Community resilience to natural resource vulnerability due to sand mining through the application of Integrated Farming System (IFS)

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Abstract

Changes in natural resources have presented major problems for farming communities in rural areas. In general, farmers diversify their livelihoods in the non-agricultural sector without paying attention to the impact on the availability of natural resources in the future. Sand mining activity has become one of the short-term solutions for farming communities in rural areas. As a result, a problem such as land degradation occurs in the village, thereby generating negative impacts on the availability of nature for the next generation. This study aimed to analyze the causes of land degradation and describe the Integrated Farming System (IFS) as a solution to address the land degradation problem in Bambang Village, Wajak District, Malang Regency. This study applied a qualitative case study research design, and the research methods included in-depth interviews with 40 informants, observation, and Focus Group Discussion (FGD). The location of this study was determined by purposive sampling, considering that Bambang Village is one of the villages affected by land degradation due to sand mining. The results of the study revealed that land degradation was due to the vulnerability of the farming community; thus, another alternative was proposed to utilize part of the land (20%) as a sand mining area without neglecting environmental preservation as a reward for environmental services. In addition, IFS and the actors as ecopreneurs were considered as alternative solutions to meet the needs and to prepare the farming community resilience through ecological preservation by sustaining the ecosystem balance. In practice, IFS requires integration among stakeholders, farmers and concerned institutions.

Keywords:
integrated farming system
resource vulnerability
sand mining

Introduction

Bambang Village is situated in Wajak District, Malang Regency, East Java, where approximately 15% of the community in this village works as sand miners. Some of the community owns sand mining land; however, its sustainable use has not been maximized; hence their children and grandchildren are threatened with losing the economic benefits. In addition, such sand mining activity does not contribute to the development and improvement of Bambang Village, as this activity has been managed without involving the synergy of village government stakeholders, solely run on the basic understanding. The contract for selecting the owner for the allocation of mountains was performed without the obligation to pay village government money, such as the cost of maintaining sand mining land. Some of the residents of Bambang Village, when mining the sand, abandoned the environmental aspects.

Farmers' dependence on natural resources often becomes the main cause of environmental degradation, including in farming communities that run their
farming businesses on a profit-oriented basis (Wang and Li, 2019; Mirzabaev et al., 2023). Moreover, in the last few decades, there have been many conventional farming practices still applying chemical fertilizers and pesticides, affecting the quality of agricultural production. In addition to conventional agricultural practices, the farming community also fulfills their needs through temporary non-agricultural livelihood activities, such as sand mining. Unselective mining of river sand directly affects the shape of the river bed. This often has various indirect and cumulative effects on the physical characteristics of the river and the dynamic balance of erosion and sedimentation. When sediment is withdrawn from the river bed, the balance of the sediment supply tends to migrate to the upstream part to compensate for the shortage (de Leeuw et al., 2010), thereby triggering erosion of the river bed and banks. The United Nations Environment Program (UNEP) and the World-Wide Fund for Nature (WWF) recently published a report on the issues associated with river sand mining, revealing insufficient information and guidance to support such activity. The increasing consumption of river sand also affects increasing river sand mining (Clements, 2018; UN Environment Programme, 2022).

The sand mining method has a negative impact on rivers because through intensive sediment mining, it increases channel capacity and minimizes the elongated slope of the river bed, increases water depth, thereby changing the chemical, physical and biological properties of the aquatic environment (Brunier et al., 2014; Yuill et al., 2016; Barman et al., 2018). Another study in the Mekong River delta reported that the rate of sand extraction was estimated to be much higher than the reaction rate of fluvial sediments (Hackney et al., 2020), and the rate of river bank erosion was higher in sand mining stations than in non-sand mining stations (Kim et al., 2020). It was also reported that sand mining methods could also have a negative impact on water quality, both in surface and groundwater (Muellegger et al., 2013; Yen and Rohasliney, 2013) due to high economic value, from which illegal sand dredging significantly changes the balance sediment flow rate in Poyang Lake. In addition, Duan et al. (2019) reported that illegal sand mining activities often occur in Hongze Lake, and the concentration of suspended particles was highly correlated with sand mining activities. Elaborating further, Meng et al. (2018) found that the number of species and biomass of aquatic organisms decreased significantly due to long-term sand mining activities in Dongting Lake, China. Landowners and local communities experienced a significant stake in managing the damaged mining lands to become safe, stable, non-polluting and economically productive mining areas. However, most mining planning is driven mainly by economic factors.

