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Research Article

Impacts of Coal Mining on Farmers' Well-Being in Barapukuria, Bangladesh

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ABSTRACT

The Barapukuria coal mining area in Dinajpur district of Bangladesh is vital for energy generation but raises significant concerns about its effects on the livelihoods and well-being of the local farmers. The study examined the socioeconomic impact of coal mine on farmers' well-being. We collected primary data using a multistage random sampling technique through direct interviews during the paddy harvesting period from January to March 2020. Considering the scope of the study, farm-level cross-section data of a total of 100 rice-growing farmers from Parbatipur Upazila of Dinajpur district was collected for the present study. Descriptive statistics were used to depict the socioeconomic status of the farmers and the well-being of the farmers in the permitted coal mining areas was assessed using multiple linear regression analysis, taking social, economic, and environmental factors into account. The survey revealed that the majority of the respondents were male (96%) and were within the age range of 36-50 years, accounting for 52% of the total. About 52% of the farmers had a primary level education, whereas 37% of the farmers had agricultural experience ranging from 11 to 20 years. The study also found that environmental and economic factors of farmers' well-being were affected significantly by the presence of coal mines. However, the effects of coal mines on social elements were determined to be insignificant. Considering the identified problems, it was recommended that farmers in these areas should be treated in a better way so that they do not have to change their profession. A variety of policies ought to be made accessible for the benefit of the farmers in the study area.

Introduction

For many decades, agriculture, and mining are important for Bangladesh's economic growth and the establishment of unskilled employment prospects. Mining operations are dispersed over a variety of regions, from arid areas with limited potential for agriculture to areas where mine operations have encroached on extremely productive agricultural land. Industrial and agricultural growth are not mutually incompatible; instead, they are interdependent and mutually reinforce one other's contributions and outcomes. A huge part of individuals in Bangladesh work in agriculture, which provides food and raw materials as well as jobs. According to the BBS, 2021, the agricultural sector accounts for around 12.07% of the nation's GDP and employs 37.75% of all workers in Bangladesh. Native substances found on Earth include fresh air, water, soil, plants, minerals, and animals. Natural resources can be categorized into two separate columns: renewable and non-renewable, depending on their ecological composition (OECD, 2011). The resource coal is regarded as non-renewable. Coal is still a booming industry in today's context of huge energy demand. The World Coal Association (WCA), 2012 data states that coal keeps producing 41% of the world's electricity and 29% of all primary energy. The demand for electricity will rise globally by 3% per year over the 2023-2025 period, compared with the 2022 growth rate, estimates by the International Energy Agency (IEA) (Ellerbeck, 2023). Coal will be crucial to the provision of energy in the future, along with gas and oil (Viljoen, 1979). Bangladesh must therefore make sure to adequately prepare for the near future and establish a fuel diversification strategy based on trends in the global coal market (Amin and Rahman, 2018).

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Barapukuria Coal Field of Dinajpur District was explored by the Geological Survey of Bangladesh (GSB) in 1985. It was possible to produce about 3.651 million tons of coal from the central part during the contracted time. A total of 390 million tons of coal are in the Barapukuria, Dinajpur coal field. The depth of the coal is between 118 and 509 meters, and 1 million tons of coal are produced every year (Monir and Hossain, 2012). A region's sustainable economic development may be attributed to mining (Perry, 1982). Mining provides the atmosphere for spending on various issues, including housing and health care, in addition to providing improved work opportunities. The population affected by mining is concurrently engaging in a variety of illegal and antisocial behaviors. While the current generation experiences social ills like inequality, disempowerment, and competition, it leaves a legacy for the following generation to continue the same (Colagiuri et al., 2012). The mining firms are educating the local communities about the immediate benefits while neglecting the propagation of any information about the long-term consequences, such as eviction, relocation, and pollution (Badera and Kocon, 2014). The start of coal mining projects has brought about several other socioeconomic problems, including the loss of arable land, pollution of waterways, a rise in farmers who are without land, etc. The land is the only source of income for many who live in rural areas. However, the expansion of mining operations is not only driving them away from their main sources of income but is also pushing them to relocate. But as mining activities increase, they are being forced to abandon their main sources of income and transition to farming without any land (Hu et al., 2014). Dinajpur district is one of the major crop production zones in Bangladesh. At the Barapukuria coal mine area and its surrounding area, paddy is the primary agricultural commodity produced. Hence, it's crucial to determine whether the coal mine project impacts the area's farmers' quality of life and paddy output. This study attempts to investigate the actual socioeconomic status of the farmers and to evaluate the impact of the Barapukuria coal mine on many aspects of farmers' wellbeing, which can be divided into environmental, social, and economic aspects. The findings would benefit farmers as well as offer researchers' pointers for understanding the situation of the farmers in that region and conducting future research. To set up agricultural policies in the mining area and avoiding any negative effects of the coalmine project, policymakers will benefit from the knowledge provided by this research.

