Agriculture-based Livelihoods and Mining: In synergy or conflict? Analyses from rural Rajasthan in India

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ABSTRACT

Mining operations close to the agriculture fields are known to affect traditional agricultural-based livelihoods. The study explores the impact of mining on livelihood by discerning the changes in the source of earnings of the households and changes in the cropping patterns pre and post-mining times and comparing the amount of fertilizer usage, the physical condition of livestock, and the amount of agriculture yield produced in the mining and non-mining regions. After-only with control design is used to compare the experimental and control groups, which are the mining and non-mining areas, respectively. The main occupation of the households in the mining villages has been transformed to manual labor. Farming and animal husbandry, which is still a significant income source in the non-mining village, indicates that their agriculture fields were intact against the agricultural fields close to the mines. A modified and extended version of the basic production function is used for modeling fertilizer consumption and agricultural output in regression estimation. The mean fertilizer use of mining villages is higher than non-mining by 14.15 kgs per Bigha. Higher use of fertilizer in mining areas indicates soil degradation in the agricultural fields near the mines. The mean production of maize in mining villages is lower than that of non-mining by 171.79 kgs per Bigha, establishing that agriculture has been affected by mining operations. Shift from poly cropping to mono-cropping in mining villages and, weak and feeble livestock in mining areas further point to the distressed state of farm-based livelihoods. To sustain the livelihoods of the affected community trickle-down approach needs to be replaced with a bottom-up approach through improvement in the skill sets of the affected households and creating enhanced livelihood opportunities for them.
Keywords: Agriculture-based livelihoods; mining; agriculture; resource wealth; development

1. Introduction

Economy, environment, and society are the three pillars of the triple bottom line approach to achieve sustainability. Economic activity, whether agriculture or industry, should be in synergy with the nation's environmental and social goals. Economic prosperity must be watchful of environmental safety and resource use on one hand and income inequality and poverty among the masses on the other, which fall within the ambit of environmental and social goals, respectively. Nations endowed with mines and minerals have excellent prospects for building their economic prosperity and social progress. The transformation of non-renewable natural resources into marketable products can facilitate the transition of a nation from a poor to a middle-income nation, and foster a better quality of life for the citizens of the country (Cameron & Stanley, 2017). It can spur employment opportunities, eradicate poverty and create backward and forward linkages (Libenthal et al., 2005; Barma et al., 2012). Many developing countries are well endowed with mineral reserves, which account for their enormous share of gross domestic product, at least 20 percent of total exports, public revenue, and employment (IMF, 2012). For instance, the monetary value of mining production in Sierra Leone and Mozambique in 2014 was approximately 54 percent and 38 percent of their gross domestic product, respectively (Canadian Audit & Accountability Foundation, 2017).

Mining operations have the potential to either negatively or positively influence the socio-economic life of rural communities in the ecosystems in which they are set up (Cole and Broadhurst, 2020). Mining operations have abundant prospects to serve in attaining the sustainable development goals (SDGs) as metals and minerals are essential for the progress of technology for sustainable economies (Vidal et al., 2013) and for the development of national economies and human development (Elshkaki et al., 2016). Thus, there is no denying the fact that the mining sector places economic and social transformation prospects more than the subsistence agriculture sector. However, it has been at the center of controversies for deficiencies in achieving economic and social goals.

As an extractive industry with a probability of adverse effects, mining is one of the most controversial development industries due to its environmental and social consequences (Syahrir et al., 2020). Skewed distributional effects of resource exploitation, like deforestation, benefit a few while leaving rural communities worse off (Millennium Ecosystem Assessment, 2005). As the bulk of mines are situated in tribal areas, apart from direct dislocation of people residing there, mining disturbs the livelihoods of many more, due to the groundwater tables that gets disrupted, overburden gets dumped on fertile agricultural fields, and forests being cut for carrying out mining operations (Mahapatra,1991; Adu-Yeboah et al., 2008; Andrews, 2018; Issah and Umejesi, 2018). Agricultural ecosystems are essential to human welfare as they provide food, fodder, biofuel, and various biomaterials (like drugs, dyes, and stimulants). Agriculture is not only an essential source of livelihood for a large section of the rural community but also the source of food for the entire human race. In the entire mining process, from extraction to its closure, various acute issues sufficiently lack serious consideration, viz., the environmental and social impacts of mining and extraction activities (Hudson Mtegha, 2013). Damage or harm to common lands can significantly affect people's lives and livelihoods, especially in rural, underdeveloped areas (Shackleton, 2020). While extractive industries, business associations, and national and international development organizations argue in favor of the prospective progressive contributions from extractive industries to poverty reduction, several other voices have empirically defied the prevailing optimism (Gamu et al. 2015).

