

Peatland Use Optimization through Potential Agriculture for Rural Development in Indonesia

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ABSTRACT

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The scarcity of human resources and technology increases the likelihood that the usage of peatland is suboptimal. Overutilization of peatlands also promotes land degradation, resulting in a decline in agricultural productivity. Nevertheless, there is a lack of comprehension among certain farmers regarding the correlation between environmental sustainability and local economic output. This project aims to explore the inherent potential and characteristics of peatlands in Jambi province. Determine the specific agricultural commodities that can be enhanced through the efficient usage of peatlands. Additionally, explore strategies for effectively handling agricultural waste that can be used to provide additional benefits for local populations. Some of this information can be acquired using a qualitative research methodology with qualitative descriptive analysis. The concept of optimization has not been comprehended in terms of environmental equilibrium; hence, it is still landintensification, which has a tendency to harm peatlands. The Liberica coffee commodity is the most lucrative agricultural enterprise. Liberica coffee represents the quintessential agricultural emblem of Jambi. Additional viable crops encompass coconut, watermelon, cucumber, and rice. Some of these agricultural enterprises indirectly promote the adoption of sustainable farming practices among farmers. Simultaneously diminishing the incentive of the palm oil industry, which has a tendency to exploit. Furthermore, farmers effectively handle agricultural waste that has not been utilized. The utilization of processed waste products provides significant benefits.

1. Introduction

Peatland is a type of land characterized by water-saturated soil derived from accumulated decomposed plant material (Pangaribuan, N, 2018). Irma (2018) states that the presence of peat with a high level of dominance and a lack of diverse vegetation could contribute to a reduction in the resilience of the environment. Peatland is a distinct ecosystem that supports a diverse range of plant and animal life (Nursyamsi et al., 2014). In terms of horticulture, fruits such as pineapples, bananas, papayas, watermelons, and melons can be grown in the shallow peat fields. Additionally,

vegetables like tomatoes, bitter melon, cucumbers, chilies, kale, and spinach thrive in this environment (Masganti et al., 2017).

Sufardi et al (2016) reported that the utilization of peatland in the Forest Areas Swamp Peat Tripa (TPSF) for coconut palm cultivation has had a significant impact on agricultural development in Aceh Province. Fire-induced peat has resulted in elevated soil pH, increased levels of calcium (Ca) and magnesium (Mg) in the soil, reduced biodiversity in

the affected land, and alterations in other land characteristics (Wasis B, 2005).

Every peatland has the potential to support the growth of agribusiness and bioindustry agriculture, with the ability to cultivate various types of livestock such as fish and ducks, as well as plantations of oil palm, rubber, coconut, cocoa, and other crops (Nursyamsi et al, 2014). If the conversion of land, such as the transformation of peatland into coconut palm plantations, occurs, it is necessary to take measures to minimize the negative effects and ensure that the environment is managed in a way that promotes sustainability (Nugraheni et al., 2008). If properly maintained and nurtured, peatland has the potential to yield high-quality plants and achieve productivity comparable to mineral soil (Hidir, 2021). Certain regions of Jambi still retain their natural state, while there are already instances of land peat opening due to concessions. If the issue of matter is not promptly addressed and resolved, it could have a detrimental impact on the diverse range of fish species that inhabit it (G Wahyudewantoro, 2010).

Organic fertilizers offer numerous benefits compared to inorganic fertilizers, such as enhancing the chemical, physical, and biological characteristics of the soil. In addition, it can also supply essential nutrients in both large and small quantities, enhance the arrangement of soil particles, minimize variations in temperature, and serve as nourishment for soil organisms (Hartatik et al., 2015). This liquid organic fertilizer promotes plant development, facilitates the synthesis of plant protein, serves as a source of plant energy, and contributes to plant photosynthesis (Sundari et al., 2012). According to Effendi et al. (2022), it has been found that fertilizer derived from the internal organs of fish and seaweed is already meeting the required standards and has a nutritional value for enhancing the growth of vegetable plants.

In their study, Qurani et al. (2022) argued that engaging in sustainable agricultural practices not only preserves biodiversity and enhances the quality of life but also improves the well-being and financial stability of individuals within society and the economy. The study conducted by Suharyon (2019) demonstrates that coffee plants cultivated from the remains of burnt peatland exhibit favorable growth. Coffee plantations that utilize Liberica coffee as a stem variety consistently yield stable outcomes, but there may be occasional decreases in height. The use of Coffee stems lowers enhances the productivity of coffee plants in arid conditions and allows for more efficient land utilization, even in less fertile areas (Evizal et al., 2021). According to Hartatik et al. (2015), the use of organic fertilizers can enhance fertilization efficiency, resulting in a potential reduction of up to 30% in the application of inorganic fertilizers.