Particularly in this study, environmental damage due to sand mining activities has caused damage to the agricultural environment in Bambang Village, even though most of the community's economy of this village is based on the agricultural sector. It is suggested that the development of sustainable agriculture-based mining lands requires partnerships among planners, developers, local governments, ecologists, and local communities (Svobodova et al., 2019; Hendrychová et al., 2020). This is because the Integrated Farming System can improve the agricultural environment and the socio-economic conditions of the people affected by sand mining activities in Bambang Village. Integrated Agricultural System (IFS) is defined as a mixed farming system practiced in agriculture and animal husbandry business, both of which are interrelated but logistically interdependent (Sheikh et al., 2021). IFS aims to minimize or even eliminate the volume of waste from various agricultural subsystems, generating job prospects, nutritional security, and income for rural communities in sand mining areas.

Hence, IFS is proposed in this study as a solution to the phenomenon of land degradation by minimizing threats in the future and managing the risk to farmers' livelihoods through the integration of several sources of livelihood (agriculture and animal husbandry) with natural and human resources. Referring to such potential, this present study aimed to analyze the causes of land degradation and describe the Integrated Farming System (IFS) in the sand mining area of Bambang Village, Wajak District of Malang Regency, East Java.

Materials and Methods

Conditions of the study area

This study was conducted at Bambang Village, Wajak District, Malang Regency, East Java (Figure 1), situated around ± 13 km from the district town proximity, which can be reached in about 30 minutes. Meanwhile, the distance to the Regency capital is approximately ± 40 km, which can be reached in about 1.5 hours. In addition, Bambang Village is one of the villages directly adjacent to the Bromo Tengger Semeru National Park (TNBTS) area. Bambang Village's altitude lies 700 meters above sea level with a rainfall of 405.04 mm/year, located at the coordinates of 112.793682 E/-8.130025 South Latitude, signed with its geographical characteristics of hilly topography and slopes. Geophysically, Bambang Village has both physical and non-physical potential, comprising area, fertility, yields and other aspects. The area of Bambang Village covers 1,761 ha, divided into several designations, including 89 ha of residential land, 212 ha of agricultural land (paddy/moor fields), 53 ha of smallholder plantations, and 1,396 ha of forest. Meanwhile, the mapped soil fertility of Bambang Village includes 265 ha of significantly fertile, 1,246 ha of fertile, 214 ha of moderate, and 36 ha of infertile. From these data, soil conditions are concluded to be fertile.
One of the existing plants includes the dryland food crops such as peanuts, long beans, corn, cassava, taro, sweet potatoes, and sugarcane. Apart from food crops, fruit commodities are also present in this village, such as avocados, bananas, and papayas, sold as an additional source of income. From the total yield and planting area of crops, a land area of 213 ha was obtained, and production reached 5,327 t/year. Sugarcane is a commodity that has the highest yield, which reaches 4,335 t/year. Apart from sugarcane, corn is the second highest production, reaching 850 t/year. The data is further followed by cassava production, which reaches 105 t/year. As for fruit commodities, the highest production is bananas, which reach 112 t/year. Meanwhile, avocado has a fairly large area of 15 ha. Apart from food and horticultural commodities, Bambang village also has biopharmaceutical commodities, such as turmeric. The area of land provided for frozen turmeric products covers 0.25 ha spread across Bambang Village. In terms of the livestock sector, Bambang Village is enriched with poultries, dairy cows, and goats (7782, 521 and 819, respectively). There are also business actors dominated by poultry owners (929 people). The second largest domination is from the goat livestock business owners, reaching 292 people.