2. **Mining in Rajasthan and the Development Agenda**

Mining and Quarrying in Rajasthan contributes to 5.98 percent of the gross value added and generates annual income of about INR 359080 million (constant at 2011-12 Prices) for the state (Ministry of Statistics & Programme Implementation, 2021). Next to agriculture, it is the second

largest sector in terms of employment generation (Gunasekaran and Manicandan, 2009). The state employs as many as three million people directly or indirectly in the mining and mineral processing industry (Anjuam T., 2020). Mining in Rajasthan is one of the most important sources of revenue and employment generation. This sector's substantial fiscal contributions overshadow the vagaries of local rural communities that are hard hit by the mining operations and their aftermath. The spillover of mining operations enriches the health of a country's economy. However, on the other hand, it bestows a wide range of harmful bearings on the local people and their livelihoods (Appiah & Buaben 2012). Mining has brought displacement of local communities homing the mineral-rich regions, modified their livelihood, and also marginalized their social and economic life (Velath, 2009; Wellstead, 2011).
Rajasthan is a drought-prone state in India with severe and more frequent spells of drought. (Government of Rajasthan, 2022). Rural communities prepare for and respond to these risks, like water scarcity, through various strategies, such as changing agricultural practices, diversifying livelihoods, and leveraging social networks (Singh C.et al., 2018). However, these adaptation strategies have been made vulnerable due to socioeconomic and ecological dynamics. These comprise:

1. Damage and loss of common and grazing lands by unrestrained deforestation and encroachment leads to livestock and fuel wood deficiency.
2. Uncontrolled underground water withdrawal, ensuing severe deterioration in water levels.
3. Need to expand irrigation prospects, mainly defensive irrigation in the rain-fed zones.
4. Absence of job and entrepreneurial prospects, especially for small and marginal farmers (Singh 2012).

Rajasthan embraced achieving sustainability of livelihoods as one of the primary agenda, which echoed in the State's Human Development program (Human Development Report, Rajasthan, 2002). The study explores whether the mining activities in the state are considering the larger goals of the state of Rajasthan, which are people-centric.

