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Analyzing Food Security Status in the Artisanal Gold Mining Communities of Ikolomani, Kakamega, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The aim of this paper is to critically analyze the food security apparatus within the artisanal and small-scale gold mining (ASGM) communities of Ikolomani in Kakamega County, Kenya. ASGM regions are often characterized by economies of speculation, land dispossession, ecosystem degradation, poverty, shifting culture, and dynamic local populations trying to make a living under these precarious conditions, which impact food security. In 2023, we investigated the status of food security in the gold mining communities of Ikolomani. Using a descriptive cross-sectional survey, 60 artisanal gold miners and 50 food vendors were interviewed. The data was collected using semi-structured interviews which were administered in the form of questionnaires, focus group discussions (FGDs), participatory transect walks, and expert informants on food systems in the

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area. The data was classified along the five dimensions of food security namely; food availability, food accessibility, food utilization, food stability, and food sovereignty. The data was then analyzed using the Statistical Package for Social Sciences (SPSS) version 24 where means, frequencies, and standard deviation were used to summarize results. Consequently, the analysis of variance (ANOVA) and Chi-square statistics were used to test the relationship between the variables, and then inferential statistics such as correlation analysis was used to indicate the strength and direction of the variables. The study established a positive correlation between ASGM and food security. The regression coefficients predicted that a unit increase in ASGM would increase food insecurity by 0.387. The study therefore concluded that ASGM is a key driver of food insecurity in Ikolomani's ASGM communities. Consequently, the study recommended a policy-regulated framework where the community can reap the economic benefits of mining with minimal impacts on food security.

Keywords: Artisanal gold mining; food security; food sovereignty; extractivism; ikolomani; Kenya.

1. INTRODUCTION

Gold is a precious metal that is predominantly mined by artisanal means and is among the most valuable minerals globally because governments use it to deal with inflation, ordinary people covet it as jewelry and criminal networks prefer it for money laundering, thus creating a global annual supply and demand of 8.91% [1-4]. While gold is extracted both industrially and artisanally, the latter is overwhelmingly popular in the Global South and has accelerated the ecological degradation of aquatic and terrestrial ecosystems, especially the biodiverse tropical forests, soils, water sources and destabilizing the climate system. It follows that most of the degradation has been extensively documented in Latin America, Africa and Asia [5-8]. The ecological harm resulting from mercury use, the release of lead and a host of other heavy metals from their natural ecosystem, result in geo-accumulation and bio-concentration thus creating great risk to the food chain and eventually to human health [9, 10]. Furthermore, ASGM is responsible for a host of topographical shifts such as sinkholes, landslides, soil erosion, rocky and sandy landscapes which all negatively influence food production [3, 11]. It is argued that ASGM directly competes with agriculture and triggers food insecurity wherever it takes place [12].

It is not just the agro-ecological underpinnings that are damaged by ASGM, but rural labor is ceded from farms to mines as the latter is perceived to have quick and better returns on invested time and resources [13]. However, the influx of migrants into ASGM regions can have a positive impact on the food micro-economics by creating demand for food and other agricultural produce and may boost local farmers [14] with the surplus resources helping to improve the nutritional outcomes for miners, their immediate communities and beyond [15].

Amoako, C. et al. [16] and Hook A. [17] discern that the food systems within the artisanal gold mining framework are further shaped by the politics of land ownership, speculative economies and land dispossession from the poor whose attachment to the land is more than a livelihood source but a link to their ancestral heritage, a source of pride and inheritance for their descendants. Artisanal mining thus alienates the rural poor from their traditions and exacerbates neoliberal plunder for the accumulation of wealth and power among a tiny elite [18].

Such arrangements go contrary to the 2007 Nyéléni Declaration on Food Sovereignty affirming the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right of indigenous people to define their own food and agriculture systems [19, 20]. The outcome is socioeconomic anxiety of varying proportions including but not limited to food and nutrition inadequacy and poverty entrenchment due to the systematic defunding of social safety nets such as pensions, education, and healthcare among others. Due to the lack of nationalized resource control frameworks, resource solidarity, and political autonomy, governments across the Global South still depend on prices that are set by the Global North thus creating resource flight and entrenching extractivism, a situation that has resulted in deep poverty among indigenous communities whenever mining takes place [21-23]. This is despite these minerals powering key areas of the capitalist wheel such as finance, green energy transition leaving scholars to equate mining with

some of the worst ills in the history of humanity such as slavery and colonialism [24].

In Kenya, mining funds less than a percentage of the country's gross domestic product (GDP) with gold contributing about 10.3 million dollars per year [25, 2] while agriculture accounts for one-third (31%) of the country's Gross Domestic Product (GDP). Agriculture is the leading contributor to the GDP to grow at an annual rate of 10% of the GDP by the year 2030 [26]. For most African artisanal mining communities, Kenya included, a key reason for diverting from agriculture to mining is to alleviate poverty and to solve perennial food insecurity, particularly in the wake of structural adjustment programs that have been instigated by the Bretton Woods Institutions in the recent years [27]. The rollout of the Mining Act 2016 in Kenya prioritized large-scale mining which is consistent with the World Bank policies, over ASGM miners thus exposing the latter to exploitation [28].

