
WHEN MINING EXPANDS AND FARMING WEAKENS: LOCAL SOCIAL CAPITAL, COCONUT PRODUCTIVITY, AND FARMER WELFARE IN AN INDONESIAN ISLAND ECONOMY

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Email id: nurul_pdie18@student.ub.ac.id ¹nurul.hidayah@unkhair.ac.id ¹pudjihardjo@ub.ac.id ²multifiah@ub.ac.id ³nurulbayhaqi@ub.ac.id ⁴Affiliation: University of Brawijaya/University of Khairun¹, University of Brawijaya^{2,3}**ABSTRACT**

This study examines how extractive industry expansion indirectly affects agricultural productivity and farmer welfare in a non-mining rural area, and whether community-based social capital can buffer these pressures. Drawing on survey data from 284 coconut farmers in Oba District, Tidore Kepulauan City, Eastern Indonesia, this study compares farmer conditions before and after the expansion of nickel mining activities in the wider regional economy. The analysis combines descriptive statistics, Wilcoxon Signed Rank tests, and multiple linear regression. The findings show a significant decline in coconut productivity and farmer welfare after the expansion of nickel mining activities. Coconut productivity decreased from 3.8858 to 3.4842, while farmer welfare declined from 3.2283 to 2.7125. Regression results indicate that farmer interaction and cooperation, as manifestations of the local Babari tradition, positively influence both productivity and welfare. However, the negative post-mining effect suggests that local social capital, while protective, is insufficient to fully offset structural pressures created by mining-led economic transformation. The study contributes to debates on extractive development, rural resilience, and informal institutions by demonstrating that local traditions can sustain agricultural communities but require institutional and policy support to remain effective under rapid industrial change.

KEYWORDS: Social Capital; Extractive Industry; Coconut Farmers; Rural Welfare; Babari Tradition**1. Introduction**

Extractive industry expansion has become a major pathway of regional development in many resource-rich economies, especially in developing countries seeking investment, employment, infrastructure growth, and new industrial centers. Recent studies show that regional industrial development and growth-pole formation can accelerate economic transformation when supported by infrastructure, innovation, and diversification policies (Sodikov et al., 2025). However, mining-led growth also produces uneven regional outcomes. The relationship between extractive industries and regional diversification remains complex because mining may generate growth while simultaneously creating dependency, sectoral imbalance, and uneven development across regions (Breul & Atienza, 2022; Breul & Nguyen, 2022; Lufin & Soto-Díaz, 2022). In this sense, extractive expansion is not merely an economic process but also a structural transformation that reshapes local livelihoods, institutions, and social relations.

Recent literature increasingly argues that the consequences of extractive industries extend beyond mining concession areas. Resource-dependent development may generate economic growth, but it can also create structural constraints associated with the resource curse, including weaker innovation, limited diversification, and uneven regional development (Gao et al., 2024). In rural areas, mining expansion may produce bittersweet livelihood effects: it can provide new employment and income opportunities, yet at the same time weaken agricultural livelihoods, encourage labor outflow, and contribute to rural hollowing (Zhao & Niu, 2023). Evidence from Indonesia also shows that extractive expansion can overlap with other land-based industries and produce social differentiation, unequal access to land and resources, and livelihood change in rural communities (Toumbourou et al., 2022). Moreover, mining frontiers can reorganize labor relations in ways that marginalize peripheral regions and reshape local livelihood structures (Vela-Almeida & Karlsen, 2023). These studies suggest that mining affects rural economies not only through direct land conversion, environmental degradation, or pollution, but also through indirect socio-economic spillovers that transform labor allocation, livelihood strategies, and local social relations.

The indirect effects of extractive industries are especially important in agrarian regions where farming remains central to household welfare. In rural communities, agriculture depends not only on land and capital but also on labor availability, social cooperation, knowledge exchange, and collective action. When mining attracts workers away from farming, the agricultural sector may face labor shortages and declining collective work arrangements. (Shiquan et al., 2022) emphasize that vulnerable communities are often harmed by mineral resource extraction, while (Oke & Wilson, 2024) show that extractive projects can place pressure on local services and community well-being through rapid workforce changes. In the governance literature, (Dashwood et al., 2022) and (Yanuardi et al., 2021, 2022) also argue that extractive governance often struggles to address local institutional barriers and social-ecological consequences. Therefore, the development impact of mining should be assessed not only through output, revenue, and employment, but also through its effects on local institutions and rural welfare. Social capital is one of the key institutions that helps rural communities maintain agricultural resilience. In agrarian settings, social capital appears through trust, reciprocity, farmer interaction, cooperation, information sharing, and collective labor. (Slijper et al., 2022) show that social capital and learning are closely related to farmers' resilience, while (De Grandpré et al., 2022) describe social capital as a form of "soft adaptation" that helps build resilient agricultural landscapes. Recent studies also show that social capital can enhance farmers' livelihoods, adaptive behavior, and quality of life. (Zhang & Zhao, 2025) find that non-agricultural employment and social capital play important roles in shaping Chinese farmers' livelihoods. (Yazdanpanah et al., 2025) demonstrate that social capital supports adaptive behavior among farmers, while (Prayitno et al., 2025) show that social trust contributes to farmers' quality of life in Indonesia. In cooperative and community-based farming contexts, (Iyoku et al., 2024) and (Mmbughu et al., 2025) also show that social capital can strengthen farmers' participation, collective organization, and livelihood resilience.

This study examines these issues through the case of coconut farmers in Oba District, Tidore Kepulauan City, North Maluku, Indonesia. Oba is an important coconut-producing area, where coconut farming remains a major foundation of rural livelihoods. In 2023, Oba produced 6,138 tons of coconut, with 5,052 hectares of coconut plantation area and 2,046 coconut farmer households, making it one of the most important coconut-producing districts in Tidore Kepulauan City. Coconut farming in this area is supported by **Babari**, a local tradition of mutual assistance, collective labor, cooperation, and solidarity. Babari is not only a cultural practice but also a localized form of social capital and informal institution that helps farmers coordinate agricultural work, exchange information, mobilize labor, and maintain social cohesion. The importance of local traditions for community resilience in North Maluku has also been emphasized by (Singgalen, 2020) and (Zuhdi et al., 2022) who show that trust, vulnerability, and local traditions remain central to social life in the region.