**Socio-economic and ecological characteristics of the communities of the study area**

The demographic characteristics of the people of Bambang Village based on age, education level, and occupation are as follows: the average age of the respondents is relatively productive (30 to 55 years). Their average education is elementary school. On average, they work as farmers and breeders; the rest are sand miners and housewives. About 38% of people work as farmers, 46% as farmers and ranchers, and 15% as sand miners. The number of residents in Bambang village practicing the terracing technique on the main land is 38%. Considering the water sources, any activities depend on the rain. The technical culture of agricultural cultivation in the people of Bambang Village applies a farming pattern by combining several types of horticultural, agroforestry and forage commodities. The farming pattern is aimed at sustaining land efficiency in the Bambang Village area. Some of the community owns sand mining land; however, its sustainable use has not been maximized, thereby threatening their generations from losing economic benefits.

Socially, the people of Bambang Village are also harmonious, as evidenced by the maintenance of the mutual cooperation system in various activities of personal and public interest, such as reconstructing the physical damage to land and religious activities through a religious ritual of “tahlilan” activities. As for certain rituals related to the safety of businesses in the agricultural sector, they have gradually been abandoned in an effort to anticipate the uncertainty of the next generation. On average, the people of Bambang Village own their land privately, indicating less-likelihoodness of renting the land to other parties; in fact, many village people rent their agricultural land to residents of other sub-villages, considering that renting land will add to the burden economically. As a result, they prefer to do farming at a moderate level, pivotal for domestic life, not for commercialization-related purposes.

**Research methods**

This study implemented a qualitative approach through the case study method to explore the problems of the internal socio-ecological conditions of the people of Bambang Village, the social, economic and ecological reality and management of sand mining, and to determine the planning steps.
Data collection and data source determination techniques

Data collection was conducted through in-depth interviews, observation, and Focus Group Discussion (FGD) with the main theme related to land reclamation initiatives based on the Integrated Farming System (IFS). The in-depth interview involved 40 informants (Table 1), including key informants such as villagers involved in social activities, sand mining and FGD among stakeholders, community leaders, and representatives of the Bambang Village community from all households (heads or those representing a total of 20 household heads). The results of the FGD and observation were then developed into a model along with the stepwise process defined by Lisson et al. (2010), from which productive agricultural production land is used as a benchmark for their current activities and processes by identifying the constraints to develop a system model and evaluation of potential interventions performed. After that, it was identified, followed by field testing of interventions that were acceptable to different farmers in Bambang Village. Table 1 describes a number of key and supporting informants in order to achieve research objectives related to the resilience of farmers-sand miners in Bambang Village, Wajak District, Malang Regency. The village government and the community, both in agricultural and non-agricultural activities, play an important role in forming community resilience by maintaining ecological sustainability, economic welfare, and social equality which is pursued through the collaboration of actors in Bambang Village. Retrieval of data requires sufficient time in order to explore any information submitted by informants to be further proceeded with data analysis.

<table>
<thead>
<tr>
<th>No</th>
<th>Informant Characteristics</th>
<th>Informant Status</th>
<th>Total (head)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Village government (village head and village officials)</td>
<td>Key informants</td>
<td>7</td>
<td>17.5</td>
</tr>
<tr>
<td>2</td>
<td>Farmers, laborers and workers in the non-agricultural sector, including sand miners</td>
<td>Supporting informants</td>
<td>33</td>
<td>82.5</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>

Data analysis technique

The present research applied interactive model by Miles et al. (2014), comprising three steps in terms of condensing data, presenting data, and verifying the conclusion (Figure 2). Condensing data refers to the process of selecting, focusing, simplifying, abstracting, and transforming data. In further process, data display is presented through the matrix building followed by drawing the conclusion.

Data Collection → Data Display → Data Condensation → Conclusion → Drawing/Verifying

Figure 2. Interactive model by Miles et al. (2014).