Conceptual Background and Hypotheses of the Study

The sum of a farmer's wealth, degree of education, asset ownership, income relationship, and political involvement is considered to be a measure of that farmer's well-being. According to Sach and Warner (2001), a nation with plenty of natural resources may not always have rapid economic expansion. Owning an abundance of natural resources, according to Torvik (2002), can lower income and welfare. According to Gosawami (2014), coal mining has a detrimental impact on ecology, agricultural production, and community wealth. This study intends to investigate the effects of coal mining on farmers' well-being in environmental, social, and economic issues in coal mining concession areas.

Environmental Factors

Environmental issues and the level of affluence in the communities surrounding the coal mining authority area are inextricably linked to coal mining operations. The coal mining industry's environmental changes will influence the well-being of farmers in the coal mining region. The coal mining industry has negative consequences on welfare quality (as measured by economic, healthy, social, and infrastructure dimensions) that are brought on by deteriorating environmental circumstances (Suharto et al., 2015). According to research by Mubarok and Ciptomulyono (2012), most communities respond favorably to measures adopted in mining sites to preserve and control people's mental and physical health. In their study, Juniah et al. (2013) concluded that coal mining has an impact on environmental services, community benefits, and a variety of health conditions. According to Goswami and Goswami (2015), coal mining damages the environment and farms. To assess the impact of different environmental factors we assume the null hypothesis, H_1: There is no environmental impact of coal mining on farmers' well-being in the study area (Figure 1).

Economic Factors

Coal mining often enhances the overall well-being of the local community in nearby areas of the mining site. The study conducted by Suhartini and Abubakar (2017) determined that small-scale mining had a positive impact on social income and well-being. The presence of a coal mining enterprise is anticipated to enhance profitability in the farming industry via greater demand and higher prices for agricultural products. Furthermore, there is a growing endorsement of workers in the workforce and a guarantee that agricultural regions would not be converted for other purposes. The economic aspects are assessed based on the conversion of agricultural land, which might have an impact on the welfare of farmers. This study proposes the following hypothesis to be tested, denoted as H_2: There is no economic impact of coal mining on farmers' well-being in the study area (Figure 1).

Social Factors

The social aspects examined in this study include farmers' expertise and experience, their view of the mining sector, the presence of farmer groups, and signs of solidarity within these groups. Experiences include a range of knowledge and events acquired during one's lifetime history. As one gets older, their accumulation of experiences will continue to grow. In this research, it is proposed to test the hypothesis as follows: H_3: There is no social impact of coal mining on farmers' well-being in the study area (Figure 1).

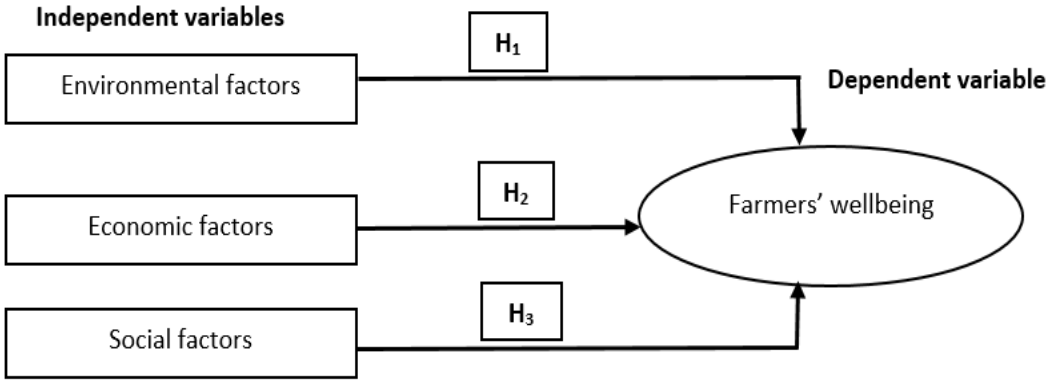

Figure 1. Conceptual Framework of Independent Variables Effect on Dependent Variable