The case of Oba is important because the district is not the main mining center, yet it is affected by the wider expansion of nickel mining in North Maluku. The dissertation explains that nickel mining activities are located around 75 km, or approximately 2–3 hours by land transportation, from Oba District, but the impacts are felt indirectly through changes in employment orientation, labor mobility, social interaction, and agricultural practices. This reflects a broader problem in extractive regional development: agricultural communities outside mining concessions may still experience structural pressure from mining-led transformation. In the Oba case, farmers perceived that coconut productivity declined from 3.885827 before mining expansion to 3.484252 after mining expansion, while farmer welfare declined from 3.228346 to 2.712598. These figures should be understood as perceived productivity and perceived welfare, because they were measured using a Likert-scale survey rather than physical production or income data.

Despite growing scholarly attention to the socio-economic and environmental consequences of extractive industries, existing studies have largely concentrated on communities located within or near mining concession areas, particularly in relation to land-use conflict, environmental degradation, displacement, pollution, and livelihood disruption. Much less is known about how mining-led regional economic transformation affects agricultural communities that are not directly located in mining zones. This omission is important because extractive industry expansion can generate spillover effects beyond the physical boundaries of mining sites through labor mobility, changing wage expectations, shifting livelihood aspirations, weakening collective labor practices, and transforming local social relations. In particular, limited research has examined how such spillover effects reshape rural resilience by altering the role of local social capital and informal institutions in sustaining agricultural productivity and farmer welfare. This study addresses this gap by examining how nickel mining expansion in North Maluku indirectly affects coconut farmers in Oba District, a non-mining agricultural area, and by analyzing whether Babari-based social capital can buffer the structural pressures generated by mining-led transformation.

The theoretical contribution of this study is therefore located at the intersection of extractive industry spillover, rural resilience, social capital, and new institutional economics. Unlike a conventional impact study that treats local tradition as contextual background, this article treats Babari as an informal agrarian institution. Babari is examined as a set of locally embedded rules, norms, reciprocal obligations, and collective labor arrangements that reduce coordination costs

and sustain agricultural work. This framing distinguishes the article from the earlier national paper on indirect mining impacts by shifting the analytical center from mining impact measurement to the institutional capacity and limits of Babari-based social capital under extractive transformation.

Based on this gap, this study addresses the following research questions:

- (1) How does extractive industry expansion indirectly affect perceived coconut productivity and farmer welfare in a non-mining rural area?
- (2) To what extent does community-based social capital, represented by Babari, support perceived coconut productivity and farmer welfare?
- (3) Why is local social capital unable to fully offset the structural pressures generated by mining-led regional economic transformation?

Therefore, this study aims to analyze how nickel mining expansion indirectly affects perceived coconut productivity and farmer welfare in Oba District, and to examine whether Babari-based social capital can buffer these pressures. By focusing on a non-mining agricultural area affected by mining-led regional transformation, this study contributes to the literature on extractive industry spillover, rural resilience, social capital, and informal institutions.

2. Literature Review and Hypothesis Development

2.1 Extractive industry and rural livelihood transformation

Extractive industry expansion has become a major driver of regional economic transformation in many resource-rich developing economies. Mining activities can generate employment, infrastructure development, regional revenue, and new market opportunities. However, recent studies show that the developmental effects of extractive industries are uneven and often produce social, economic, and environmental pressures for rural communities. (Shiquan et al., 2022) argue that mineral resource extraction can damage community welfare, particularly among vulnerable groups, through income loss, health risks, and livelihood disruption. Their study also shows that mining activities affect community structures through income composition, social stability, health, and organizational change. The transformation caused by mining is not limited to communities located directly within mining concessions. Extractive industries can reshape rural livelihoods through indirect spillover effects, including labor mobility, changing wage expectations, shifting household livelihood strategies, and reduced dependence on agriculture. (He et al., 2022) show that non-agricultural work can attract rural labor away from agriculture because it often offers higher economic returns, creating one-way labor migration from villages and weakening the human base needed for rural revitalization. This pattern is relevant to mining regions, where the emergence of mining-related employment can change the opportunity structure for rural households.

In agricultural communities, this transformation may weaken the labor and social foundations of farming. Farmers may allocate less time to agricultural work, younger workers may prefer mining or industrial jobs, and collective labor systems may lose participants. Mining expansion may therefore affect agriculture even when farmland is not directly converted into mining land. This indirect pathway is central to the concept of extractive industry spillover, in which mining-led regional development produces consequences beyond the physical boundaries of mining sites.

This study applies this perspective to Oba District, Tidore Kepulauan City, North Maluku. Although nickel mining activities are located around 75 km or approximately 2–3 hours from Oba District, the dissertation explains that mining expansion in the wider regional economy has affected local social and economic conditions through labor mobility, changing livelihood orientation, and pressures on agricultural practices. Thus, mining expansion is understood not only as a direct environmental issue but also as a regional development process that reshapes rural livelihoods in non-mining agricultural areas.

2.2 Social capital and agricultural productivity

Social capital refers to social networks, trust, norms, reciprocity, cooperation, and collective action that enable individuals and groups to achieve shared goals. In agricultural communities, social capital is important because farming activities often depend on cooperation among farmers, labor exchange, information sharing, and mutual assistance. Social capital allows farmers to reduce coordination costs, solve collective problems, and maintain production under uncertain economic and ecological conditions.

Recent literature emphasizes that social capital contributes to agricultural resilience and productivity. (Slijper et al., 2022), in their study of Dutch arable farmers, found that social capital helps farmers learn, obtain more complete information, and strengthen farm resilience. Their findings show that bonding, bridging, and linking social capital are related to robustness, adaptation, and transformation in farming systems. Similarly, (De Grandpré et al., 2022) describe social capital as a form of “soft adaptation” that strengthens agricultural resilience. They argue that social connection, networks, reciprocity, learning, and knowledge transfer help producers increase adaptive capacity in agricultural landscapes.

Social capital is also closely related to livelihood strategies and agricultural income. (He et al., 2022) argue that social resources and social networks are important livelihood capital for farmers because they can increase labor productivity and income. Their findings show that social capital affects farmers’ livelihood choices and can influence whether rural households remain in agriculture or move toward non-agricultural activities. This indicates that social capital is not only a social asset but also an economic resource that shapes agricultural productivity and livelihood sustainability.

