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Effect of Lead Mining on the Livelihood Structure and Food Security Dynamics of Agribusiness Households in Ikwo, Ebonyi State, Nigeria

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ABSTRACT

This study investigated the effect of lead mining on the livelihood structure and food security dynamics of agribusiness households in Ikwo Local Government Area of Ebonyi State, Nigeria. A multi-stage sampling technique was used to select a sample of 60 agribusiness households. The Foster-Greer-Thorbecke (FGT) model for food security assessment and probit regression analysis for identifying food security and livelihood diversification determinants were all employed. The findings revealed a predominantly middle-aged workforce, with significant economic diversification and a concerning shift towards mining as a primary income source, increasing from 7% to 93% over the past decade. This transition raised food security concerns, with 63% of respondents classified as food insecure. Key factors positively influencing food security included own food production, education level, and livelihood diversification, while age, household size, and losses due to mining negatively impacted food security outcomes. Farm size, level of education, cooperative membership, losses from lead mining, climate change and low agricultural yield positively affected the decision to diversify livelihood from agriculture into other income while age of farmers and income from farming negatively affected this. Policy interventions that enforce stricter environmental regulations to mitigate the adverse effects of mining on agricultural land and water resources is highly recommended. Policymakers and community leaders must consider integrated approaches that balance mining activities with sustainable agricultural practices to ensure long-term food security and community resilience.

1. Introduction

Lead mining is an economic activity that involves extracting lead from the earth. It's a prominent economic activity worldwide, involving the extraction of lead from the earth's crust. Lead mining can have profound effects on the livelihood structure and dynamics of rural agribusiness households in the agricultural sector as a whole (both internationally and locally), particularly in terms of food security. According to Haile et al. (2024), Castro-Bedriñana et al. (2021) and Hiwatari et al. (2024), the extraction and processing of lead ores can lead to both direct and indirect impacts on the agricultural sector, influencing the livelihood choices and food security of rural communities. They further argued that the extraction and processing of lead ores wield both direct and indirect influences on the agricultural sector, exerting significant pressure on the livelihood choices and food security of rural communities.

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Obviously, mining projects can disrupt farmland, livestock, and grazing areas essential for household food security, while lead contamination from mining activities negatively impacts food quality, human health, and the socio-economic status of rural populations, making agribusiness households particularly susceptible to these disruptions.

One notable repercussion of lead mining expansion is the phenomenon of land acquisition, often resulting in the displacement of rural households and the loss of agricultural land. Studies highlight that such displacement can severely alter the livelihood structure of affected communities, compelling households to seek alternative income-generating activities beyond agriculture (Mondal & Mistri, 2022; Mandishekwa & Mutenheri, 2020). The migration of individuals seeking mining-related employment can disrupt traditional social networks and community cohesion, potentially undermining collective agricultural activities and local food systems. Additionally, lead exposure from mining exacerbates poverty, negatively impacts health and education, and has long-term implications for sustainable development in affected communities. Furthermore, the rapid expansion of mining industries often leads to a shift of labor from agriculture to mining, which strains agricultural labor resources and can worsen food security. This phenomenon, sometimes referred to as the "Dutch disease," describes how the demand for mining labor diverts able individuals away from farming, creating vulnerabilities in rural agrarian economies and challenging agricultural sustainability as observed by Ofosu et al. (2020). Lead mining activities significantly influence the socioeconomic dynamics of rural communities by altering local labor markets, wage rates, and income distribution, which directly affect household purchasing power and access to food (Hiwatari et al., 2024).

Environmental degradation from lead mining significantly threatens agricultural productivity and food safety by releasing toxic substances that contaminate soil, water, and crops. Studies have shown that lead mining activities result in elevated concentrations of lead and other heavy metals in agricultural soils, which can be taken up by crops, thereby compromising the safety of locally produced food and posing health risks to consumers (Mandal et al., 2022). As observed by Sharifi et al. (2023), this contamination leads to reduced soil fertility, degraded water quality, and increased health risks, collectively diminishing agricultural productivity among rural agribusiness households. In regions impacted by lead mining, such as Ebonyi State, Nigeria, and other global mining areas, environmental pollution and degradation have been documented to threaten farming activities and food security.