Materials and Methods

Selection of the Study Area

The study was conducted in the Barapukuria coal mine area under the Parbatipur upazila of Dinajpur district (Figure 2). To assess the detailed information about socio-economic, environmental, and economic aspects of paddy cultivation, data were collected purposively from five villages named Durgapur, Shahgram, Kalupara, Chouhati, and Pathrapara considering the nearby locations of the coalmine area where no economic and farmers' welfare study has yet been conducted previously.

Figure 2. Selected study area (Parbatipur upazila of Dinajpur district in Bangladesh)

Selection of Sample and Sampling Technique

A multistage random sampling technique combining purposive and random sampling at different stages was followed in this study. In the first stage, Barapukuria from the Parbatipur upazila of Dinajpur district was chosen purposively. In the second stage, a total of five villages were also selected purposively considering the nearby place of the coal mine area. In the last stage, 20 farmers from each village, in total of 100 (12% of the total population) sample paddy farmers were selected using lottery system to avoid biasness through simple random sampling technique. The farmers actively engaged in paddy cultivation and the total numbers of farmers were 850 in the study area. The researcher collected relevant information of the farmers from the local Upazila Agricultural Office. A pre-tested, structured interview schedule was used for primary data collection purposes.

Period of Data Collection

The duration of data collection was January to March 2020. To obtain trustworthy data, the researcher initially visited the study area several times and data were collected during the leisure period of the respondents.

Table 1. Socioeconomic characteristics of sample paddy farmers

Selected Characteristics	Categories score	Farmers (n=100)
		Percentage (%)
Gender	Male	96
	Female	4
Age	Young aged (18-35 years)	7
	Middle aged (36-50 years)	52
	Old aged (>50 years)	41
Education	No Formal Education	22
	Primary (1-5th)	52
	Secondary (6-10th)	18
	Higher Secondary (11-12th)	4
	Graduation and above (>12th)	4
Farming experience	1-10 years	20
	11-20 years	37
	21-30 years	21
	31-40 years	13
	>40 years	9
Farm size	Landless farmers (<0.05 acres)	45
	Marginal farmers (0.05-0.49 acres)	34
	Small farmers (0.5-2.49 acres)	14
	Medium farmers (2.50-7.49 acres)	5
	Large farmers (>7.50 acres)	2
Extension service received	Yes	31
	No	69
Training received	Yes	17
	No	83
Agricultural credit received	Yes	93
	No	7

Source: Field Survey, 2020.

Data Analytical Technique

The study's data analysis was conducted using Microsoft Excel and SPSS software. To present the socioeconomic status of the sample farmers, descriptive statistics were used. To assess the farmers' well-being considering the environmental, economic, and social factors, a multiple linear regression analysis was applied. In the regression model, the dependent variable was farmer well-being (Y), and the independent variables consisted of environmental factors (X_1), social factors (X_2), and economic factors (X_3). The independent variable- farmers' well-being and dependent variables i.e. environmental, social and economic factors were assessed using a five-point Likert scale, which assigned scores ranging from 1 to 5. In which, Strongly Disagree=1, Disagree=2, Neutral=3, Agree=4, and Strongly Agree=5. The Likert scale in this calculation is used to quantify farmers' perceptions, attitudes, and experiences related to environmental, social, and economic factors, as well as their overall well-being. By assigning numeric values to qualitative

responses, the Likert scale enables a structured and comparative analysis of subjective factors, providing insight into farmers' perspectives on each indicator.

The following regression model was used to test the proposed hypotheses: $Y=\beta_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+e$

Where, Y=Respondents' well-being; β_0=constant; $\beta_{1, 2, 3}$=regression coefficient of each independent variable; X_1=environmental factors; X_2=social factors; X_3=economic factors; e=residual factors.

Results and Discussion

The socio-demographic characteristics of the respondents are important since they have the potential to impact the agricultural practices of farmers. The socioeconomic background of respondents indicates that most of the farmers were (96%) male rice farmers and just 4% female paddy growers. According to Table 1, the respondents were classified in three categories (Islam et al., 2023), in which largest proportion of chosen farmers was middle aged (36-50 years), accounting for 52% of the total. The literacy level of farmers significantly influences the decision-making processes of agricultural output. Table 1 demonstrates that the majority of the chosen farmers (52%) had received education up to the primary grade.