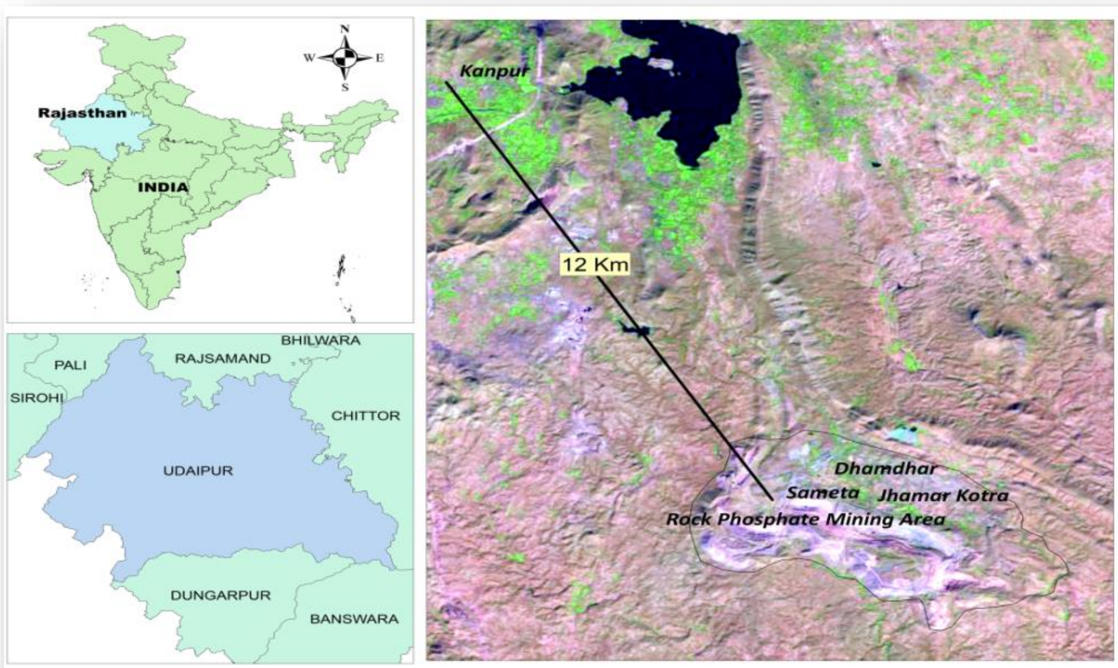
3. Materials and Methods

Experimental research design is used to ascertain the impact of mining (independent variable) on livelihoods. The modern experimental statistics applied widely in physical, biological, and social science is attributed to Professor R.A. Fisher's monumental work entitled "The Design of Experiments" (Stanley, J. C., 1966). The most relevant experimental design suited for this study is the after-only with control design, in which one experimental group and one control group are selected, and the treatment is administered to the experimental group only. Treatment impact is assessed by subtracting the value of the dependent variable in both groups (Kothari, C.R., 2004). Since mining (which would act as treatment) is an activity that has already occurred, here, ex post facto or after-the-fact research design is used, which is a category of quasi-experimental research design where the investigation starts after the fact has occurred without intervention from the researcher (Silva, C., 2010). It is more helpful in this study as it can be used in analyzing a cause based on the effect.
Agriculture-based livelihoods may be affected by factors like soil type and quality, weather conditions, irrigation, and socioeconomic level (Belay and Bewket, 2013) apart from the industrial activity in the vicinity of agricultural lands. Mining is the factor that the study tries to explore; therefore, the control group is selected so that all other variables that could affect

livelihood are the same as in the experimental group except for mining to ascertain the impact of only mining on agriculture-based livelihoods.

The mixed method research approach involving qualitative and quantitative methods is used while conducting intensive fieldwork in the tribal predominant belt of the Udaipur district. Qualitative research often involves detailed, open-ended analysis of verbal, written, or visual material, which is not converted into numerical scales (Searle, Ann., 1999). In contrast, the quantitative method involves data collection in numerical form.

Figure 1: Satellite Imagery of the Study Area



Source: Authors own (through Google Earth)

The region surrounding the phosphate mines is divided into different groups depending upon the nearness of the mines. Stratified random sampling is used. Two villages within 0-2 kilometers of the mining operations were selected as mining villages, and one non-mining village was categorized which lies around 10-12 kilometers away from the mining activity (figure 1). The mining and non-mining villages chosen were matched for homogeneity on various characteristics which may influence the livelihood choices like educational background, social status, skill sets, and access to local associations apart from climatic and other local conditions. The two mining villages were completely surveyed as their population of households was only 99 in Sameta and 116 in Dhamdhar. Therefore, in Sameta, all 99 households were surveyed, and in Dhamdhar, 106 households were surveyed, as the remaining households were unavailable during the survey. While in Kanpur (the non-mining village), out of the total of 829 households, 202 households were randomly sampled for the survey. The total number of households surveyed together in the two mining villages was 215 and 202 in the non-mining village. To assess the impact on agricultural yield, and fertilizer consumption, 135 households from mining and 134 from non-mining villages were surveyed.

Pictorial analysis has been carried out to understand the differential status of resources in the mining and non-mining region. Primary data is collected by conducting semi-structured interviews with gram sarpanch, social activists, and Non-Government Organizations (NGOs) and household surveys using a structured schedule. The empirical analysis in sections 4.3 and 4.5 to assess the impact on fertilizer consumption and agricultural yield is conducted using the production function approach. Production or output is a function of various inputs. Capital (K) and labor (L) are combined in an aggregate production function to determine the aggregate level of output (Y) of the economy.

