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GREEN INNOVATION: MANAGING POST-TIN MINING LAND (*ABANG TIMAH UNTUK BUDISA*) IN JELUTUNG VILLAGE, BANGKA BELITUNG

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ABSTRACT

This article discusses green innovation in post-tin mining land management in Jelutung Village, Bangka Belitung. The long-standing illegal mining in this area has caused significant environmental damage, leading to numerous abandoned mining pits. The innovation "*Abang Timah Untuk Budisa*" was launched to revitalize these lands through rice cultivation. This program aims not only to address land degradation issues but also to enhance local food security. This study employs a descriptive qualitative method, focusing on the policy implementation process using Edward III's analysis theory. The results indicate that this innovation can meet the food needs of some residents of Jelutung Village and help fill some of the abandoned mining pits. Challenges faced during the implementation of this innovation included limited availability of fertilizers and agricultural facilities, which were addressed by utilizing manure and other management techniques. Overall, the "*Abang Timah Untuk Budisa*" innovation successfully transformed the former mining lands into productive areas, supported food security, and provided economic benefits to the community. This study employs a qualitative method because the problem presents a general description of the issue, along with a proposed solution. The conclusion is that the problem is about preserving the environment for future generations, so everyone must strive to maintain it. This innovation has also gained national recognition, receiving awards from *Menpan RB* and *Mendagri* as one of the top 45 innovations in Indonesia.

Keywords: Green innovation, post-mining land management, environmental sustainability, food security, community-based innovation.

INTRODUCTION

Illegal mining in Bangka Belitung Province has persisted for a long time. Problems arose when conflicts emerged among tin miners, students, and the general public, all of whom shared the same goal of

stopping illegal mining activities conducted by the community. Despite these mining activities contributing to the local economy, the new provincial authorities' mission is to put an end to illegal mining, considering the severe environmental degradation in Bangka, which includes numerous abandoned mining pits resulting from unlawful tin mining. Illegal mining is the primary cause of the formation of these pits that damage the surface of Bangka Belitung. One of the most affected regencies is Bangka Regency, where nearly 45% of its area is filled with these pits. The remaining land is designated only for residential areas and plantations. From this situation, the idea emerged to create an innovation that benefits the Bangka Regency community.

The problem faced was the lack of improvement or revitalization of tin mines that had been abandoned for decades during the leadership of the 15th Regent of Bangka, Mr. Tarmizi. The most prominent program during that time was in the agricultural sector, focusing on a sustainable self-sufficiency initiative achieved within three years (2015-2017). The rampant mining activities in Bangka Regency have increased the areas of abandoned mines, resulting in a loss of potential land. In response, the Bangka Regency Food and Agriculture Office launched the innovation program “*Abang Timah Untuk Budisa*” aimed at reviving the former mining lands for rice cultivation. In 2005, Indonesia still dominated global production of white tin, with an average annual output of 120,000 tons.

Bangka Induk Regency, through the Agriculture and Food Office, introduced the *Abang Timah Untuk Budisa* innovation. The advantages of this innovation include meeting the food needs of some residents of Jelutung Village, Matras Subdistrict, and covering the open pits resulting from illegal mining. These pits are scattered across almost the entire Bangka Belitung area. With the *Abang Timah Untuk Budisa* innovation, some of these pits can be effectively managed. The food needs of the farming community in Jelutung Village can be met by using the rice from their crops as daily food supplies. At least, the land damage can be mitigated by this innovation initiated by Bangka Regency. Approximately 31 hectares of former tin mining land have been repurposed for rice cultivation by the Bangka Regency government through farming groups. From the inventory data, the percentage of critical land in the Bangka Belitung Islands Province consists of:

Table 1

Critical Land Conditions in Bangka Belitung Province

Criticality	Kabupaten/Kota						
	Bangka	West Bangka	South Bangka	Central Bangka	Belitung	East Belitung	Pangkal Pinang
Not Critical Potential to be Critical	58,469	82,674	63,503	53,017	93,307	106,771	4,658
Quite Critical	151,187	148,768	221,296	91,008	86,806	89,947	5,679
Critical	87,079	49,279	79,855	71,149	44,995	59,569	232
Very Critical	4,832	4,006	4,630	1,776	977	4,189	0
	0	12	191	57	0	0	0
Total (Hectares)	301,567	284,739	369,475	217,007	226,085	260,476	10,569

From Table 1, the critical land conditions in Bangka Belitung Province are evident. In Bangka Regency, there are 58,469 hectares of non-critical land; in West Bangka Regency, 82,674 hectares; in South Bangka Regency, 63,503 hectares; in Central Bangka Regency, 53,017 hectares; in Belitung, 93,307 hectares; in East Belitung, 106,771 hectares; and in Pangkalpinang, 4,658 hectares. The total non-critical land in Bangka Belitung Province can be utilized for agriculture, residential areas, tourism spots,

and other purposes. For potentially critical land, Bangka Regency has 151,187 hectares; West Bangka Regency, 148,768 hectares; South Bangka Regency, 221,296 hectares; Central Bangka Regency, 91,008 hectares; East Belitung, 89,947 hectares; and Pangkalpinang, 5,679 hectares.