These impacts permeate various aspects of rural life, including land dispossession, compromised soil fertility, and transformations in labor markets, all of which disrupt traditional livelihood structures and increase living expenses for affected populations (Unagwu, 2021).

The situation in Ebonyi State reflects broader patterns observed across Sub-Saharan Africa, where mining-induced environmental and socio-economic changes challenge the delicate balance of rural food systems and livelihoods.

Our study offers clear evidences on how lead mining has dispassionately impacted and disrupted longstanding traditional agricultural practices, precipitating into what could be referred to as "crisis of livelihood" for rural households (Tiamgne et al., 2022).

The study specifically examined the livelihood structure of the agribusiness households for the past 10 years, determined the food security status of the respondents and factors affecting food security, and

assessed the influence of lead mining on the food security and livelihood dynamics of the affected populations.

2. Literature review

Research in mining-affected areas like Ebonyi state demonstrates that lead contamination impacts not only environmental quality and food safety but also household livelihoods and community resilience. For example, studies have shown that lead mining leads to elevated lead levels in soils, crops, and food products, posing significant health risks and threatening food security for local populations (Zhang et al., 2020; Samuel & Babatunde, 2021). Further evidences reveal that mining activities can alter income sources, disrupt traditional agricultural practices, and affect access to nutritious food, thereby increasing vulnerabilities among rural households (Castro-Bedriñana et al., 2021, Samuel & Babatunde, 2021). Evaluating these impacts allows researchers to identify both the risks and the adaptive strategies employed by affected communities to maintain food security in the face of environmental and economic challenges. The need for extensive research in Ebonyi State, particularly around mining communities on the profound effects of lead mining on the livelihood structure and food security dynamics of rural agribusiness households follows documented evidences that mining activities lead to land degradation, reduced agricultural productivity, and increased health risks due to heavy metal contamination in soils and food crops, which directly threaten local food security and household well-being (Orji et al., 2021; Obasi et al., 2020).

3. Materials and methods

3.1 Study area

The study was conducted in Ikwo Local Government Area of Ebonyi State. It is located in South-East Nigeria and lies in the humid tropical agro-ecological zone of Nigeria within Longitudes 70 30 E and 80 30 E and Latitudes 50 40 N and 60 45 N. It has a land area of 6,488 km^2 with a projected population of 3,242,500 persons in 2022 using a growth rate of 2.5% (National Population Commission, 2022).

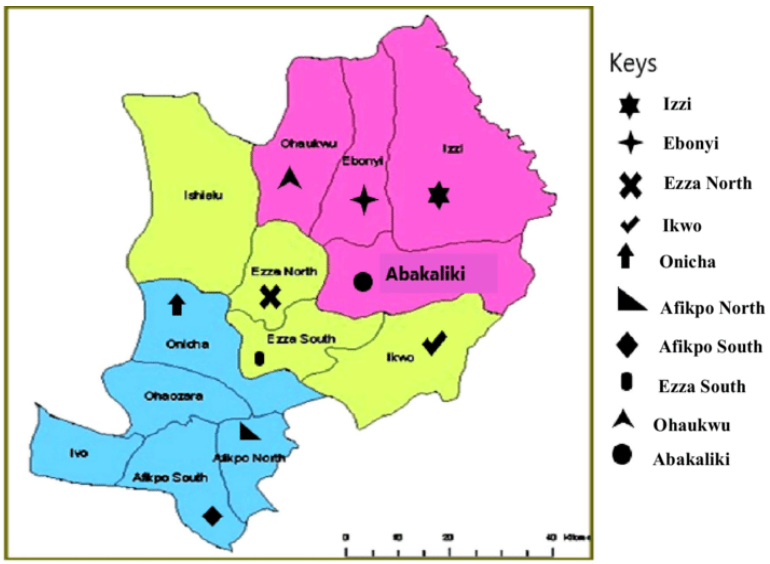

Figure 1. Map of Ebonyi State showing all the Local Government Areas
Source: Ajah et al. (2022)

3.2 Methods of data collection and sampling techniques

For a comprehensive study on the effects of lead mining in Ikwo Local Government Area of Ebonyi State, a combination of quantitative and qualitative data collection methods were employed. Primary data was collected with the use of structured questionnaires administered to the respondents in the affected areas. A multi-stage sampling technique was adopted for this study. Four (4) communities affected by lead mining were randomly selected. They are Enyime Nchifu normally known as Nwakpu, Enyim agalegu popularly known as Royal salt, Oyikwa and Ohankwu. In the next stage, fifteen (15) agribusiness households were randomly selected from the four (4) communities making it a total of 60 respondents.