Results and Discussion

Socio-economic and ecological characteristics of the communities of Bambang Village

Socially, the people of Bambang Village are also harmonious, as evidenced by the maintenance of the mutual cooperation system in various activities of personal and public interest, such as repairing physical damage to land and religious activities, such as “tahlilan” activities. As for certain rituals related to the safety of businesses in the agricultural sector, they have gradually been abandoned in an effort to anticipate the uncertainty of the next generation. On average, the people of Bambang Village own their land privately, which means that there are no people who rent land to other parties; in fact, many village people rent their agricultural land to residents of other hamlets. The people of Bambang Village think that renting land will actually add to the burden economically. So they choose to do farming at a moderate level, which is important enough for domestic life, not for commercialization. The characteristics of the people of Bambang Village based on age, education level, and occupation are as follows: the average age of the respondents is still relatively productive, namely 30 to over 50 years. Their average education is elementary school. On average, they work as farmers and breeders; the rest are sand miners, illustrated in Table 2. Data presented in Table 2 show that the age of the informants was dominated (90%) by farmers with ages ranging from 30 to more than 50 years of male (80%). Most of the 40 informants (32.5%) had livelihood activities in the agricultural and non-agricultural sectors. Livelihood activities include farming and dairy farming, while non-agricultural livelihoods consist of sand mining, construction workers, craftsmen, traders, and others.
Table 2. Characteristics of age, gender, and occupation of informants in Bambang Village.

<table>
<thead>
<tr>
<th>No</th>
<th>Informant Characteristics</th>
<th>Total (head)</th>
<th>Percentage (%)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;30 year</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>30-50 year</td>
<td>18</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>&gt;50 year</td>
<td>18</td>
<td>45</td>
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<tr>
<td>2</td>
<td>Gender</td>
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<td></td>
<td>Male</td>
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<tr>
<td></td>
<td>Female</td>
<td>8</td>
<td>20</td>
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<tr>
<td>3</td>
<td>Occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agriculture and non-agriculture</td>
<td>13</td>
<td>32.5</td>
</tr>
<tr>
<td></td>
<td>Agriculture, non-agriculture, and laborers</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(farmers/livestock workers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agriculture and laborers (farmers/livestock workers)</td>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>Agriculture</td>
<td>9</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>Laborers (farmers/livestock workers)</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Laborers (farmers/livestock workers) and non-agriculture</td>
<td>7</td>
<td>17.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40</td>
<td>100</td>
</tr>
</tbody>
</table>

Through information on the characteristics of these informants, it is apparent that the farmers in Bambang Village have diversified their livelihoods in the non-agricultural sector, especially for sand mining, by considering that sand mining has the characteristic of "quick-cash out" when compared to farming which needs to wait for one production season. In accordance with the statement of Damilola and Akintunde (2023), it is pointed out that non-agricultural livelihood activities provide a source of income for rural communities as an alternative solution to overcome poverty. Diversification of agricultural and non-agricultural livelihoods is interlinked with the economic growth of farming communities in rural areas (Danso-abbeam et al., 2020; George, 2020).

As in the case of Bambang Village, most (90%) of the informants have their main livelihood as farmers; thus, the agricultural cultivation techniques experienced development through the adoption of cultivation innovations. The technical culture of agricultural cultivation by farmers in Bambang Village applies a farming pattern that combines several types of horticultural, agroforestry and forage commodities, still sustaining the efficiency in the Bambang Village area. Some of the community owns sand mining land; however, its sustainable utilization has not been maximized, thereby threatening the next generation from losing economic benefits.

**Facts and impact of sand mining management in social, economic and ecological aspects**

During the dry season, the farming community in Bambang village do not cultivate crops, encouraging some farmers to diversify their livelihoods into laborers, plantations, breeders, and non-agricultural sector livelihoods. One of the non-agricultural livelihood diversifications is sand mining due to utilizing the type of soil in Bambang Village, which is sandy soil. Around 20% of the productive land in Bambang Village is currently a sand mining area, as illustrated in the following Figure 3. The average daily capacity of sand transported accommodates 1-2 trucks in one mining area. Each truck reaches a sand capacity of 6-8 tons in the mining area. The average income of sand miners participating in one program is IDR 25,000 - IDR 50,000 per day. The lowest price of sand per truck is IDR 500,000 - IDR 600,000 per load. Even though the highest price is IDR 900,000-1,000,000 per load, delivery can be made a maximum of 3 times a week. Then, the average net income of truck drivers is IDR 500,000. Some of the sand miners of Bambang Village even neglect the environmental aspects emerging when the sand mine owner enters into an oral/written memorandum of understanding with (the dozer truck owner) without arranging clear boundaries for the maximum depth and distance of sand mining.