In the Solow growth model the level of output (Y), the level of capital (K), and the level of labor (L) are all linked through the following production function equation

$$Y = F(K, L)$$

However, this overly modest structure excludes other inputs, such as natural resources, research, and education, which boost production (Hamilton. and Hartwick, 2014; Romer, 1990). The explicit omission of natural capital from theories of economic growth has been critiqued (Daly, 1996; NCC, 2015). Deterioration in environmental quality or natural resource stocks can adversely impact aggregate output (Polasky et al., 2015). Natural resources contribute significantly to economic sectors and services (e.g., tourism and recreation) as well as the role of some natural assets (greenspace and urban air quality) in enhancing human capital is well-established (Atkinson G, 2015). Nevertheless, the aggregate production function can be modified and extended to contain inputs other than labor and physical capital. Therefore, a modified, extended version of the basic production function is used for modeling fertilizer consumption and agricultural output estimation. The modeling estimation is done using the statistical software STATA 10.

4. Impact of Mining on Livelihood

Agriculture has been the primary source of living for the rural communities. With the advent of mining activities, the lives of communities close to the mining operations are primarily altered. Resource extraction via mining may bring more job opportunities, increase market accessibility for farmers and improve the rural infrastructure. However, it may also contribute to the marginalization of small farmers through land grabs, environmental deterioration, and structural labor market shifts (Wegenast T. & Beck Jule, 2020). Mining has several typical phases, each of which is detrimental to the natural environment, society and cultural heritage, livestock and wildlife biodiversity, and the health and safety of mine workers (Akabzaa TM, 2000; Noronha L., 2001; Kitula,2006, Askland, 2018). A study in Peru revealed that mining had influenced the terrestrial and water resources decreasing the access to piped water and polluting main rivers, thus adversely affecting livelihoods in the region (Bebbington & Bury, 2009). The livelihood strategies of communities have been affected by changes in the state of the environment due to pressures created by mining activities like alterations in land cover and habitat degradation resulting in biodiversity loss and pollution (Xavier et al., 2022).

4.1 Mining and Livelihood Shifts

One of the crucial ingredients of economic development is structural change. It entails the transformation of economies from agrarian-led to industrial and service-led economies. Structural transformation involves a changing pattern in livelihood options reducing the number of people from the agriculture sector to the industrial and service sectors (Losch, 2016). Structural change is estimated by shifting labor from low-productive traditional sectors to modern sectors with high efficiency (Zhang & Diao, 2020). An empirical investigation of structural change through labor push and labor pull in agriculture has been carried out (Alvarez-Cuadrado & Poschke, 2011). Also, studies have shown increasing concern for rural households needing to catch up to structural change (Zhang & Diao, 2020).

The predominantly agriculture-based livelihood in the pre-mining period in Sameta and Dhamdar (Figures 2 and 3) village has been shifted to various income-earning avenues like manual labor, driving, helper, and self-enterprise[1]. The main occupation of households has now been transformed into manual labor. Livelihood shifts in Kanpur village (Figure 4) depict the process of structural transformation in its true sense, as people have shifted from traditional agriculture to serving in government sectors like the police department, banking, and education sector. Animal husbandry as a significant income source indicates that agriculture fields were not

Figure 2: Percentage of Households with the major source of livelihood in mining village Sameta: Pre and Post Mining

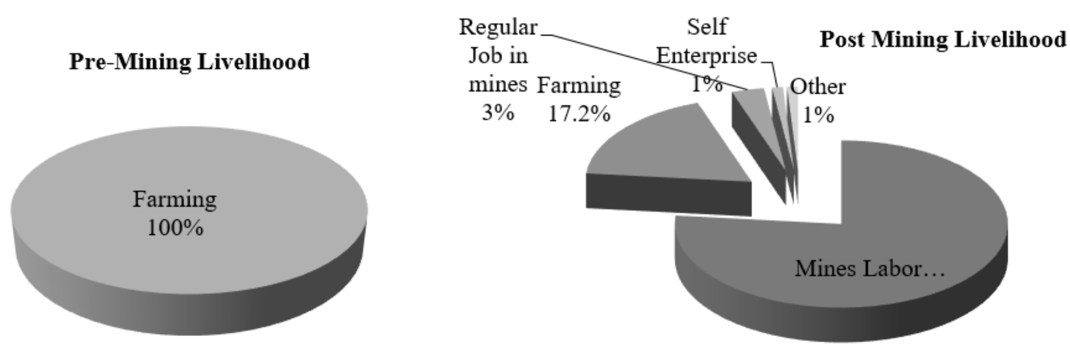


Figure 3: Percentage of Households with the major source of livelihood in mining village Dhamdar: Pre and Post Mining

