



Artisanal small scale mining: Farm household welfare and coping strategies in Asutifi North district of Ghana

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ABSTRACT

Artisanal small-scale mining (ASM) in Ghana has caused harmful effects on natural resources and the livelihoods of the rural farm households. These effects necessitate the search for and implementation of remedial solutions. This study investigated the perceived effects of ASM on households' welfare in the Asutifi North District using descriptive statistic. The study also identified the drivers of coping strategies to ASM activities using multivariate probit. The study showed that majority of the respondents perceived moderate to high deterioration in food security, food consumption, water quality and access to land whilst over 50% perceived moderate to high improvement in income and employment generation. The results from the multivariate model revealed that majority (75%) of households adopted coping strategies. The drivers of the coping strategies were household size, marital status, level of education, extension visits, engagement in off-farm activities and years of stay in the area. The study recommends the need to prioritize and encourage the formation of cooperatives and FBOs to ensure improved access to joint resources that could be used to cope with ASM induced shocks. There is the need to provide credit facilities to farm households in mining communities.

Keywords: Artisanal small-scale mining, galamsey, Ghana, welfare

RÉSUMÉ

L'exploitation minière artisanale à petite échelle (ASM) au Ghana a des effets nocifs sur les ressources naturelles et les moyens de subsistance des ménages agricoles ruraux. Ces effets nécessitent la recherche et la mise en œuvre de solutions correctives. Cette étude a enquêté sur les effets perçus de l'ASM sur le bien-être des ménages dans le district d'Asutifi Nord en utilisant des statistiques descriptives. L'étude a également identifié les moteurs des stratégies d'adaptation aux activités de l'ASM en utilisant un modèle probit multivarié. L'étude a montré que la majorité des répondants percevaient une détérioration modérée à élevée de la sécurité alimentaire, de la consommation alimentaire, de la qualité de l'eau et de l'accès à la terre, tandis que plus de 50 % percevaient une amélioration modérée à élevée du revenu et de la génération d'emploi. Les résultats du modèle multivarié ont révélé que la majorité (75 %) des ménages adoptaient des stratégies d'adaptation. Les moteurs des stratégies d'adaptation étaient la taille du ménage, l'état matrimonial, le niveau d'éducation, les visites d'extension, l'engagement dans des activités hors exploitation et le nombre d'années passées dans la région. L'étude recommande la

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nécessité de prioriser et d'encourager la formation de coopératives et d'organisations de producteurs pour assurer un meilleur accès à des ressources communes pouvant être utilisées pour faire face aux chocs induits par l'ASM. Il est nécessaire de fournir des facilités de crédit aux ménages agricoles dans les communautés minières.

Mots-clés : Exploitation minière artisanale à petite échelle, galamsey, Ghana, bien-être

INTRODUCTION

Artisanal and Small-Scale Mining (ASM) is becoming a key part of many areas endowed with mineral resources. The term “artisanal and small-scale mining” refers to mining that involves the use of manual labour, low technology and less sophisticated equipment in mineral extraction (The World Bank, 2015). The ASM sector is, without question, an unrivalled employment engine, providing means of livelihood to many young people in the mining communities in Ghana. According to Franks *et al.* (2020), an estimated 1.1 million people directly work in ASM activities, representing nearly two-thirds of Ghana's total mining labor force though much of this activity is considered “informal”, “unregistered”, and illegal. Additionally, there is wealth of evidence showing that inseparable linkages (flows of capital and labour) exist between agriculture and ASM in Ghana with many miners using earnings from ASM to finance their agricultural enterprise. Studies show that many ASM operators in the Northern Region, Brong-Ahafo Region, Eastern Region and Western Region ‘branch out’ into ASM as a livelihood alternative during the dry season (Hilson and Garforth, 2012; Hilson and Garforth, 2013).

In spite of the growing significance of ASM as alternative livelihood for the many young people in Ghana, donors and policymakers, who have long regarded rural families as agricultural continue to promote a ‘small farm first’ agenda as the way to meet people's basic needs and improve their well-being. Even when thinking turned to livelihood diversification

towards the turn of the century, ASM's economic contribution at the household level continued to be almost entirely overlooked by policy makers and researchers. According to Hilson (2019), ASM was barely mentioned in most of the early landmark analyses on livelihood diversification studies that profiled a number of countries such as Ghana, Tanzania, Burkina Faso and Sierra Leone, which today are the locations of dynamic ASM economies. In Ghana, the ASM sector has been left ‘out in the cold’ by development practitioners who have promoted support for farming as the solution to rural poverty and championed large-scale resource extraction as the vehicle for facilitating economic development in Ghana (Hilson, 2016).

Over the decades, ASM has received increasing condemnation by the section of the general public, the media and political actors due to its social and environmental ills in the areas endowed with mineral resources (Zolnikov, 2020). As a matter of fact, negative externalities arising from ‘entrepreneurs’ actively evading regulations and subjecting mining communities to vulnerability have likened ASM scenario in Ghana to the popular economic concept of the paradox of plenty. It is therefore not surprisingly that in the public and governmental discourse in Ghana, ASM operators popularly referred to as “galamsey” operators have been portrayed as a “headache,” “challenge,” “problem,” “menace,” and “threat,” whose presence necessitates the search for and implementation of a “lasting solution” (Obiri *et al.*, 2016; McQuilken and Hilson, 2018).

According to Hilson and Maconachie (2020), several attempts have been made in the past by government to sanitize the ASM sector through policies and laws. Among these interventions included the enactment of several legislations including but not limited to the Mining and Mineral Act, 2006 (Act 703), Mineral and Mining (Health, Safety and Technical) Regulation, 2012 (LI 2182), Mineral and Mining (Amendment) Act, 2015 (Act 900), Artisanal and Small-Scale Mining Framework (2015), and Mineral and Mining Policy of Ghana (2016). To enforce these legislations, the government instituted a task force comprising of officials from the Military, Police, and the Immigration Service to ensure that mining activities are halted.

Unfortunately, these and other related interventions have not yielded the desired results as studies by Banchirigah (2008) and Hilson *et al.* (2017) revealed that ASM mining activities have increased in intensity because of weak enforcement, coordination, incomprehensive collaboration and consultation among relevant stakeholders as well as ASM being a significant source of livelihood for many young people in Ghana.

