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Cocoa Farming and Illegal Mining: Farmers' Perception on the Livelihood Impacts in the Obuasi, Juabeso, and Amansie West Districts of Ghana

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Abstract

Cocoa and gold are vital contributors to Ghana's GDP, with many cocoa-growing communities also serving as hotspots for illegal small-scale mining. This study investigated cocoa farmers' perceptions of the impact of illegal mining on their livelihoods in three districts where both activities coexist. Data was collected from 180 purposively selected cocoa farmers using questionnaires. The findings revealed that illegal mining poses significant challenges, including water pollution, land degradation, cocoa tree mortality, and reduced yields, leading to income losses for farmers. Uncovered mining pits also contribute to health risks such as mosquito-borne diseases. Key drivers of illegal mining include unemployment, poverty, and quick financial gains from illegal mining activities. The study recommends increased environmental education by the Ministry of Food and Agriculture in collaboration with the Ministry of Lands and Natural Resources to raise awareness among cocoa farmers and mining communities about the adverse effects of illegal small-scale mining on cocoa production and the environment.

Keywords: Cocoa farming, illegal small-scale mining, environmental degradation, cocoa production

INTRODUCTION

Cocoa farming remains a vital part of Ghana's agricultural sector, contributing significantly to the national economy and providing livelihoods for millions of rural households (Wessel & Quist-Wessel, 2015; Ali *et al*., 2018; Donkor *et al*., 2024). In addition to being a significant income source for smallholder farmers, cocoa cultivation also enhances food security, playing a vital role in household agricultural income (Hashmiu *et al*., 2022; Tham-Agyekum *et al*., 2024). The sector is responsible for creating approximately 800,000 jobs across the country (Bunn *et al*., 2019; Maguire Rajpaul *et al*., 2020; Afele *et al*., 2021). Ghana ranks as the second-largest cocoa producer globally, generating an estimated US$ 2 billion in export revenues in 2013 (Osei-Bagyina, 2012; Boakye, 2020; Osman *et al*., 2022;). In 2016, the country accounted for about 52% of the world's total cocoa production, alongside Côte d'Ivoire (Osman *et al*., 2022). The cocoa sector is vital for job creation, health, education, infrastructure development, and foreign exchange earnings (Enu, 2014).

Valuable resources like gold and diamonds have been integral to local economies for millennia (Hess, 2022). In Ghana, metals such as gold, and manganese have been present since pre-colonial times and are extracted by both smaller artisanal mines and larger industrial-scale operations (Worlanyo *et al.*, 2022). Gold is a key component of the Ghanaian economy, accounting for about 38% of total merchandise, 95% of mineral exports, and contributing roughly 80% of all mineral revenue (McQuilken & Hilson, 2016; Gomashie, 2022; Ndikumana & Cantah, 2023). Ghana ranks as Africa's second-largest gold producer, with an average annual output of 77 tons, following South Africa (Gajigo *et al*., 2012). In 2011, the mineral sector contributed around 14% of total tax revenues and 5.5% of the country's gross domestic product (GDP) (Gomashie, 2022), along with accounting for 44% of Ghana's exports (Gajigo *et al*., 2012).

Gold mining in Ghana can be categorized into two primary types based on production scale: large-scale mining (LSM) and small-scale mining (SSM). The SSM sector also includes artisanal small-scale mining (ASSM), which primarily involves indigenous individuals (Owusu-Nimo *et al*., 2018). Following the legalization of small-scale gold mining in Ghana, two distinct groups of small-scale miners have emerged: licensed (legal) miners and unlicensed (illegal) miners (Bansah *et al*., 2016).

Illegal small-scale mining, commonly referred to as "galamsey," poses a significant challenge to cocoa production (Osman *et al.*, 2022; Nikoi, 2024). This practice is defined as the extraction of minerals without the necessary tools, mining licenses, exploration permits, or any legal documentation that would authorize such activities (Aneani *et al.*, 2017). The term "galamsey," which translates to "gather and sell," has increasingly become a pressing issue in Ghana's mining regions (Aneani *et al*., 2017). The environmental impacts of galamsey are severe, leading to deforestation, land degradation, and pollution of water and air (Aneani *et al.*, 2017). These environmental damages adversely affect cocoa yields by destroying the topsoil essential for healthy plant growth, potentially wiping out entire cocoa farms (Takyi *et al*., 2019). The rise of galamsey is often linked to various factors, including poverty, unemployment, and inadequate enforcement of regulations in the small-scale mining sector (Amponsah-Tawiah & Dartey-Baah, 2011; Osman *et al*., 2022).

The relationship between agriculture and illegal Artisanal and Small-Scale Gold Mining (ASGM) involves not only cocoa but also a range of other cash crops, highlighting the intricate dynamics that affect rural livelihoods (Donkor *et al*., 2024). Moreover, the reliance on both cash crops and mining as income sources creates a complex dependency, where communities may prioritize short-term gains from mining over the long-term benefits of agriculture (Donkor *et al*., 2024). While cocoa farming and illegal ASGM might seem like separate activities, they are closely connected (Adjei, 2017; Ntiamoah, 2019; Nunoo *et al*., 2023). Both activities frequently compete for the same fertile land, which is also highly sought after by gold miners, resulting in significant competition for scarce land resources (Agyei-manu *et al.*, 2020; Adranyi *et al*., 2023). Illegal ASGM greatly affects the agricultural sector, with cocoa farming being particularly vulnerable to its impacts (Donkor *et al*., 2024).

Illegal small-scale mining has escalated across cocoa-growing areas, driven by the rising global demand for gold and the economic hardships faced by many rural communities (Ntiamoah, 2019). Despite being illegal, galamsey operations have continued to expand, often encroaching on farmlands, forest reserves, and

water bodies (Aneani *et al*., 2017). This has created a severe conflict between cocoa farming and illegal mining activities. The impact of these mining operations on the environment is devastating, as they degrade farmlands, pollute water sources, and lead to deforestation (Aneani *et al*., 2017; Adjei, 2017; Osman *et al*., 2022; Donkor *et al*., 2024). The environmental damage, combined with the displacement of farmers from their lands, has serious implications for the livelihoods of cocoa farmers.

In districts like Obuasi, Juabeso, and Amansie West, where cocoa farming is a traditional economic activity, illegal mining activities have led to declining productivity and financial instability (Adjei, 2017; Abbiw, 2020; Osman *et al*., 2022; Donkor *et al*., 2024). The loss of farmland due to mining has resulted in a significant reduction in cocoa production, affecting farmers' incomes and threatening the long-term sustainability of cocoa farming in these areas (Adjei, 2017). Furthermore, illegal mining disrupts community life, bringing social challenges such as increased crime rates, child labor, and conflicts over land rights (Addah, 2014).

The encroachment of illegal small-scale mining on cocoa farms presents a significant challenge to farmers who rely on these lands for their livelihood (Donkor *et al*., 2024). Understanding farmers' perceptions is important because it provides insight into how they view the threat posed by illegal mining and the strategies they may adopt to cope with or resist these encroachments. This study aims to explore these perceptions and focuses on the livelihood impacts experienced by farmers in the Obuasi, Juabeso, and Amansie West districts. Through examining the interactions between cocoa farming and illegal mining, this research will provide insights into the socio-economic dynamics at play, highlighting the need for sustainable agricultural practices and improved regulatory frameworks. This investigation will contribute to the existing body of knowledge on agricultural and environmental challenges in Ghana. Ultimately, this research seeks to inform strategies that can mitigate the negative effects of illegal mining while promoting sustainable cocoa production, thereby supporting the livelihoods of vulnerable farming communities

MATERIALS AND METHODS

Study Area Description

The study was conducted in three districts known for their significant cocoa production and the widespread prevalence of illegal small-scale mining activities. These districts are Obuasi, Juabeso, and Amansie West. Each of these areas has long been recognized for its role in Ghana's cocoa sector (Adjei, 2017), while also facing severe challenges due to the encroachment of illegal mining operations (Osman *et al*., 2022).