In Migori, Kenya, the ASGM economies and the agricultural economies are interlinked with 30% of ASGM workers engaging in some form of agriculture [29]. In spite of the scenario, the quality of the food produced within ASGM and from ASGM-adjacent ecosystems is still a cause for concern as postulated by Ngure & Kinuthia [30] and Odumo et al. [25] that Migori miners and their communities are exposed to heavy metal contamination through locally produced foods and drinking water. Other scholars have observed and recorded similar agro-ecological dynamics and undesirable nutritional outcomes in the artisanal mining communities of Kakamega, Kisii, Kajiado, and Nandi among other ASGM regions in Kenya [31, 32]. Small-scale farming and food production have often been a preserve of rural peasant women, patterns that have been observed in Migori where women dominate the food supply chain from the farm to the plate [33]. As such, it is women who mostly operate restaurants and shops within the ASGM camps, a key component for the ASGM economic system [34, 35]. Notably, diversification and divestment from farming is increasingly weakening food sufficiency [33].

In Vihiga and Kakamega counties of Kenya, ASGM has repurposed what was once arable land for growing food and grazing animals. At the same time, the change of use is exacerbating the concentration of heavy metals such as mercury, nickel arsenic, lead, cadmium, and chromium metals in both terrestrial and aquatic ecosystems [36, 13]. This has dire consequences not just on the local food needs, but on the national and transnational scale. This is because Kakamega has fertile soils and receives almost three times rainfall (1742mm) than the national average of 680mm [37]. As such, a decline in food production has a ripple effect across the country. As Jotham & Mulinya [2] observed in Rosterman communities, the consequences of taking up arable land are food shortages from production shortages, poverty and malnutrition. Even with the certainty of a daily wage, the energy and hours expended into the ASGM work may not be sufficiently restored by the meager and often unstable incomes that affords very minimal and often unhealthy nutritional options [38, 39].

In Ikolomani, for instance, gold mining has led to situations where rich elites dispossess peasant farmers of their land [40]. Despite the dispossession, the miners still try to adapt to the changing situation by combining both agriculture and mining to improve their livelihoods and food security [41, 37]. The literature review has exposed the intricate relationship between ASGM and food systems as reflected on the agroecological underpinnings, land politics, quality of food, and the sociocultural complexities that are uniquely generated by ASGM. This implies general complementarity between ASGM work and food security. Further, literature has revealed that there is scanty knowledge on the nexus between gold mining and food security in Ikomani. Although food security is analysed using different frameworks [42-44], this article bases on the frameworks by the Food and Agriculture Organization (FAO) and by La Vía Campesina together with other rural social and agro ecological movements globally [45-47]. The framework encompasses four pillars namely "availability, access, utilization and stability" [42]. It also includes "food sovereignty" as a fifth pillar [46, 48]. Therefore, this article seeks to critically assess the scope of food security along the five dimensions of food security within the gold mining communities of Ikolomani.

2. MATERIALS AND METHODS

This section will describe the methodology employed in this study. This will be achieved through elaborating the geographical scope of the study, the population, the research instruments and the data analysis tools. Finally, the section will conclude with the logistical and ethical considerations that ultimately made the study possible.

2.1 Study Area Description

Kakamega County lies on the west of Kenya's capital city Nairobi at about 370 and 288 kilometers by road and air respectively and is on the north of the equator at longitudes of 34° 45' 0" E and latitudes of 0° 17' 0" N [49]. The county is serviced by an airstrip, well-tarmacked roads and a connection to the national electricity grid. Kakamega County is comprised of 12 sub-counties Lurambi, Ikolomani, Shinyalu, Khwisero, Malava, Navakholo, Lukuyani, Lugari Mumias East, Butere, Matungu, and Mumias West.

The county is abundant in flora and fauna with Kakamega Forest, a tropical bio-diverse rainforest that sits on 32,800 hectares of land and is home to 380 tree species (50% of the coverage being indigenous species), about 330 bird species, 400 butterfly species, 7 primate species, 27 snake species, several amphibian species, insect species and other mammals [37, 50]. The forest is also the source of several permanent rivers such as Nzoia, Yala and Isiukhu rivers which drain into Lake Victoria in the west [37]. The geological composition is of both the Nyanzian volcanic formations and the younger Kavirondian sediments [51, 52], with the altitude of the county ranging between 1240m - 2000m above sea level [37]. Fig. 1 represents the two villages that were purposively sampled as the area of study in Idakho Central of Ikolomani Sub-county.

The temperature of the county has been rising for the last 60 years, a situation that has been attributed to climate change. Currently, the average temperature is at 20.8 °C, the average annual rainfall is 1742 mm and the average humidity is 67% [38] with chilly nights and warm daytimes. The rainfall is evenly distributed throughout the year, with the heaviest rains often received between the months March and July, short rains between the months of September and November while the least rain is received in the months of January, December and February [37]. Over the years, the population of the county has risen to 1.87 million people, with a population density of 764 people for every square kilometer making it the fourth most densely populated county in Kenya [53]. With a population of 111,743 people, Ikolomani Subcounty is further divided into four administrative sections known as wards that is Idakho Central, Idakho East, Idakho South, Idakho North and Idakho Central which has a population of 31,134 people, where this research was conducted [53]. To offset the rising poverty (35.8%) and food insecurity (33.3%), the communities within Ikolomani and Kakamega at large are divesting from subsistence farming (maize, beans, potatoes, dairy, chicken and aquaculture) and cash crop farming (sugarcane, tea) in favor of alternative economic activities, like mining of gold [37].