The Asutifi Municipality is dominated by agricultural activity with about 60 percent of the households depending on a single livelihood activity which is weather oriented agriculture (Asutifi North District, 2019). These households find it difficult to avoid, withstand or bounce back during times of economic stress and shocks. With the upsurge of mining activities in the area, there is opportunity for livelihood as many households have been resorted to ASM for additional income to support their families and farming enterprises. Conversely, there is also a threat to existing livelihood of many households, especially tenant farmers in the area as many farm lands have taken over by

ASM operators.

Without a doubt, there is now a wealth of evidence that points contradicting positions on the effects of mining, especially ASM on development in Ghana. These different perspectives see mining as either contributing negatively or positively to rural economic development. This research moves the discussion further from the macro-level perspectives to the micro-level with emphasis on ASM and farm household welfare. The key argument of this research is that the welfare level of farm households is a good indicator or pointer to the level of development of that household. Thus, if mining should impact positively on a locality, then the assumption is that households will move from lower-level welfare to higher level welfare. On the contrary, if the welfare level of farm households is lower, then mining would have contributed negatively to development.

Existing literatures on ASM in Ghana such as Akabzaa (2000); Amoah (2003); Banchirigah (2008); Amponsah-Tawiah and Dartey-Baah (2011); Onumah *et al.* (2013); Aragon and Rud (2015); Hilson (2016); and Yankson and Gough (2019), among several others, have focused on environment, women participation and policy implications. Understanding the effects of ASM and its linkages to welfare at the household level is essential for developing effective coping strategies that strengthen existing coping measures (Franks *et al.*, 2020). Currently, there is no empirical study on ASM effects and coping strategies adoption among farm households in Asutifi North District in particular and Ghana in general. This study therefore fills knowledge gap and it is being conducted in a time when the activities of artisanal small-scale miners are generating huge debate in the political, social and economic landscape of Ghana.

METHODOLOGY

Study area. The study was conducted in the Asutifi North District of the Ahafo region of Ghana. The Asutifi North District occupies an area of 1,500 square kilometers. The main economic activity in the District is agriculture. The farmers rely on the traditional methods of farming such as slash and burn with little or no technology. This indicates that food crop and vegetable production are generally done at subsistence level with a substantially low output. There are reported cases of gold deposits at Kenyasi, Ntotroso, Nkrankrom, Acherensua and Wamahinso. Diamond has also been discovered at Wamahinso. Perhaps the most important potentials for the development of the district lies in the abundant natural resources in the areas of forest and forestry products, good soil of high agronomic value and mineral deposits like gold, diamond, and bauxite (Asutifi North District Assembly, 2019).

Data collection. A two-stage sampling method was adopted to select the respondents from the mining communities in the District. In the first stage, ten mining communities were selected using a simple random sampling technique from a sampling frame of 20 mining communities. In the second stage, representative sample of 317 households was selected using proportionate probability sampling and systematic sampling techniques which relied solely on the respective sizes of the communities as well as house numbers. A semi-structured questionnaire with both open-ended and closed-ended questions was used to collect data from 317 respondents. The reliability of the research instrument was checked by doing a pilot study (pre-test) involving ten respondents in a mining community in the Savanna region. Lessons learnt from the pre-test were used to make the necessary amendments to improve the questionnaire. The Cronbach Alpha of 89% shows that the survey instrument was reliable.

Theoretical Framework. This study is based on the Random Utility Model of microeconomic consumer theory. The Random Utility Model (RUM) defines a choice resolution of which an individual i has a set of substitutes coping strategies j from which to select (McFadden, 1978). It is presumed that each coping alternative has its specific qualities which influence an individual's choice. The RUM aids to address farm households' choices over alternative coping strategies. Applying the concept of random utility to coping strategies adoption, a farm household will adopt any of the coping strategies if the expected utility is greater than zero and fail to adopt any of the strategies if the expected utility is less than zero (Negative). The utility derived from adoption can reduce risk as a result of increased resilience. Following Asfaw *et al.* (2012), the utility among adoption (U_{AI}) and non-adoption (U_{AN}) of the coping strategies may be noted as G^* , such that a utility-maximizing farm household, i , will make the decision to adopt a coping strategy if the utility gained from adopting is greater than that of non-adopting.

$$G^* = U_{AI} - U_{AN} \quad (2)$$

$$G_{ij}^* = \beta X_i + e_{ij} \quad \text{with } G_i = \begin{cases} 1 & \text{adoption if } G_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

where G is a binary indicator variable that equals 1 if a farmer adopts coping strategies and zero otherwise, where U_{ij} is the utility of the various alternative coping strategies [$j = 1, \dots, J_n$] for decision-maker i . X_{ij} is a vector of explanatory variables describing alternatives j and decision-maker i . β is a vector of unknown parameters; e_{ij} is a random disturbance (error term) for i and j .

The assumption of this study is that, the adoption decision of farm household is voluntary and the response variations can be attributed to the fact that farmers have different demographic, socioeconomic and institutional factors.

Analytical Frameworks and Empirical Models

Perceived effects of ASM activities on Farm Household Welfare. The perceived effects of ASM activities in farm household welfare were assessed using both quantitative and qualitative methods. With the quantitative methods, farmers were asked to indicate how their household welfare indicators have changed over the years due to ASM operations or activities. The welfare indicators used in this study were based on OECD (2019) Regional Well-Being Indicators and included food consumption, food security, income, employment generation, crop production levels, animal production levels, access to land, children education, potable water, health conditions, access to farm labour, access to fruits, game and firewood. A five point Likert scale of 1=Highly decreased or deteriorated; 2= Moderately decreased or deteriorated; 3= Remained same; 4= Moderately Increased or Improved and 5=Highly Increased or Improved were used. Descriptive statistics such means and percentage frequencies were used to analyze the data.

Determinants of coping strategies to negative effects of ASM. Coping strategies adopted by farmers to minimize the negative effects of ASM activities on household welfare were analyzed using descriptive statistics. Frequency distribution tables were used in presenting the information. A multivariate probit model was used to estimate the magnitude and direction of the factors influencing the adoption of the various coping strategies against the negative effects of ASM. This model is more realistic considering that farmers use multiple options to deal with shocks.

The multivariate probit approach concurrently models the effect of a set of explanatory variables on each different coping strategy and at the same time allows for the possible relationship between unobserved disturbances, as well as the association among the adoptions

of diverse strategies (Mulwa *et al.*, 2017). Such correlations allow error terms for positive correlation (complementarity) and negative correlation (substitutability) between the various coping strategies (Ndiritu *et al.*, 2014). As revealed from literature and reconnaissance survey, coping strategies such as land reclamation, resettlement to a different community, control of animal movement, petty trading, dependence on market for food, social networking, sale of assets and borrowing were considered. The assumption is that farmers are more likely to adopt a mix of these techniques to deal with the negative impacts of ASM than to adopt a single strategy.

