also found that households in mining communities decrease their agricultural productivity by about 40% compared to their counterpart households who live beyond 20 kilometers away to the mining sites (Aragon and Rud, 2012). These findings lend credence to the point that mine displacement reduces the amount of farming activities among displaced households. A similar study conducted by Mishra et al. (2005) confirmed that mining displaced farm lands all villages surrounding the mining area, hence these farmers displaced no more see farming as their main source of livelihood especially if appropriate compensation enabled these farmers to engage in other economic activities such as petty trading and jobs with the mines (Mishra and Pujari 2005).

The study also examines the effects of mining on the propensity to farm among native households. Similarly, the findings predicted that a native household in a mining community is associated with 2% to 7% lower probability to own a farm than a non-native household. This is an indication that even though native households decrease their ability to engage in farming, they are about 7% better in owning a farm than migrant households. This could be due to the land tenure system which gives more ownership to natives than non-natives (Newmont Ghana Gold Limited 2006).

The third component of the assessment examines the association between mine employment and household propensity to engage in farming. The findings show that a household that has employment with a mine is associated with between 9% to 15% lower probability to engage in farming. This is an indication that as households gets employment with the mines; they are less likely to engage in farming. Similar findings by Aragon et al. (2012) reveals that mining companies "compete with farmers for scarce local inputs, such as

unskilled labor" (Aragon and Rud 2012). It is therefore expected that as more and more households are gaining employment with the mines coupled with the continuing loss of farm lands to the mines, farming activities are going to reduce in the long run in communities located in mining areas.

5.2. Mining and household propensity to be poor

While there is ample evidence to support the claim that mining reduces farming among households living in mining communities, the findings in this study revealed mixed effects of mining on household propensity to be poor. It is therefore inconclusive to confirm or reject *Hypothesis 2* which expected households in mining communities to be more likely to be poor than their counterpart households in non-mining communities. Rather, the results indicate that mining has both positive and negative effects on household propensity to be poor depending on the level and type of exposure households have with mining.

In the first place, at the aggregate community level, being a resident household of a mining community is associated with about 3% propensity to be poor. Despite the lack of statistical power, it nonetheless supports the general view that mining companies impoverish local communities in which they operate. This is consistent with the findings of Aragon et al. (2012) which revealed that despite the huge income tax and royalties from mining companies, the level of poverty in mining communities continue to increase because majority of the revenues and taxes are channeled to the central government with only about 9% of royalties going to the local and traditional authorities to promote community development (Aragon and Rud, 2012). Kapstein et al. (2011) also confirmed that the Newmont Mining Project improved household income in a form of wages and compensation but the bigger impact of mining is more felt at the national level in form of taxes, royalties, corporate profits, savings and dividends paid to the central government (Kapstein and Kim 2011). However, when mining is interacted with additional variables the findings reveal that mining decreases household propensity to be poor by about 8%. This is attributable to the compensation paid to local residents and the direct corporate social responsibility investment projects implemented in the communities to benefit impacted communities (PAB Development Consult, 2008).

Surprisingly, the findings of the study show that mining does not make native households poor. This is counter intuitive to the expectation that mining impoverishes native communities within the mining sites. Rather the results show being a native household is associated with between 2% to 14% less likely to be poor in the mining area. This is mainly to due to the huge compensation that was paid out to the affected households and the conscious implementation of the indigenous employment policy of the company. Also, during the compensation phase, the native(s) received the biggest share of cash compensation because they had more entitlement to the lands and other properties that qualified for huge compensation. The company also supported the displaced households through the Livelihood Empowerment and Income Improvement Program (LEEP) to use their compensation money to set up new businesses that enabled them to diversify their livelihood activities in order to take advantage of the population influx into the communities. Livelihoods diversification is considered to help sustain household economies (Assan et al., 2009).

The introduction of the local supplier development program by the company empowered many native businesses which enabled them to form and register small companies that provided them the legal credibility

to engage in petty contractual agreements with the mining company in areas such as waste management, catering and other supporting services to the mine. Also, apart from the few skilled migrant mine workers, majority of the migrants in the mining communities were mainly used as caretaker farmers in cocoa and other cash farms. Therefore, when these farms were destroyed as result of the mine, the migrant households received little or no compensation at all because they were not the owners of the farms and properties compensated.

Perhaps, one of the most obvious of findings of the study in that households who gained employment with the mining company are less likely to be poor compared to identical households who do not gain employment with the mine. For instance, gaining employment with a mining company reduces the probability of a household to be poor by up to 16% point compared to counterpart households who are not employed with the mine. This is an indication that despite the loss of farm labor and other agricultural inputs to the mining operation, households affected can be compensated with commensurate employment compensation in order to reduce their propensity to be poor as a result of the mine.

6. Conclusion and policy implications

The study revealed three main findings on the effects of mining on farming. First, the study confirmed that households in close proximity to the mine site are less likely to engage in farming compared to their counterpart households in communities outside the mining zone. This is mainly due to the large tracks of farm lands lost to the mine and the associated disincentives to engage in farming in a mining community. Second, the study also revealed that even though mining reduces the probability of both native and non-native households to engage in farming, native households have up to about 7% lower probability to engage in farming than non-native households.

Similarly, the findings further revealed that households that get employment with the mining company reduce their ability to farm significantly compared to their counterpart households that are not employed with the mines. This is consistent with the prior expectation because mine employment is seen to be more lucrative than farming so any household that gets employment with the mine is more likely to abandon his or her farming activities even if there is land available for farming. Also, the majority of households abandon their farming activities in favor of the lucrative mine employment.

The results of this paper however revealed varied (positive and negative) effects of mining on household propensity to be poor. First, at the broader community level, the effects of mining on household's propensity to be poor range from -3% to 8% depending on the type and nature of impact the mining activities has on the household. Second, the findings do not support the claim that mining impoverishes indigenous households within a mining area. Rather, the findings predicted that a native household within the Ahafo mining area is less likely to be poor than a non-native household. This might be due to the huge compensations and the corporate social responsibility programs that the mining company has implemented that targeted mostly indigenous households within the mining area. As expected, the findings also revealed that gaining employment with the mining company reduces household's poverty.

Overall, while some observed groups are seen to be adversely affected by the Ahafo mining operation, others appeared to be gaining tremendously from the mine operations. It is therefore imperative to strengthen ongoing policy and program interventions to widen the net benefit of mining to the wider society especially the local communities whose vulnerability to the mine operations is often underestimated. It is worth considering interventions that will not only re-distribute the mineral wealth to the local communities, but also empower these indigenous households to gain as much employment and contract services related to the mining operation as possible. This will not only directly enhance the re-distributive efforts of the mineral wealth, but will also provide an opportunity to actively participate in decisions regarding the operations of the mine.

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