2.2 Study Methods

This was a descriptive cross-sectional study. The participants were purposively sampled by geographical location and by profession and classified into the two distinct demographics that is ASGM miners and food vendors in Bushiangala and Isulu villages of Ikolomani. It is after this that they were randomly sampled for the study. Each focus group was classified by occupation that is food vendors or the ASGM miners. Eventually, each group was moderated by the researchers and research assistants. Expert informants were narrowed down to representatives from The Ministry of Agriculture, Livestock, Fisheries, and Cooperatives, Ministry of Environment, Climate change and Forestry, and the local administrative chiefs.

Upon receiving permission from the community leaders and consent from the participants, the researchers distributed the first set of 60 questionnaires to the ASGM miners in Bushiangala and Isulu villages of Ikolomani, Kakamega. The researchers further distributed a different set of questionnaires (50 in total) to the food vendors across the six small markets servicing the ASGM community in Bushiangala and Isulu villages, borrowed from the techniques by Zhang et al. [54].

Both sets of questionnaires were broadly organized into several variables. At the top of the questionnaire were the social demographic factors, followed by work factors, then organizational factors and then external factors that link ASGM to food security or insecurity. Both the qualitative and the quantitative data would be classified into the dimensions of food security; food availability, food accessibility, food utilization and food sovereignty.

The validity of the research instruments was attained through matching the variables with the objective of the research. A pilot program was also conducted prior to this research to guarantee the reliability of the data through the indicated instruments.

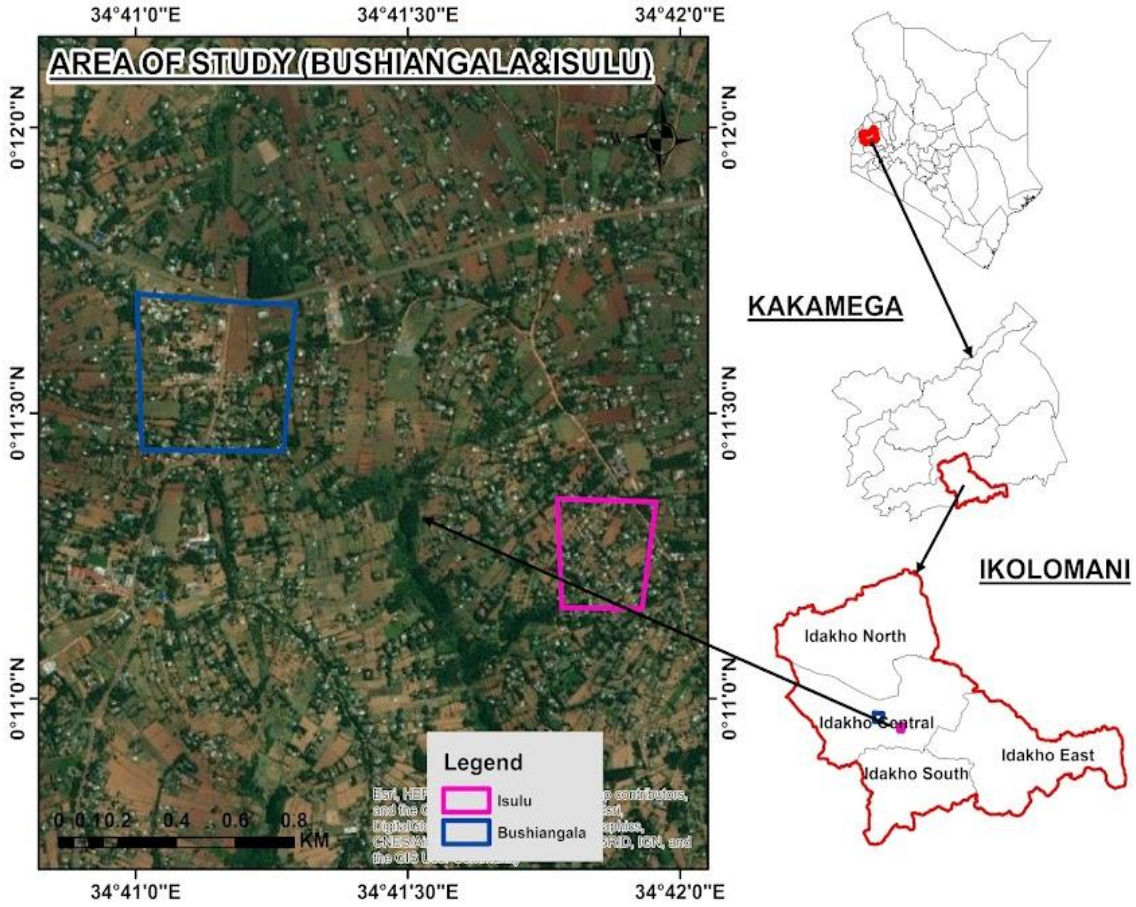

Fig. 1. Study area map showing the Isulu and Bushiangala villages within Ikolomani Sub county where data was collected