Following the study conducted by Teklewold *et al.* (2013), the MVP regression model for this study is described by a set of binary dependent variables Y_{ij}^* as follows;

$$Y_{ij}^* = X_{ij}\beta_j + e_{ij} \quad (J = 1, 2, 3, \dots, m) \quad (4)$$

where

Y_{ij}^* for $J = 1, 2, 3, \dots, m$ is the unobserved latent variable of the coping strategy J , applied by farmer i ,

X_{ij} is a set of explanatory variables assumed to influence coping strategies,

β_j is a vector of unknown parameter to be estimated,

e_{ij} is the error term assumed to be normally and independently distributed with a zero mean and a constant variance.

The observable dependent variable is defined by:

$$y = \begin{cases} 1 & \text{adoption if } y^* > 0 \\ 0 & \text{no adoption if } y^* \leq 0 \end{cases} \quad (5)$$

Therefore, the empirical MVP model is specified in the following form:

$$\begin{aligned} \text{Adoption}_{ji} = & \beta_0 + \beta_1 \text{AGE}_i + \beta_2 \text{SEX}_i + \beta_3 \text{EDU}_i \\ & + \beta_4 \text{MARST}_i + \beta_5 \text{HHSIZE}_i + \beta_6 \text{FMSIZE} + \\ & \beta_7 \text{OFFM} + \beta_8 \text{MFBO}_i + \beta_9 \text{YRS} + \beta_{10} \text{ACCRES} + e_i \end{aligned}$$

Table 1 in appendix shows the definition of variables used in the MVP model and their a priori expectations.

RESULTS AND DISCUSSIONS

Demographic characteristics of farmers.

The demographic characteristics of surveyed farm households are presented in Table 2. The average age of the respondents was 51 years. The average age of 51 years reflects the high involvement of the elderly in agricultural activities. From the results, the high dominance of male-headed households (67.7%) compared to female-headed households (33.3%) is consistent with the household distribution in Ghana where 65.3% are male-headed and 34.7% are female-headed (GSS, 2019). The mean years of education was six (6) years. With majority of heads in the study area without formal education beyond the primary level, it can be argued that most of these people would not be able to engage in formal non-farm activities hence increasing their likelihood of resorting to the various activities along the ASM value chain.

From the results, the average household size from the study area was six. The result agreed with the findings of Mabe *et al.* (2021) who reported an average household size of 7.8 people per household among households in areas dominated by small scale mining in Ghana. It is also worth noting that, the average household size in the study area is relatively

higher than the GSS (2019) national average of 3.6. The reason for this difference can be attributed to the fact that agriculture-related households are found in rural areas with large household sizes.

With respect to Farmer Bared Organization (FBO) membership, 51.2% of the respondents were members of an FBO. The respondents who were members of FBO meet on average two times a month indicating the farmer-based organization is fairly strong in the study area. It should be noted that the use of communal labour is common in the communities during some basic farming activities like land clearing and weeding. The policy implication is that FBOs create the avenue for the efficient dissemination of new innovations in agricultural productions as well as the mobilization of funds through the “susu” system and the access to external credit and other resources necessary for coping with ASM induced shocks. The majority (60.01%) of the farmers had access to credit whilst an estimated 39.9% had no credit access. From the study, it was found out that the average farm size cultivated was 3.8 acres (1.5 ha) with the largest farm size being 14 acres (approximately 6.8 ha) and the smallest being 1 acre (0.4 ha). The average farm size of 3.8 acres falls within the range of the national farm holding of 1 to 5 acres (2 hectares). Higher landholdings serve as an incentive to produce a surplus for the market (Martey *et al.*, 2012).

Table 2. Descriptive statistics of continuous variables for the study population

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	316	51.013	13.49	28	76
Sex	316	0.677	.468	0	1
Educational level (Years)	316	6.0380	5.231	0	17
Household size	316	6.165	1.734	3	11
Membership of FBO	316	0.5126	0.500	0	1
Off farm activity	316	0.6392	0.4810	0	1
Access to credit	316	0.601	.49	0	1
Farm size	316	3.7879	2.1795	1	14
Years of ASM in community	316	10.26	1.84	3.5	13

From the results, 63.9% of farmers combined other off-farm activities with farming activities. Previous studies also found that capital raised from working from off-farm activities is used to establish small-scale non-farm business activities (Osei *et al.*, 2021). The average years of ASM existence in the study area was approximately 10 years.

Effects of Artisanal Small-Scale Mining (ASM) activities on household welfare. Farm households' hold several perceptions about the effects of Artisanal Small-Scale Mining (ASM) activities on households' welfare. With the help of five points Likert scale, respondents were interviewed on the changes they had observed with respect to some key welfare indicators in accordance with the OECD (2019) Regional Well-Being Indicators. The selected welfare indicators were food consumption, food security, income, employment generation, crop production, animal production, access to farm labour, access to potable water, housing conditions, health conditions, education of children, access to land, access to game, fruit and firewood. Table 3 shows the results of the respondents' perception on each of welfare indicator.

With respect to food consumption, the result as presented in Table 3 shows that, as high as 87.97% of the respondents in the study area perceived moderate deterioration in food consumption with less than 3% perceiving an improved food consumption level due to ASM activities. With ASM activities taking place on farmlands, the moderate decrease in food consumption may worsen in the long run when major agricultural lands are destroyed or rendered unproductive by ASM activities. The results on the perceived effects of ASM on food consumption agrees with the findings of Tenkorang and Osei-Kufuor (2013) and Kelly (2014). Specifically, for instance, Kelly (2014) reported that ASM areas in Tanzania recorded higher Consumer Price Indices than the national average. With increased prices of

goods, food consumption by households in the mining communities who are not earning the higher revenues from ASM could become worse as they can only buy fewer commodities with their normal low earnings from their declining agricultural enterprises.