In the Obuasi District, the specific communities focused on were Adaase, Memrewa, and Sanso. These areas are historically known for their cocoa farming but have experienced increasing mining activities in recent years. Similarly, in the Juabeso District, the study focused on the communities of Kwawkrom, Abrokofe, and Boinzan, where both cocoa farming and illegal mining are prevalent. Finally, in the Amansie West District, the research targeted Antoakrom, Omanadwareye, and Besease communities that are key for cocoa production but have also seen a rise in illegal mining, posing threats to agricultural livelihoods. This selection of communities provides a representative view of the broader conflict between cocoa farming and illegal small-scale mining in Ghana.

The Obuasi Municipal Assembly is located in the Ashanti region of Ghana, positioned between latitudes 5° 35'N and 5° 65'N, and longitudes 6° 35'W and 6° 90'W. It spans an area of 162.4 square kilometers and comprises 52 communities, divided into 30 electoral areas, with one Urban Council. According to the Ghana Statistical Service (GSS, 2021), the municipality has an estimated population of 104,297 people. It is bordered to the south by the Upper Denkyira District of the Central Region, to the east by Adansi South, to the west by Amansie Central, and to the north by Adansi North, situated approximately 80 km south of Kumasi (Obuasi Municipal Assembly, 2006). Obuasi serves as the capital of this administrative municipality.

The population includes both urban and rural residents (Mohammed *et al.*, 2019), who engage in various economic activities, with farming and petty trading being the primary sources of income. Major crops cultivated in the district include cocoa, maize, plantain, citrus fruits, and vegetables such as garden eggs and pepper. Additionally, non-traditional crops like cashew and pineapple are also grown. The total cultivable land area is estimated at 94,400 hectares, with around 50,200 hectares currently under cultivation. The region features semi-deciduous vegetation (Osei-Bagyina, 2019).

Obuasi experiences a semi-equatorial climate characterized by a double maximum rainfall pattern. Annual rainfall averages between 125 cm and 175 cm, while temperatures remain consistently high throughout the year, peaking in March when temperatures often exceed 30 °C. The mean annual temperature is approximately 25.5 °C, and relative humidity is highest during the wet season, ranging from 75% to 80% (Obuasi Municipal Assembly, 2006). The area's vegetation is primarily composed of a degraded semi-deciduous forest, featuring a limited variety of hardwood species, which are harvested for timber (Mohammed *et al.*, 2019). Additionally, Anglo Gold Ashanti has established extensive teak plantations covering 12.10 km² within its concession area (Obuasi Municipal Assembly, 2006).

The Juabeso District is located at 6° 20' north latitude and 2° 50' west longitude, with Juabeso as its capital. Juabeso is situated 360 km northwest of Sekondi-Takoradi, the regional capital, and 225 km from Kumasi, the capital of the Ashanti Region. Covering an area of 1,329 km², Juabeso serves as a key entry and exit point between Ghana and Côte d'Ivoire (Abbiw, 2020).

The district has a predominantly rural population of around 150,000 people, with a growth rate of 3.5% in 2010, higher than both the regional (3.2%) and national (2.7%) averages. The high population growth is mainly due to the migration of cocoa farmers from the Brong Ahafo and Ashanti regions (Abbiw, 2020). Juabeso is ethnically diverse, with the majority (53%) of its residents being indigenous Sefwi people, while the remaining 47% are largely migrants. It is estimated that over 65% of the cocoa farms in the district are owned by migrant farmers, with many of them acquiring land from traditional rulers and family heads for farming purposes (Abbiw, 2020).

The Amansie West District shares borders with eight districts, including Atwima Nwabiagya, Atwima Mponuah, Bekwai Municipality, Amansie Central, and Obuasi Municipal to the east, as well as Atwima Kwawhoma to the north (Osman *et al.*, 2022). It also marks the boundary between the Ashanti, Central, and Western regions. Geographically, the district is located between latitudes 6.05° N and 6.35° N, and longitudes 1.40° W and 2.05° E (MoFA, 2021).

The district experiences a wet semi-equatorial climate characterized by a double rainfall pattern. The primary rainy season

occurs from March to July, while a secondary rainy period takes place between September and November. Annual rainfall varies from 855 mm to 1,500 mm, providing conducive conditions for the cultivation of crops such as cocoa, citronella, oranges, plantain, and various vegetables (MoFA, 2021). The vegetation in the district is predominantly rainforest with semi-deciduous characteristics, resulting in fertile land that is well-suited for agriculture. Commonly grown crops include cassava, rice, maize, cocoa, citrus fruits, and oil palm. However, detrimental practices like shifting cultivation, slash-and-burn farming, illegal mining, and logging have led to significant forest destruction and degradation (MoFA, 2021).

Research Design and Sampling Approach

The research took a form of a survey and it was conducted in nine communities which were selected from three cocoa-growing districts in Ghana (Obuasi, Juabeso, and Amansie West Districts). The mixed method research approach was used and the quantitative aspect involved the collection of numerical data through structured surveys and questionnaires administered to cocoa farmers and other key informants in the selected districts. This enabled the researcher to quantify variables such as the extent of illegal mining activities, their impact on cocoa production, and the socio-economic effects on farmers. The qualitative component involved semi-structured interviews and focus group discussions with the cocoa farmers. This approach was employed to capture in-depth perspectives on the impact of illegal small-scale mining (galamsey) on livelihoods, agricultural productivity, and land use. The use of qualitative methods helped uncover personal experiences, challenges, and coping strategies that quantitative data alone might not reveal (Hennink *et al.*, 2020).

Purposive sampling was used to select the study communities. The selection of these communities is based on their production

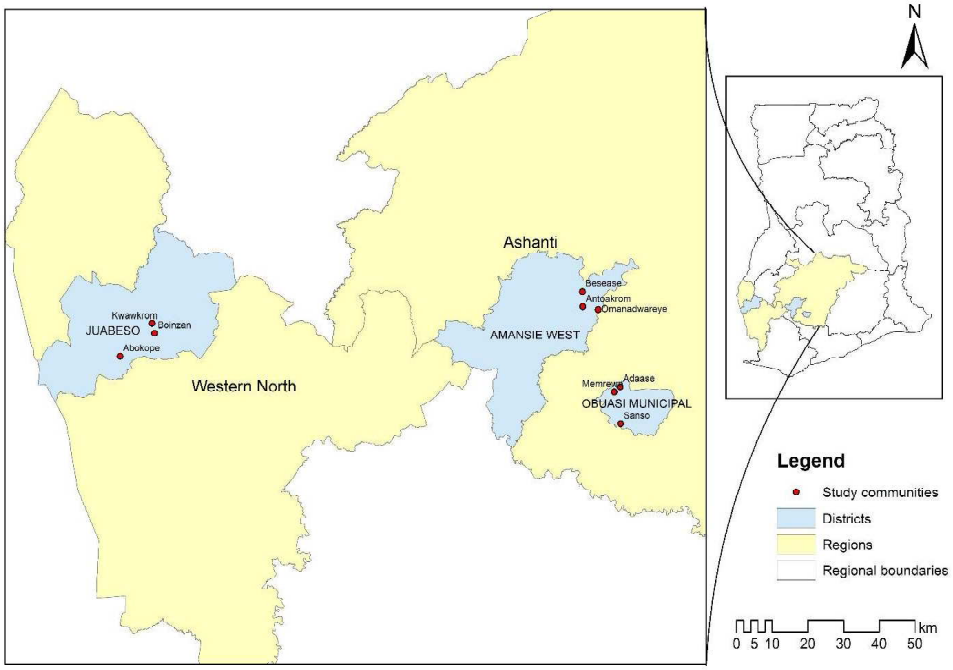

Figure 1. Study area map showing the Obuasi, Amansie West, and Juabeso Districts

of cocoa and the ongoing activities of illegal small-scale mining (Osei-Bagyina, 2012; Donkor *et al*., 2024). Cocoa farmers in the selected study communities were selected purposively. This method was chosen in this case to specifically target cocoa farmers whose livelihoods are directly affected by illegal small-scale mining. This method allows researchers to select participants based on their expertise or experience in the areas of interest, ensuring a focused and relevant sample for the study (Nyimbili & Nyimbili, 2024).