Source: Researchers, Field Data 2023

2.3 Sample population

The data was collected in February 2023, in Ikolomani's Idakho Central ward, where Bushiangala and Isulu villages are located and have a population of 31,134 according to the 2019 census by the Kenya National Bureau of Statistics [53]. For purposes of this research, two key demographics of interest were identified and purposively sampled namely; food vendors and ASGM miners. Eventually, the sample size was calculated using Yamane's 1967 formula, carefully chosen because it is dynamic and has a low (5%) margin of error. Additionally, this formula reduces the dispersion and increases the precision of findings as the target demographics were sampled randomly. It reads:

$$n = \frac{N}{1+N(e)^2}$$

$$n = \frac{31134}{1+31134*(0.10)^2}$$

$$= 99.238$$

$$n = 100$$

Where N is the population, n is the sample size, and e is the level of precision.

The final sample consisted of 60 miners and 50 food vendors distributed proportionally and randomly.

2.4 Research Instruments

This was part of a larger study whose results were recorded elsewhere. The questionnaire was the principal instrument for data collection. Other instruments were Focus Group Discussions (FGDs), expert informants, an observation checklist, participatory transect walks and photography. Cross-sectional primary data was collected from 60 miners and 50 food vendors (110 questionnaires), 2 FGDs each comprised of 8 individuals and 6 Expert Informants in Ikolomani sub-county of Kakamega, Kenya.

2.5 Data Analysis

The completed questionnaires were cleaned and the data was coded and exported to the Statistical Packages for Social Sciences (SPSS) version 24. The results were presented using tables and charts with both percentages and absolute numbers. Food security was analyzed along five dimensions of food security that is; food availability, food accessibility, food utilization, food stability and food sovereignty. Descriptive statistics such as means, means and standard deviation were then used to analyse the general responses. The relationship between the variables was then tested using chi-square statistics and analysis of variance (ANOVA) while the strength and direction of the relationship were measured using a correlation analysis. Finally, the qualitative data obtained from focused group discussions, interviews, observation checklists and participatory transect walks were qualitatively analysed to answer the research question and to test the research hypothesis.

2.6 Logistical and Ethical Considerations

Permission to collect the data was granted by the university and consequently by the National Commission for Science, Technology & Innovation (NACOSTI) under the license number: NACOSTI/P/23/23218. The fieldwork was conducted in February 2023.

3. RESULTS AND DISCUSSION

The study sought to critically appraise the food security in the mining communities of Ikolomani. This was achieved by analyzing food security using the five dimensions that are; food availability, food accessibility, food utilization, food stability, and food sovereignty.

3.1 Food Availability

The cause-impact outcomes of ASGM on the land and rural labor on food production in the area was revealed to be undesirable. The researchers observed heaps of soils across the mining camps, mining pits within farmlands and within homesteads. The researchers further observed the ASGM miners processing the gold ores along rivers, the cyanide facilities disposing the waste into the rivers while many more pumped water from the underground sources leaving the rest to waste away as runoffs. It was not easy to ignore the gaping holes from abandoned mine sites often holding stagnant waters as well as vast deforestation to provide timber for mine construction. Fig. 2 displays the main occupation of the participating ASGM miners. While 49.1% of the interviewed miners self-identified as farmers, the majority of them (51.9 %) listed mining, business and wage labor as their principal livelihood source. Only 28.9 % of those who identified as farmers are practicing subsistence farming with majority (63%) of them practicing commercial agriculture. This puts a dent on the food availability within Ikolomani's gold mining community as the food production vectors such as fertile land, local labor as well as subsistence farming are diminished significantly. These inferences are undergirded by Wegenast & Beck [55] that mining constrains local food productivity across sub-Saharan Africa through the reassignment and consequent destruction of arable land and the striping of farm labor from rural agricultural communities, which often leads to permanent abandonment of farming once the mining activities are exhausted.

The analysis also shows that a paltry 20% of the food is locally produced in the area, with 80% sourced from other regions, as shown in Fig. 3. This poses a risk to domestic food production in a region is endowed with favorable climate, rainfall, and rich soils for agriculture. Furthermore, 17.8 % of the food vendors indicated that they source their food, such as legumes and fruits are from outside the country. Uganda and Tanzania were prominently featured as cross-border food sources. This matches the verdicts by Obodai [12] that ASGM has crippled food production in mining areas by destroying arable lands and water supply systems in rural mining communities of Ghana. As such, such ASGM communities are forced to depend on food from other regions and can make it difficult to sustain their food needs in the event of a change in the local economic power or other food production factors from these alternative sources of food. Such sentiments were expressed by one of the expert informants who is an agricultural economist:

> *"Gold mining activities have crippled food production in Ikolomani and Kakamega at large and creates what I like to refer to as the 'economies of speculation'. A paradox exists where land is simultaneously valuable and useless with wealthy individuals from all over the country buying out the poor just because of gold (...) the poor often form the backbone of food production not just here but across the country."- Expert Informant 1.*

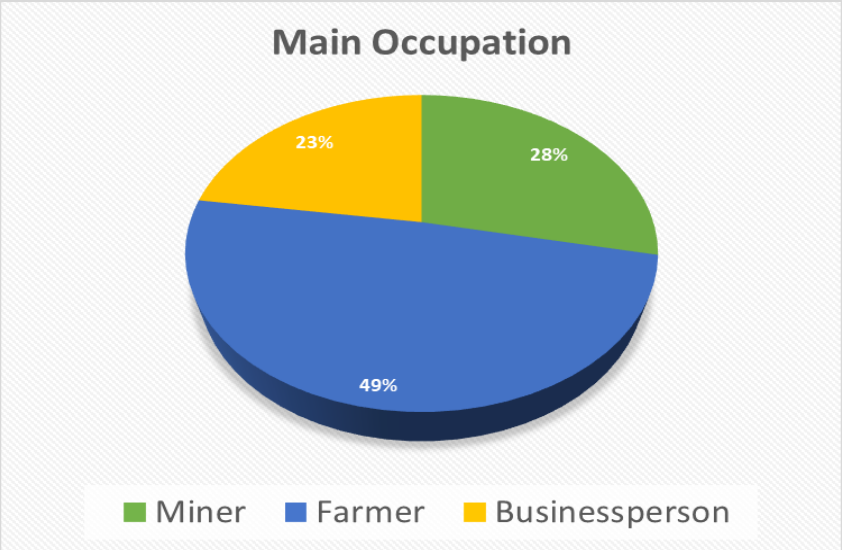

Fig. 2. The Main Occupation of the artisanal miners

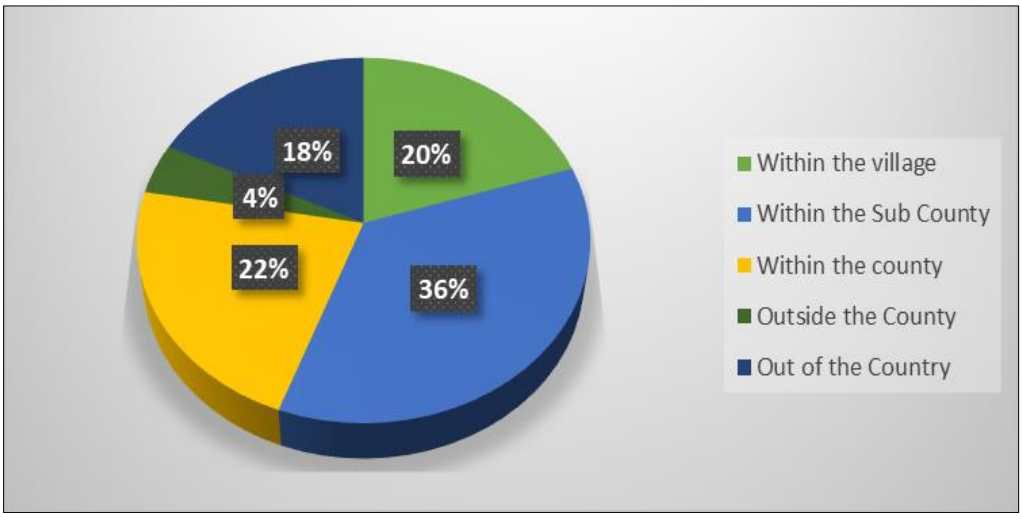

Fig. 3. Source of food supply for the food vendors

Nonetheless, the majority of miners self-identify as farmers, an indication that agriculture is their core livelihood source and that mining is perceived as a temporary means to an economic end, as opposed to being a sustainable livelihood source.

The majority of the participants in the miners' focus group expressed a preference for mining because it has better rewards than farming. A significant number of these participants said that they were preparing their farms for planting come the month of March because they had saved enough money from the mines to afford seeds, fertilizers, livestock and a farm worker or two, indicating a symbiotic relationship between the mining and farming and reflecting the findings by Mkodzongi & Spiegel [14] in Zimbabwe, where artisanal gold mining is practiced symbiotically with farming with proceeds from mining used to support farming and the vice versa. Some members in the focus group discussion expressed that the dry seasons usually create a shortage of gold while the rains tend to improve the gold volumes, a phenomenon that was attributed to superstition. It is however possible that the scorching heat, more compact soils and in some cases, scarce food stocks and limited circulation of money within the community make the mining work more difficult during the dry seasons and hence less proceeds from gold.