Closely linked to food consumption is food security. All other things being equal, a decrease in food consumption is expected to lower the food security level of households. The result of the study shows that, over 10% and 85% of the sampled household reported high and moderate decrease in food security, respectively, whilst less than 2% of the respondents reported positive outcome of ASM on food security. The implication of this finding is that, many residents in the study area find it very difficult to secure adequate food for their families, possibly due to rising costs of foodstuffs or deterioration in quality of agricultural lands for production. This finding validates that of Yankson and Gough (2019) in that, a weakened agricultural sector in ASM communities, coupled with the surge in demand for food arising from rapid population increase makes foodstuffs very expensive to the detriment of food security of the majority of the households. Similarly, the finding of this study agrees with those of Tenkorang and Osei-Kufuor (2013) that, residents of ASM communities in Ghana reported lower food intake and hence high level of food insecurity compared to residents of other surrounding areas.

Income is one of the key drivers behind quality of life among household members. High income is an indication of higher living standards, which allows people to fulfil their own ambitions and develop skills and abilities. Mining has been associated with higher than average income (Carvalho, 2017). The result shows positive relationship between ASM activities and income as about 55% of the respondents in the study area perceived a moderate increase in their income compared to 35% of the respondents who held a contrary

view. Households who reported an improvement in their income level due to ASM in the study area further indicated direct participation in ASM, receipts of compensation from ASM operators for carrying out mining activity on the land owned by farm households and direct selling of goods by farm households members at the ASM sites.

Just like income, the level of employment generation is an important indicator of the level of welfare in the society. All other things being equal, employment empowers people to earn income needed to meet their basic and other needs. ASM seems to have had a positive impact on local level employment as about 48% and 3% of farm household respondents in the study area indicated that, employment has moderately and highly increased employment due to the presence of ASM in their communities. This finding concurs with the findings of Hilson (2001) as well as Isung *et al.* (2021) that ASM provide direct and indirect job opportunities to many unemployed young people in the

mining communities. This is not surprising considering the labour-intensive nature, low educational requirement and low cost of investments associated with ASM activities. From focus group discussion and household interview, it was evident that, young people who could not get any meaningful employment with Newmont Ghana Gold Limited or the formal sector due to lack of skills or the low level of education entered into the ASM sector. However, approximately 29% indicated that employment creation has moderately decreased whilst 18% believed that, employment level had remained the same.

The ASM activities compete with agricultural activities for common inputs particularly land and labour. With crop and animal production requiring the same inputs required by ASM, it is not surprising that 71.52% and 26.5% of the respondents reported moderate and high decrease in crop production compared to less than 2 % of respondents who felt contrary. With regards to animal production, 91% and

Table 3. Farmers’ perception of the effects of Artisanal Small-Scale Mining (ASM) activities on household welfare

Welfare Indicator	Highly decreased		Moderately decreased		Remain same		Moderately increased		Highly increased		Mean score
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	
Food consumption	20	6.33	278	87.97	10	3.16	6	1.90	2	0.63	3.97
Food security	34	10.76	268	84.81	8	2.53	4	1.27	2	0.63	4.04
Income	0	0	110	34.81	24	7.59	174	55.06	8	2.53	2.75
Employment generation	6	1.91	90	28.66	58	18.47	150	47.77	10	3.18	2.78
Crop production	84	26.58	226	71.52	2	0.63	2	0.63	2	0.63	4.23
Animal production	14	4.46	286	91.08	12	3.82	2	0.64	0	0	3.99
Access to farm labour	98	31.01	218	68.99	0	0	0	0	0	0	4.31
Housing condition	8	2.53	176	55.70	96	30.38	36	11.39	0	0	3.49
Potable drinking water	70	22.29	234	74.52	6	1.91	4	1.27	0	0	4.18
Health condition	0	0	236	74.68	62	19.62	18	5.70	0	0	3.69
Education of children	0	0	186	59.24	104	33.12	24	7.64	0	0	3.52
Access to firewood	2	0.63	306	96.84	6	1.90	2	0.63	0	0	3.97
Access to game	10	3.16	306	96.84	0	0	0	0	0	0	4.03
Access to fruits	26	8.23	288	91.14	2	0.63	0	0	0	0	4.08
Access to land	168	53.16	148	46.84	0	0	0	0	0	0	4.53

4.6% of the respondents indicated moderate and high decline in the animal rearing compared to only 0.63% of respondents who believed otherwise. This situation is worrying considering the relevance of agriculture and its sustainability potential in Ghana on one side and unsustainability of ASM and its associated environmental consequences on the other side. The result agrees with Aragon and Rud (2015) who reported that farmers located near mines experienced a relative reduction in total factor productivity of almost 40% between 1997 and 2005, with pollution emanating from mining as the most plausible explanation for the agricultural productivity slowdown. Again, the finding of this study confirms Hilson and McQuilken (2014) observation that expansion of ASM projects which are located in rural areas where agriculture is the main economic activity leads to significant yield reductions ranging from 30 to 60% depending on the type of crop.

From the results in Table 3, all the respondents (100%) perceived deterioration in terms of access to farm labour with 69% and 31% specifically indicating moderate deterioration and high deterioration in accessing farm labour in the study area. With farm households assumed to be rational, the attractive and quick financial reward associated with ASM, coupled with the low returns from agriculture, may induce household members in mining communities to offer their labour in the ASM sector over farming. The implication is shortage of farm labour in mining communities and consequent increase in the price of agricultural labour. The finding of this study with regards to the nexus between ASM and access to farm labour confirms the findings by Lwakatare (1993) that, almost all ASM operators in Tanzania were previously farmers who had moved to the mining in order to earn more money quickly. To this end, farm labour in mining communities could be drastically reduced as most of the youth abandon their farming activities in favour

of employment with the mining sector.

Adequate housing is key to the well-being of households as it determines people's ability to meet very basic needs and is largely connected to other well-being factors such as health, environment and community life. All other things being equal, housing forms an important component of household expenditure and can therefore determine the ability to spend on other basic necessities if rental value increases. The result on the perceived effect of ASM on housing in the study area shows that the majority of the respondents (55.7%) indicating moderate deterioration in housing condition compared to only 11.3% of the respondents who thought otherwise. However, about 30% of the respondents indicated that housing conditions had remained the same over the period. The relatively large percentage of the respondents reporting a moderate deterioration in their housing conditions due to ASM is not surprising considering the fact that mining activities act as a pull that attracts people from other geographical areas for employment and related reasons.