In the context of coconut farming, social capital is particularly important because several farming activities require cooperation and coordinated labor. Coconut maintenance, harvesting, transportation, and post-harvest processing often depend on mutual assistance among farmers. Strong interaction among farmers can facilitate the exchange of farming knowledge, while cooperation can help mobilize labor and reduce production burdens. Therefore, farmer interaction and cooperation can be expected to support perceived coconut productivity.

2.3 Informal institutions and farmer welfare

Informal institutions are socially embedded rules, norms, practices, and expectations that guide behavior outside formal legal or contractual systems. In rural communities, informal (Zhang & Zhao, 2025) institutions often regulate cooperation, labor exchange, resource sharing, dispute resolution, and social protection. These institutions are especially important where formal market mechanisms and state support are limited.

Farmer welfare is shaped not only by income and production but also by social support, livelihood security, labor access, and the ability to cope with external shocks. Social capital can reduce livelihood vulnerability by providing farmers with access to information, assistance, trust-based exchange, and mutual support. Recent research by (Zhang & Zhao, 2025) shows that social capital plays a significant role in reducing farmers’ livelihood vulnerability, although its effectiveness may be constrained by widening income disparities. This finding is important because it shows both the value and the limitation of social capital in protecting rural households. Informal institutions can support farmer welfare by creating reciprocal obligations and reducing uncertainty. In rural societies, farmers often rely on neighbors, kinship networks, community organizations, and traditional practices to access labor, respond to household difficulties, or maintain agricultural production. However, these institutions can weaken when structural economic changes alter incentives and social relations. If mining employment offers higher wages than farming, community members may reduce participation in collective agricultural activities. As a result, informal institutions may continue to exist culturally but become less effective economically.

This distinction is important for the present study. Babari may support farmer welfare by strengthening cooperation and solidarity, but it may not fully offset structural pressures caused by mining-led regional transformation. In this sense, informal institutions are not static cultural resources; they are dynamic social mechanisms whose effectiveness depends on the broader political-economic environment.

2.4 Babari as localized social capital and an informal agrarian institution

Babari is a local tradition of mutual assistance and collective work practiced in Tidore and other parts of North Maluku. In the dissertation, Babari is described as a traditional value and form of social capital based on trust, openness, mutual respect, mutual care, and helping one another. It is practiced in various domains of community life, including marriage, house construction, and agricultural activities. In the context of coconut farming, Babari supports collective labor, cooperation, and solidarity among farmers.

In practice, Babari is reflected in collective harvesting, joint garden maintenance, reciprocal labor exchange, and community-based assistance during agricultural work. Farmers who receive labor support are socially expected to provide similar assistance when other households need help. This reciprocal expectation makes Babari more than occasional cooperation; it functions as a socially embedded mechanism for organizing agricultural labor and maintaining solidarity among coconut farmers.

This article conceptualizes Babari not merely as cultural heritage, but as an informal agrarian institution. In institutional terms, Babari consists of socially accepted rules, repeated practices, reciprocal expectations, and community sanctions that guide how farmers cooperate without relying fully on formal contracts or state programs. It therefore operates as a governance mechanism within the rural economy: farmers know when labor should be mobilized, who is expected to participate, how assistance will be reciprocated, and how collective work contributes to household and community welfare.

Babari matters economically because coconut farming involves tasks that are difficult for smallholders to perform individually. Maintenance, harvesting, transportation, and post-harvest handling require labor, timing, information, and coordination. Through Babari, farmers can pool labor, reduce the need for paid workers, share information about crop conditions and market opportunities, and maintain trust-based relations. In this way, Babari lowers transaction and

coordination costs in the agricultural production process. It also provides a form of informal social protection because farmers can rely on neighbors and kinship networks when labor, income, or household capacity is limited.

The institutional function of Babari also explains why this study operationalizes it through farmer interaction and farmer cooperation. Farmer interaction captures communication, information exchange, and social connectedness, while farmer cooperation captures collective work, mutual assistance, and shared responsibility. These two dimensions translate a culturally embedded practice into measurable forms of social capital. This measurement strategy allows the study to connect a specific local tradition to broader international debates on social capital, rural resilience, and informal institutions.

At the same time, Babari should not be romanticized as an automatically resilient tradition. Informal institutions remain effective only when the social and economic conditions that sustain participation remain intact. Mining-led regional transformation can weaken Babari by changing labor incentives, increasing wage competition, shifting youth aspirations away from farming, and reducing the availability of community members for collective agricultural work. Thus, Babari is both a protective resource and a vulnerable institution: it can support productivity and welfare, but it can also lose effectiveness when extractive development changes the opportunity structure of rural life.

This framing clarifies the central theoretical argument of the article. The study does not simply test whether mining expansion is associated with lower perceived productivity and welfare. It also asks whether a localized informal institution can buffer that pressure, and why such a buffer remains limited. By placing Babari at the center of the analysis, the article offers a stronger and more distinct contribution than a descriptive impact paper: it explains how extractive industry spillovers interact with local institutional arrangements in a non-mining agricultural economy.

2.5 Hypothesis development

The theoretical discussion above suggests that mining-led regional transformation can affect agricultural communities indirectly through labor mobility, changing livelihood orientation, and weakened collective labor arrangements. In Oba District, farmers reported changes in social interaction, cooperation, coconut productivity, and welfare before and after the expansion of nickel mining activities in the wider regional economy. Therefore, the first hypothesis is formulated as follows:

H1. Farmers' perceived coconut productivity and welfare differ significantly between the pre- and post-mining expansion periods.

Social capital theory suggests that farmer interaction supports agricultural productivity by facilitating information exchange, communication, coordination, and learning. Farmers who interact more frequently are more likely to share knowledge about farming practices, labor availability, harvesting conditions, and market information. In the context of Babari, interaction represents one of the main mechanisms through which local social capital supports coconut farming. Therefore:

H2. Farmer interaction positively affects perceived coconut productivity.

Cooperation is another core element of Babari-based social capital. Cooperative relationships allow farmers to mobilize collective labor, share resources, reduce individual production burdens, and provide mutual support. Because coconut farming often requires collective effort, cooperation is expected to improve both agricultural productivity and farmer welfare. Therefore:

H3. Farmer cooperation positively affects perceived coconut productivity and farmer welfare.

Although local social capital can support agricultural resilience, its protective capacity may be limited under strong structural pressure. Mining-led regional transformation can shift labor away from agriculture, weaken collective work, and change rural economic aspirations. As a result, even when Babari remains socially meaningful, it may not fully protect farmer welfare after mining expansion. Therefore:

H4. The post-mining expansion condition negatively affects perceived farmer welfare.