3.2 Food Accessibility

The community is serviced by a network of good infrastructure such as tarmacked roads, banking services, electricity, schools, vibrant food markets and a technical training college. Over a dozen different communities from across Kenya such as Somalis, Luos, Kikuyus, Kisiis, Kurias, Merus, Taitas, Kalenjins, Maasai provide the area and the ASGM operations with critical migrant labor. More migrants also originate from neighboring countries such as Tanzania, Uganda, and the Democratic Republic of Congo (DRC) and they bring in a wealth of gold mining experience, capital and business networks to facilitate and expand gold mining in the area. This cosmopolitanism has enriched the economic, social, technical, cultural, financial, political, and intelligence networks in Ikolomani. Most of the mining equipment within the camps is predominantly sourced from Migori-Kenya and/or Tanzania, leading to strong interregional and cross-border economic ties. The mining practices, thus the economic output from mining was the second most important factor that influences food consumption from the food vendors at 31.1%, with the leading factor being the cost of food at 44.4% as indicated in Fig. 4. Our earlier analysis in subtopic 3.1 revealed that food production is already compromised, and as such the best way for miners to access adequate food is to earn a lot more from the mining proceeds, a condition that is greatly diminished by the seasonality and unpredictability of gold mining business in Ikolomani.

When the type of agriculture was cross-tabulated with the miners' monthly income, a majority (76.9 %) of miners who practice subsistence farming earn a monthly income of KES 15,000. It is a signifier to limited food purchasing power. In the event of one or a combination of domestic food shortages, inflation, global pandemics and political instabilities, these low proceeds from mining will be unable to provide the community members or the different households with sufficient food. As such, economic insecurity has direct negative impact on food accessibility decisions. Thirty-one point one percent (31.1%) the food vendors indicated that the ASGM activities in the area have influenced food consumption; with improved mining outcomes attributed to better food accessibility outcomes and poor mining outcomes attributed to poor food access. This was the second most important factor after the cost of food. Having inherited her small restaurant business from her family, a 29-year-old food vendor attributed her socioeconomic success to gold mining:

> *"…even miners who buy food on credit are sure to pay once they earn from the gold. Compared to my mother 13 years ago, I can say that selling food here has improved my life and that of my children significantly. I earn enough to save through table banking and SACCOs and have witnessed my business grow. Just from 'this soil'."*

By "this soil", she meant the gold. The food vendors expressed that miners are biased towards heavy starches and ready-to-eat meals. Participatory transect walks in the different markets exposed the researchers to organizational factors and different territorial strategies to keep food consumers contented and coming back. In multiple market stands, the researchers observed that the popular foods were stacked at the front while the less popular foods were at the back or placed in sacks and only retrieved on demand. In other instances, hawking while shouting rhythmically would be a strategy to attract as many customers as possible. The hawked foods would likely be cooked food with a low shelf like such as tea and porridge packed in giant thermos flasks, flatbread, buns, samosas or *githeri* which is a combination of maize and beans and a popular Kenyan cuisine.

Some mine sites were marked as "men-only sites". Here, the male miners would prepare their own food and not depend on the food vendors who were majority women. One of the reasons for such patriarchal balkanization was the notion that women's presence is a bad omen to their work, therefore these men would organize every facet of their mining work including cooking. The researchers observed that the cooking in these instances was designated to younger men within the groups. The researchers to only able to access some of these sites upon being granted special permission by the participants.

While skipping meals was frequently brought up as a coping strategy by the different participants, a compromise such as opting for cheaper and non-nutritive foods came up multiple times too, including in the focus group discussions. A 31-year-old food vendor pointed out that food consumption patterns were dictated by cost and cultural preferences:

> *"…if I decide to sell arrowroots, sweet potatoes, chicken, or fish, I will close my*

doors tomorrow because we no longer grow them locally, thus trading in them is so expensive. Meat and fruits are for the rich. I therefore sell what people can afford. Githeri, chapati (flat bread), sodas, and bread are cheaper and universally preferred."

With the irregularity of the mining income, the food vendors' income is subject to seasonality and this interferes with their access to food. Such situations have been observed in Ghana's ASGM communities and often the most vulnerable members of the communities such as children are affected the most by the unpredictability of mining incomes thus impacting their nutritional outcomes [27]. Compounding this cost with limited domestic stocks creates a dire situation and is a major threat to food accessibility for the community. These observations echo the findings by Zhang, et al, [54] that areas near mining sites have less access to fruits and vegetables and more access to cheap, ready-to-eat, often non-nutritive foods.

Other community members, however, argue that ASGM compliments food accessibility: A 46-year-old male miner was of the opinion that cash crop farming and mining support his food needs. Usually, the differences would be informed by social class as the relatively wealthy miners are more secure when it comes to food accessibility while the majority of the people from the lower classes are disadvantaged regardless of the supporting food infrastructure. Some food vendors noted that food wastage is common especially when the gold business is low and when the mine labourers migrate to other regions whenever new gold deposits are discovered. Other factors influencing food access from the vendors are consumer preferences/ taboos, food seasons and the population density at 15.6%, 6.7% and 2.2% respectively. Consumer preferences and food taboos were cited for their influence on food consumption within the community the participants said that some foods however nutritious or affordable are just not as popular while other foods are a daily staple due to historical and cultural advantages within the community. With that said, a symbiotic relationship exists between mining and farming.