The Yamane's formula was employed to determine the sample size for the study. With the formula $n = N/(1+Ne^2)$, where n is the required sample size, N is the population size, and e is the desired precision level set at 10% (expressed as a decimal) is applied. Following this calculation, 180 cocoa farmers were interviewed from the districts to obtain a representative sample for a thorough data collection and analysis. This approach ensures a balance between the study's precision requirements and practical considerations in conducting interviews within the given.

Data Collection

The data collection process for this study primarily relied on the use of questionnaires as the main instrument. The questionnaires consisted of both open and close-ended questions. Through the use of the questionnaires, the selected farmers were interviewed and asked questions relating to the set objectives. The questionnaire was categorized into sections which include respondents' socio-economic and demographic characteristics such as age, sex, marital status, education level, occupation and monthly income and also the perceived effects of illegal mining on their livelihood.

Key informants, including extension officers, chief farmers, and assembly members, were interviewed to provide additional information and validate the responses obtained from cocoa farmers. These informants were selected for their expertise and leadership roles within the communities, allowing them to offer informed perspectives on the impact of illegal small-scale mining on cocoa farming. Their input helped to corroborate the farmers' accounts, ensuring the accuracy and reliability of the data collected and providing a more detailed understanding of the situation

The quantitative data were analyzed using the Statistical Package for Social Science (SPSS version 27.0). Descriptive statistics, including frequencies, percentages, and means, were used to summarize the responses. Responses from interviews with key informants like extension officers and chief farmers were transcribed and analyzed using thematic analysis. Thematic coding was used to identify recurring patterns and themes

RESULTS AND DISCUSSION

Demographic Characteristics of Respondents

The demographic characteristics of the study participants are summarized in the Table 1 below. It was revealed that the majority of the participants fall within the 46–60 year age bracket, representing 41.1% of the sample. The younger age group (26–45 years) comprises 31.1%, while participants aged 61 and above make up 27.8%. The gender distribution shows a slight male dominance, with 53.3% of the participants being male and 46.7% female. Participants were categorized into four income brackets, with the majority (39.4%) earning above 1000gh

(66.23$). However, 26.1% earn between 800gh (52.99$)–1000gh (66.23$), 16.7% between 500gh (33.12$)–700gh (46.36$), and 17.8% between 200gh (13.25$)–400gh (26.50$). The exchange rate used for conversion was 15.10 GHS/USD, based on the Bank of Ghana's exchange rate for August 2024 (Bank of Ghana, 2024). The educational levels among participants show a significant proportion with junior high school education (37.2% having completed Junior High School). Participants with only basic education form 33.3% of the sample, while 10.6% have no formal education. A considerable majority (62.2%) of participants are married, and single people make up 16.7%, divorced 11.1%, and widowed (10.0%) categories make up the remainder. Household size varied, with the largest group (37.8%) having between 4–6 members. Most participants (43.9%) have 1–10 years of farming experience, followed by 31.7% with 11–20 years of experience. In terms of farm size, the majority of participants (50.0%) cultivate between 1–5 acres, while 31.7% farm on 6–10 acres of land.

Cocoa Farmers Perception of Illegal Small-Scale Mining

The study found that all 180 cocoa farmers interviewed were fully aware of the presence of illegal small-scale mining in their local areas, representing 100% of the respondents (Table 2). This high level of awareness highlights the widespread prevalence of illegal mining (galamsey) in the study areas and reflects the significant impact of these activities on the daily lives and livelihoods of cocoa farmers.

Table 1. Demographic characteristics of the surveyed respondents (n = 180)

Variable	Category	Frequency	Percentage (%)
Age	26–45 years	56	31.1
	46–60 years	74	41.1
	61 and above years	50	27.8
Gender	Male	96	53.3
	Female	84	46.7
Income level	200gh (13.25$)–400gh (26.50$)	32	17.8
	500gh (33.12$)–700gh (46.36$)	30	16.7
	800gh (52.99$)–1000gh (66.23$)	47	26.1
	Above 1000gh (66.23$)	71	39.4
Educational level	Basic	60	33.3
	JHS	67	37.2
	SHS	29	16.1
	Tertiary	5	2.8
	No education	19	10.6
Marital status	Married	112	62.2
	Single	30	16.7
	Divorced	20	11.1
	Widow	18	10.0
Household size	0–3 people	30	16.7
	4–6 people	68	37.8
	7–10 people	63	35.0
	Above 10	19	10.6
Years of farming	1–10 years	79	43.9
	11–20 years	57	31.7
	More than 20 years	44	24.4
Size of farm	Less than 1 acre	9	5.0
	1–5 acres	90	50.0
	6–10 acres	57	31.7
	More than 10 acres	24	13.3

Table 2. Awareness and perception of illegal small-scale mining

Variable	Category	Frequency	Percentage (%)
Awareness of illegal mining	Yes	180	100
	No	0	0
General perception of illegal mining	It is a bad practice	160	89
	It is good practice	20	11

The complete awareness across all respondents shows the fact that illegal mining is not an isolated issue but a pervasive challenge affecting numerous farming communities. This observation aligns with previous research by Laari (2018), who conducted a similar study assessing the impact of illegal small-scale mining on cocoa farming and farmers' livelihoods in the Amenfi West district of Ghana. His study found that farmers were highly aware of the presence of illegal mining activities in their communities, further emphasizing the deep-rooted nature of the problem in cocoa-producing regions of Ghana. The high level of awareness among farmers could also reflect the growing discourse around the adverse effects of illegal mining on agriculture, supported by media reports, governmental efforts, and community discussions.

When asked about their views on this activity, an overwhelming majority (89%) expressed a negative perception, considering illegal mining to be harmful or detrimental. However, a smaller segment of the respondents (11%) held differing views, by seeing the activity in a more positive light (Table 2). These respondents stated that the activity is a source of income and employment for most people in the area including some cocoa farmers, which help them to generate income to supplement their cocoa farmers. Boakye, (2020) reported similar observations in assessing the effects of illegal mining on cocoa farming and livelihood in the Birim North District. This divergence in perception could be influenced by various factors, such as personal experiences, economic pressures, or a detailed understanding of the socio-economic impacts illegal mining has on their communities (Osman *et al.*, 2022). While the majority view illegal mining as damaging likely due to its harmful effects on land degradation, water pollution, and interference with cocoa farming, those with alternative views recognize the financial benefits or employment opportunities it provides in areas with limited economic options. The key informants interviewed also shared negative perceptions about illegal small-scale mining. The chief farmer for Antoakrom mentioned that, *"Illegal mining has caused irreparable damage to our lands and water bodies, making it difficult for farmers to maintain healthy cocoa farms. This activity is destroying our future."* This highlights the shared concern among local leaders about the long-term effects of illegal mining on both the environment and livelihoods.