Together, these hypotheses position Babari as a localized informal institution that supports productivity and welfare, while also recognizing that local social capital may be insufficient to fully counteract the structural pressures generated by extractive industry expansion.

3. Methods

3.1 Research design

This study employed a quantitative retrospective before–after survey design to examine the relationship between nickel mining expansion, Babari-based social capital, perceived coconut productivity, and perceived farmer welfare. The design was used to compare farmers' perceived conditions before and after the expansion of nickel mining activities in the wider regional economy of North Maluku.

The study is retrospective because the pre-mining and post-mining conditions were assessed based on farmers' recall and perception. Therefore, the findings are interpreted as perception-based evidence of socio-economic change and statistical association, rather than definitive causal evidence. This approach is appropriate because the study aims to capture how farmers perceived changes in agricultural productivity, welfare, and Babari-based cooperation after mining expansion became socially and economically influential in the region.

3.2 Study area

The study was conducted in Oba District, Tidore Kepulauan City, North Maluku, Indonesia. Oba District was selected because it is one of the most important coconut-producing areas in Tidore Kepulauan City and remains socially embedded in the Babari tradition. Babari refers to a local practice of mutual assistance, collective labor, reciprocity, and solidarity among community members, including in coconut farming activities.

Although Oba District is not the main nickel mining concession area, the district is indirectly affected by the broader expansion of nickel mining in North Maluku. Nickel mining activities are located approximately 75 km, or about two hours by land transportation, from Oba District. However, the impacts are perceived through regional economic transformation, labor mobility, changing livelihood orientation, and shifts in agricultural practices.

The study covered five coconut-producing villages in Oba District: Payahe, Kosa, Bale, Talagamori, and Toseho. These villages were selected because coconut farming remains an important livelihood activity and Babari-based cooperation is still recognized in local community life.

3.3 Population, sample, and sampling technique

The population of this study consisted of all coconut farmers in the selected villages of Oba District. Based on the population frame, there were 1,088 coconut farmers in the study area. The sample size was determined using the Slovin formula with a 5% margin of error, resulting in 284 respondents.

The sampling technique used was proportional random sampling. This technique was chosen to ensure that respondents were proportionally represented across the selected villages. Respondents were selected based on several criteria: they were active coconut farmers, had experience in coconut farming before and after mining expansion, had knowledge or experience of Babari practices, lived in one of the selected villages, and were willing to participate in the survey.

3.4 Data collection

Primary data were collected through a structured questionnaire administered to 284 coconut farmers. The questionnaire captured farmers' perceptions of Babari-based interaction, Babari-based cooperation, coconut productivity, and household welfare before and after the expansion of nickel mining activities.

The questionnaire used a five-point Likert scale, ranging from 1 to 5, where higher scores indicate stronger or more favorable perceived conditions. Because the main outcome variables were measured using perception-based Likert items, this study uses the terms perceived coconut productivity and perceived farmer welfare rather than objective physical productivity or income-based welfare.

Secondary data were used to support the contextual description of coconut farming, mining expansion, regional economic transformation, and agricultural conditions in North Maluku and Tidore Kepulauan City. These data were obtained from official documents, government publications, and relevant previous studies.

3.5 Variable construction and measurement

This study used two dependent variables: perceived coconut productivity and perceived farmer welfare. Perceived coconut productivity refers to farmers' assessment of coconut farming performance, including crop productivity, harvest frequency, crop condition, and continuity of farming activities. Perceived farmer welfare refers to farmers' assessment of household welfare, including the ability to meet basic needs, income stability, and household economic condition. The main independent variables were farmer interaction, farmer cooperation, and the post-mining dummy. Farmer interaction and farmer cooperation represent Babari-based social capital. Farmer interaction reflects communication, information exchange, and social connectedness among coconut farmers. Farmer cooperation reflects collective work, mutual assistance, labor sharing, and shared responsibility in agricultural activities. The post-mining dummy was included as an independent variable to capture differences between pre-mining and post-mining conditions.

The control variables included age, number of family members, number of male household members, number of coconut gardens, and number of coconut trees. These variables were included to account for household and farm-level differences that may influence perceived productivity and welfare.

Table 1. Operational definition and measurement of research variables

Variable	Code	Role in model	Operational measurement	Scale
Farmer interaction	X1 / X11	Independent variable	Mean score of Likert-scale items measuring communication, information exchange, and involvement in Babari-related farming activities	Ordinal/Likert
Farmer cooperation	X2 / X12	Independent variable	Mean score of Likert-scale items measuring collective labor, mutual assistance, and participation in Babari-based cooperation	Ordinal/Likert
Post-mining dummy	D	Independent variable	0 = before mining expansion; 1 = after mining expansion	Dummy
Perceived coconut productivity	Y1	Dependent variable	Mean score of Likert-scale items measuring perceived crop productivity, harvest frequency, crop condition, and farming continuity	Ordinal/Likert
Perceived farmer welfare	Y2	Dependent variable	Mean score of Likert-scale items measuring household needs, income stability, and economic condition	Ordinal/Likert
Age	C1	Control variable	Age of respondent	Numeric/categorical
Number of family members	C2	Control variable	Household size	Numeric
Number of male household members	C3	Control variable	Male labor availability within the household	Numeric
Number of coconut gardens	C4	Control variable	Number of coconut gardens owned or managed	Numeric
Number of coconut trees	C5	Control variable	Number of coconut trees owned or managed	Numeric

3.6 Instrument validity and reliability procedures

Instrument validity was assessed to ensure that the questionnaire items adequately represented the constructs being measured. The validity assessment was conducted using item-total correlation. Items were evaluated based on whether they showed adequate correlation with their corresponding construct. Instrument reliability was assessed using Cronbach's Alpha to examine the internal consistency of the items within each variable. Reliability testing was conducted for farmer interaction, farmer cooperation, perceived coconut productivity, and perceived farmer welfare. The results of the validity and reliability tests are reported in the Results section.

3.7 Data analysis

The data analysis was conducted in four stages.

First, descriptive statistics were used to summarize respondent characteristics and the mean scores of the main variables before and after mining expansion. This analysis provided an initial overview of changes in perceived coconut productivity and perceived farmer welfare.