![Figure 3. Sand mining area in Bambang Village. Source: Research documentation (2021).](image-url)
In accordance with previous research results (Da and Le Billon, 2022), sand mining is practiced without considering the regulation, especially with industrial authorities who exploit the environment by involving the "sand mafia". Accordingly, sand mining activity without proper regulation directly affects the shape of the soil surface, and on a riskier scale, it can cause erosion/landslide, as illustrated in Figure 4.

![Figure 4. Landslide conditions in Bambang Village in 2021. Source: Research documentation (2021).](image)

As such, this activity often leads to various indirect and cumulative effects on the physical characteristics of the soil and the dynamic balance of erosion and sedimentation (Figure 4). This statement is in accordance with the prior study of Karan et al. (2019) that sand mining areas contain easily eroded materials and low vegetation, causing higher soil loss and the potential for erosion disasters. The same case was found in another study by Choudhury et al. (2022), reporting that sand mining activities had an impact on increasing soil erosion. Additionally, sand mining could reduce soil quality by reducing the ability of the soil to sequester carbon and nitrogen (Qin et al., 2020), and it could affect the supply of natural resources in the long term (Da and Le Billon, 2022). Farahani and Bayazidi (2018) emphasized that natural resource problems could affect the increase in the poverty rate of farming communities in rural areas. As presented in Figure 4, the erosion process of top-layer soil is evident as a result of sand mining livelihood activities. In line with the statements of Nur Fauzan et al. (2022) and Da and Le Billon (2022), sand mining has a significant impact on the removal of sand which could alter the flow of the soil surface and increase the potential for erosion.

Mining itself already causes drastic environmental changes, but without proper laws and regulations, the results could be further catastrophic. Disabling one ecosystem service could potentially reduce the availability of several other services. The United Nations Environment Program (UNEP) and the World-Wide Fund for Nature (WWF) recently published issues regarding sand mining and found that there was insufficient information and guidance to support it, in particular, that has an impact on increasing sand mining (Clements, 2018; Purnomo et al., 2022; Hidayat and Ambayoen, 2023). The sand mining activity also does not contribute to the development and improvement of Bambang village, as it is practiced without the synergy of village government stakeholders, solely run on the basic understanding. The contract for selecting the owner of the allocation of mountains and dump trucks is executed without the obligation to pay village government money, such as the cost of maintaining sand mining land. Therefore, based on the results of this FGD, the management of sand mining must be managed wisely by considering the social, economic, and environmental aspects. Moreover, the management of sand mining had discouraged the community from having an intra-community agreement (sand mining), an agreement between sand owners, entrepreneurs and local residents. Consequently, an administrative coordinator (local village head) was appointed to accommodate such FGDs. This rule was also formalized as a general rule in Bambang village. Society also faces a dilemma between social, economic, and environmental interests (Rangel-Buitrago et al., 2023). Upon facing critical natural resources, some farming communities seek other employment opportunities to survive, with some working in the plantation sector and having livestock as an alternative source of income in order to continue the economy when they do not receive income from agriculture.

**Integrated Farming System (IFS)**

Environmental problems triggered by sand mining activities require recovery. Several residents of Bambang village have adopted a multicultural farming system for some garden crops combined with Colonial corn feed. Selection of smallholder proximity is conducted by considering several factors, such as improving nutrition, market diversification and risk reduction. In line with the statement of Ferrer et al. (2021), the restoration of degraded areas due to development is arranged by reforesting native vegetation to maintain soil and water quality. Agricultural diversification occurs when a farm or farming community increases the number of crops, plant varieties or animal breeds.