Impact of Illegal Small-scale Mining on the Community and Local Economy

With the issue of illegal small-scale mining happening in the community, cocoa farmers were asked about their opinion on how illegal small-scale mining affects the community and the local economy (Figure 2). A greater part of the respondents, (31%) talked about environmental pollution being a major effect of illegal small-scale mining on the community and the local economy. Among this group of respondents, they highlighted several environmental pollutions resulting from illegal mining. Such of these are water pollution, land degradation, deforestation and noise pollution which have long-term detrimental effects on the environment and biodiversity.

These observations align with findings from previous studies, such as those by Denkyirah *et al*., (2017) and Addah (2014), who also reported similar environmental damages linked to illegal small-scale mining. Both studies emphasized the far-reaching effects of these activities, particularly on local ecosystems and the sustainability of agriculture, reinforcing the urgent need to address the environmental degradation caused by illegal mining. Also 21% of the respondents stated that illegal mining is seen to contribute significantly to the increased cost of living in the community. Several reasons were pointed out on how the activity increases cost of living. The most concerning ones were inflation of pieces for basic goods and services like food, health care, and increased competition for resources. The respondents acknowledged that illegal mining attracts a significant influx of people to mining communities, leading to increased demand for food, transportation, and other basic necessities. This surge in demand often drives up prices, contributing to a rise in the overall cost of living in these areas. The influx of miners and associated workers puts additional pressure on local resources, causing supply shortages and making it harder for residents to afford essential goods and services. This observation is consistent with findings from Gilbert & Albert (2016) and Asiama (2019), who reported that illegal mining activities result in population growth within mining communities, further straining local infrastructure and basic services. As a result, residents face higher living costs, including inflated prices for food, housing, and transportation.

Some respondents (17%), believe that illegal mining leads to an increase in poverty rate. This was attributed to destruction of farmlands, and loss of livelihood for those who depend on the land for their income. Similar results were identified by Owusu & Dwomoh, (2012) on the impact of illegal mining of Ghanaian youth in the Kwaebibirem district of Ghana. Another group of respondents (16%) mentioned that illegal small scale mining leads to decreased economic development. The reason being that the activity leads to environmental degradation which make the land unusable for cocoa production and other productive activities. This is in line with the studies done by Kervankiran *et al*., (2016) on illegal mining as a threat to sustainable development. Another pressing issue revealed by respondents were the fact that mining operators were outsiders and take the wealth generated from galamsey to develop their native towns forgetting their community of work. About 15% mentioned that the activity of illegal mining is associated with diseases. These respondents attributed this to the contamination of water sources with hazardous chemicals used in the mining process, poor standard of living of miners and inadequate health infrastructure in the communities, uncovered pits serving as breeding sites for mosquitoes causing severe illness. These findings echo previous studies by Rozo (2020), Awudu Iddriss (2022), Boakye (2020), and Obiri *et al*., (2016), all of which reported similar impacts of illegal mining. These studies highlight the severe health hazards and environmental degradation caused by the mining activities, further emphasizing the urgent need for intervention to mitigate these harmful effects on local communities. The key informants also expressed their views on the impact of illegal small-scale mining on the community and local economy. The extension officer at Adaase in Obuasi stated that, *"Illegal mining has disrupted the local economy by reducing agricultural productivity, especially in cocoa farming. Farmers are losing their primary source of income, and the cost of living has increased as a result of environmental degradation and resource scarcity."* This sentiment reflects the broader concern that illegal mining

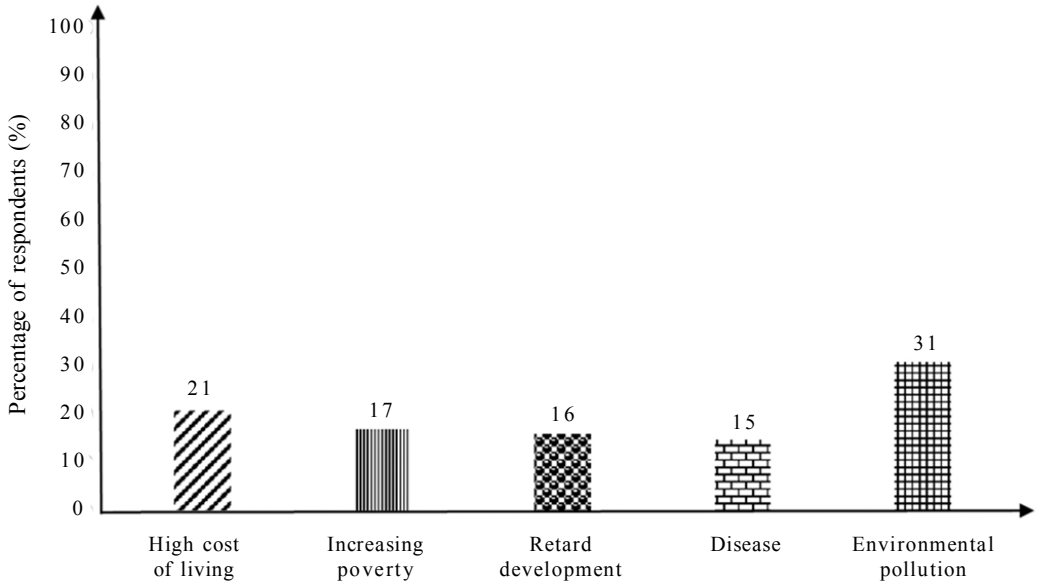

Figure 2. Effects of illegal small-scale mining on the community

is not only harming the environment but also weakening the economic stability of affected communities.

Perceived Causes of Illegal Small-Scale Mining

Cocoa farmers were asked to mention their perceived causes of illegal small-scale mining (Figure 3). The largest percentage of respondents (39%) identified unemployment as a primary cause of illegal mining. Respondents believe illegal mining employ numerous individuals which truly put money in their pocket and since unemployment is a problem for them, people end up engaging in galamsey to sustain their livelihood and for survival (Faamaa *et al*., 2020). They suggested that the lack of employment opportunities is driving individuals to engage in the activity. Faamaa *et al*., (2020) and Arthur-Holmes *et al*., (2022) similarly emphasized unemployment significantly and positively relating to illegal mining. These studies emphasize that addressing the unemployment crisis is key to curbing illegal mining activities.

Moreover, a significant portion of the cocoa farmers, 28% stated poverty as another cause. They believe the economic desperation leads people to engage in the activity. This reinforces the idea that poverty is a powerful motivator behind illegal mining, as economic necessity often overrides concerns about the environmental and legal consequences (Arthur-Holmes *et al*., 2022).

The desire for quick financial gains was identified by 23% of respondents as a cause of illegal mining. The assembly member for Boinzan highlighted that, *"Many individuals turn to illegal mining out of desperation for quick money, especially in our community where there are limited opportunities for formal employment."* These underlying causes contribute to the persistence of illegal small-scale mining despite its detrimental effects on the environment and local livelihoods. This indicates that the potential for rapid earnings can be a strong motivator, even if activity is illegal. Farmers made it clear that individuals in galamsey operations generate a lot of money in a day than what

a cocoa farmer would take weeks to accumulate. This motivates individual to engage in the activity and sometimes even some cocoa farmers themselves. Research conducted by Owusu & Dwomoh (2012) in the Kwaebibirem District indicated that illegal mining offers quick money. A smaller but notable portion of respondents, (10%) attributed illegal to ignorance of its negative impacts. Which clearly suggests the lack of awareness and knowledge of the environmental health, and economic consequences. This lack of knowledge awareness highlights a gap in education and outreach efforts aimed at raising awareness about the dangers of illegal mining. Without understanding the full scope of its harmful consequences, some people may continue to engage in or tolerate the practice, unknowingly contributing to environmental degradation and socio-economic instability.