With regards to access to potable drinking water, the result shows strong agreement by respondents about ASM having serious negative effects on the quantity and quality of water for various domestic purposes. Specifically, 22.29% and 74.52% of the respondents in the study area attributed high and moderate deterioration in accessing potable drinking water to ASM in the study area. During the household interview and focus group discussion, it came to light that, the deterioration in accessing potable drinking water was due to chemical pollution of groundwater and streams as well as siltation through increased sediment load. This result agrees with Amoah (2003) who reported that the concentration of mining operations in Tarkwa had been a major source of both surface and groundwater pollution and consequently, deterioration in the quality and availability of

potable drinking water for residents in Tarkwa mining areas.

Health is essential for life and for achieving other well-being dimensions as it defines people's ability to work and generate income as well as participate in education, social life and civil activities. From the results in Table 3, the majority of the respondents (74.68%) in the study area indicated a moderate decrease in health conditions whilst only 5.7% reported a moderate improvement in health conditions due to ASM. However, 19.6% of the respondents believed that their health condition had not changed because of the presence of ASM in their communities. The relatively large number of respondents who reported a decrease in health status due to ASM probably point to likely negative effects on labour productivity by reducing physical and cognitive capacities as well as working time of household members. The results from this study concur with the findings by Hilson (2001) that the creation and subsequent abandonment of pits and trenches by ASM operators leave surrounding communities with stagnant water and malaria-carrying mosquitoes hence resulting in the frequent outbreak of malaria in mining areas. However, the results from this study contradicts an econometric study in Ghana by Chuhan-Pole *et al.* (2015) who indicated that mining activities improve the health outcomes of long-established households and that infant mortality rates significantly decrease in mining communities relative to non-mining areas.

Education is an important enabling factor not only for individual well-being but also for the development of the country. Graduate unemployment and lack of financial assistance to fund education as well as the desire to attain economic and financial independence drive many young people of school going age to enter into ASM activities (Banchirigah, 2008; Osei *et al.*, 2021). The consequential effect of such decision is negative impact on education among youths and children in mining areas. According

to the study, 59.24% of the respondents reported moderate decrease in education among children whilst 33.12% also opined that education among children had remained the same inspie of activities of ASM. Households who reported deterioration in their children education mentioned the direct involvement of their children in ASM activities as well as indirect involvement through selling of goods as well as rendering of auxiliary services at the mine sites. This result is consistent with the findings of Boateng (2017) that, students' involvement in galamsey activities during school hours has resulted in the low school attendance as well as a drop in the academic performance of students in mining communities in Ghana.

All other things being equal, access to adequate productive land for agricultural purposes can go a long way to improve the welfare outcome of households and vice versa. The results from Table 3 show clearly that ASM had a negative impacts on agricultural land as 53.16% and 46.84% of the respondents indicated highly and moderately decrease in access to arable land, respectively. With mining activities competing with agricultural activities for land, this specific finding is not surprising but worrying because access to arable land can lead to sustainable food production which in turns can result in food security and improved income among households. The result supports the findings by Duncan (2009) 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 in Ghana.

Access to game, fruits and firewood can have positive outcome on the welfare of households in rural areas through job creation and income. The respondents in the study area reported moderate deterioration in terms of access to firewood, game and fruits. Respondents in three of the communities (Ntotroso, Kenyasi

No. 1 and No. 2 and Wamahinso) alluded to the abundance of snail, mushroom, pawpaw and bush meat (particularly grasscutter) in the study area prior to commencement of mining activities in the study area. The respondents in these communities rated the current availability of mushroom, snail and grasscutter meat as very scarce and expensive. This result is similar to the findings by Obeng and Appiah (2019) who reported that illegal mining had resulted in the scarcity of non-timber forest products like mushroom, chewing stick, pestles, herbs and medicine in the Western North Region of Ghana.

Coping strategies to ASM activities. Table 4 presents the frequency distribution of the coping strategies against the negative effects ASM activities. Considering the responses from respondents, it was identified that farmers rely on land reclamation, resettlement to a different community, diversification/petty trading, dependence on market for food, social networking, sale of asset and borrowing as coping strategies to minimise the effects of ASM activities on their welfare. According to the result, diversification or petty trading forms the highest adopted strategy (36.08%), followed by social networking (34.18%), land reclamation and borrowing (31.01%), dependence on market for food (30.38%), resettlement to a different community (29.11%) and sale of household asset (22.78%).

Determinants of adoption of coping strategies against the negative effects of ASM. The study used multivariate probit regression to analyse the factors influencing farmers' decision to adopt coping strategies against the negative effects of ASM in the study area. The result in Table 5 indicated that the log likelihood ratio (LR) of the model (-756.26) and Wald $\chi^2(90) = 490.45$ are significant (Prob > chi2 = 0.0000). The likelihood ratio test based on the log-likelihood values leads us to conclude that, the model is of a good fit as well as to reject the null hypothesis of independent error terms. To this end, Multivariate probit is preferred statistically because it indicates that the probability of adopting one set is interdependent of the decision of whether to adopt another set.

The estimates of the correlation between the regression error terms are both positive and negative, suggesting complementarities of coping strategies for positive co-efficient values and substitutability of coping strategies for negative co-efficient values. More specifically, strategies with positive values suggest a joint usage of more than one of those strategies whilst strategies with negative values suggest that, coping strategies adoption against negative effects of ASM will be used as substitutes.

Table 4. Coping strategies to ASM activities

Coping strategies	Frequency	Percentage
Land reclamation	98	31.01
Resettlement to a different community	92	29.11
Diversification/petty trading	114	36.08
Dependence on market for food	96	30.38
Social networking	108	34.18
Sale of asset	72	22.78
Borrow food	98	31.01

Table 5. Correlation Coefficients for MVP Regression Equations

Coping Strategies	Land reclamation	Resettlement/ Out-migration	Diversification /Petty Trading	Dependence on Mkt for Food	Social Networking	Borrowing of food
Land Reclamation	X					
Resettlement / Outmigration	0.4194) (0.1133***)	X				
Diversification / Petty Trading	0.2793) (0.1259**)	0.0410 (0.1457)	X			
Dependence on Mkt for Food	0.2316) (0.1223*)	0.1866 (0.1488)	-0.2938 (0.13170**)	X		
Social Networking	0.2222) (0.0978**)	-0.1919 (0.1168)	0.0418 (0.1079)	0.2094 (0.1035**)	X	
Borrowing Food	-0.0913 (0.1212)	0.2051 (0.1259)	-0.1792 (0.1225)	0.0880 (0.1313)	-0.0515 (0.1226)	X

Note: *** p<0.01, ** p<0.05, * p<0.1
Source: Field Survey, 2021.