IFS is the cultivation of various plants such as catchment plants, mixed plants, successional plants, and so forth (including annual crops, annual crops and woody plants), thereby providing agro-ecosystem services (nutrient replenishment, soil quality improvement, crop failure, nitrogen fixation, air infiltration and pollution). This notion is consistent with previous research indicating the extent to which IFS increased farm profitability by increasing net income to 263% compared to monoculture (Singh et al., 2022). IFS is characterized by a temporal and spatial mixing of crops, livestock, fishing, and related activities on a single farm. In accordance with research...
by Bieluczyk et al. (2020), IFS is selected as a strategy to restore sustainable soil productivity through a combination of annual crop cultivation, animal husbandry, and/or forestry subsistence activities with spatial-temporal adjustments.

Farmers in Bambang Village attempted to apply IFS, as an alternative solution addressing the problem of degraded land by practicing livestock farming (Figure 5) in order to produce animal manure (both cows, goats and chickens) for plants’ nourishment. Similarly, the cultivation of annual crops and other vegetation, such as corn, especially coffee, produces litter to be used as compost which could improve soil quality in ex-mining areas. In accordance with the results of De Corato (2020), compost refers to a biological control agent playing a role in improving the quality of soil and plants oriented towards a circular economy. The application of IFS through livestock husbandry and agricultural cultivation activities has a positive impact on the preservation and sustainability of environmental resources in Bambang Village. The pattern of IFS practices in Bambang Village, which is integrated through several subsistence activities and efforts to reforest degraded land areas due to sand mining, is illustrated in Figure 6. Complex facilities in this sand mining area are more productive at the systematic level, which is less susceptible to volatility, but are slightly more negative externalities than simplified facilities. Therefore, they serve the needs of the small and marginal farmers as the backbone of Bambang Village’s agriculture.

Figure 5. Livestock activities by farming communities in Bambang Village. Source: Research documentation (2021).

IFS improves food recycling through composting, shredding and the addition of residues, thereby minimizing the generated external costs. Recycling nutrients in the field helps improve soil quality indicators, such as soil nutrient availability, and also increases soil microbial activity. Thus so far, IFS has played an important role in the bioconservation of the sand mining area through the integration of diverse farming systems and local cattle ranches, significantly due to the increasing carbon sequestration, production of tree biomass, and reduced consumption of fertilizers and pesticides.

All result in connected systems for sustainability and resilience to climate change. In line with the results of IFS research, the integration of agricultural-livestock, livestock-forestry and agricultural-livestock-forestry cultivation activities indicated the potential values of environmental preservation (Figure 7), including reducing N₂O emissions (Do Nascimento et al., 2020; Amadori et al., 2022). Similarly, the research result of Choudhury et al. (2022) showed that IFS practices could reduce runoff and/or soil loss in horticultural and agroforestry systems with soil conservation measures on steep slopes. IFS also plays an important role in increasing soil organic carbon from 0.75 percent to 0.82 percent. Subsequently, greenhouse gases can be reduced.

Figure 6. Commodity types in Bambang Village. Source: Research documentation (2021).

Figure 7. Integrated Farming System (IFS) practice pattern in Bambang Village.
The biggest challenge in implementing IFS lies in the need for skills, knowledge, resources, labor and capital, which are not always available to small and marginal farmers. Furthermore, productivity, profitability and environmental sustainability variables should be integrated into a common assessment framework to effectively generate information to enhance IFS adaptability. The integrated farming systems model (Figure 8) focuses on the household context of the farmer, encompassing the important biophysical and economic processes associated with the production and marketing of crops and livestock, as well as the use of off-farm employment opportunities and their small-scale interactions. The main application of IFS lies in the integration of crops, livestock and socio-economic outcomes of various strategic initiatives that propose and assess the level of risk of various components of the farmer's household.

Thanh Hai et al. (2020) added that IFS practices are capable of improving agricultural productivity through environmental sustainability to generate sustainable livelihoods for farming communities. The impact of sand mining leads to the occurrence of land degradation, which affects the availability of long-term natural resources, requiring further attention to the development of the adaptive capacity of each actor involved in sand mining (Figure 9).