Effects of Illegal Small-Scale Mining on Cocoa Yield

When respondents were asked whether illegal mining has affected their cocoa yield, the majority (67%) responded that indeed illegal mining has affected their cocoa yields (Table 3). This group of farmers claim they lose between 3 to 4 bags of cocoa every year since the commencement of the activity near and on their farms. This correlates with studies done by Osman *et al*., (2022) where cocoa farmers revealed illegal mining reduces cocoa yield and thus causes economic instability. The remaining 33% of cocoa farmers reported illegal mining has not affected their cocoa yield (Table 3). Their reasons were clearly stated that the operations are not near or on their farms, thus there is no way it can affect their cocoa yield. Farms located within

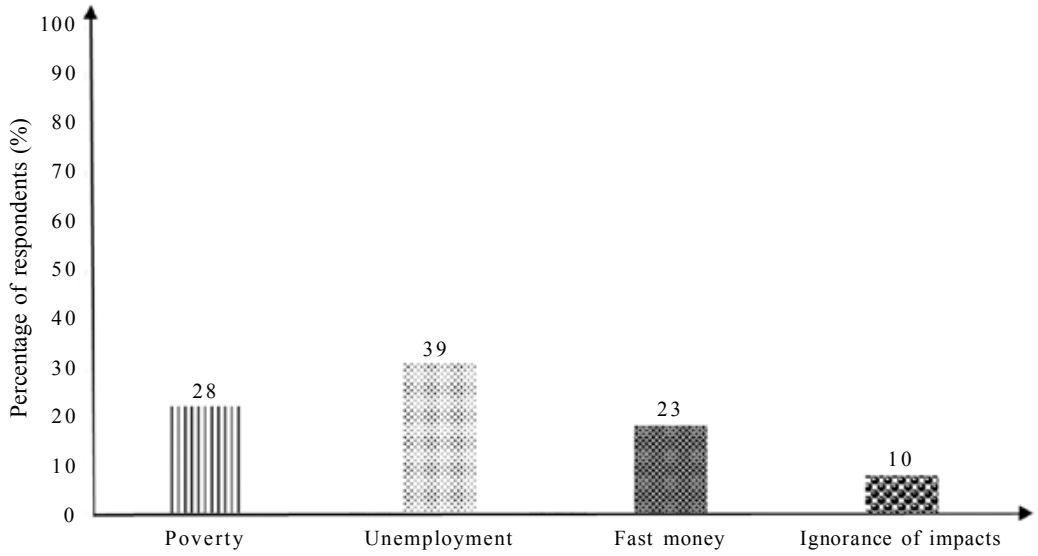

Figure 3. Causes of illegal small-scale mining

Table 3. Effect of illegal mining on cocoa yield

Response	Frequency	Percentage (%)
Illegal mining has affected my cocoa yield	120	67
Illegal mining has not affected my cocoa yield	60	33

about 1 km of illegal mining operations were near whereas farms located beyond 1 km from illegal mining operations were considered to be far.

Ways Illegal Small-Scale Mining has Affected Cocoa Yield

When farmers were asked to mention ways illegal small-scale mining has affected their cocoa yield, they made mention of several factors on how they believe illegal mining affects their cocoa yield (Figure 4). The 33% of respondents (Table 3) who claimed their yields were not affected said nothing about this question because they believe they are not affected. Aside this group of respondents, a significant portion (19%) of those who were affected believe that "polluted water for irrigation" is how illegal small scale has affected their cocoa yields. Donkor *et al*. (2024) also revealed that the pollution of water by illegal mining affect cocoa yield. This highlights the impact of the activity on water quality. Upon their further explanation, they all stressed on the matter of the introduction of harmful substances to the plants, affecting their health and productivity when they irrigate with nearby stream water which are polluted with heavy metals.

The death of cocoa trees, as reported by 17% of the farmers, indicates severe impacts from mining activities that lead to the complete loss of plants which represents a significant economic loss for cocoa farmers and long-term sustainability. Farmers think their cocoa trees dying are as a result of the negative impacts of illegal mining. They are certain that poor water quality cause the plants to die due to harmful chemicals inclusion. This loss goes beyond the immediate financial implications, as it also threatens the long-term sustainability of cocoa production (Laari, 2018). The destruction of cocoa trees not only reduces yield in the short term but also undermines future productivity, as it takes years for newly planted cocoa trees to mature and bear fruit (Boakye, 2020). This prolonged recovery period places an additional burden on farmers, making it difficult for them to recover economically and maintain their livelihoods. Again, they mentioned miners directly damage cocoa tress physically through their operations. All these factors stated by the cocoa farmers contribute to the mortality of their cocoa trees, which they believe through that, their cocoa yield gets affected by illegal mining. A study by Agyei-Manu *et al*. (2022) also reported illegal mining kill cocoa trees therefore affecting cocoa yield.

About (14%) of the cocoa farmers reported "contaminated soil" as a way through which illegal mining affects cocoa yield. A study by Amponsah-Doku *et al*. (2022) also revealed that cocoa output decreases significantly as a result of illegal mining contaminating the soil. This points to the presence of harmful substances in the soil as a result of illegal small-scale mining. Farmers have an idea that soil contamination leads to poor plant health which eventually reduce yield and potentially unsafe cocoa products. It was also mentioned that heavy metals and other chemicals used in mining can persist in the soil, making it difficult to grow healthy crops. Another portion of respondents, 17% claim "stunted growth" is how illegal mining tends to affect their cocoa yields. They indicated this to the fact that the plants do not reach their full potential size and productivity. They attributed this to several impacts such as soil degradation, and reduced water quality caused by the operation. Farmers confirm stunted growth directly impact cocoa yield quantity and quality leading to economic loss on their side (Wessel & Quist-Wessel, 2015).

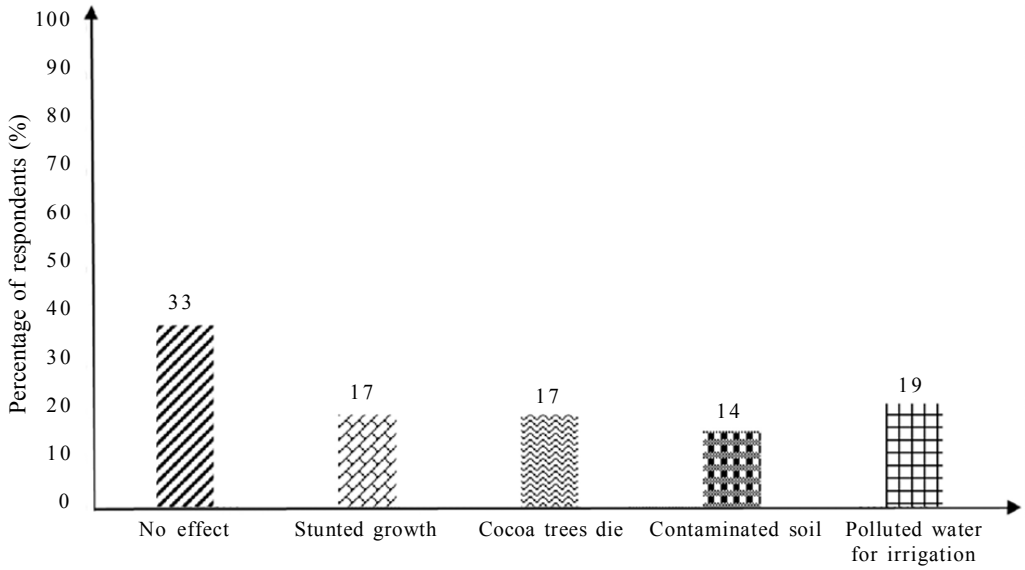

Figure 4. Ways illegal small-scale mining affect cocoa yield

Impact of Illegal Small-Scale Mining on Yield and Income from Cocoa Farming

The study revealed that the majority of the respondents (89%) reported a sharp decline in their cocoa yields due to the impact of illegal small-scale mining (Table 4). To ensure accurate responses, participants were specifically asked to exclude other factors, such as climate change, inadequate labor, pest and disease and focus solely on the influence of illegal mining on their yields. Upon further investigation, it became evident that some farmers had parts of their cocoa farms converted into mining sites without their consent. This conversion has severely reduced the available land for cocoa cultivation, directly lowering production output.