Slightly critical land in Bangka Regency amounts to 87,079 hectares; in West Bangka, 49,279 hectares; in South Bangka, 79,855 hectares; in Central Bangka, 71,149 hectares; in Belitung, 44,995 hectares; in East Belitung, 59,569 hectares; and in Pangkalpinang City, 232 hectares. For highly critical land, Bangka Regency contains 4,832 hectares; West Bangka has 4,006 hectares; South Bangka has 4,630 hectares; Central Bangka features 1,776 hectares; Belitung has 977 hectares; and East Belitung has 4,189 hectares. The total amount of land, whether non-critical, potentially critical, slightly critical, or highly critical, in Bangka Regency, is 301,567 hectares.

Critical land refers to land that has experienced physical, chemical, and biological damage, which can endanger hydrological, ecological, agricultural production, residential functions, and the socio-economic life of the surrounding community (Erfandi et al., 2020). It is essential to rehabilitate critical land so that it can be utilized optimally for the community's welfare. According to a report from BPS Bangka, several pits in Bangka Regency require attention (Erfandi et al., 2020). Some studies highlight various land rehabilitation techniques that can be applied to address critical land issues. For instance, the use of nano-scale Fe⁰ particles and organic waste has been shown to improve the nutritional status of tree seedlings growing in heavy metal-contaminated soil (Tafazoli et al., 2021). Additionally, other studies have shown that tree planting using specific techniques can enhance groundwater content, survival rates, and seedling growth (Bayen et al., 2020).

This is the understanding of critical land that we need to be aware of. It is best to rehabilitate the land immediately so that it can benefit the welfare and prosperity of the community. Considering the numerous pits in the Bangka Belitung Islands, here is the number of pits in Bangka Regency based on the report from BPS Bangka.

Table 2

Number of Pits in Bangka Island

Numbers	Total Pits	Wide	Distribution	Breadth (Hectares)
1	887	11,712.65	544 (Bangka Island)	1,035.51
2			343 (Belitung Island)	677.14

Source. Menpan.go.id

The number of pits on Bangka Island reaches approximately 887 pits with a total area of 11,712.65 hectares, consisting of 544 holes with an area of 1,035.51 hectares. Meanwhile, the number of pits on Belitung Island amounts to 343 holes with an area of 677.14 hectares. In Bangka Regency, environmental damage is also very severe, necessitating the planning of environmental management for post-tin mining areas by reclaiming these areas into productive zones. This plan encompasses a range of activities, including cattle farming, fruit orchards, seed gardens, water parks, aquaculture, hydroponics, traditional houses, sunflower gardens, and vegetable gardens.

The "Abang Timah Untuk Budisa" innovation, or the utilization of former mining land for rice paddy cultivation, began in 2014. However, this idea had been in the minds of the leaders of Bangka Regency since around 2005, to support the food security of Bangka Regency's residents, who have had to buy rice at high prices in the market.

The main issues faced in this innovation, as reported by farming groups, are the lack of fertilizers. They have requested assistance from the local government. However, it has been challenging due to specific

regulations, and they must wait until fertilizers are available, while the stock was empty at that time. Additionally, the necessary tools and infrastructure, from hoes to tractors, still must be borrowed alternately from other departments. Another problem is that due to the difficulty in obtaining fertilizers and tools, farmers have sought alternatives by using manure to supplement the nutrients in their rice. However, some of this manure must also be purchased, which has disappointed farmers as they feel burdened by the cost of purchasing manure, like buying urea fertilizer.

Based on this, research is needed to obtain data and information that can be utilized for sustainable fisheries management. This article will examine food sovereignty, which is defined as a nation's ability to meet its food needs, independently formulate food policies, and protect and ensure the welfare of farmers, the leading actors in the agricultural food sector. In other words, food sovereignty must start with gradual food self-sufficiency, followed by increasing the added value of agricultural enterprises to improve the welfare of farmers. Here are the strategic targets of the Ministry of Agriculture for the next five years:

1. Increasing food diversification,
2. Increasing high-value and competitive commodities to meet export markets and import substitution,
3. Providing raw materials for bioindustry and bioenergy,
4. Increasing farmer family income, and
5. Good performance accountability of the government apparatus.

With these strategic targets, the Ministry of Agriculture has formulated and implemented seven main strategies to strengthen agricultural development for Food Sovereignty (P3KP), which include:

1. Achieving self-sufficiency in rice, corn, and soybeans as well as increasing sugar and meat production,
2. Increasing food diversification,
3. Increasing high-value and competitive commodities to meet export markets and import substitution,
4. Providing raw materials for bioindustry and bioenergy,
5. Increasing farmer family income, and
6. Good performance accountability of the government apparatus.