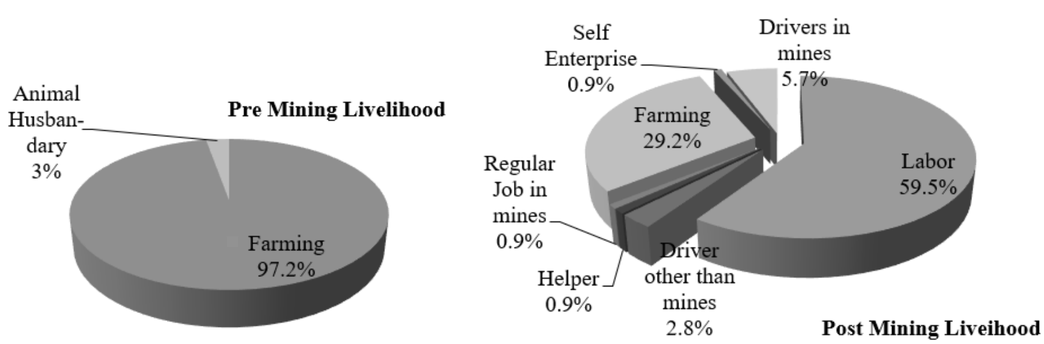
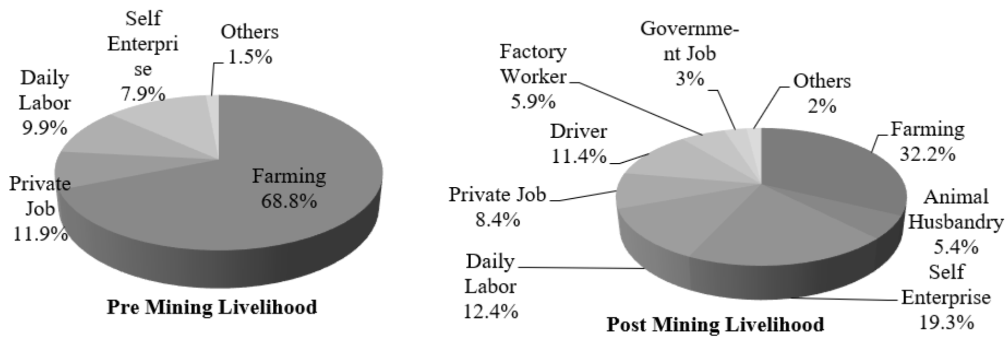


Figure 4: Percentage of Households with the major source of livelihood in non-mining village, Kanpur: Pre and Post Mining



disrupted, as in the case of villages close to the mines. Livelihood Shifts are a natural phenomenon in a developing society. However, it is worrisome when such transformations are thrust upon and without developing the required skill sets. Migration and remittances have mixed and countervailing effects on agriculture in the origin areas of migration due to subsequent declines in labor availability and income increases (Gray, 2009, Redehegn MA et al., 2019). The mixed effect has been witnessed here, too, with remunerative transformation in non-mining villages compared to mining. As remittances result in an investment boost, animal husbandry in the non-mining village has been boosted. These permanently increased avenues of income have resulted in opportunities for the youth of the households to enhance their skills for entry into the service sectors. This local-level disparity in the mining and non-mining regions of the study area is in tune with studies that claim that man-made disasters accentuate inequalities disrupting the well-being of the marginalized ones (Reid, 2013).

4.2 Mining and Cropping Pattern

In the arid and semiarid areas of the world, water scarcity is becoming an increasingly severe constraint to the growth of agricultural production (Raskin et al., 1998; Dalezios et al., 2018; Redhu, S., Jain, P., 2023). Mining operations extract tonnes of water from underground, reducing groundwater tables in the surrounding area (IEA, 2022; Qu S. et al., 2022). Previous studies endorse that mining results in huge losses of underground water resources (Kuma & Younger, 2004) and freshwater resources (Schueler et al., 2011). Water availability has conditioned the farming practices in the mining villages of the study area, i.e., Sameta and Dhamdar. Farming activity has been cut down from two crops (Rabi and Kharif)[2] to one crop (Rabi) in the mining villages, whereas the non-mining villages continue to harvest two crops. Farmers stopped growing water-demanding crops like wheat due to the depletion of the underground water table. This confirms previous studies stating mining degrades and decreases agricultural land by shortening the fallow period. (Akabzaa & Darimani, 2001). Mono-cropping is being practiced, which reduces the means of living for subsistence for a few and means of income for others. All in all, lowering the groundwater table has also brought many indirect effects, like increasing the fuel cost of pumping and further impoverishing them with scarce resources to perform farming activities.