A large number of farmers (37%) have a range of 11-20 years of experience, which includes the cultivation of other commodities such as wheat, maize, and vegetables, in addition to rice farming. According to farm size, the respondents were classified into five different categories (Islam et al., 2023). The study results indicate that around 45% of the individuals surveyed were marginal farmers, with less than 0.05 acres land. Only 2% were large farmers owned more than 7.50 acres of land. The most crucial determinant of agricultural productivity is the training and extension service, as seen in Table 1. Approximately 69% of the farmers surveyed said that they had regular interactions with extension agents throughout the cultivation of paddy. Merely a few of the surveyed farmers (17%) have received instruction in agricultural practices, while the majority (83%) have not taken part in any agricultural training programs conducted by various governmental organizations (GOs) and non-governmental organizations (NGOs). Microcredit is widely used in rural areas of Bangladesh, with over 93% of farmers using this service specifically for rice cultivation (Table 1).

Farmers' Well-being Analysis

Natural resource abundance does not always equate to a successful environment for the local inhabitants. According to Sachs and Warner (2001), economies in nations with plenty of natural resources are growing slowly. Stiglitz et al. (2011) identified various dimensions of well-being, including physical and economic insecurity, material living standards (such as income, consumption, and wealth), health, education, personal activities (such as work and political participation), governance, social relationships and kinship, and the environment (both current and future conditions). To examine the relationship between farmers' well-being and environmental, social, and economic factors, a multiple linear regression analysis was conducted.

Reliability Test

Research variables such as well-being, economic considerations, social factors, and environmental factors are subjected to reliability testing. Reliable tools can be used again to measure the same thing and deliver consistent results. If an instrument has a Cronbach's alpha value greater than 0.60, it is considered reliable (Ghozali, 2011). Based on Table 2, all research instruments are said to be reliable.

Table 2. Reliability Test

Variable	Cronbach's Alpha	Explanation
Environmental factors (X_1)	0.77	Reliable
Social factors (X_2)	0.75	Reliable
Economic factors(X_3)	0.76	Reliable
Well-being (Y)	0.80	Reliable

Source: Authors Calculation, 2020

Normality Test

The objective of a normality test is to ascertain whether the data is normally distributed. The Kolmogorov-Smirnov test is employed to check for normality. If the Asymptotic Significance (2-tailed) level exceeds 0.05, data is regarded as normally distributed. (Ghozali, 2011; Sujianto, 2009). The Asymptotic Significance (2-tailed) value of the normality test is greater than 0.05, as indicated in Table 3. This illustrates that the data were distributed normally.

Table 3. Normality Test

Variables	Statistics	Sig.	Decision
Environmental factors(X_1)	0.021	0.200	Normal
Social factors (X_2)	0.013	0.350	Normal
Economic factors (X_3)	0.019	0.225	Normal
Well-being (Y)	0.015	0.501	Normal

Source: Authors Calculation, 2020

Multicollinearity Test

The multicollinearity test is measured by the Variance Inflation Factor (VIF) and tolerance values. The findings in Table 4 indicate that none of the independent variables had a VIF value over 10 and a tolerance value below 0.10. Thus, it can be said that there is no multicollinearity among the explanatory variables included in the regression model (Sujianto, 2009).

Table 4. Multicollinearity Test

Variables	VIF	Tolerance	Decision
Environmental factors (X_1)	1.01	0.988530	No multicollinearity
Social factors (X_2)	1.02	0.984605	No multicollinearity
Economic factors (X_3)	1.02	0.980335	No multicollinearity
Mean VIF	1.02		

Source: Authors Calculation, 2020

Heteroscedasticity Test

The heteroscedasticity test seeks to ascertain if inequality of variant and residual between one observation and another observation occurs in the regression model. The Glejser test was included in this study's heteroscedasticity test. If the probability is greater than the 0.05 confidence level, the regression model is not a heteroscedasticity problem (Ghozali, 2011).