Moreover, some respondents mentioned experiencing a decline in yield due to the proximity of illegal mining operations to their farms. The miners, often violent or confrontational, discourage farmers from raising complaints about the destruction of their land or crops. This threat of violence has instilled fear in the farmers, leading them to visit their farms less frequently, which in turn results in neglected crops and reduced productivity.

Another significant concern raised by the farmers is the physical damage caused by illegal mining. Mining activities create pits, holes, and sometimes cause trees to be felled, blocking access routes to the farms (Funoh, 2014). This not only makes it difficult for farmers to reach their land but also disrupts the overall management of the cocoa farms. Furthermore, the pollution of nearby water bodies, often contaminated with chemicals used in mining, has affected the quality of water available for irrigation. This contamination further hinders cocoa production, as the polluted water can damage the crops and soil. The study's findings align with previous reports by Laari (2018) and Osman *et al.* (2022), who similarly documented the adverse effects of illegal small-scale mining on cocoa yields.

On the other hand, a small group of respondents (11%) acknowledged a decrease in yield but clarified that it was not directly due to illegal mining. Their lower productivity was likely influenced by other, unrelated factors, although they still recognized the broader negative impact of mining activities in their communities. The findings indicate that illegal mining is not only reducing cocoa farm yields through direct land encroachment but also indirectly through threats, physical barriers, and environmental pollution, all of which disrupt farming activities and limit productivity.

Moreover, cocoa farmers were asked how illegal small-scale mining has affected their income from cocoa farming (Table 4). A significant majority, (66%) responded their income had been affected, indicating that illegal mining is a major issue for the majority of cocoa farmers. This widespread impact on income suggests that many farmers are facing financial difficulties (Osman *et al*., 2022). This portion of respondents added that since their income from cocoa has decreased, it has reduced their ability to invest in farming inputs, maintain their farms and sustain their livelihoods. The remaining 34% of cocoa farmers stated that their income from cocoa farming had not been impacted. They explained that the effects of illegal mining are unevenly distributed, and they were not directly affected, but they agreed to the fact that their income could reduce when the impacts finally hit their cocoa farms. A study by Obeng *et al.*, (2019) revealed that less severe impacts of illegal mining possibly have less impact of farmers' yield. In cases where the illegal mining activities are less intense or occur further from farming areas, the negative effects on agricultural productivity, specifically cocoa yields, might be less pronounced. This could mean that while some illegal mining operations disrupt farming activities by degrading the land, contaminating water, or reducing arable land, smaller or less invasive operations may not drastically harm yields. As a result, farmers in such areas might experience milder declines or even continue their agricultural activities with minimal disruption.

Further analysis was conducted (non-parametric Mann-Whitney U-test and Kruskal-Wallis H test) to assess the impact of illegal small-scale mining on cocoa yield decline and income reduction across key demographic variables including district, age, gender, and farm size (Table 5). The Kruskal-Wallis H test revealed a significant difference in the impact of illegal small-scale mining on cocoa yield across the three districts: Obuasi, Juabeso and Amansie West, with a test statistic of H(2)

Table 4. Impact of illegal small-scale mining on yield and income from cocoa farming

Response	Frequency	Percentage (%)
Impact on cocoa yields		
Yield declined due to illegal small-scale mining	160	89
Yield declined due to other factors	20	11
Impact on cocoa farmers' income		
Income affected by illegal small-scale mining	119	66
Income not affected	61	34

= 10.345 p = 0.046 (Table 5). This finding shows the differential environmental impact of illegal mining activities in these regions, which is critical given the socioeconomic reliance on cocoa farming in Ghana (Peprah, 2015). Pairwise Mann-Whitney U tests with Bonferroni adjustment (Table 6) indicated that farmers in Obuasi experienced significantly greater yield decline compared to those in both Juabeso (U = 230.500, p = 0.043) and Amansie West (U = 250.000, p = 0.047). However, there was no significant difference between Juabeso and Amansie West (U = 470.500, p = 0.450). This suggests that the environmental degradation caused by illegal mining activities may be more severe in Obuasi, likely due to its higher intensity of mining operations (Bondah, 2020). The higher level of mining operations in Obuasi, often characterized by unregulated and informal practices, likely contributes to soil degradation, water contamination, and habitat destruction (Osei-Bagyina, 2012; Peprah, 2008). The pronounced impact of illegal mining on cocoa yields necessitates targeted interventions to mitigate environmental degradation. This could include stricter enforcement of mining regulations, rehabilitation of degraded land, and initiatives to promote sustainable agricultural practices among cocoa farmers (Osei-Kojo & Andrews, 2020).

Table 5. The result of non-parametric analysis for the impact of illegal small-scale mining

Variables	Test Statistic	df	p-value
Yield declined due to illegal mining			
District (Kruskal-Wallis H test)	10.345	2	0.046
Age (Kruskal-Wallis H test)	23.762	2	0.000
Gender (Mann–Whitney U-Test)	3486.000	-	0.043
Size of farm	3.097	3	0.377
Income affected by illegal mining			
District (Kruskal-Wallis H test)	9.764	2	0.048
Age (Kruskal-Wallis H test)	25.003	2	0.000
Gender (Mann–Whitney U-Test)	3402.000	-	0.027
Size of farm (Kruskal-Wallis H test)	3.939	3	0.268

Table 6. Pairwise comparisons for significant variables using Mann-Whitney U Test with Bonferroni adjustment

Variable (Yield declined due to illegal mining)	Group 1	Group 2	Mann-Whitney U	p-value (Bonferroni adjusted)	Significance
District	Obuasi	Juabeso	U = 230.500	0.043	Significant
	Obuasi	Amansie West	U = 250.000	0.047	Significant
	Juabeso	Amansie West	U = 470.500	0.450	Not significant
Age	26–45 years	46-60 years	U = 195.000		Significant
	26–45 years	61+ years	U = 215.000		Significant
	46–60 years	61+ years	U = 480.000		Not significant
Gender	Male	Female	U = 3486.000 (Bonferroni-adjusted = N/A)	0.043	Significant

For age groups, the Kruskal-Wallis H test also showed significant differences in the impact of illegal mining on cocoa yield ($H(2) = 23.762$, $p<0.001$). Pairwise comparisons revealed that farmers aged 26–45 years were significantly more affected than those in the 46–60 years age group ($U = 195.000$, $p = 0.001$) and the 61+ years group ($U = 215.000$, $p = 0.005$). There was no significant difference between the 46–60 and 61+ age groups ($U = 480.000$, $p = 0.432$). This suggests that younger farmers are more sensitive to the adverse effects of illegal mining, possibly due to their longer expected years of farming, which makes them more concerned about long-term productivity losses. The implications of these findings are profound for policymakers and agricultural support programs. Educational programs focused on sustainable farming practices and the environmental impacts of illegal mining could be instrumental in equipping younger farmers with the knowledge and skills needed to adapt their practices (Mensah *et al*., 2015). Moreover, the differing impacts across age groups suggest a need for inclusive policy frameworks that consider the specific needs and vulnerabilities of various demographics within the cocoa farming community. As highlighted by Samaddar *et al.* (2015), community engagement and participatory approaches can lead to more effective resource management strategies that are responsive to the unique challenges faced by farmers.