The results show that respondents will jointly use land reclamation and resettlement as a coping strategy. Such joint usage of land reclamation and resettlement becomes more real and practical when residents affected by adverse effect of small-scale mining seeks temporal relocation whiles they work to reclaim their damaged lands for their return. Under such condition, residents move to nearby communities for temporal livelihood. Further to this, the propensity of farm households to adopt land reclamation increases with the use of diversification and social networking, respectively. The accompanying factors of land reclamation are often investment in other income generating activities to cope with negative effects of ASM as well as creating a pool of social capital. Again, the likelihood of farm households depending on market for food increases with the use of social networking and land reclamation at 5% and 10% level of significance, respectively.

It is worth noting that, the decision to adopt a coping strategy against the negative effects of ASM may be affected by the availability of substitutes as indicated by the

negatively correlated coping strategies pairs: diversification and dependence on market for food. This shows that, the probability of adopting diversification is highly negatively correlated with dependence on market for food, suggesting that farm households to a large extent either adopt more of a diversification and depend less on market for food or substitute one for the other.

The study found out that age of respondents negatively and significantly affected the decision to practice land reclamation, resettlement as well as borrowing. The negative and significant sign of age of farmers indicate that younger farmers in the study area have greater likelihood to use land reclamation, resettlement and borrowing of food as a strategy to cope with the adverse effect of artisanal small-scale mining. In the case of land reclamation, practically, there is the need for high energy involvement in the highly mechanized mining processes to refill abandoned mining sites as well as the use of other land reclamation practices or projects. For this reason, older people may not have the requisite physical energy to carry out such physically demanding activities. With

regards to resettlement, the negative coefficient of the age of respondents suggests that, the probability of adoption is higher for relatively younger farmers. Again, the negative but significant coefficient of the age of respondents on borrowing of food implies that, younger farmers are more likely to resort to borrowing of food. This may be due to the fact that, older people are largely considered resourceful, hence may tend to rely on other household resource to cope with the negative effect of ASM rather than borrowing from peers or relatives or institutions. The finding is in line with the observation made by Deressa *et al.* (2008) and Heltberg and Lund (2009) that as farmers age, they become less likely to adopt strategies to cope with livelihood shocks.

Sex of the respondent was found to have a negative and significant effect on the adoption of diversification/petty trading and social networking as coping strategies. The implication is that, males are less likely to adopt these coping strategies to deal with ASM induced shocks. For diversification, the negative coefficient can be attributed to the fact that females do not fully engage in farming but rather engage in off farm activities, especially petty trading to raise income to support their homes. Males on the other hands are more likely to be fully involved in farming activities which are physically demanding and hence may not fully resort to petty trading or diversification to deal with the negative effects of ASM. With regards to social networking, men in most societies are breadwinners and may be preoccupied with their farming most of the time. This can limit their social relationship outside home thereby making them less likely to rely on social networking as a coping strategy. The finding of this study in respect to gender and coping strategies adoption contradicts Ngenoh *et al.* (2018) that, female headed households are less likely to adopt appropriate

coping mechanisms against livelihood shocks compared to male headed households, due to cultural beliefs, access to resources as well as resource management.

Education prepares people to gain skills and knowledge needed to secure alternative jobs in the formal sector and at same time influences people's access to information on the technical aspects of the adverse effects of ASM on agricultural production and the environment at large. From Table 6, the education of the farm household was significant and positively related to the adoption of resettlement and borrowing of food but negatively related to the adoption of land reclamation. This implies that, highly educated households are less likely to reclaim abandoned field of ASM but will resettle in other communities. In practice, more educated households will demand for more environmentally sound communities free from pollution arising from ASM activities. Thus, at 5% significance level, a year increase in formal education of households increases the chances of resorting to resettlement to a different community by 3.6%. Also, the positive coefficient of education on borrowing implies that, highly educated households are more likely to resort to borrowing as a coping strategy. This is contrary to the a priori expectation since it was hypothesized that education is accompanied with larger incomes that can be enough to meet household food needs. This finding concurs with Alemayehu and Bewket (2017) who reported that, education fosters a willingness to undergo training and acquire new knowledge and is positively associated with adoption of coping strategies in times of livelihood shocks. Household size was found to be positively and significantly associated with the likelihood of using land reclamation, resettlement and social networking. At 10% significance level, households with larger membership are more likely to adopt land reclamation strategy.

Household size is one important variable that can determine the availability of labour hence households with large membership are well positioned to undertake land reclamation practices like refilling of abandoned pits which are labour intensive in nature. Previous study points out that larger households provide helping hands in carrying out labour intensive activities such as land reclamation, farming, among others (Mabe *et al.*, 2021). Also, larger household size is a suggestive of several outlets of the household that establish several social networks for household members to rely on in times of livelihood shocks.

From this perspective, it can be argued that larger households increase the likelihood of households adopting social networking as a coping strategy. The finding agrees with Mabe *et al.* (2021) who reported a positive effect of household size on the adoption coping strategies among mining households. Again, the positive effect of household size on resettlement is highly unexpected since larger households cannot easily relocate to other areas due to their large number for economic and social reasons. However, the positive effect of household size on resettlement may be attributed to the extreme negative effects of ASM like scarcity of food and high cost of living which can impact severely on larger households in mining areas compared to smaller households. For this reason, households with more members may be compelled to relocate to other areas where the living condition is comparatively more favourable.

Household access to credit plays a crucial role in maintaining household welfare and recovery from shocks including adverse effect of ASM. The result from Table 6 shows that access to credit by farm households significantly increases the likelihood of using dependence on market for food, diversification and borrowing at 1% level of significance. Firstly, the positive coefficient of credit on dependence on market

for food can be attributed to the fact that, credit often in the form of cash increases the purchasing power of households in the short run enabling the purchase of food from the market. Also, the positive relationship between access to credit and diversification can be attributed to the fact that, cash credit helps households to increase their investment in various off farm activities to generate additional income to serve as security in the event of agricultural production shocks or other forms of livelihood shocks. Contrary to the study's expectation, there was a positive association between access to credit and borrowing of food indicating households with credit access are more likely to borrow food to deal with ASM shocks.