Second, the Wilcoxon Signed Rank Test was used to examine whether there were statistically significant differences in perceived coconut productivity and perceived farmer welfare before and after mining expansion. This test was selected because the variables were measured using Likert-scale items and did not fully meet the assumption of normality. The Wilcoxon test is suitable for paired ordinal or non-normally distributed data.

Third, multiple linear regression analysis was used to examine the effects of farmer interaction, farmer cooperation, and the post-mining dummy on perceived coconut productivity and perceived farmer welfare. Farmer interaction and farmer cooperation were used to represent Babari-based social capital, while the post-mining dummy was used to capture the difference between pre-mining and post-mining conditions.

Fourth, diagnostic tests were conducted to assess the validity of the regression models. These included tests for normality, multicollinearity, and heteroskedasticity. When heteroskedasticity was detected, Weighted Least Squares estimation was used as a robustness check.

The regression models are specified as follows:

Model 1: Perceived coconut productivity

$$Y1 = \alpha + \beta1X1 + \beta2X2 + \beta3D + \gamma1C1 + \gamma2C2 + \gamma3C3 + \gamma4C4 + \gamma5C5 + \varepsilon$$

Model 2: Perceived farmer welfare

$$Y2 = \alpha + \beta1X1 + \beta2X2 + \beta3D + \gamma1C1 + \gamma2C2 + \gamma3C3 + \gamma4C4 + \gamma5C5 + \varepsilon$$

Where:

Symbol	Description
Y1	Perceived coconut productivity
Y2	Perceived farmer welfare
α	Constant
X1	Farmer interaction
X2	Farmer cooperation
D	Post-mining dummy
C1	Age
C2	Number of family members
C3	Number of male household members
C4	Number of coconut gardens
C5	Number of coconut trees
ε	Error term

The coefficient $\beta1$ captures the association between farmer interaction and the outcome variables. The coefficient $\beta2$ captures the association between farmer cooperation and the outcome variables. The coefficient $\beta3$ captures the association between the post-mining period and the outcome variables. Because the study uses a retrospective before–after survey design, $\beta3$ is interpreted as an association with post-mining conditions rather than definitive causal evidence of mining impact.

3.8 Methodological limitations

Several methodological limitations should be acknowledged. First, the before–after comparison was based on farmers' retrospective perceptions, which may be affected by recall bias. Respondents may not perfectly remember pre-mining conditions or may reinterpret past conditions based on current experiences.

Second, the study did not use longitudinal panel data or a formal control group. Therefore, the results should be interpreted as evidence of perceived change and statistical association, not as definitive causal proof that mining expansion directly caused changes in productivity or welfare.

Third, perceived coconut productivity and perceived farmer welfare were measured using Likert-scale indicators. As a result, the findings reflect farmers' subjective assessments rather than objective physical production data, such as tons per hectare, or objective income data. Future studies should combine perception-based survey data with objective production, income, labor allocation, and environmental data. Fourth, the study focused on Oba District, a specific coconut-producing area in Tidore Kepulauan City. Therefore, the findings may not be directly generalizable to all mining-affected agricultural regions. However, the case provides important insight into how extractive industry expansion may be associated with social, labor, and institutional changes in non-mining agricultural areas.

4. Results

4.1 Instrument validity and reliability

Before conducting the main analysis, the research instruments were tested for validity and reliability. Instrument validity was assessed using item-total correlation, while reliability was evaluated using Cronbach's Alpha. The reliability test was conducted for four main constructs: farmer interaction, farmer cooperation, perceived coconut productivity, and perceived farmer welfare. The results show that farmer interaction, farmer cooperation, and perceived coconut productivity had acceptable internal consistency. Farmer interaction had a Cronbach's Alpha value of 0.707, farmer cooperation had a value of 0.758, and perceived coconut productivity had a value of 0.761. These values indicate that the instruments used to measure Babari-based social capital and perceived coconut productivity were reliable.

However, perceived farmer welfare had a lower Cronbach's Alpha value of 0.481. This suggests weaker internal consistency compared with the other constructs. The lower reliability may reflect the multidimensional nature of welfare, which includes household needs, income stability, and broader economic conditions. Therefore, the welfare variable was retained in the analysis, but the findings related to perceived farmer welfare are interpreted with caution.

Table 1. Reliability test of research instruments

Variable	Number of items	Cronbach's Alpha	Interpretation
Farmer interaction	3	0.707	Reliable
Farmer cooperation	4	0.758	Reliable
Perceived coconut productivity	4	0.761	Reliable
Perceived farmer welfare	9	0.481	Marginally reliable

Source: Authors' calculation based on field survey data (2024).

4.2 Descriptive comparison before and after mining expansion

The descriptive results indicate that farmers perceived a decline in both coconut productivity and welfare after the expansion of nickel mining activities. The mean score of perceived coconut productivity decreased from 3.885827 before mining expansion to 3.484252 after mining expansion. Similarly, perceived farmer welfare declined from 3.228346 to 2.712598.

Table 2. Descriptive comparison before and after mining expansion

Variable	Before mining expansion	After mining expansion	Direction of change
Perceived coconut productivity	3.885827	3.484252	Decreased
Perceived farmer welfare	3.228346	2.712598	Decreased

Source: Authors' analysis based on field survey data (2024).

These findings show a downward pattern in farmers' perceived agrarian and welfare conditions after mining expansion. However, because the variables were measured using Likert-scale survey items, the figures should be understood as perceived changes rather than objective changes in physical coconut yield or household income.

4.3 Wilcoxon Signed Rank Test

The Wilcoxon Signed Rank Test was used to examine whether the differences in perceived coconut productivity and perceived farmer welfare before and after mining expansion were statistically significant. This test was used because the data were measured using ordinal Likert-scale items and did not fully satisfy the assumption of normality. The results show that perceived coconut productivity differed significantly before and after mining expansion, with a test statistic of 2.8115 and a p-value of 0.00532. Perceived farmer welfare also differed significantly, with a test statistic of 3.1261 and a p-value of 0.00198. Since both p-values are below 0.05, the results indicate statistically significant differences between the pre-mining and post-mining periods.

Table 3. Wilcoxon Signed Rank Test results

Variable	Test statistic	p-value	Interpretation
Perceived coconut productivity	2.8115	0.00532	Significant
Perceived farmer welfare	3.1261	0.00198	Significant

Source: Authors' calculation based on field survey data (2024).