Tin production continues to increase year by year due to the growing global demand. Tin is used in various products, including food cans, aluminium foil, paper, food wrapping layers, automotive components, computers, pipes, glass, dentures, and door and window guards. Based on the export data of tin and non-tin products from Bangka Belitung Island (HS, 2022), the production of tin and mineral mining products has continued to decline over the past three years. Nonetheless, this decline in production has not reduced the vast area of former tin mining lands. Below is the extent of former tin mining areas in Bangka Regency.

Table 3

Area of Former Tin Mining Lands

Number	Description	Information
1	Area width	18.016.76 ha
2	Spread to	6 areas and 30 villages
3	Tin former areas in the protected forest	538 ha (2.99%)
4	Cultivation area	17.49 ha (97.01%)

Based on Table 3, the area of former tin mining lands in Bangka Regency is 18,016.76 hectares, spread across six sub-districts and 30 villages, with 538 hectares located in protected forest areas (2.99%) and 17,479 hectares in cultivation areas (97.01%). Past tin mining activities have resulted in mining pits scattered throughout the Bangka Belitung Islands Province, varying in size, depth, and usage, including for tourism, fish farming, and others (Nurtjahja, 2008).

The potential of former tin mining lands on Bangka Island can be utilized for fish farming. Older pits are preferred because they will not become turbid when used for fish farming, thus benefiting daily food needs, particularly in increasing the portion of protein in the diet. However, the problem caused by this mining is environmental damage. Initially, tin mining was only conducted on land. However, as land areas became depleted, miners turned to the sea, leading to an increase in unconventional (TI) floating mines and suction vessels.

The damage occurring in Bangka Belitung is due to the excessive exploitation of natural resources without adequate maintenance and environmental conservation efforts, resulting in soil, river, beach, and sea pollution. Therefore, the "*Abang Timah Untuk Budisa*" innovation emerged in 2014. This innovation aims to utilize former mining lands for rice paddy cultivation and enhance community food security, especially during the COVID-19 pandemic. The characteristics of this innovation include:

1. New
2. Distinctive
3. Planned
4. Having clear objectives

Further explanation of the "*Abang Timah Untuk Budisa*" innovation: (1) New: This innovation was newly introduced in 2018 with a shared system, which involves entrusting livestock maintenance to other farmers in exchange for profit-sharing. (2) Distinctive: This innovation aims to improve food security during the COVID-19 pandemic. (3) Planned: Before the innovation, the former mining lands had large holes, irregular contours, and were nutrient-poor, making them unproductive for agriculture. This innovation enhances agricultural activity on critical land and supports the achievement of the Sustainable Development Goals (SDGs). (4) Having clear objectives: The objective of this innovation is to improve the food needs of the community during the COVID-19 pandemic.

Another study by Erfandi et al. (2020) demonstrates that the application of compost soil amendments and/or clay leads to optimal growth of rubber plants on former tin mining lands. The use of mulch also plays a crucial role in maintaining the soil microclimate conditions for microorganism activity. Additionally, according to Asmarhansyah et al. (2020), pits are depressions filled with water due to tin mining activities. Mining activities on Bangka Island increased after the enactment of the Regional Regulation of the Bangka Belitung Islands Province Number 3 of 2004 on General Mining Business Management. Based on Law No. 4 of 2009, mining activities encompass various stages, including research, management, and exploitation of minerals or coal.

Indonesia has a long history of tin mining and is currently the world's second-largest producer of tin, after China. Bangka Belitung has been rife with community mining since the 2000s. Previously, mining was conducted by PT. Timah, Tbk, and the foreign company PT. Kobatin. The reclamation of former tin mining lands is one of the challenges to achieving sustainable management in mining areas, as stipulated in Law No. 4/2009 on Mineral and Coal Mining. The goal is to restore and enhance the quality of the environment and ecosystems, and to restore land functions through mine closure planning. In general, the utilization of mining lands includes potential fish resources; some groups in the Muntok Subdistrict utilize pit waters as a medium for fish farming. The utilized pits have water quality that can support the survival and growth of fish. In addition to fish, former mining lands can also be used for vegetable cultivation. Research by Sukarman et al. (2020) demonstrates that former tin mining lands on Bangka Island can be successfully planted with vegetables through environmental modification and organic additions. Sustainable mining management includes:

1. Ethical business practices and sound corporate governance systems
2. Integration of sustainable development considerations in corporate decision-making processes
3. Respect for human rights, culture, and values in dealing with employees and affected communities
4. Implementation of risk management strategies based on valid data and solid science
5. Continuous improvement of health and safety performance
6. Continuous improvement of environmental performance
7. Contribution to biodiversity conservation and integrated land use planning
8. Facilitation and encouragement of responsible product design, use, recycling, and disposal
9. Contribution to social, economic, and institutional development of surrounding communities
10. Implementation of effective and transparent stakeholder engagement, communication, and reporting