3.3 Data analysis

In order to achieve the objective of the study both descriptive (frequencies and percentages) and inferential statistical techniques (Foster Greer Thorbecke and Probit regression model) were employed (Foster, Greer and Thorbecke, 2010).

3.3.1 Foster–Greer and Thorbecke (FGT) Food Security Analysis

The Foster–Greer–Thorbecke (FGT) class of decomposable poverty measures was used to assess the food security status of the agribusiness households. The food security line is often set at two-thirds of the Mean Per Capita Household Food Expenditure (MPCHFE), categorizing households as food secure if their MPCHFE is above this threshold and food insecure if below. The FGT measures allow for the estimation of food insecurity incidence, gap, and severity, and have been applied in numerous studies to analyze poverty and food security (Abaynew et al., 2024) (formula 1).

$$P_{\alpha} = \frac{1}{N}\left(\frac{z-yi}{z}\right)^{\alpha} 1(yi \leq z) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

α = FGT food insecurity index which takes values 0,1,2,
P_0 = food insecurity headcount.
P_1 = food insecurity depth
P_2 = food insecurity severity. It is also referred to as the elasticity of individual's food insecurity with respect to the normalized gap (z − yi) such that a 1% increase in the insecurity gap of a food insecure person leads to an α percent increase in the individual's food insecurity level (Foster et al., 2010)
n =Total number of households.
z = Food security line.
p = Number of households below the food security line
yi = Per-capita monthly food expenditure of the household.

3.3.2 Determinants of food security

Probit regression is commonly employed to analyze the drivers of food security when the dependent variable is dichotomous, as it effectively distinguishes between food secure and food insecure households (Ogunniyi et al., 2021; Hastuti et al., 2022; Oduntan & Akinro, 2021; Kasim & Harikumar, 2024).This approach allows researchers to determine the influence of factors such as education,

income, household size, and access to credit on food security status, providing valuable insights for targeted interventions. (formulas 2, 3, 4).

$$Y^* = \beta_i X_i \varepsilon_i \quad (2)$$

$$\{Y = 1 \text{ if } Y^* > 0\} \quad (3)$$

Or

$$\{Y^* = 0 \text{ if otherwise }\} \quad (4)$$

Where:

Y*= Food Security (food secure = 1, otherwise = 0);

X_1 = Age of the respondents (years);

X_2 = Education of household head (years);

X_3 = Agribusiness experience (years);

X_4 = Sex of household head (1= male, 0 = female);

X_5 = Total household income (Naira);

X_6 = Access to credit (yes = 1, no = 0);

X_7 = Off-farm participation (yes = 1, no = 0);

X_8 = Own production (Kg);

X_9 = Cooperation membership (member = 1, non-member = 0);

X_{10} = Assets ownership (Naira); ε_i = Error Term-

Where 'Y' is the unobserved latent variable, assuming value 0 for food insecure households and 1 for food secure households. Xi represents a vector of independent variables.

4. Results and Discussion

Livelihood structure of the respondents

Table 1 presents the livelihood structure of the respondents

Table 1. Livelihood structure of the respondents

Livelihood activity	Last 10 years		Currently	
	Frequency	Percent	Frequency	Percent
Mining activities	4	7	56	93
Trading	18	30	42	70
Crop processing	35	58	25	42
Crop production	35	58	25	42
Poultry and livestock	23	38	37	62

Source: Field survey, 2024

The results in Table 1 show a dramatic shift over the past decade, with mining activities rising significantly from just 7% to 93% currently, indicating a substantial transition towards mining as a primary source of income. Conversely, traditional activities such as crop processing and production have decreased from 58% to 42%, reflecting the community's adaptation to changing economic circumstances driven by mining opportunities. This trend represents the growing reliance on mining, which may enhance household incomes but could also pose risks to food security and sustainability in agricultural practices. Moreover, the increase in poultry and livestock activities from 38% to 62%

suggests that while traditional crop farming may be waning, households are still seeking ways to diversify their income sources through animal husbandry. This diversification can serve as a buffer against the volatility of mining income and contribute positively to household nutrition and food security. However, the overwhelming shift towards mining raises concerns about the long-term sustainability of livelihoods in the area, particularly regarding environmental degradation and its impact on agricultural land. Studies emphasize that while mining can provide immediate economic benefits, it often leads to adverse effects on local communities, including diminished agricultural productivity and increased food insecurity.