3.3 Food Utilization

This study further revealed that about thirty one point one (31.1 %) of food vendors prepare food at home, about a quarter (24.4 %) trade in processed foods while 13.3% cook at the mine sites as shown in Table 1. This poses a risk to food safety because domestic food preparation is not subject to strict regulations as it would under a commercial setup. The participatory transect walks consequently revealed a bias towards junk foods, processed foods or other non-nutritive options by both the food sellers and the food consumers. Most of the interviewed participants explained that the bias towards these non-nutritive options is because of the long mining hours, which unlike agriculture or other forms of rural labor leaves little room to prioritize meal preparation after work.

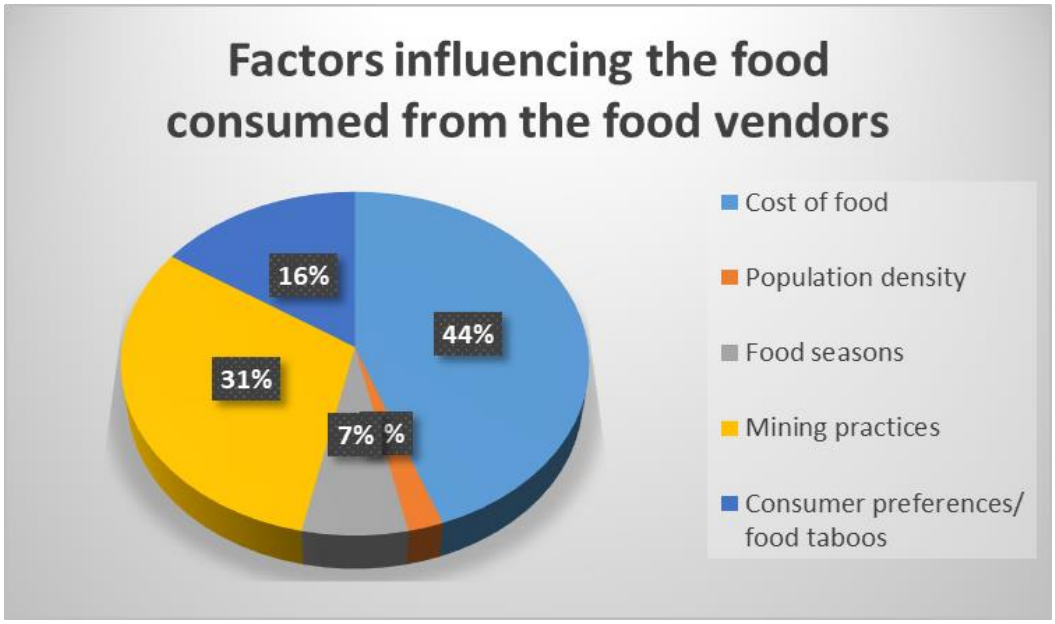

Fig. 4. Factors influencing food consumption from the food vendors

Table 1. The type of food sold by the food vendors

	Frequency	Percent	Valid Percent	Cumulative Percent
Home-made food	14	31.1	31.1	31.1
Processed foods and beverages	11	24.4	24.4	55.6
Cooked at the mine sites	6	13.3	13.3	68.9
Fruits and vegetables	2	4.4	4.4	73.3
Raw foods and cereals	12	26.7	26.7	100.0
Total	45	100.0	100.0	

One participant, a food vendor with a popular soft drink and French fries outlet in Bushiangala village remarked how profitable his business was that the consumption of junk foods was a marker of sophistication in these mining camps: "*I rarely sell chips and sodas on credit yet my business is still successful…everyone pays cash."* When the researchers probed on whether there are any demographic preferences, the 40-year-old pointed out that his major clientele is mostly young people and women as it is more culturally accepted for them to sit and eat at a fast-food outlet than in the bar next door.

Fifty-three point three percent of the sampled food vendors sell starch with hot beverages for breakfast. The most popular breakfast starches on the menus are flatbread, buns, and bread while the most popular beverages are tea, milk, or porridge. Excluding milk, proteins, and vitamins are generally rare on the breakfast menu. During lunchtime, the majority of the miners can access a balanced diet since carbohydrates are served with vegetables, meat, cereals, and other demand-based options. Over half of the participants (53.3 %) can afford a three-course meal per day with 46.7 % only able to afford two meals daily. This is consistent with Zhang et al. [54]'s analysis that artisanal mining has a tendency to upset nutritional multiplicity, as was the case in rural Guinea. This research further observes that the most vulnerable groups to these nutritional outcomes are children.

Concerns over the long-term health implications to the community owing to how liberally the mercury as well as the cyanide is used and disposed in both the terrestrial and aquatic ecosystems in the area. An expert informant with healthcare expertise remarked: *"Malnutrition is of concern, but bioaccumulation as well. Special attention needs to be paid to the quality of water and the quality of the food we grow locally to avert any future disasters."*

This bolsters the argument by Ngure & Kinuthia [30] that ASGM aggravates the geoaccumulation and consequently hurts the quality of food and water, thus posing long-term health risks for the communities in Migori, Kenya. The other valid concern to food utilization was the fact that both the miners and the food vendors reported that fruit consumption was not a priority with this research finding out that only 4.4% of the sampled food vendors sold fruits and vegetables, indicating that the miners' diet is inadequate and could have long-term health consequences.