The development of the concept of sustainable development in the mining industry has led to changes in mining laws. On January 12, 2009, Law No. 4 of 2009 replaced Law No. 11 of 1967 to reflect changes relevant to the management of mineral and coal resources. This article is expected to contribute to the development of public administration studies, especially in the management of post-tin mining lands in Bangka Belitung. The results of this study can spark new themes for the management of former mining lands and provide input to the Pangkalpinang City Government in managing these areas. The current reference mining law is Mineral and Coal Mining Law No. 4/2009.

METHODOLOGY

The method used is descriptive qualitative. The content of this article focuses on the process and meaning from the subject's perspective, with Edward III's policy implementation analysis theory as a guide to align with the facts on the ground. The descriptive method aims to depict conditions using interrelated data to understand social issues systematically. This article describes the planning of post-tin mining land management in Bangka Belitung Islands Province. A qualitative approach is employed to study the natural condition of the object, with the researcher serving as the primary instrument, utilizing purposive sampling, and collecting data through triangulation.

The diffusion and adoption of innovation involve the communication of innovation through certain channels over a specific period within a social system. The key elements of diffusion are (1) innovation, (2) communication channels, (3) time, and (4) members of the social system. This research was conducted on former tin mining rice fields in Sinarjaya Village, Sungailiat City, Bangka Regency, by the national mineral and coal policy aimed at promoting the prosperity of the people, as outlined in Article 33 of the 1945 Constitution. The "*Abang Timah Untuk Budisa*" innovation is an effort to utilize former mining lands for rice paddy cultivation, intending to improve the community's food security.

RESULT AND DISCUSSION

Innovation is the process of presenting and implementing new ideas or concepts to utilize existing resources optimally. The "*Abang Timah Untuk Budisa*" innovation is an example of an innovation implemented in Bangka Regency. This innovation process involves a series of activities carried out by individuals or organizations, from awareness of the innovation to its implementation. In this context, the innovation focuses on utilizing less productive and neglected lands that have the potential to become critical lands and cause problems. This situation prompted the government, specifically the Agriculture Office of Bangka Regency, along with the community to seek solutions to repurpose these lands.

The innovation process is not without challenges and competition. Other groups are undertaking similar innovations in the management of mining areas by planting rice. However, their efforts are still limited, not reaching one hectare. For some residents of Bangka Island, farming is a secondary activity, as they hold other jobs. They grow rice as an additional food source for daily consumption, but now many have turned into commercial farmers, planting crops that match market demand, such as black glutinous rice, red rice, or black rice, to facilitate sales. The remainder is used for their daily needs.

Further research was conducted through interviews in several villages around Jelutung Village, including Deniang Village. Informants explained that the land around Deniang Village currently can only support oil palm cultivation. Besides oil palm, former tin mining lands are also being reclaimed with plants known as paper trees, a type of coniferous tree. Although many types of plants could potentially be grown, currently only a few hardy plants, like oil palm and paper trees, can thrive. This innovation highlights the importance of an integrated and collaborative approach between the government and the community in addressing critical land issues and enhancing the productivity of former mining lands for the mutual benefit of all parties.

Figure 1

Oil Palm Seedling Nursery in Deniang Village



Can former mining lands be planted with other crops? According to the Head of the Horticulture Division, there is currently avocado seedling cultivation underway. The Head of Rias Village explained that avocados, originating from Central America and Mexico, have been cultivated in South America and Central America as monoculture crops, as well as backyard plants in other tropical regions around the world.

Avocados are rich in nutrients, including 83.4 grams of water, 0.9 grams of protein, 85 calories of energy, 6.5 grams of fat, 0.6 grams of ash, 20 mg of phosphorus, 7.7 grams of carbohydrates, and 0.9 mg of iron (Fe). Here are the steps for planting avocados (Sukarman et al., 2020):

1. **Avocado Seedling Preparation:** Avocado seedlings can be obtained in three ways: grafting or stem cutting, seeds, and budding or top-grafting. If planting from seeds, seeding needs to be done first. Avocado seeds from ripe fruits are taken and dried for about three hours, then placed in a shaded area before being sown in polybags. Seed care is done until they grow into seedlings with a height of about 1 meter, ready to be transplanted into the field.
2. **Land Preparation:** The land must contain good nutrients, such as *Nitrogen (N)*, *Phosphorus (P)*, *Potassium (K)*, *Magnesium (Mg)*, *Calcium (Ca)*, *Boron (B)*, *Copper (Cu)*, and *Zinc (Zn)*. These elements are crucial for the formation of plant cells, tissues, and organs.