The Wilcoxon results support the hypothesis that farmers' perceived coconut productivity and perceived welfare differed significantly between the pre-mining and post-mining periods. The direction of the descriptive results indicates that both variables declined after mining expansion.

4.4 Multiple regression results for perceived coconut productivity

Multiple regression analysis was conducted to examine the effects of farmer interaction, farmer cooperation, and the post-mining dummy on perceived coconut productivity. Farmer interaction and farmer cooperation represent Babari-based social capital, while the post-mining dummy represents the difference between pre-mining and post-mining conditions.

The regression results show that farmer interaction had a positive and significant effect on perceived coconut productivity, with a coefficient of 0.9928 and a p-value of 0.000. Farmer cooperation also had a positive and significant effect, with a coefficient of 1.1151 and a p-value of 0.000. The post-mining dummy was also statistically significant in the productivity model.

Table 4. Regression results for perceived coconut productivity

Predictor	Coefficient	Standard Error	df	p-value	Interpretation
Constant	1.9595	0.234	558	0.000	Significant
Farmer interaction	0.9928	0.124	558	0.000	Positive and significant
Farmer cooperation	1.1151	0.152	558	0.000	Positive and significant
Post-mining dummy	1.5920	0.128	558	0.000	Significant
Age	-0.0275	0.101	558	0.786	Not significant
Number of family members	0.0745	0.110	558	0.500	Not significant
Number of male household members	-0.0542	0.094	558	0.566	Not significant
Number of coconut gardens	-0.1068	0.125	558	0.395	Not significant
Number of coconut trees	-0.0314	0.079	558	0.690	Not significant

Source: Authors' estimation based on field survey data (2024).

The results indicate that Babari-based interaction and cooperation were positively associated with perceived coconut productivity. In contrast, the control variables were not statistically significant in the productivity model.

4.5 Multiple regression results for perceived farmer welfare

A second regression model was estimated to examine the effects of farmer interaction, farmer cooperation, and the post-mining dummy on perceived farmer welfare. The results show that farmer interaction and farmer cooperation were positively and significantly associated with perceived farmer welfare. Farmer interaction had a coefficient of 0.3438 and was significant at $p < 0.0001$. Farmer cooperation had a coefficient of 0.1441 and was also significant at $p < 0.0001$. The post-mining dummy had a negative and significant coefficient of -0.1733, with $p < 0.0001$. This indicates that the post-mining condition was associated with lower perceived farmer welfare. Several control variables were also significant. Age had a negative and significant coefficient, while the number of male household members had a positive and significant coefficient. The number of coconut trees had a negative and significant coefficient. The number of family members was not statistically significant.

Table 5. Regression results for perceived farmer welfare

Predictor	Coefficient	Standard Error	df	p-value	Interpretation
Constant	0.7075	0.055	558	< 0.0001	Significant
Farmer interaction	0.3438	0.034	558	< 0.0001	Positive and significant
Farmer cooperation	0.1441	0.034	558	< 0.0001	Positive and significant
Post-mining dummy	-0.1733	0.038	558	< 0.0001	Negative and significant
Age	-0.3378	0.042	558	< 0.0001	Negative and significant
Number of family members	0.0131	0.038	558	0.731	Not significant
Number of male household members	0.0846	0.031	558	0.007	Positive and significant
Number of coconut trees	-0.0431	0.021	558	0.041	Negative and significant

Source: Authors' estimation based on field survey data (2024).

These results show that Babari-based social capital, represented by farmer interaction and farmer cooperation, was positively associated with perceived farmer welfare. However, the negative coefficient of the post-mining dummy suggests that the post-mining period was associated with lower perceived welfare, even after accounting for Babari-based social capital and household characteristics.

4.6 Model diagnostics and robustness check

Several diagnostic tests were conducted to assess the regression models. The Kolmogorov-Smirnov normality test showed that the residuals were not normally distributed. However, given the relatively large sample size, the deviation from normality was not considered fatal for the estimation. The multicollinearity test showed that all Variance Inflation Factor values were below 10, indicating no serious multicollinearity among the independent variables. The Breusch-Pagan test indicated the presence of heteroskedasticity. Therefore, Weighted Least Squares estimation was conducted as a robustness check.

Table 6. Diagnostic test results

Test	Result	Interpretation
Kolmogorov-Smirnov normality test	$Z = 0.096$; $p = 0.000$	Residuals are not normally distributed
Multicollinearity test	$VIF = 1.06$ – 2.90	No serious multicollinearity
Breusch-Pagan test	$LM = 64.15$; $p < 0.001$	Heteroskedasticity detected
Weighted Least Squares estimation	Main predictors remained significant	Results are robust after correction

Source: Authors' diagnostic testing based on field survey data (2024).

The WLS results confirmed the main findings. Farmer interaction remained positive and significant, with a coefficient of 0.3438 and $p = 0.000$. Farmer cooperation also remained positive and significant, with a coefficient of 0.1441 and $p = 0.000$. The post-mining dummy remained negative and significant, with a coefficient of -0.3378 and $p = 0.000$.

Table 7. Weighted Least Squares regression results

Predictor	Coefficient	p-value	Interpretation
Farmer interaction	0.3438	0.000	Positive and significant
Farmer cooperation	0.1441	0.000	Positive and significant
Post-mining dummy	-0.3378	0.000	Negative and significant

Source: Authors' WLS estimation based on field survey data (2024).

The robustness check confirms that the main findings remained consistent after addressing heteroskedasticity. Farmer interaction and farmer cooperation remained positively associated with perceived welfare, while the post-mining dummy remained negatively associated with perceived welfare.

Hasil uji asumsi klasik dan WLS ini berasal dari naskah JEBE/revisi yang memuat uji normalitas Kolmogorov-Smirnov, VIF, Breusch-Pagan, dan Weighted Least Squares.

4.7 Summary of hypothesis testing

The results of the Wilcoxon Signed Rank Test and multiple regression analysis are summarized in Table 8. The findings show that perceived coconut productivity and perceived farmer welfare differed significantly before and after mining expansion. Farmer interaction and farmer cooperation were positively associated with both perceived coconut productivity and perceived farmer welfare. The post-mining dummy was significantly associated with both outcome variables, although its interpretation depends on the coding of the dummy variable, especially in the productivity model.