The FBO is positively associated with the adoption social networking. The positive sign is somewhat not surprising as membership of farmer groups provides social capital and network. Such groups lend support to members in times of difficulties. Previous study also points out that membership of a farmer group serves as an effective pathway for shock mitigation including ASM (Ma and Abdulai, 2016). Membership of such groups provide members with extra benefit of capacity building in diverse ways to curb adverse effects of ASM. However, at 10% significance level, members of FBO are about 65% less likely to borrow food from friends and relatives.

Farm size was found to be significant with varied effect on adoption of land reclamation, resettlement, dependence on market for food and social networking as coping strategies against ASM induced shocks. Firstly, the result showed that farm size is negatively related to adoption of land reclamation, dependence on market for food and social networking. This also implies that farmers with relatively smaller farm size are more likely to use land reclamation, dependence on market for food and social networking. This result is intuitively apt and depict reality as many small sized

farmers are in a better position to undertake land reclamation strategies because land reclamation activities can be easily carried under small areas relative to large acreage. Similarly, small farm size generally denotes smaller farm output thereby prompting farmers with smaller farm size to purchase additional food from the market to supplement own production. Again, holding other factors constant, farmers with smaller farmer size are more likely to suffer severely from the negative effects and may have to resort to relying on existing social networks and relationships to survive, especially in the presence of credit constraints and poor yield. However, farm size positively influences households' decision to resort to resettling to other non-affected communities suggesting that, an increase in farm size by 1 acre increases the probability of households relocating to other communities by 37%, *ceteris paribus*.

Table 6. Multivariate probit results: determinants of adoption of coping strategies to ASM activities

Variables	Land reclamation	Resettlement/ Out-migration	Diversification / Petty Trading	Dependence on Mkt for Food	Social Networking	Borrowing of food
AGE	-0.0245** (0.0201)	-0.0107** (0.0208)	0.0235 (0.0208)	0.0042 (0.0208)	-0.0015 (0.0172)	-0.0677*** (0.0191)
SEX	-0.6746 (0.2258)	0.4377 (0.2369)	-1.1448*** (0.2610)	-0.1287 (0.2406)	-0.4895** (0.1911)	0.1432 (0.2426)
EDU	-0.0041** (0.0224)	0.0364** (0.0246)	-0.0290 (0.0258)	0.0137 (0.0261)	-0.014 (0.0206)	0.0824*** (0.0239)
HHSIZE	0.2457* (0.0712)	0.2408* (0.0847)	-0.0354 (0.0772)	-0.0110 (0.0798)	0.2255*** (0.0636)	0.0036 (0.07450)
CREDIT	0.4057 (0.2528)	-0.0871 (0.2806)	2.2789*** (0.3515)	1.1869*** (0.2951)	0.2477 (0.2317)	1.1874*** (0.3336)
FMSIZE	-0.2528* (0.0568)	0.3724* (0.0566)	-0.0691 (0.0483)	-0.3981*** (0.0714)	-0.0772* (0.0409)	0.0432 (0.0500)
FBO	0.3067 (0.2576)	0.3136 (0.2935)	0.0611 (0.3060)	-0.3657 (0.3036)	0.6375*** (0.2398)	-0.6464** (0.3027)
FARM YRS	0.0281** (0.0178)	-0.0103** (0.0186)	-0.0543*** (0.0201)	-0.0186 (0.0205)	0.0062 (0.0156)	0.0150 (0.0183)
HH INCOME	1.62e-05*** (8.45e-06)	2.11e-05*** (7.68e-06)	1.34e-05** (6.63e-06)	2.45e-05*** (6.81e-06)	-4.76e-06 (5.69e-06)	1.62e-06** (6.98e-06)
ASM YRS	-0.0640** (0.0484)	-0.1638* (0.0580)	0.0053 (0.0582)	-0.3542*** (0.0636)	-0.1245*** (0.0454)	0.1610** (0.0634)
DIST TO SITE	0.0556* (0.0808)	0.4631 (0.1031)	0.1636* (0.0905)	0.4534*** (0.0989)	0.0592 (0.0734)	-0.3560*** (0.1058)
HH CONSU.	3.82e-05*** (8.45e-06)	2.34e-05** (9.22e-06)	-1.47e-06 (1.08e-05)	-6.97e-07 (1.02e-05)	2.37e-05*** (7.50e-06)	1.15e-05 (1.08e-05)
EXT QTY	-0.1396 (0.1178)	0.1460 (0.1192)	-0.3134** (0.1274)	0.0896 (0.1409)	-0.0947 (0.0998)	0.3069** (0.1258)
CONSTANT	-0.8331 (0.9254)	-1.5469 (0.9412)	-1.3418 (0.8934)	1.7342 (0.9740)	0.0544 (0.7914)	0.0933 (0.9808)

Multivariate probit (MSL, # draws = 5); n=316; Wald chi2(90) = 490.45***;

Log likelihood = -756.26***; Prob > chi2 = 0.0000

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho32 = rho42 = rho52 = rho62 = rho43 = rho53 = rho63 = rho54 = rho64 = rho65 = 0: chi2(15) = 47.9795*** Prob > chi2 = 0.0000

Source: Field Survey, 2021. Note: *** p<0.01, ** p<0.05, * p<0.

Farm size was found to be significant with varied effect on adoption of land reclamation, resettlement, dependence on market for food and social networking as coping strategies against ASM induced shocks. Firstly, the result showed that farm size is negatively related to adoption of land reclamation, dependence on market for food and social networking. This also implies that, farmers with relatively smaller farm size are more likely to use land reclamation, dependence on market for food and social networking. This result is intuitively apt and depict reality as many small sized farmers are in a better position to undertake land reclamation strategies because land reclamation activities can be easily carried under small areas relative to large acreage. Similarly, small farm size generally denotes smaller farm output thereby prompting farmers with smaller farm size to purchase additional food from the market to supplement own production. Again, holding other factors constant, farmers with smaller farmer size are more likely to suffer severely from the negative effects and may have to resort to relying on existing social networks and relationships to survive, especially in the presence of credit constraints and poor yield. However, farm size positively influences households' decision to resort to resettling to other non-affected communities suggesting that, an increase in farm size by 1 acre increases the probability of households relocating to other communities by 37%, *ceteris paribus*.

Years in farming was found to have a significant positive effect on land reclamation. The positive relationship between farming experience and land reclamation may be attributed to the fact that, households with longer years of farming have accumulated more experience and are in a better position to device easy ways to reclaim their farm lands for production. According to the result, at 1% significance level, a year increase in farming experience increases

the likelihood of adopting land reclamation by 2.8%. On the other side, household with higher farm experience tend to have less likelihood of resettling to other communities as well as venturing into income diversification activities. The finding shows that at 5% and 1% significance level, a year increase in farming activities decreases the likelihood of households resettling to a different community by 1% as well as the likelihood of resorting to diversification by about 5%, holding all other factors constant.