4.3 Mining and Fertilizer Use

Mining results in the degradation of fertile land by destroying the soil surface and structure and decreasing the productivity of farming land (Mensah, 2011). Mining and its associated activities, like blasting and loading, form a silt cover on the croplands, reducing soil fertility. Vohra (2020) found that owing to the acid spillover of mining operations in Mayem village in northeast Goa, it produces barely 40 percent of the output even after doubling the fertilizer use.

A survey on fertilizer use by the mining and non-mining village farmers in the study region revealed striking outcomes. Mean fertilizer consumption per bigha[3] on the agricultural fields of the non-mining village is 7.14, while in the mining village, it is 20.48. Statistical analysis using Two group mean t-test (Table 1) on the means of fertilizer consumption further showed that this difference in fertilizer consumption is statistically significant[4]. The farming community in these regions ascribes soil degradation as the critical factor for the increase in the use of fertilizers. A deeper investigation during the survey with the members of the households revealed that shifting from poly-cropping to mono-cropping has contributed to soil degradation. Agricultural experts (Timothy M. Bowles et al., 2020) also recognize the significance of wheat in improving long-term corn yields through crop rotation, as does the farming community. Harvesting wheat in the crop rotation process involves several benefits like improving the quality of the soil, driving nutrients and furnishing nitrogen credit, putting a break on the cycle of persistent weeds, shielding the soil from eroding, and giving a decent return on investments (Warncke, 2007, Klein et al., 2016).

Table 1: T-test Two-group mean fertilizer consumption comparison test

Region	Observation	Mean	Std. Error	[95% Conf. Interval]	
Non-mining	134	7.13806	.1824403	6.7772	7.49892
Mining	135	20.4818	.4851415	19.52196	21.44101
Difference		-13.34342	.5197714	1.654221	6.859707

Diff = mean (Non-Mining) - mean (Mining) t = -25.74

Satterthwaite's Degree of Freedom = 171.132

Ho: Non-Mining Mean Score – Mining Mean Score = 0

Pr(|T| > |t|) = 0.0000

Fertilizer Consumption Model

Fertilizer is an input in the agriculture production process. An Inverse Production Function where input is a function of output (Debertin, 2012) is applied to determine the influence of agriculture output and type of location on fertilizer consumption. The fertilizer consumption model is used with fertilizer {Kilograms[5] (kgs) per Bigha} as the explained variable and agricultural yield (kgs per Bigha) and location as the explanatory variables (Table 2). The high R square (.715) value denotes that agriculture yield and location describe fertilizer use quite well.

$$\widehat{Y}_i = 4.25 + .006X_{1i} + 14.15D_i \qquad \text{Eq 1}$$

The dummy variable (D= 1 if Mining village, 0 if Non-Mining) is used to assess the impact of mining with the assumption that regions nearest to the mines would be affected most and would help to discern the environmental impacts of mining on agricultural production. The regression results can be interpreted as; holding agriculture yield constant; the mean fertilizer use of the mining villages is higher than non-mining village by 14.15 kgs per Bigha. Holding location differences constant, the agriculture yield coefficient of 0.006 denotes that the mean fertilizer use goes up by about 0.006 kgs per Bigha for production for every additional agricultural yield. As higher fertilization tend to increase the yield (Miltiadis Iatrou et al., 2018), higher use of fertilizer in the agricultural fields near the mines indicates soil degradation.