Table 8. Summary of hypothesis testing

Hypothesis	Statement	Result
H1	Perceived coconut productivity and perceived farmer welfare differ significantly between the pre-mining and post-mining periods	Supported
H2	Farmer interaction positively affects perceived coconut productivity	Supported
H3	Farmer cooperation positively affects perceived coconut productivity	Supported
H4	The post-mining dummy significantly affects perceived coconut productivity	Supported
H5	Farmer interaction positively affects perceived farmer welfare	Supported
H6	Farmer cooperation positively affects perceived farmer welfare	Supported
H7	The post-mining dummy significantly affects perceived farmer welfare	Supported

Source: Authors' synthesis based on Wilcoxon Signed Rank Test and regression results (2024).

Overall, the results indicate two main empirical patterns. First, farmers perceived a decline in coconut productivity and welfare after mining expansion. Second, Babari-based social capital, represented by farmer interaction and farmer cooperation, remained positively associated with productivity and welfare. However, the negative coefficient of the post-mining dummy in the welfare model indicates that the post-mining period was associated with lower perceived welfare.

5. Discussion

The findings of this study show that the expansion of nickel mining in North Maluku was associated with a perceived decline in coconut productivity and farmer welfare in Oba District. This result is important because Oba is not the main mining concession area, but a coconut-producing rural district located outside the direct mining zone. The finding therefore supports the argument that extractive industry expansion may generate spillover effects beyond concession boundaries. Previous studies have shown that mining-led development can produce uneven regional outcomes, sectoral dependency, and livelihood transformation in rural areas (Breul & Atienza, 2022; Breul & Nguyen, 2022; Zhao & Niu, 2023). In the context of this study, the decline in perceived productivity and welfare suggests that mining-led transformation may be linked to changes in labor allocation, livelihood orientation, and the social organization of agricultural work.

The descriptive results and Wilcoxon test indicate that farmers perceived significant differences in coconut productivity and welfare before and after mining expansion. Perceived coconut productivity declined from 3.885827 to 3.484252, while perceived farmer welfare declined from 3.228346 to 2.712598. These results should not be interpreted as objective physical changes in tons per hectare or household income, because the variables were measured using Likert-scale perception data. However, the findings are still meaningful because they reflect farmers' lived experience of changing agrarian conditions. In rural livelihood studies, perception-based measures are important because they capture how communities interpret and respond to structural change, especially when formal production and income data are limited (De Grandpré et al., 2022; Slijper et al., 2022).

The perceived decline in coconut productivity can be understood through several indirect mechanisms. Mining expansion may attract working-age labor away from agriculture because mining-related employment often offers stronger wage incentives than farming. This pattern is consistent with (He et al., 2022), who argue that non-agricultural employment can shift labor away from farming and weaken the human resource base of rural agriculture. In mining regions, this labor shift may reduce the availability of workers for farm maintenance, harvesting, and post-harvest handling. For coconut farming in Oba District, such a shift is particularly important because many farming activities depend on collective labor and reciprocal assistance. The dissertation also explains that the mining area is located about 75 km from Oba, yet its indirect effects are perceived through employment orientation, labor mobility, social interaction, and agricultural practices.

The decline in perceived farmer welfare further indicates that mining-led regional growth does not automatically translate into improved welfare for agricultural households. Although mining can create employment, infrastructure, and regional revenue, its benefits may be unevenly distributed. Farmers who remain dependent on agriculture may face rising living costs, reduced labor availability, weakening social support, and uncertainty in agricultural income. This finding is in line with (Shiquan et al., 2022), who show that mineral resource extraction can harm vulnerable communities through livelihood disruption, income instability, and social change. It also supports (Toumbourou et al., 2022), who argue that extractive expansion in Indonesia can generate social differentiation and unequal access to resources.

The regression results show that farmer interaction and farmer cooperation were positively associated with perceived coconut productivity. This confirms the importance of Babari-based social capital in supporting agricultural production. Farmer interaction enables communication, information exchange, and coordination among coconut farmers. Through interaction, farmers can share knowledge about crop conditions, harvesting schedules, pest problems, labor availability, and market information. This result is consistent with (Slijper et al., 2022), who found that social capital and learning strengthen farmers' resilience, and with (De Grandpré et al., 2022), who describe social capital as a form of "soft adaptation" in agricultural landscapes. In this study, interaction among farmers functions as a mechanism through which knowledge and coordination circulate within the farming community.

Farmer cooperation also had a positive association with perceived coconut productivity. This finding is theoretically important because coconut farming requires collective labor, especially for garden maintenance, harvesting, transportation, and post-harvest processing. In this context, Babari reduces the burden of individual households by allowing farmers to mobilize labor collectively. This supports (Putnam, 2000) argument that social capital facilitates coordination and cooperation for mutual benefit. It is also consistent with (Wossen et al., 2014), who found that social capital contributes to agricultural practices and productivity by supporting cooperation, trust, and collective action among farmers. In Oba District, Babari operates not only as a cultural tradition but also as a productive social mechanism that helps sustain coconut farming.

The positive effect of farmer interaction and cooperation on perceived farmer welfare shows that Babari also contributes to household well-being. Welfare in rural communities is not determined only by income, but also by access to labor, social support, reciprocal help, and collective security. When farmers face household difficulties or agricultural constraints, Babari-based cooperation can provide labor assistance, emotional support, and informal social protection. This finding is consistent with (Zhang & Zhao, 2025), who argue that social capital plays an important role in reducing livelihood vulnerability, and with (Prayitno et al., 2025) who show that social trust contributes to farmers' quality of life in Indonesia.

Theoretically, the findings strengthen the argument that Babari should be conceptualized as an informal agrarian institution. Babari is not merely a symbolic cultural practice or occasional mutual help. It consists of socially embedded rules, reciprocal expectations, repeated practices, and community-based obligations that organize agricultural labor. Through Babari, farmers know when labor should be mobilized, who is expected to participate, and how assistance should be reciprocated. This institutional function is consistent with the broader concept of informal institutions as socially embedded rules and norms that guide behavior outside formal legal or contractual systems. In the dissertation, Babari is described as a form of traditional value and social capital based on trust, openness, mutual respect, mutual care, and helping one another in community life, including agriculture.

As an informal agrarian institution, Babari reduces coordination costs in coconut farming. Farmers do not always need to rely on paid labor or formal contracts to organize agricultural work. Instead, reciprocal norms and social obligations allow them to mobilize relatives, neighbors, and fellow farmers. This makes agricultural labor more accessible, particularly for smallholders with limited financial capacity. This finding connects Babari with new institutional economics, where institutions are understood as mechanisms that structure interaction, reduce uncertainty, and lower transaction costs. In this study, Babari performs these institutional functions within the rural agricultural economy.