Total household income was also found to be a significant factor in explaining farming households' decision to adopt ASM adaptation strategies. Total household income has positive effect on the adoption of land reclamation, resettlement, diversification activities, dependence on market and borrowing. At 1% significance level, an increase in household income is positively related to the adoption of land reclamation, resettlement and dependence on market for food as coping strategies. Land reclamation is expensive activity and more financial resources are required to convert waste mined lands into fertile agricultural land hence household with higher income are more likely to be in a better position to carry out reclamation activities. In the case of resettlement, the possible reason for a highly significant positive coefficient could be that, households with higher income are able to afford the cost of relocating their families from ASM communities beset with many social, economic and environmental problems to other communities where living conditions may be comparatively better. For dependence of market for food, the possible reason could be that, households with higher income have the wherewithal to purchase food from the market within or outside the community to supplement shortages of own production arising from the destruction of farmlands by ASM activities. The result further showed that, at 5% level of

significance, households have higher propensity to engage in diversification and borrowing of food. In respect to diversification, the finding is not surprising because households need income to venture into such off-farm activities especially those that need high start-up capital. However, the finding with respect to the effect of income on borrowing is highly contradictory to the study's expectation. The reason is that, higher income level of households is an indication of the ability to make the necessary purchases required to maintain household's food consumption level in the event of food shortages.

Years of existence of artisanal small-scale mining activities was found to have a significant negative effect on the adoption of land reclamation, resettlement, dependence on market for food and social networking. However, years in the mining activities tend to be positively associated with borrowing of food. The negative coefficient on land reclamation is a suggestive that, many years of ASM operation might have caused significant degradation to the land, making land reclamation an expensive and less attractive option for poor farm households who lost their lands to mining activities. The highly significant and positive sign of ASM years of existence on borrowing of food may be attributed to the destruction of agricultural land through many years of ASM activities which probably might have resulted in reduction in households' food production thereby compelling households to borrow from family members, friends and neighbours with surplus food. The negative coefficient of ASM years of existence on dependence on market for food implies that, an increase in ASM operation by one year in the community decreases the likelihood of households relying on the market for their food needs. This is surprising because ASM activities have been found to have negative impact of food production (Hilson, 2001).

Distance to mining site had different effect on adoption of coping strategies. In the first place, an increase in the distance to the mining field by a kilometre increases the likelihood of adopting land reclamation, diversification and dependence on market for food by 5.6% and 9% at 10% and 1% level of significance respectively. By implication, the farther the mining site from the community the more likely mining fields will be reclaim. Similarly, the longer the distance the more likely households will depend on market for their food needs while engaging in off-farm economic activities like trading. However, an increase in distance to mining field decreases the chances of households resorting to borrowing food to cope with ASM-induced shocks by 10%.

Households' consumption expenditure is significant and positively correlated to the adoption of land reclamation, resettlement and social network implying that an increase in the consumption level significantly increases the decision to adopt these coping strategies. Specifically, an increase in household consumption expenditure by one Ghana cedi increases the propensity to adopt land reclamation and social network by 0.0038% and 0.0024% respectively at 1% significance level. Similarly, an increase in consumption expenditure by Ghana cedi increases the adoption of resettlement to a different community by 0.0023% at 5% level of significance.

Extension services provide education to farmers as well as small-scale miners on the detrimental effect of mining on agriculture. Such education and awareness creation are expected to lead to the adoption of adaptation strategies. However, receipt of extension services decreases the likelihood of diversifying into other income generating activities but increases the adoption of borrowing of food.

CONCLUSIONS

The aim of the study was to assess farmers' perceptions about the effects of ASM as well as the adoption of coping strategies and their determinants in the Asutifi North District in Ghana. The study made use of data obtained from a random sample of 316 farm households collected through personal interviews using semi structured questionnaires. Descriptive statistics were employed in the analysis of farmers' demographic and socioeconomic characteristics as well as their perceptions on the effects of ASM. The Multivariate probit model was used in assessing the determinants of coping strategies adoption.

From the study, ASM on one side has serious negative implications on the welfare indicators such as food security, health conditions, housing conditions, land availability, potable drinking water among others of farm households living in mining areas. On another side ASM has positive implications on the welfare indicators such as employment generation and income of farm households living in mining areas, mainly through direct participation, receipt of compensation and boost in business activities. Majority of the respondents (75%) who adopted coping strategies used two or more strategies as compliment or substitutes to deal with the negative impacts of ASM on welfare indicators of farm households. All the explanatory variables included in the MVP model (age, sex, marital status, household size, educational status, farm size, access to credit, membership of FBO, main occupation, off farm activities, land ownership and years of stay in the area) have different magnitude and direction of significance in influencing the adoption of coping strategies in the study area.

RECOMMENDATIONS

Based on the findings, it is recommended that farmers should be encouraged to form

cooperatives and FBOs to help in the dissemination of information on the benefits of adopting coping strategies as well as improving access to joint resources that could be used by farm households to cope with ASM induced shocks. To this end, enhancing supportive social foundation can provide the groundwork from which vulnerable farm households in mining communities can collectively diversify their activities, especially where social capital is more readily available than financial capital. Credit should be provided on priority basis by NGOs, financial institutions and government to farm households in mining communities so that they can efficiently cope with ASM induced shocks and sustain their livelihood through income diversification. Specific policies geared towards overcoming resource constraints would lead to high adoption of appropriate strategies that are capable of enabling farm households to successfully respond to ASM and its associated shocks on livelihood.

Ghana Government, through Ministry of Lands and Natural Resources should consider integrating land reclamation practices in the sector's policy comprehensively to ensure sustainable food production and hence food security in the mining areas. Although this practice may seem to be costly in the short run, in the long run it will reduce the household's vulnerability by increasing farm households' access to land. Interventions by government and NGOs aimed at improving the welfare of farm households in mining communities should target providing alternative livelihood training that ensure significant participation in off-farm economic activities as well as expanding the government's planting for food and job program. With only 32% participating in PFJ in the study area, larger coverage will help to increase food production in the area which in turns can go a long way to improve the welfare indicators of households especially

food security income and employment

STATEMENT OF NO CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

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