3. Planting avocados on former tin mining lands requires special attention to ensure the soil has sufficient nutrient content. With proper care, these lands can become productive again and yield highly nutritious crops, such as avocados (Harahap et al., 2016). This approach is part of the effort to diversify crops and sustainably utilize land, addressing environmental issues while enhancing community welfare through more diverse and economically valuable agricultural produce.

Figure 2

Avocado Seedling Nursery on Former Mining Land



In addition to avocados, date palms are the latest innovation to be planted on former tin mining lands in Bangka Regency. Previously, these lands have also been planted with red and white dragon fruit. Dates, or date palms, are a type of palm tree that can survive in desert environments. Dates (Arabic: نخل, *Nakhla*; Latin: *Phoenix dactylifera*) are plants whose fruits can be eaten, and their origin is not known.

Date palms likely originated from Persia. The Bangka Regency government, through the Agriculture Office, has distributed several date palm seedlings to each village as a pilot to see if this plant is suitable as an addition to other crops. The distributed date palm seedlings are approximately 15–25 cm tall. The Agriculture Office chose date palms because this plant has a long history as a staple crop for Middle Eastern societies for thousands of years. Dates are believed to have originated from around the Persian Gulf and have been cultivated since ancient times, from Mesopotamia to prehistoric Egypt, possibly as early as 4000 BC. Ancient Egyptians used its fruit to make date wine and consumed it during harvest. Archaeological evidence suggests that dates were cultivated in eastern Arabia around 6000 BC (Baryshnikov et al., 2022). In later times, Arabs spread dates to South and Southwest Asia, North Africa, Spain, and Italy. Dates were introduced to Mexico and California by the Spanish in the 1760s.

Dates are oval-cylindrical fruits measuring 3 to 7 cm in length and 2 to 3 cm in diameter. When young, the fruits are bright red to bright yellow, depending on the variety. Dates have a single seed that is about 2 to 2.5 cm long and 6 to 8 mm thick. Date fruits are classified into three main groups: soft (e.g., 'Barhee', 'Halaw', 'Khadrawy', 'Medjool'), semi-dry (e.g., 'Dayri', 'Deglet Noor', 'Zahidi'), and dry (e.g., 'Thoory'). These types depend on their glucose, fructose, and sucrose content. Date palms are dioecious, meaning they have separate male and female plants. They can easily grow from seeds, but only 50% of the female plants grown from seeds will produce fruit.

Figure 3

Date Palm Seedling Nursery on Former Mining Land



In addition to rice, avocados, and dates, dragon fruit is also being tested for cultivation on former mining land. This innovation showcases Bangka Regency's efforts to utilize former mining areas productively and sustainably while enhancing community welfare through crop diversification. Dragon fruit hails from Mexico and Central America, and it has now been cultivated in various Asian countries such as Thailand, the Philippines, Malaysia, and Indonesia. In 1870, the French brought the plant from Guyana to Vietnam as an ornamental species. In Vietnam and China, dragon fruit is believed to bring blessings. Therefore, this fruit is always placed between two green dragon statues on the altar table, making the red dragon fruit stand out among the green figures. This custom led to the fruit being known among the Vietnamese as Thang Loy, which was later translated into English as Dragon Fruit.

In Bangka Regency, dragon fruit is cultivated in several villages. Dragon fruit farming in this area progresses by utilizing coconut husks as a nursery medium. Below is an image of one of the dragon fruit nursery methods involving coconut husks. The development of dragon fruit in Bangka Regency represents one of the crop diversification efforts aimed at increasing the productivity of former mining lands and providing economic benefits to the local community.

Figure 4

Dragon Fruit Seedling Nursery on Former Mining Land

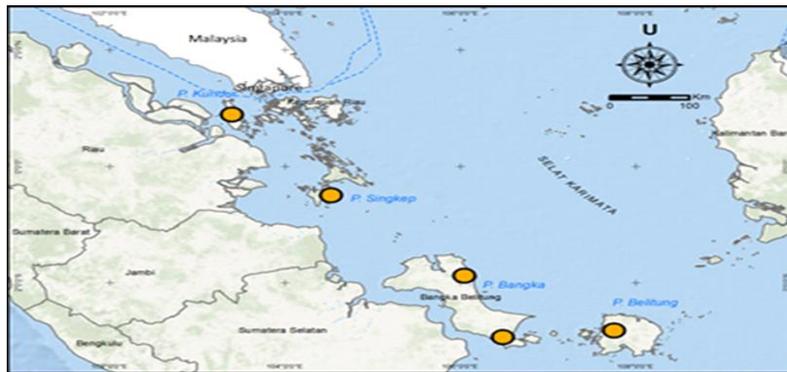


Novelty Factor

This research emphasizes methods for utilizing idle land to ensure no land is wasted. The demand for land is significant, and it is essential to make use of every available inch. Bangka Regency covers an area of 295,068 hectares, with a potential agricultural land area of 112,284 hectares. Of this, approximately 4,410 hectares have the potential to be developed as rice fields.