Table 2: Fertilizer Consumption Model

Fertilizer	Coefficient	Std. Error	t	P> t	[95% Conf. Interval]
Production	.0061397	.0027073	2.27**	0.024	0.008093 0.0114702
Dummy _Mining	14.14624	.6255795	22.61*	0.000	12.91452 15.37796
Constant	4.256964	1.321912	3.22*	0.001	1.654221 6.859707
F-Statistics(2, 266) : 337.20			Prob> F : 0.000		Adjusted R2 : 0.7150

Significance Level (* 1%, ** 5% and ***10%)

4.4 Mining and Livestock Rearing

Livestock acts as an essential livelihood asset for the farmers. The livestock sector is vital as a supplemental source of income for the farmers as it acts as a buffer in times of crop failure and monetary losses (Shanmathy, M., 2018). Cattle wealth, apart from holding a core cultural significance and a symbol of communal individuality and position for the cattle owners, also works as security against impoverishment (NSSO, 2012).

The mining operations in the study area especially blasting, loading, and transportation activities, result in enormous dust and particulate matter, which accumulates on the leaf surface of plants, rendering it non-consumable for the animals.

Figure 5: Livestock in the mining-affected villages: Sameta and Dhamdar

Source: Author’s Own

The livestock in the mining region is weak, thin, and feeble (Figure 5). The nonavailability of fodder, dusty open spaces, and lack of green grazing lands have resulted in the poor condition of the livestock. Livestock in the non-mining area are strong and healthy (Figure 6). The weak livestock is of minimal use as a source of dairy products for households or manure for agricultural fields.

Figure 6: Livestock in the non–mining village: of Kanpur

Source: Author's Own

4.5 Mining and Agricultural Yield

Industrial activity creates resource conflicts for the agricultural sector and generates productivity losses (Jain, P., & Jain, P., 2016). Agriculture and the industrial sector compete for inputs like water. Industrial operations create dust and smoke, which are deleterious for other life forms. Also the deposit of smoke particles on leaves obstructs the process of photosynthesis (Bergin et al. 2001). When the food-making process of the plants gets obstructed by dust on the leaf surface, it results in stunted growth and reduced productivity.
The impact of an economic activity resulting in negative externality[6] on agricultural yield can be estimated using various environmental valuation techniques. Productivity method[7] is one such method that can be used to quantify ecosystem services like soil fertility, temperature, and rainfall that contribute to producing a good or service that is traded on the market (Giani, 2013).

As the agricultural production function describes the technical relationship that transforms inputs (labor, seeds, fertilizer, etc.) into outputs (agriculture yield), any variation in the quality or quantity of the inputs would produce variations in output.

Agricultural Yield Model

$$Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 D_{1i} + u_i$$

$$\hat{Y}_i = 437.441 + 9.905 X_{1i} + 3.097 X_{2i} - 171.79 D_{1i} \qquad \textit{Eq 2}$$

Where Yi= Production of Maize in kg per Bigha.
X1=Ratio of Labor cost to Total Cost
X2 = Fertilizer use in Maize crop kg per Bigha.

D1i = 1 if the Mining Village and 0 otherwise.

The regression results (Table 3) show that the coefficient of fertilizer use (X2) is statistically significant at a 10 percent level, and location as the dummy variable in the model has a statistically significant coefficient at a 1 percent level. The mean production of maize in the Mining village is lower than in the Non-Mining village by 171.79 kg per Bigha, indicating the degraded quality of agricultural land that results in lower production in mining areas. The coefficient of labor to total cost has been found to be insignificant, which indicates that variations in labor cost in the total cost of agriculture production would not bring in substantial changes.

Table 3: Agricultural Yield Model

Variables	Coefficients (β)	Std. Err.	t-test Value	P-Value
Constant	437.441	604.616	0.72	0.470
Labour-Cost Ratio(X_1)	9.905	611.738	0.02	0.987
Fertiliser (X_2)	3.097	1.646	1.88***	0.061
Mining Village(D_1)	-171.789	24.877	-6.91*	0.000
F-Statistics (3, 265):43.77		Prob> F: 0.000	Adjusted R2: 0.3331	

Significance Level (* 1%, ** 5% and ***10%)

5. Summary

As the agriculture sector is said to face inter-sectoral resource conflict arising out of any industrial activity in its vicinity (Jain, P., & Jain, P., 2020), the study explores the impact of mining operations on the traditional agricultural-based livelihoods in the mining regions of rural Rajasthan. After-only with control design is used in the study to determine how mining operations have affected agriculture and agriculture-based livelihood activities by comparing the impacts in the experimental and control groups, which are the mining and non-mining areas, respectively. The impact of mining on livelihood is explored through the impact on change in the source of earnings of the households and change in the cropping patterns in the pre and post-mining periods and a comparison of the amount of fertilizer usage, the physical condition of livestock and the amount of agriculture yield produced in the mining and non-mining regions.