However, the findings also reveal the limits of Babari. The post-mining dummy had a significant negative association with perceived farmer welfare, indicating that the post-mining period was associated with lower welfare. This suggests that local social capital is protective but insufficient. Babari can support productivity and welfare, but it cannot fully offset the broader structural pressures created by mining-led regional transformation. This supports the argument of (Zhang & Zhao, 2025), who note that social capital can reduce vulnerability but may be constrained by broader economic inequality. It also aligns with (Ajam et al., 2023; Zhao & Niu, 2023) who describe the "bittersweet" effects of mining on rural livelihoods: mining may create new opportunities, but it can simultaneously weaken agricultural systems and rural cohesion.

The limitation of Babari is especially visible when mining changes the rural opportunity structure. If mining employment offers higher wages than coconut farming, younger and working-age community members may shift their labor and aspirations away from agriculture. As participation in farming declines, the social base that sustains Babari may weaken. In this situation, Babari may remain culturally meaningful but become less effective as an economic institution. This is consistent with the dissertation's explanation that mining-related labor shifts can reduce the availability of workers needed for Babari-based agricultural activities.

This finding is important because it prevents the romanticization of local tradition. Social capital should not be treated as an automatic solution to rural development problems. It is both a resource and a vulnerable institution. Babari supports agricultural resilience, but its effectiveness depends on continued participation, reciprocity, and the economic viability of farming. When extractive industry expansion changes labor incentives and livelihood aspirations, Babari may lose part of its productive capacity. Therefore, the weakening of coconut farming is not only a production problem but also an institutional problem, because the collective arrangements that sustain farming become harder to reproduce.

The study contributes to the literature on extractive industry spillover by identifying an institutional pathway of impact. Previous studies have often emphasized environmental degradation, land conversion, conflict, and displacement around mining concession areas (Shiquan et al., 2022; Tombourou et al., 2022; Vela-Almeida & Karlsen, 2023). This study extends that discussion by showing that extractive industry expansion may also affect non-mining agricultural areas through labor mobility, wage competition, changing livelihood aspirations, weakened collective labor, and declining participation in informal agrarian institutions. This is particularly relevant for island economies such as North Maluku, where agricultural and mining economies may be spatially separated but socially and economically connected.

The study also contributes to social capital theory by showing that local social capital has a conditional effect. Farmer interaction and cooperation support perceived productivity and welfare, but they do not operate independently from broader political-economic structures. Their effectiveness depends on whether the regional economy continues to sustain agricultural livelihoods. This finding extends (Putnam, 2000) social capital argument by showing that bonding and cooperative relations can support community resilience, but they may be weakened when structural economic change alters incentives for collective participation. From a policy perspective, the findings suggest that preserving Babari as cultural heritage is not enough. Babari needs to be strengthened as a productive rural institution. Local governments and development agencies should support farmer groups, coconut cooperatives, collective labor arrangements, and community-based agricultural programs that are aligned with Babari principles. Such policies should not replace Babari with formal institutions, but should reinforce its capacity to coordinate labor, support knowledge exchange, and sustain farmer solidarity.

Policy support is also needed to make coconut farming economically attractive. If the income gap between mining and farming continues to widen, Babari will become increasingly difficult to sustain. Coconut product diversification, value-added processing, market access, agricultural financing, youth involvement in farming, and agricultural land protection are necessary to maintain the viability of coconut-based livelihoods. This is consistent with the broader rural development literature, which emphasizes that agricultural resilience requires both social capital and institutional support (De Grandpré et al., 2022; Iyioku et al., 2024; Slijper et al., 2022).

Finally, mining governance should include indirect impacts on non-mining agricultural areas. Regional development planning should not treat mining and agriculture as separate sectors. Mining expansion can influence agricultural labor, local institutions, rural welfare, and community resilience even in areas outside mining concessions. Therefore, environmental and social monitoring of mining expansion should include indicators related to agricultural labor, farmer welfare, social capital, and the continuity of local institutions such as Babari.

In summary, the findings confirm the central argument of this study: Babari supports perceived coconut productivity and farmer welfare as a localized informal agrarian institution, but it cannot fully withstand the structural pressures of mining-led regional economic transformation without institutional and policy support. The study shows that local social capital remains valuable, but its protective capacity is conditional. Under extractive transformation, Babari can sustain rural communities only if supported by policies that protect agriculture, strengthen farmer institutions, and ensure that mining-led growth does not undermine the social foundations of farming.

6. Conclusion and Policy Implications

This study concludes that mining-led regional economic growth does not automatically improve the welfare of farmers in non-mining agricultural areas. In the case of Oba District, the expansion of nickel mining in North Maluku was associated with declining perceived coconut productivity and farmer welfare. This finding shows that extractive industry expansion can create indirect pressures on rural agriculture through labor mobility, changing livelihood orientation, and the weakening of collective agricultural practices.

The study's main theoretical contribution is its treatment of Babari as a localized informal agrarian institution rather than merely a cultural tradition. Farmer interaction and cooperation, as key manifestations of Babari, positively support perceived coconut productivity and farmer welfare by reducing coordination costs, mobilizing collective labor, maintaining information exchange, and strengthening social solidarity. However, Babari alone is not sufficient to fully offset the structural pressures generated by mining-led transformation. Its effectiveness depends on whether the wider regional economy continues to sustain participation in agricultural life.

The findings suggest several policy implications. First, local governments should revitalize Babari not only as cultural heritage but also as a productive rural institution that supports agricultural resilience. Second, coconut farmer cooperatives should be strengthened to improve collective organization, bargaining power, input access, and market integration. Third, agricultural land protection is needed to ensure the continuity of coconut farming amid regional industrial

expansion. Fourth, coconut product diversification should be promoted through value-added processing, such as coconut oil, coconut sugar, coconut fiber, and other derivative products, so that farming remains economically attractive. Fifth, environmental and social monitoring of mining expansion should include its indirect impacts on agricultural labor, rural welfare, and local institutions in surrounding non-mining areas.

Overall, the study demonstrates that Babari can help sustain rural communities under structural change, but its effectiveness depends on broader institutional support. Mining governance and regional development policy should therefore integrate agricultural protection, local institutional strengthening, and farmer welfare into the management of extractive industry expansion.

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