Figure 5

Map of Rice Harvest Area in Bangka Belitung Region



The advantages of the "*Abang Timah Untuk Budisa*" innovation include: (1) National Recognition: The "*Abang Timah Untuk Budisa*" innovation received direct awards from Menpan RB, Tjahjo Kumolo, and Mendagri, Tito Karnavian. This award was earned by surpassing various regions with innovative solutions, placing it among the top 45 innovations in Indonesia. The evaluation process underwent stringent stages, demonstrating the quality and superiority of this innovation. (2) Utilization of Idle Land: This innovation is considered superior because it can utilize idle land from former tin mining in Bangka Regency. Previously unproductive land has been transformed into productive rice cultivation areas. This not only enhances land use but also provides economic and environmental benefits to the local community.

The "*Abang Timah Untuk Budisa*" innovation exemplifies how former mining lands can be transformed into valuable resources through effective planning and execution. It offers hope that, with innovation and collective effort, environmental challenges can be tackled and previously unused land can be optimized for the community's welfare. This study discovered coconut husks near the dragon fruit nursery, as dragon fruit nurseries rely heavily on coconut husks. The village head explained that dragon fruit nurseries are usually established through cuttings or seed planting. This plant thrives in porous (not waterlogged), nutrient-rich, sandy soil with ample sunlight and temperatures between 38-40°C. Therefore, Bangka Regency, particularly Rias Village, is highly suitable for dragon fruit cultivation due to the favorable weather conditions.

Figure 6

Dragon Fruit Nursery Belt



Dragon fruit can thrive in various soil conditions and altitudes, but it is highly nutrient-demanding. If provided with good fertilizers, its growth will be optimal. Within one year, this plant can reach a height

of up to 3 meters. Currently, dragon fruit cultivation is not widespread, primarily occurring in East Java and West Java. Although the "*Abang Timah Untuk Budisa*" innovation is the primary focus, the Agriculture Office of Bangka Regency is also striving to develop various types of crops to meet the local community's economic needs. Planting dragon fruit is one of the steps in agricultural diversification that can enhance the productivity of former tin mining lands and provide an alternative source of income for the community.

Communication Channels

Communication in the innovation diffusion process serves as a crucial tool for transferring information and new ideas from the source to the recipient. Individuals will only adopt an innovation if it has been effectively communicated to others. This is emphasized in studies on communication in the innovation diffusion process (Oktorina, 2018). In an interview transcript, Cik Ona, who heads the food and horticulture division, was asked about the age of the pits used for rice fields on former tin mining lands. She explained that the age of the pits is unknown because they had already formed when they arrived. The land, a production forest not owned by the community, is considered suitable for use, despite being uninhabited.

Rice and horticulture farmers receive different treatments; rice farmers receive more subsidies from the government aimed at stabilizing market prices. Although fertilizer prices are currently very high, the government is trying to provide solutions that allow farmers to continue farming. Agricultural extension workers are expected to communicate effectively and provide encouragement and confidence to farmers, enabling them to accept and utilize new agricultural innovations (Suwardi et al., 2023).

Communication channels can be categorized into two main types: verbal and non-verbal (Lasswell & Kaplan, 1970). To effectively understand the communication process, it is essential to consider the questions: who says what, through which channel, to whom, and with what effect. These dimensions were explored during interviews with key informants involved in agricultural activities. One informant explained that the agricultural extension worker serves as the primary communicator between the agricultural office and local farmers. The extension worker, previously a woman and now a man, provides technical guidance and occasionally facilitates interactions with external guests. In terms of communication channels, it was noted that face-to-face visits are the primary method used. However, when direct visits are not possible, information is conveyed through SMS or phone calls. Since farmers do not consistently carry mobile phones, such calls are often answered by family members. Regarding the recipients of the information, the extension worker typically directs communication to the group leader or, in their absence, to another designated member of the farming group.

Communication channels take various forms, ranging from interpersonal communication to mass communication, and it is important to choose the most effective channel to ensure that information or complaints from the community can be well responded to. Three forms of communication channels are Interpersonal Communication Channels. This form of communication involves direct interaction between two people, such as the direct interview I conducted with the head of the horticulture division of the Bangka Agricultural Office. Group Communication Channels: This is a form of communication conducted by the communicator to several communicants in a group, whether small or large, as seen in the interview with the farmer group. Effective communication, both individually and in groups, enables agricultural extension workers to understand farmers' needs and convey messages from the agricultural office accurately.