Table 5. Heteroscedasticity Test

Variables	t	P value	Explanation
Environmental factors(X_1)	1.107	0.460	No heteroscedasticity
Social factors (X_2)	0.742	0.241	No heteroscedasticity
Economic factors (X_3)	1.179	0.139	No heteroscedasticity

Source: Authors Calculation, 2020

The heteroscedasticity test in Table 5 shows that the t-significance values for the dependent variable, Absolute Residual are all more than the alpha level (α = 0.05), indicating their statistical significance. Therefore, it may be inferred that the regression model did not exhibit any signs of heteroscedasticity.

Description of Regression Variables

The variables used to analyze farmers' well-being surrounding the coal mining concession area consist of independent variables and dependent variables. The independent variables are:

(1) Environmental factors, namely cultivate land condition (X_11), company commitment to coal washing wastewater treatment (X_12), company commitment to reduce pollution (X_13), protection to water sources for agriculture (X_14), and company commitment not to conduct any agricultural land function conversion (X_15).

(2) Social factors, namely knowledge and experience of the farmer (X_21), farmer perception of coal mining (X_22), social status (X_23), existence of the farmer group (X_24), and togetherness in the farmer group (X_25).

(3) Economic factors, namely increased profit in farm works (X_31), land size (X_32), labor support from family (X_33), stability of grain price (X_34), and better social interest in farmer work (X_35).

(4) The dependent variable is well-being (Y) indicators of health (Y_1), level of education (Y_2), asset ownership (Y_3), income of farmer work (Y_4) as well as social and political role (Y_5).

The Likert scale-based estimation of these indicators is presented in Table 6. Each respondent's well-being score is calculated by aggregating scores across these indicators, resulting in an aggregated index score, which serves as a continuous variable for statistical analysis. While individual Likert-scale responses are technically ordinal (discrete).

Table 6. Descriptive Statistics of Research Variables

Variables	Indicators	Score					Mean
		1	2	3	4	5	
		f	f	f	f	f	
Environmental Factors	X_11	5	17	34	37	7	3.24
X_1	X_12	8	12	19	39	22	3.55
	X_13	7	6	11	59	17	3.73
	X_14	5	26	33	19	17	3.17
	X_15	8	14	17	45	16	3.47
Total X_1							17.16

Social Factors (X_2)	$X_2$1	1	10	22	50	17	3.72
	$X_2$2	3	14	18	55	10	3.55
	$X_2$3	2	20	29	35	14	3.39
	$X_2$4	7	8	15	57	13	3.61
	$X_2$5	3	14	18	50	15	3.6
Total X_2							17.87
Economic factors (X_3)	$X_3$1	4	7	30	49	10	3.54
	$X_3$2	6	4	22	54	14	3.66
	$X_3$3	6	16	36	24	18	3.32
	$X_3$4	4	19	38	25	14	3.26
	$X_3$5	5	19	28	27	21	3.4
Total X_3							17.18
Well-being (Y)	Y_1	7	5	17	61	10	3.62
	Y_2	6	8	13	61	12	3.65
	Y_3	6	10	45	33	6	3.23
	Y_4	8	7	44	30	11	3.29
	Y_5	7	8	31	46	8	3.4
Total Y							17.19

Source: Authors Calculation, 2020

Here, the mean scores for environmental factors (X_1) range from 3.17 to 3.73, with an overall mean of **17.16** reflects a moderately positive perception of environmental commitments by companies, but the variability suggests mixed satisfaction levels among farmers. The mean scores for social factors (X_2) range from 3.39 to 3.72, with an overall mean of **17.87** imply that farmers have a moderate to high level of knowledge and engagement in social activities, with positive perceptions of community solidarity. The mean scores for economic factors (X_3) range from 3.26 to 3.66, with an overall mean of **17.18** indicates farmers show moderate economic satisfaction. The mean scores for well-being (Y) range from 3.23 to 3.65, with an overall mean of **17.19**. The wellbeing scores reflect a moderately positive assessment. The descriptive statistics of research variables suggest that while farmers experience some degree of wellbeing, certain environmental and economic issues, such as resource protection and price stability, may need attention to improve their overall quality of life.

Result of Regression Analysis

Table 7 presents a concise overview of the regression findings on the impact of environmental, social, and economic factors on the well-being of farmers living near coal mining concessions.