Also, the Mann-Whitney U test revealed a statistically significant difference in how male and female farmers perceived yield declines due to illegal mining ($U = 3486.000$, $p = 0.043$). This finding indicates that male farmers, who may own larger farms and are more economically dependent on cocoa, experience a greater impact compared to female farmers. This aligns with earlier findings that male farmers often bear a disproportionate share of environmental risks in agriculture (Chandra *et al*., 2017). There was no significant difference found across different farm sizes in relation to the impact of illegal mining on cocoa yield ($H(3) = 3.097$, $p = 0.377$). This suggests that the effect of illegal mining on yield reduction is consistent, regardless of farm size. The uniform impact of illegal mining across all farm sizes implies that factors such as soil erosion, water contamination, and habitat destruction, typically associated with mining activities, are not mitigated by the scale of farming operations. As highlighted by Gbedzi *et al*., (2022), illegal mining often leads to significant alterations in land use, which can degrade soil quality and water resources which are key for cocoa production.

How Income from Cocoa Farming is Affected as a Results of Illegal Small-Scale Mining

Cocoa farmers were further asked to describe the rate to which their income is affected. A large portion, 44% reported that their income has decreased significantly due to illegal mining suggesting a severe negative impact on their financial stability. The respondents indicated that this decrease in income has led to difficulties in meeting daily needs, investing in farm improvements and maintaining a decent livelihood. Again, they mainly linked this significant decrease to their reduced cocoa yield from water and soil contamination and additional cost incurred to mitigate environmental damage. Similar observations were made by Mensah *et al.*, (2022), who found that the economic impacts of illegal mining extend beyond immediate income loss, affecting farmers' ability to invest in sustainable agricultural practices and improve their livelihoods.

Also, 23% of the cocoa farmers indicated that their income has decreased slightly. They believe with time it could significantly decrease since the illegal mining activities keep increasing. Slightly decrease means less

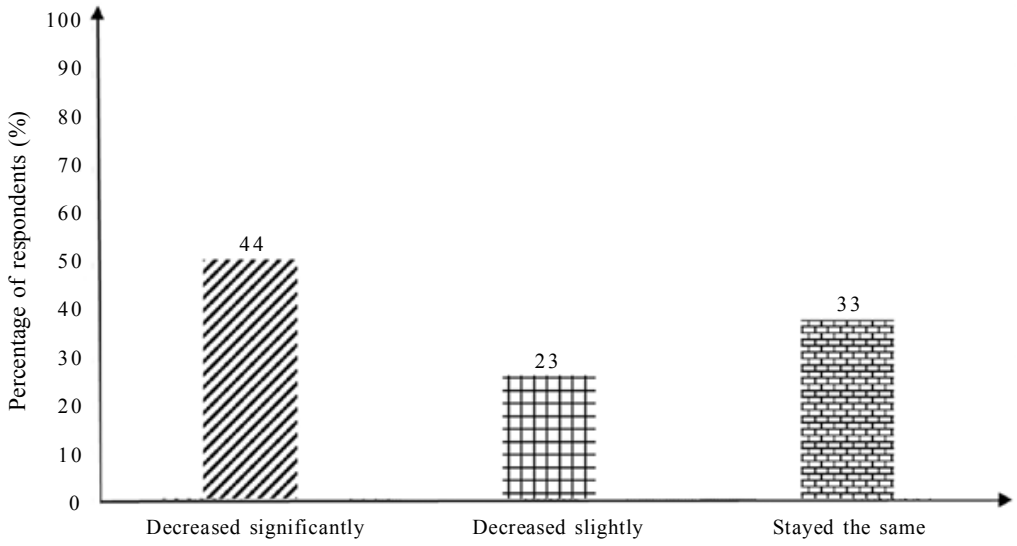

Figure 5. How income from cocoa farming is affected

severe impact of illegal mining. Another portion, (33%) claimed their income has remained the same or unaffected, and they attributed this stability not to any direct impact from illegal mining. For these farmers they say illegal mining has not yet had a noticeable impact on their income, indicating that they are not located near illegal mining operations, therefore there is no reduction in their yields which could reduce their income from cocoa farming.

Environmental Changes on Cocoa Farms Due to Illegal Mining

This study investigated the environmental effects on cocoa farms due to illegal small-scale mining (Table 6). It was revealed that 61% of the cocoa farmers interviewed admitted environmental changes on their farms, indicating that illegal activities are widespread in these selected districts and their impacts are noticeable (Osman *et al.*, 2022; Adjei 2017). The high percentage of farmers noticing these changes suggests that illegal mining is a significant issue in these districts, with visible and damaging impacts on the farming environment. The remaining (39%) of the respondents reported they have not observed any environmental changes on their farms. Some of these farmers claim their farmers are located in areas that are not affected by illegal mining, others confirm the activity around their farms but it is less prevalent hence no observation made concerning environmental changes.

Cocoa farmers who confirmed the observation of environmental changes were further asked to describe the types of environmental changes they see on their farms (Figure 6). After this enquiry, 31% respondents reported that they have observed water pollution on or near their farms. This group of farmers showed concern about the discoloration of streams passing through their farms, and the contamination of the rivers affecting its quality, making it unsafe for irrigation and consumption. Emmanuel (2013) revealed that such water pollution poses serious risks not only to agricultural practices but also to the health and well-being of local communities, highlighting the urgent need for interventions to address the environmental impacts of illegal mining.

Another portion cocoa farmers, (30%) mentioned soil degradation as the environmental change on their cocoa farm. They explained that illegal mining activities around and on their farms are leading to soil erosion, contamination and compaction of the soil, which reduce soil fertility, making it more difficult for cocoa plants to grow healthy. This is in line with the study conducted by Saviour & Stalin (2012) who reported that illegal mining causes damage to the soil. About (21%) of the respondents observe vegetation loss on or around their farms. These group of farmers are aware illegal mining operations often involves clearing large areas of vegetation to access mineral deposits. For these cocoa farmers, the loss of trees and plants also mean a loss of shade and wind protection for their plants, which are essential for optimal cocoa growth (Kuffour *et al*., 2018). The least group of respondents, (18%) confirmed a change in land structure as an environmental change on their farm. These farmers stressed on the alterations to the landscape such as the creation of pits, mounds, and other physical disruptions caused by illegal mining activities. They believe these changes hinder farming operations, making it less usable and potentially dangerous. Also, the change in the land structure affect water drainage patterns, causing issues like erosion and flooding. A study by Obeng *et al.* (2019) on the impact of illegal mining activities also highlighted that illegal small-scale mining disturbs landscapes.

Table 7. Environmental changes on cocoa farms due to illegal mining

Response	Frequency	Percentage (%)
Observed environmental changes	110	61
No environmental changes observed	70	39