3.4 Food Stability

In one of the focus group discussions, one participant observed: "*While I can't help but appreciate this gold for improving our lives, I am aware that it is destroying valuable agricultural land and that sooner or later, there will be no more gold in these lands and we'll have to start from zero. The gold business is like gambling for many of us. We sometimes earn from it, but most of the time we don't. So, food as a resource will always be weakened by gold."*

The findings and analysis have thus far revealed that food stability in Ikolomani is elusive as the three primary dimensions of food security that is food availability, food access and food utilization are impacted negatively by ASGM in the area. A community can only be said to have attained food stability not just when the three core dimensions are excellent, but when all three are aligned with each other to guarantee the long-term food needs of the community. Under ASGM, Ikolomani's food production capacity is significantly diminished as well as the food purchasing power and nutritive capacity of the food for these ASGM communities. This supports the argument by Wegenast & Beck [55] who challenged the widely held credence that extractivism engenders economic advantages in developing countries and ameliorates local livelihoods thus improving food stability.

3.5 Food Sovereignty

Our findings provide both qualitative and quantitative evidence that artisanal gold mining poses a direct threat to the food sovereignty for the communities in Ikolomani, primarily owing to the fact that this extractives business, unlike other kinds of industries, is neither locally controlled nor are the agro-ecological, social, political and cultural risks shared between the communities and the international beneficiaries. Our findings indicated that maize and beans account for about 83.4 % of the foods grown while indigenous food varieties (cassava, yams, arrowroots, sweet potatoes, millet); indigenous vegetables, and fruits of all kinds account for 12.6 % of the food crops grown. The reasons given for this partiality to maize and beans over more indigenous or healthier food varieties were the growing season, their receptiveness to fertilizers as well as the reliability of the market within the community and beyond. The overdependence on fertilizers to grow food as well as monoculture farming is a major driver of biodiversity loss. This compounded by the indiscriminate use of mercury and cyanide as well as the release of other toxins into both the terrestrial and aquatic ecosystems has long-term implications on food sovereignty and the ability of the community to maintain a healthy and seeds or indigenous food culture. The ASGM-inspired deforestation is a risk to both the climate and the biodiversity of the area. These findings are supported by food sovereignty scholarship across Latin America, among them Copeland [22] in Guatemala and more particularly Broad & Cavanagh [56] in El Salvador where anti-mining activists have waged resistance against the extractivism, which they claim impedes small-scale farming, their land rights, ecological diversity and have consequently mobilized their communities against gold mining under the campaign: “keep the gold in the ground”.

Although 80% of the respondents in Ikolomani indicated that they rear livestock such as cows, pigs, and chickens, a majority do it for sociocultural and socioeconomic purposes and not as a source of nourishment. The fact that ASGM is underpinned by neoliberalism further discounts any idea that these food choices are built on the community’s agency. In addition to the socioeconomic deprivation, land dispossession also undermines food sovereignty as evidenced in Ikolomani, Kakamega.

4. CONCLUSIONS AND RECOMMENDATIONS

The correlation analysis indicated a strong positive relationship between ASGM and food security ($r = .465$, $p = .024$) in Ikolomani, with the more ASGM activities, the higher the food insecurity. Moreover, the regression analysis generated a standardized beta coefficient of ($\beta 2 = .387$, $P = .024$) implying that an increase or decrease in ASGM activities by a single unit will lead to an increase or decrease of 0.387 units in food security. This is an indicator that ASGM has negatively impacted all the five dimensions of food security in Ikolomani Sub-county of Kakamega and that worse outcomes will ensue should the current circumstances be left constant. The study, therefore, deduces that artisanal gold mining is precarious to food availability in Ikolomani, Kakamega as it degrades the terrestrial ecosystems that are crucial for growing food and rearing animals for the farmers in the area who are overwhelmingly smallholders. The use of chemicals such as mercury for the gold amalgamation process also creates a risk for the food chain as the soil and water sources contamination leads to bioaccumulation thus hampering the quality of food produced. This indicates that both the food quality and the quantity are at risk for the community and beyond. Furthermore, food accessibility and utilization are equally precarious. Due to the low earnings from the gold business, where prices are controlled internationally, most miners require more than a single source of income to meet livelihood needs and as such, the low wages mean that they have to serve competing socioeconomic needs, therefore low access to nutritious food. The study also finds evidence that supports the hypothesis that ASGM has ruined the forests and the biodiversity of Ikolomani in Kakamega, Kenya, and this has lasting negative impacts on food stability and food sovereignty thus creating an impending danger if the current circumstances remain constant. That said, the study also found that mining and agriculture are co-dominant in Ikolomani and help the community sustain their various needs. With this being a cross-sectional study, the cause-impact analysis as well as the behavioural scope is limited. As such, the study recommends longitudinal studies in future to accurately to determine the true scope of ASGM on food security in this community, especially food stability, food sovereignty and food sustainability. The study also recommends a multi-sectorial approaches and implementation of

progressive policies that will address food insecurity and improve the Ikolomani's food needs more sustainably.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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