Table 7. Summary of Multiple Linear Regression Analysis

Variables	Coefficients	Standard error	t statistics	Sig.
Constant	1.510	0.412	3.66	0.000
Environmental factors (X_1)	0.391	0.074	5.29	0.000***
Social factors (X_2)	0.108	0.072	1.50	0.137
Economic factors (X_3)	0.165	0.0617	2.69	0.008***
F = 33.96	Prob > F = 0.000			
R = 0.815,	R^2 = 0.83, Adjusted R^2 = 0.81			

Source: Authors Calculation, 2020

Note: *** Significant at 1% level; **Significant at 5% level

Based on the Table, then, the regression equations are prepared as follows:

$$Y=1.510+0.391\ X_1+0.108\ X_2+0.165\ X_3$$

The regression coefficient for the environmental factor variable is 0.391 units which is significant at a 1% level of significance, indicating that each more action connected to the environmental factor will result in a 0.391 unit rise in farmers' well-being. The regression coefficient for the economic factor variable is 0.165 which is significant at a 1% level of significance, indicating that each action connected to the economic component would boost farmers' well-being in the coal mining concession region by 0.165 units.

Testing the significance of each independent variable on the dependent variables is accomplished through

the use of the t-test. The t-value is 5.29 and the significance level is 0.000, as determined by the statistical calculations of environmental factor variables (X_1). If the t arithmetic is greater than the t table, it indicates that environmental factors have a positive and significant impact on the well-being of farmers in the vicinity of the coal mining concession areas. Therefore, the hypothesis (H_1) that was proposed is refuted. The statistical computation for the economic factor variables (X_3) yielded a t arithmetic value of 2.69 and a significant level of 0.008. This indicates that there are substantial correlations and impacts between the economic aspects and the well-being of farmers living in the vicinity of coal mining concession areas. Therefore, the suggested hypothesis (H_2) is invalidated. The statistical computation for the social factor variables (X_2) yielded a t value of 1.50 and a significance level of 0.137. The t-statistic for social factor variables is less than the critical value from the t-table, indicating that social factors have positive impacts on farmer's well-being but these effects are not statistically significant.

The R-squared value (R^2) of 0.83 indicates that environmental factors, social factors, and economic factors can account for 83% of the variation in farmers' well-being in the coal mining concession area.

Effects of Environmental, Social, and Economic Factors on Farmers' Well-being

The results of the study show that economic and environmental factors have a positive and significant impact on farmers' well-being in the vicinity of the coal mining concession area. These research results concur with those of Fatah (2008). It implies that environmental management contributes to greater well-being. Regulating land and water pollution by proper oversight and implementing protective measures at water sources for agriculture might lead to an increase in agricultural production, hence potentially enhancing farmers' income. Coal mining will benefit low-income neighborhoods, but it will also have a growing negative impact on the environment. Farmers are encouraged to work harder so that they can increase their income and, ultimately, their well-being because of the existence of work labor support from the family and the certainty that agricultural land will not be converted. This research supports of Wahed (2015) assertion that the farmers' well-being is significantly influenced by the land. The results of the study also show that social variables have a small but favorable impact on farmers' well-being. The knowledge and experience of farmers in their profession play a significant role in attempts to enhance well-being. The transmission of knowledge about farmers' labor from one generation to the next has no real impact on the welfare of farmers. Farmer opinions of the presence of coal mining are classified as moderate, which hinders their ability to fully capitalize on commercial prospects. These study results contradict the assertion made by Ruky (2006) that knowledge and experience may enhance performance.

Conclusion

This research has provided an analysis of the environmental, social and economic effects of mining on the well-being of paddy producers located near the Barapukuria coal mine area. Rice farming is found mainly male dominated and a large portion of them were middle aged. Majority of the respondents were marginal and small farmers. Extension services and training facilities were not well-introduced among them. The regression analysis reveals that environmental and economic factors positively influence farmers' well-being, with economic factors such as farm size and financial stability being significant predictors, while social variables have no significant effect. The study indicates that focused initiatives aimed at improving economic stability, offering farmer education, and enhancing environmental conditions could result in better livelihoods for farmers in the regions impacted by coal mining. Extensive future research is required to investigate the long-term effects of these initiatives, taking into account the changes over time in environmental, social, and economic factors, and their combined influence on farmers' well-being. Moreover, additional research could explore the wider regional consequences and the impact of government policies in facilitating sustainable agriculture in these areas. To enhance the well-being of farmers near the coal mining concession zone, businesses holding usage rights can increase their involvement in environmental management.

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