Innovation Time

The "*Abang Timah Untuk Budisa*" innovation has been implemented in rice fields in the Sinar Jaya Jelutung area of Sungailiat District. This implementation has yielded a highly satisfactory initial rice harvest, achieving a productivity level of 5.1 tons per hectare of dry grain in the 2020 harvest. To explain, the Regent revealed that this innovation was part of a competition that lasted approximately one year, although its impact has been felt for years. Initially regarded merely as a competitive effort,

this innovation has been included in the 2020 competition since 2014. Farmers are expected to continue planting rice as a staple food for the community. The government provides subsidies, especially for expensive fertilizers, with farmers currently relying on manure from cattle farming. The entire farming process, from planting to threshing rice, receives special attention from the government, including pest control and assistance during harvest.

Small-scale farmers or subsistence farmers who have succeeded often transition from rice farming to plantation crops. To support these farmers, the government offers rice insurance, which can be purchased by paying a premium of IDR 36,000.00 per hectare of land. In the event of crop failure, farmers can claim insurance of 6 million rupiah, representing approximately 75% of the total premium. The government aims to provide ongoing capital for farmers who face crop failure, illustrating its profound concern for farmers' welfare. Rice farming is indeed complex and requires special attention at various stages, including seeding, transplantation, and irrigation. Consequently, the Bangka Regency Agriculture Office aids by supplying milling equipment for all farmer groups and optimizing assistance for farmers, creating conditions that enhance their farming activities.

Social System

A social system is formed through relatively constant reciprocal interactions among various activities or individuals. As outlined by Jabal Tarik Ibrahim in *Rural Sociology*, these interactions occur continuously and indicate that a social system is a unit composed of multiple interrelated components. Since a social system is a human construct and humans are inherently social beings its existence is fundamentally shaped by ongoing social interactions (Susilawati et al., 2019).

In the context of a social system, human behavior is influenced because this system encompasses values and norms that serve as behavioural guidelines for its members. Every social system, at a certain level, maintains boundaries that separate it from its external environment or other social systems, thereby preserving its unique identity and function. Additionally, there are mechanisms within the social system that play a role in maintaining and sustaining the system. It is also interesting to observe the interaction between humans and nature in a social and economic context. For instance, although the presence of lush plants with good panicles does not always guarantee a successful harvest, each planting hopes to continue until harvest. Meanwhile, the plants grown on former tin mining lands, now planted with horticultural crops such as chilies, tomatoes, and others, illustrate the adaptation and reutilization of reclaimed land.

The presence of reclaimed former mining lands in Pugul Village by PT. Timah Tbk illustrates efforts to restore and enhance environmental and ecosystem quality. Conservation areas in Indonesia, which are categorized into production forests, protected forests, and conservation forests, reflect the government's policies for managing natural resources while maintaining ecological and social sustainability. In this context, it is crucial to highlight the intricate relationship between policies, environmental sustainability, and social dynamics in managing natural resources. Awareness of the importance of maintaining ecosystem balance while supporting social life becomes a crucial point in the narrative that combines social, economic, and ecological aspects in environmental and natural resource management.

Supporting and Inhibiting Factors of Green Innovation

To understand the factors that support and hinder, we need to recognize the basic needs of farmers. These needs include physical aspects, security, social recognition, and self-actualization. In this study, the selected sample consists of B farmers working in rice fields with a rotational management system that is part of a farmer group association. The primary challenge in managing former tin mining lands in Jelutung Village is increasing production yields. The challenges faced include inadequate fertilizer availability and a shortage of agricultural tools, necessitating comprehensive solutions to address these issues. This research also highlights the distribution of mining pits based on forest types. Information on the distribution of pits in forest areas is vital, primarily due to innovations in forest production

management that enable significant land-use changes, affecting land cover. In evaluating the innovations implemented, the researcher aims to identify the strengths and weaknesses of the existing system. Despite being categorized as a national achievement, there are still shortcomings that need to be addressed, including improving field facilities and infrastructure, as well as enhancing the quality of fertilizers and the knowledge of farmers. Another identified challenge is ineffective communication among various stakeholders, including the regent, the agriculture office, extension workers, and the farmer groups themselves. Table 4 illustrates the number of pits in various forest areas, including Protected Forests (HL), Production Forests (HP), Convertible Production Forests (HPK), Nature Reserve Areas, and other utilization allocations (APL) or Nature Conservation Areas (KPA).

Table 4

Area of Former Tin Mining Lands

No	Subdistric	Total Kolong
1	Bakam	216
2	Belinyu	1095
3	Mendobarat	144
4	Merawang	309
5	Pemali	285
6	Riau Silip	1026

Table 5

Distribution of Pits Based on Forest Areas

Number	Area	Wide	Total Kulong
1	APL	1646.66	2278
2	HL	151.9	118
3	HP	674.96	963
4	KPA/KSA	4.28	4
Total		2477.8	3363

Based on Table 5, one of the weaknesses of this innovation lies in how to increase agricultural yields amid fertilizer shortages. Farmers use available manure and cattle dung and optimize the use of straw reused in the rice fields. This approach is examined through a SWOT analysis adapted to environmental innovation theory. Innovation is defined as the application of new knowledge beneficial to human life, as seen in the case of the Horticulture journal, where fruits and vegetables are the primary focus.