Largely farming-based livelihoods in the pre-mining period in Sameta and Dhamdar villages have been transformed into diverse income-earning avenues like manual labor, driving, helping, and self-enterprise in the post-mining period. The main occupation of households has now been transformed into manual labor. Livelihood alterations in the non-mining village describe the process of structural change in its true sense, as individuals have moved from traditional agriculture practice to serving in sectors like police department, banking, and education sector, and some are into self-enterprise. Farming and animal husbandry as a significant income source in the non-mining village indicates that agriculture fields were not disrupted, as in the case of villages close to the mines. The pattern of livelihood changes in the control and experimental groups shows that agriculture has been affected severely in the mining villages, which has been further explored and established through fertilizer consumption and agriculture yield regression models. The use of fertilizer (Y, Kg per Bigha) in Mining village is higher than Non-Mining villages by 14.15 kg per Bigha. The production of maize(Y) in the Mining village is lower than in the Non-Mining village by 171.79 kg., establishing that agriculture has been affected by mining operations. Shift from poly cropping to mono-cropping in mining villages, weak and feeble livestock in mining areas further points to the distressed state of farm-based livelihoods. The higher use of fertilizer, reduced agriculture yield, mono-cropping, and lean livestock in the mining villages indicate the impact of mining operations, which not only increases the cost of production but also reduces the incomes of the farming households.

6. Discussion and Policy Relevance

Has the shift in focus towards sustainability of livelihoods which is pro-people and pro-poor, been able to manifest in reality? The study shows that livelihood changes in the mining regions have yet to bring the intended changes of inclusive, decent, and sustainable livelihoods that development should bring about.

1. The livelihood shift that has taken place does not offer any social security: health benefits, retirement benefits, paid holiday benefits, and not even job security.
2. Contractual manual laborers are stigmatized as being contractual, not regular. There is a sense of social exclusion, for they feel discriminated for having offered contract labor compared to regular jobs.
3. These livelihood shifts tend to accentuate inequalities and socioeconomic distress, as the hardships of the laborers have increased without improvement in their skill sets.

Anthropogenic disasters unreasonably affect the livelihoods and landscapes of rural populations, undermining the welfare, disrupting social networks, accelerating the inequalities between rural and urban populations, and disparities in access to state resources and supports. (Susan P. Kemp & Lawrence A. P., 2015). Mining cannot be halted completely, but alternative solutions can simultaneously be formulated to sustain the livelihoods of the affected community. The trickle-down approach needs to be replaced with a bottom-up approach by improving the skill sets and creating enhanced livelihood opportunities for them both inside the mining units and outside. Economic support, financial allocations (Ioanna & Stefanos, 2018), and activities under corporate social responsibility are to be meticulously targeted toward achieving these ends. Designing a responsible policy through the triple bottom line approach of sustainability catering to profit, planet, and people (Jain. et al., 2022) has to be executed through a participatory method involving all the stakeholders.

Footnotes

1. Manual labor, river, helper, and self-enterprise involve physical work (lifting heavy blocks of raw material in factories), driving vehicles, earth drillers, and mining machine workers; self-enterprise involves self-employment (grocery shop), respectively.
2. Kharif is a rainfed crop, and Rabi is an irrigated crop.
3. Bigha is a unit of measurement of land. One Bigha, a local unit of area, equals 2529.28 square meters.
4. Significant (Statistically) implies that the difference is not due to chance, but there is/are some other factor(s) causing this difference to occur.

5. A kilogram is a unit of measurement of mass (here fertilizer)
6. Negative externalities refer to situations when the production or consumption of a commodity or service has a negative impact on a third party independent of the transaction.
7. Productivity Method is a method for assessment of the economic value of ecosystem products or services that contribute to the production of marketed goods

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Declaration:

We declare that we have no significant competing interests that might have influenced the work described in this manuscript.

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