For instance, researches around Sub-Saharan Africa found that mining operations are associated with reduced food availability, land dispossession, water pollution, and a decline in crop yields, all of which threaten food security and the sustainability of traditional livelihoods (Wegenast & Beck, 2020; Obodai et al., 2024; Shackleton, 2020; Diallo & Soumah, 2023; Nunoo et al., 2023).

Food security status of the respondents

Table 2 presents the food security status of the respondents.

Table 2. Food security status of the respondents

Food security status	Frequency	Percent (%)
Food insecure	38	63
Food secure	22	37
Total	60	100

Source: Field survey, 2024

The results in Table 2 reveal that a significant majority (63%) are classified as food insecure, while only 37% are considered food secure. This high level of food insecurity suggests that many households face challenges in accessing sufficient and nutritious food, which may be exacerbated by economic pressures and the recent shift towards mining activities as a primary livelihood. The findings align with recent research indicating that food insecurity is prevalent in rural areas, often linked to factors such as low income, limited access to resources, and changing livelihood strategies. Studies in mining communities have documented alarming levels of food insecurity, with over half of surveyed populations experiencing moderate to severe food insecurity, and mining identified as a substantial contributor to these challenges (Obodai et al., 2024; Amayi et al., 2024).

Determinants of food security of the respondents

To examine the food security status of the respondents, the probit model was employed. The Pseudo R-squared value of 0.625 implies that 62.5% of changes in the food security level of the respondents were explained by changes in the independent variables included in the model. Furthermore, the Likelihood Ratio which determines the influence of all independent variables together on the dependent variable was statistically significant at 1% level and shows that the model was well fitted, that is, the independent variables influenced the food security level of the households. The result is presented in Table 3.

Table 3. Determinants of food security of the respondents

Variables	Coefficient	Standard error	Z
Constant	.0719	1.185	0.062
Age (years)	-.055	.020	-2.751**
Own food production (Kg)	0.234	.067	3.493***
Farm size	.382	.103	3.709***
Gender (Male=1; Female=0)	.472	.115	4.104***
Level of education	.038	.009	4.222***
Household size	-.455	.133	-3.421***
Cooperative membership	.173	.049	3.531***
Diversification	.580	.122	4.765***
Losses	-.121	.029	-4.172***
LR chi2(8)	12.819		
Log-likelihood	-33.023		
Pseudo R^2	0.625		

Source: Field survey (2024)

Result showed that the coefficients of own food production, farm size, gender, level of education, cooperative membership and livelihood diversification were positively related to the food security status of the respondents at 1% level of significance each. On the other hand, the age of respondents, household size, and losses through mining activities negatively impacted the food security status of the households at 5%, 1% and 1% levels of significance respectively. Own food production, such as home gardening, small-scale farming, or foraging, has several positive effects on food security. It increases the availability and diversity of nutritious foods, making diets healthier and more resilient to market fluctuations or supply chain disruptions (Azadi et al., 2022). Research shows that own food production benefits households across income levels, supporting community food security and improving overall well-being, though access to land and skills can be barriers (Bliss et al., 2024). A positive relationship between farm size (measured in hectares) and food security is well-documented in diverse contexts. Larger farms generally provide households with greater food self-sufficiency, higher agricultural incomes, and a reduced likelihood of experiencing food insecurity (Ademola et al., 2021). Studies show that households with larger farms are more likely to be food secure, as they can meet caloric needs and generate surplus for income (Giller et al., 2021).

Gender significantly influences food security, with women and female-headed households generally facing higher risks of food insecurity than men and male-headed households. This disparity is observed globally and is often explained by differences in access to income, education, social networks, and productive resources, though unobservable factors and structural inequalities also play a role (Choithani, 2020). Empowering women through increased decision-making power, education, and access to resources has been shown to improve household food security, but persistent gender-based disadvantages and social norms continue to create vulnerabilities for women, even when they gain greater autonomy or control over resources (Ashagidigbi et al., 2022; Gebre et al., 2021).