Planting fruits such as rambutan, mango, and dragon fruit is achieved by improving soil quality to a limited extent using the pot system. Standard planting holes measure 50 cm x 50 cm x 50 cm, filled with topsoil, organic fertilizer, and lime. Meanwhile, vegetables such as cucumbers, long beans, mustard greens, water spinach, eggplants, and chilies are cultivated in raised beds, where soil quality is enhanced with topsoil, organic fertilizer, lime, and chemical fertilizers.

A study by Herwan et al. (2006) on former mining lands in Merawang Village, Bangka, yielded positive results with the application of organic fertilizers and lime, resulting in a significant increase in the production of cucumbers, long beans, mustard greens, and water spinach. The "*Abang Timah Untuk Budisa*" innovation approach employs a concrete and holistic systemic strategy that integrates rice field and cattle farming, along with the proper implementation of standard operating procedures (SOPs)

involving all stakeholders. This holistic approach aims to develop individual potential within an enjoyable, democratic, and humanistic learning environment.

Improvement of coastal sandy soils involves the use of soil conditioners, both synthetic and natural, to enhance the physical and chemical properties of the soil, improve soil aggregation, increase water retention capacity, and boost nutrient availability. Research by Nurtjahja (2008) found that Gamal leaf compost and Angsana leaf compost have higher organic content compared to manure, indicating that the use of compost may be more effective in such environments. In managing coastal sandy soils and tailing soils, the application of appropriate technologies such as micro-irrigation, which ensures efficient water use and can be integrated with fertilization, plays a critical role. This is essential for maintaining environmental sustainability, particularly in preserving freshwater resources. Opportunity analyses suggest that coastal sandy soils and former mining lands have potential for agricultural use if managed appropriately; however, they are also vulnerable to external threats, such as policy shifts or extreme weather events.

By understanding these factors, more comprehensive strategies can be formulated to support the success of agriculture in areas with specific challenges like Jelutung Village. This also entails a deeper understanding of the social conditions in rural communities, which can have a profound impact on agricultural development.

CONCLUSIONS

Conclusion Drawn from the Study: (1) Innovation: There is a gap in the understanding among the community that what they are doing constitutes an innovation. For example, it was found in the field that rice fields on former tin mining lands do not require excessive plowing because the land is already saturated with water. Therefore, it is important for the community to first understand the essence of innovation. Additionally, it is crucial for all related parties to recognize the strengths and weaknesses of this innovation so that the innovation dissemination process can run effectively. Innovation must be communicated to the lower levels of society, specifically the farmers, so they understand and can implement it properly. (2) Communication Channels: In the communication process, it is important to ensure that agricultural extension workers and the Agriculture Office, which act as information connectors, understand and can effectively convey messages to the community, especially the farmers who are the target for adopting this innovation. (3) Time: The duration required to carry out this innovation process needs to be carefully considered, ensuring that the entire process runs efficiently and its progress can be measured. (4) Social System: Social norms must be properly enforced so that the social system can function effectively. For example, there must be respect for an individual's social status within the community, which supports the adoption of innovation.

Supporting and Hindering Factors of Innovation: (1) Source of Message: Agricultural extension workers need to create opportunities for farmers to understand the communication process. The reality in the field reveals that conveying messages about rice field plowing is not easy, as farmers' perceptions of adoption can vary significantly. (2) Message Delivery: The language and delivery of the message must be clear and appropriate to the cultural background of the message recipient. Using the local language can be an effective way to ensure the message is well-received. (3) Message Interaction: The message source should avoid one-way communication and ensure that the body language used is relevant to the message content. Farmers, agricultural extension workers, and other relevant stakeholders need to establish effective two-way communication. (4) Honesty and Relationships: Both the message source and the recipient must be honest and build strong, close relationships, which allow for open and transparent information dissemination.

Recommended Model to Improve the '*Abang Timah Untuk Budisa*' Innovation: (1) Innovation: There needs to be an improvement in understanding the current state, strengths, weaknesses, and what is new about this innovation. (2) Communication Channels: The communication actors must be clear agricultural extension workers, related agencies, and farmers must be actively involved. (3) Time: The

implementation time must be efficient and not prolonged to avoid losing momentum or relevance. (4) Social System: Understanding the existing social structure and how the innovation can be adapted within the applicable social context is crucial for the innovation's success. By implementing a structured innovation diffusion model and considering the local context, it is expected that '*Abang Timah Untuk Budisa*' can become a successful example of using former mining land for productive and sustainable agriculture.

CONFLICT OF INTEREST

The author declares no potential conflict of interest.

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