Figure 8. Integrated Agricultural Systems provide ecosystem services.

Figure 10 illustrates that environmental degradation in the sand mining area of Bambang Village is inseparable from the involvement of actors, including the community, village government, sand mafia, and truck drivers. The wider the land is utilized for sand mining, the wider the market network is required by brokers and truck entrepreneurs to provide benefits to the income of the village treasury (every truck levy is IDR 10,000/truck in 2022. Likewise, the government can easily provide access and/or permits for some people to conduct sand mining on their land. However, the sand mining livelihood activity presents a dilemma in meeting the benefits to the income of the village treasury; alongside this privilege, it has an impact on the greater damage to natural resources in Bambang Village. Several involved actors in sand mining activity have a sustainable role in utilizing natural resources in the form of sandy soil as an alternative source of income that helps the community's economy. Some people act as landowners, while others become workers with the consideration that sand mining is a "high return sector" without requiring special skills (Purnomo et al., 2021). Other involved actors include truck drivers and sand brokers who act as marketing intermediaries for the results of sand mining by providing village income through the village government. In this case, it is revealed that the livelihood of sand mining also has a contribution to village development and the economic welfare of the community.
Therefore, the livelihood of sand mining needs to be supported by livelihood sustainability by preserving the surrounding environment through the adaptive capacity of actors strengthening their role as an "Ecopreneur". According to Magnani et al. (2017) and Sarkar and Pansera (2017), ecopreneurs refer to business actors who combine environmental awareness, economic growth and promote social awareness. The role of ecopreneurs in business activities is apparent in their ability to allocate natural resources optimally and are oriented towards activities that are more environmentally friendly to achieve business continuity and/or livelihood. Practically, the solution to sand mining activities is the application of IFS concept involving the role of ecopreneurs for actors engaging with sand mining in Bambang Village (Figure 9). The combination of IFS and ecopreneur concepts is illustrated in Figure 10. One of the ways to achieve livelihood sustainability and ecological sustainability is through the application of IFS with the ecopreneur concept considering the harmony among social, economic and ecological benefits. The impacts of sand mining range from landslides, land damage, and land inability for crop production. Damage due to sand mining land needs to be handled comprehensively by various parties (community, government officials and related parties) with due regard to environmental, social and economic aspects.

The steps in implementing IFS sustainability include (1) land owners through making use of the potential for animal manure waste from cattle breeders, poultry breeders and other concerned parties; (2) the Bambang Village government agreement with the community to make regulations regarding the implementation of IFS according to local wisdom and community capabilities; and (3) stakeholders or related parties assisting the IFS program in Bambang Village.

Based on this study's observations, it is revealed that landowners still experience difficulties in utilizing...
former mining land for planting timber; one of the obstacles is the infertility of the former mining sand. In addition, the village government does not have a rural development program, especially the implementation of IFS in an integrated and sustainable manner, expected to build local community awareness as well as to maintain ecological sustainability in the sand mining area, considering the benefit economically and socially.

**Conclusion**

One of the causes of land degradation is uncontrolled sand mining, which neglects the various consequences of sand mining. The advantage of sand mining activities is targeted to achieve economic value in the short term; however, sand mining in the long term has a fatal impact on the environment. Hence, the application of IFS provides an answer as well as a choice that can be continuously applied and implemented as a method of increasing socio-economic development in Bambang Village. Apart from the application of IFS, the role of actors as ecopreneurs is equally deemed pivotal to achieving sustainability in sand mining activity from social, economic, and ecological perspectives.

Recommendations for future research are to encourage thorough evaluation in understanding the causes and to provide solutions in dealing with degraded land issues as well as by involving the actors in anticipating environmental damage. In addition, the recommendations include anticipating the physical, biological, chemical and anthropogenic environmental impacts of sand mining by referring to the political and economic roles of various stakeholders when expecting to implement sustainable mining policies.

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