A positive relationship exists between education level and food security, that is, as individuals or household heads attain more years of schooling or higher educational qualifications, their likelihood of being food secure increases. Gnedeka and Wonyra (2024) and Kara and Kithu (2020) stated that

education enhances employability and earning potential, enabling households to purchase sufficient and nutritious food. Individuals with higher level of education are better equipped to access information on nutrition, health, and agricultural practices, leading to improved food utilization and production efficiency (Mohamed, 2025).

Membership in agricultural cooperatives has been shown to significantly enhance food security for rural households and smallholder farmers. Cooperative members benefit from improved access to credit, productive resources, agricultural inputs, and training, which collectively increase food production, dietary diversity, and household resilience. Studies in Zambia and Nigeria found that cooperative membership led to higher dietary diversity scores and increased daily caloric intake, directly improving food and nutrition security (Ng'ombe et al., 2024, Kehinde & Kehinde, 2020).

Income diversification further improves food security: Households that diversify their income sources, combining farming with other activities are even more likely to be food secure, as additional income helps buffer against shocks and seasonal shortages (Salifu & Salifu, 2023; Gebre, et al., 2023). Increased income allows for greater access to food, improved dietary diversity, and the ability to withstand market or climate shocks (Liu et al., 2025; Setsoafia et al., 2022).

Several studies have consistently reported a negative relationship between the age of household heads and food security. As household heads age, their physical capacity for labor-intensive activities, especially in agricultural settings, declines. According to Khan & Sadozai (2024), the reduced productivity limits their ability to generate income and produce food, increasing the risk of food insecurity. Older household heads may also face health challenges and have fewer economic opportunities, further constraining their access to adequate food (Oduniyi & Tekana, 2020; Oburu et al., 2024). The negative relationship between household size and food security implies that households with more members, particularly those with many children or dependents, are more likely to experience food shortages, fall below the poverty line, and face challenges such as financial strain, lack of parental care, and poor health. Larger households place greater demands on available food and financial resources, making it harder to meet everyone's nutritional needs, especially when income does not increase proportionally (Akello & Mwesigwa, 2023; Stanley et al., 2025). Monetary losses from lead mining negatively food security. These losses directly reduce the quantity of food available for consumption and sale, thereby undermining food security at both household and national levels (Ogundele, 2022; Fnimn, 2020).

Determinants of livelihood diversification of the respondents

To examine the determinants of the livelihood diversification of the respondents, the probit model was employed. The Pseudo R-Squared value of 0.729 implies that 73% of changes in the decision to diversify livelihood from agriculture into other income activities were explained by changes in the independent variables included in the model. The result is presented in Table 4.

Table 4. Determinants of livelihood diversification of the respondents

Variables	Coefficient	Standard error	Z
Constant	4.791	2.611	1.831
Age (years)	-.056	.026	-2.115**
Farm size (Hectares)	-.012	.013	-.923

Variables	Coefficient	Standard error	Z
Household size	.073	.129	0.573
Gender (M=1, F=0)	-.198	.509	-0.394
Level of education	.075	.021	3.571***
Cooperative membership	.559	.271	2.066**
Losses (₦)	.423	.241	1.757*
Climate change	1.452	.722	2.018**
Low yield (yes=1, no=0)	1.477	.741	2.001**
Income from farming (₦)	-2.056	1.120	-1.841*
LR chi2(12)	23.432		
Log-likelihood	-23.834		
Pseudo R^2	0.729		

Source: Field survey, 2024

Findings showed that farm size, level of education, cooperative membership, losses from lead mining, climate change and low agricultural yield positively affected the decision to diversify livelihood from agriculture into other income activities at 1%, 5%, 10%, 5%, and 5% levels of significance respectively while age of farmers and income from farming negatively affected the decision to diversify livelihood from agriculture into other income activities at 5% and 10% levels of significance respectively.

There is a strong positive relationship between farmers' level of education and their decision to diversify livelihoods from agriculture into other income activities. Higher education equips farmers with knowledge, skills, and confidence to explore and successfully engage in off-farm and non-farm income-generating activities, making them more adaptable to economic and environmental challenges (Gebru et al., 2018; Habib et al., 2023). Educated farmers are therefore more likely to seek out and utilize opportunities beyond traditional farming, such as wage employment, small businesses, or skilled labor, which can increase household income and resilience (Igwe et al., 2020).