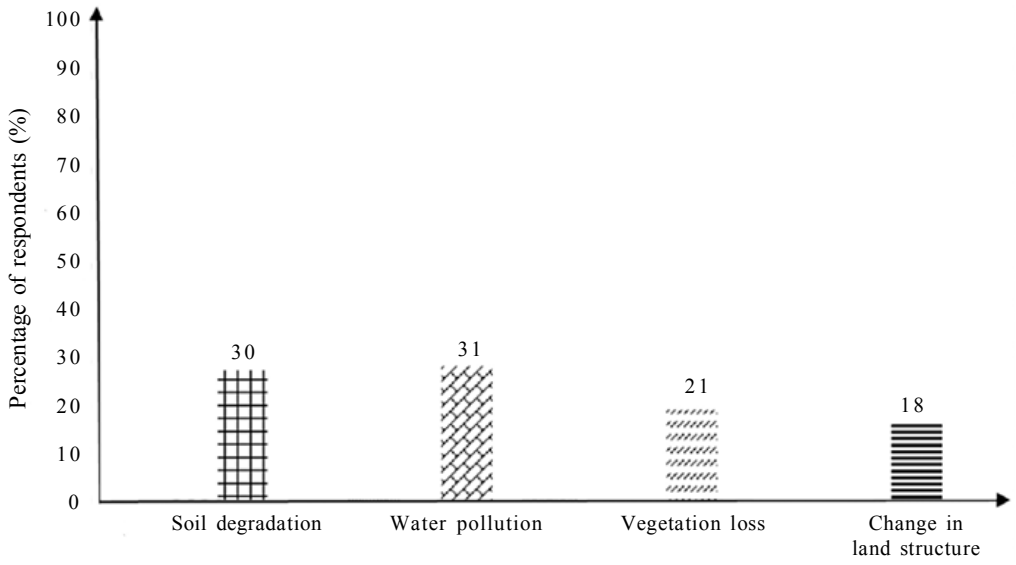

Figure 6. Type of environmental change observed on the farm

Dealing with Environmental Effects of Illegal Small-Scale Mining on the Farm

Cocoa farmers were asked about the methods they use to address the environmental impacts of illegal mining on their farms (Figure 7). The results revealed that 39% of the interviewed farmers reported that their farms are not affected by the environmental consequences of illegal mining, leading them to feel there is no cause for concern regarding its negative impacts. Conversely, a quarter of the respondents (25%) indicated that they take no action in response to these environmental effects. Some of these farmers stated a lack of financial resources and technical knowledge necessary to implement effective countermeasures. A study by Boadi *et al*. (2016) highlighted that inadequate resources hinder farmers' ability to address environmental challenges. Moreover, many farmers expressed skepticism about the efficacy of any mitigation efforts, believing that the scale of mining operations renders their actions futile, consistent with observations by Darko *et al*. (2023), who noted the overwhelming challenges posed by illegal mining. Others described a sense of resignation, feeling powerless to effect meaningful change in their circumstances. This sentiment aligns with Agariga *et al*. (2021), who indicated that cocoa farmers often feel they have limited options to address the effects of illegal mining.

Also, 18% of cocoa farmers reported taking proactive measures by planting multipurpose trees (MPTs) as a strategy to mitigate the negative impacts of illegal mining. These farmers believe that MPTs help prevent soil erosion and improve soil structure, making their farms more resilient to degradation. Studies by Asare *et al*. (2019) and Asitoakor *et al*. (2022) confirm that agroforestry practices, including MPTs, contribute to increased soil organic matter and moisture retention, which are essential for cocoa production. Moreover, research by Sonwa *et al*. (2017) indicates that cocoa farms incorporating shade trees, such as MPTs, experience lower temperature fluctuations and reduced water stress, leading to higher yields compared to farms without tree cover. These findings align with the farmers' rationale for adopting MPTs, as they not only provide ecosystem benefits but also enhance resilience against environmental degradation caused by illegal mining.

Beyond environmental benefits, farmers appreciate the additional resources that MPTs provide, such as fruits and fodder, which contribute to supplementary income and enrich the soil, ultimately promoting cocoa growth (Hirons *et al*., 2018). A few farmers also noted that MPTs offer shade and help maintain a favorable microclimate for cocoa plants, thereby enhancing their agricultural productivity. This approach is supported by research from Mensah *et al*. (2019) and Diswandi (2022) which emphasizes the role of agroforestry in improving farm resilience.

Another 18% of farmers have resorted to carrying water from their homes to irrigate their crops, a response necessitated by the pollution that has rendered local water sources unsuitable for irrigation. Many farmers fill gallons and small barrels with water and transport them to their farms, but this approach is labor-intensive and insufficient to meet the water needs of cocoa trees. The feasibility of this strategy is limited by the physical burden on farmers, the volume of water required to maintain cocoa trees, and the time constraints associated with manually transporting water. According to Osman *et al*. (2022), smallholder cocoa farmers in Ghana already face labor shortages, making additional irrigation efforts impractical. Furthermore, studies by Donkor *et al*. (2024) indicate that access to clean and adequate water is a

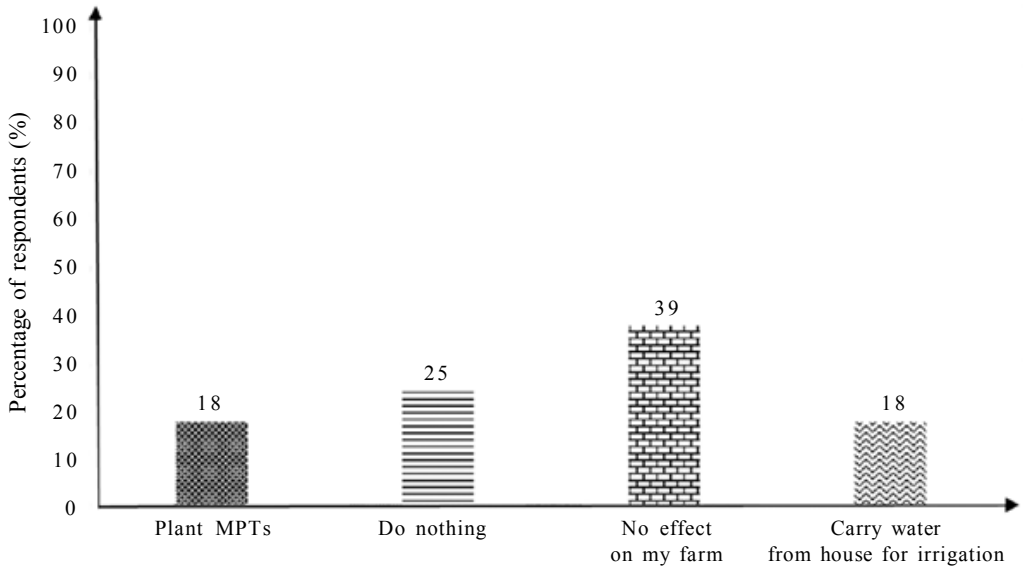

Figure 7. Environmental effects management on the farm

critical factor in sustaining cocoa production, and relying on household water sources may not be a viable option, especially in areas with inconsistent water supply.

Despite the challenges, these farmers remain determined to ensure their cocoa plants receive adequate water, highlighting their commitment to sustaining their livelihoods under difficult conditions. Research by Ortega *et al*. (2024) has shown that cocoa farmers require quality water for effective irrigation, further emphasizing the importance of addressing water quality issues to support agricultural viability. A more effective approach would involve exploring community-based irrigation solutions to address water shortages caused by illegal mining-related pollution.

CONCLUSION

The study highlights the multiple implications of illegal small-scale mining on cocoa farmers livelihoods in Obuasi, Juabeso and Amansie-West district of Ghana. Cocoa farmers in these selected districts perceive illegal small-scale mining as a detrimental activity, causing significant environmental damage and worsening the socio-economic conditions of affected communities. The study revealed that the primary motivations for engaging in illegal mining include the short-term economic benefits, unemployment, and poverty. However, these gains are limited to those directly involved, while the broader community suffers from long-term consequences such as diminished livelihoods, increased disease prevalence, and elevated living costs. Cocoa farmers have observed a direct decline in their income due to reduced cocoa yields, which has led to a shift from higher to lower income levels, negatively affecting their standard of living.

Furthermore, the environmental effects of illegal mining activities, such as land degradation, deforestation, and water pollution, have collectively hindered productivity on cocoa farms. In response, some farmers have adopted

strategies such as planting multipurpose trees, implementing basic irrigation using water carried to farm to mitigate the damage caused by polluted water sources. These findings highlight the urgent need for interventions to address illegal small-scale mining and its detrimental effects on cocoa farming and the overall well-being of local communities.

DECLARATION OF INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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