Farmers' cooperative membership is positively related to the decision to diversify livelihoods from agriculture into other income activities. Cooperatives provide members with improved access to credit, training, market information, and social networks, which lower barriers to entering non-farm or off-farm income-generating activities (Popoola et al., 2023; Mojo et al., 2017). According to Olojede et al. (2020), membership often increases household income and assets, making it easier for farmers to invest in new ventures such as craftsmanship, paid labor, trading, or service delivery, all of which contribute to poverty reduction and improved welfare.

Agricultural losses from lead mining and other forms of mineral extraction often force farmers to diversify their livelihoods into non-agricultural income activities. Mining operations can cause land degradation, water pollution, and loss of access to arable land, which directly reduce agricultural productivity and income, making farming less viable for affected households (Shackleton, 2020; Ofosu et al., 2020). As a result, many farmers are compelled to seek alternative sources of income, such as small-scale mining, wage labor, small businesses, or migration for work, to compensate for lost agricultural earnings and maintain household food security (Zhao & Niu, 2023).

Climate change has a positive relationship with farmers' decisions to diversify their livelihoods from agriculture into other income activities. As climate change increases the frequency and severity of

droughts, floods, unpredictable rainfall, and other environmental stresses, it threatens agricultural productivity and income, making farming less reliable as a sole source of livelihood (Mohammed et al., 2021; Amfo & Ali, 2020). In response, farmers adopt diversification strategies such as engaging in non-farm work, small businesses, migration, or livestock rearing to spread risk and improve household resilience to climate shocks (Bernzen et al., 2023; Kumasi et al., 2019).

Low agricultural yield is positively associated with farmers' decisions to diversify their livelihoods into non-agricultural income activities. When crop yields are low, farming becomes less profitable and less reliable as a sole source of income, prompting farmers to seek alternative ways to support their households and reduce vulnerability to food insecurity and poverty (Ulilalbab et al., 2025; Manickam et al., 2023). Gebru et al. (2018) reported that low yields often due to factors like poor soil, high production costs, or environmental shocks encourage farmers to adopt new crops, engage in horticulture, or pursue off-farm and non-farm activities to stabilize and increase their income.

The negative relationship between farmers' age and their decision to diversify livelihoods from agriculture into other income activities implies that as farmers get older, they are less likely to diversify their income sources beyond agriculture, often preferring to stick with familiar farming practices rather than pursue new or non-farm opportunities (Akinyemi et al., 2021; Mbewana & Kaseeram, 2024). According to Workie (2023), this reluctance may be due to factors such as reduced physical capacity, lower willingness to take risks, limited education or training in non-agricultural sectors, and a preference for traditional livelihoods. There is a negative relationship between farm income and farmers' decision to diversify their livelihoods from agriculture into other income activities. When farm income is high and sufficient to meet household needs, farmers are less likely to seek alternative income sources, as agriculture alone provides adequate financial security and stability (Iqbal et al., 2021; Gebru et al., 2018). Conversely, low or unstable farm income acts as a push factor, motivating farmers to diversify into off-farm or non-farm activities to supplement their earnings and reduce vulnerability to risks such as crop failure or market fluctuations (Bojnec & Knific, 2021).

5. Conclusions

This study was conducted to ascertain the livelihood dynamics and food security conditions of agribusiness households amidst rising migration from agriculture to lead-mining and related activities in Ebonyi state. Findings showed that a dramatic shift was noted in the community's livelihood over the past decade, with mining activities significantly increasing from 7% to 93%, while traditional agricultural practices drastically declined. This transition raised concerns about long-term sustainability and food security, as 63% of respondents were classified as food insecure.

The probit estimates revealed that own food production, education level, livelihood diversification, household head age, household size, and mining-related losses all impacted food security. Similarly, educational attainment, cooperative membership, age of household head and reliance on farming income significantly impacted diversification decision.

There is a critical need for policy interventions that enforce stricter environmental regulations to mitigate the adverse effects of mining on agricultural land and water resources. Households should be encouraged to engage in a mix of agricultural and non-agricultural activities. While the current trends indicate a significant economic shift towards mining, policymakers and community leaders must

consider integrated approaches that balance mining activities with sustainable agricultural practices to ensure long-term food security and community resilience.

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