Mawardhi et al (2019) asserted that potential peatland is a vast and very suitable area for cultivating liberica coffee, particularly due to its inadequate conditions for other types of crops. The refund function utilization is safeguarded by the restoration of the peat environment, specifically the Unity

Hydrological Peat (KHG), with prior notification. This condition has significant implications for the operational aspects of the forestry industry, particularly in the pulp and paper sector (Suwondo et al., 2018). The importance of land utilization in power support is emphasized by managerial wisdom (Putro et al., 2021).

Among the many instances, it is crucial to elucidate research that delineates the utilization of peatlands in productive agricultural enterprises. Simultaneously, recognizing the agricultural capacity of peatlands helps bolster the local economy. Furthermore, I am interested in exploring the capacity of agriculture and the utilization of current waste to establish an environmentally sustainable and economically viable green economy.

2. Research Methods

This research was conducted in a collaborative manner involving both teachers and students. Lecturers initiate the research process by selecting the topic, defining the site, planning the technical execution, and identifying the respondents. The ultimate goal is to produce valuable research findings. Students endorse the practice of data mining and data analysis. The investigation was conducted in 15 purposely selected villages located throughout Jambi Province. The selected location parameters include settlements with peatland. Encompassing the vast majority of farmers that operate on peatlands.

This study employs a qualitative methodology with the aim of acquiring comprehensive and detailed data. Furthermore, it offers comprehensive, unambiguous, and authenticated information. Additionally, it includes aspects of progress in utilizing peatlands for profitable agricultural enterprises. The approach employed is the interactive model analysis developed by Miles and Huberman. The analysis process encompasses the gathering of data, the verification of data, drawing conclusions, and presenting the findings.

This study also concentrates on facilitating students in acquiring the skills to comprehend and assess research publications. Offers equitable and impartial coverage of the qualitative approach. Offers a wide range of illustrative instances and interactive exercises to actively include students in the process of conducting research. This practice also aids in developing students' proficiency and discernment as research readers, specifically in relation to the substance of articles.

3. Results and Discussion

Potential Natural Resources and Peatland Characteristics

Peatlands exhibit two distinct soil qualities: physical properties and chemical properties (Dariah et al., 2012). The attributes of peatlands in Jambi Province inherently differ from those of peatlands in other provinces. The characteristics of peatlands can be defined as unique

attributes or distinguishing features inherent to peatlands. Although these regions are classified as peatlands, their distinct characteristics set them apart. There will be several forms of treatment applied to the land, either for land preparation or for cultivating a specific crop. Peatlands possess the capacity to be utilized for the growing of plants for food production. According to Agus F et al. (2008), certain plants, including rice, corn, soybeans, cassava, peanuts, and many types of vegetables, are capable of adapting to peatland conditions.

Dariah et al (2012) found that when peat matures, its water absorption and storage capacity improve due to the development of micro and meso pores. Sabiham (2006) identified the significant phenolic acids for peat soils in Jambi as ferulic, sinapic, p-coumaric, vanillic, syringic, and p-hydroxybenzoic acids. Understanding the features of peatlands is crucial for making informed decisions on land management. The attributes of peatlands are observed by two soil characteristics, specifically the physical and chemical qualities of peat soil (Dariah et al., 2012). The attributes of peatlands in Jambi Province inherently differ from those of peatlands in other provinces. Hence, the subsequent passage delineates the attributes of peatlands and their correlation with empirical data in Jambi Province.

The physical characteristics of peat soil play a crucial role in determining the production potential of plants grown on peatland. The aeration, drainage, and load-bearing capacity of peat soil are determined by its physical properties. Aeration refers to the soil's ability to exchange air, which is influenced by its porosity and the presence of pores. This is important for supporting root growth and soil fertility. Drainage refers to the flow of water in the soil, while load-bearing capacity refers to the soil's ability to withstand its own weight. Apart from that, there is also the possibility of peatland degradation, which refers to a drop in peatland productivity. Key factors to consider while utilizing peat land

for agriculture are the physical characteristics of the peat soil, which encompass peat thickness, peat maturity, bulk density, water content, bearing capacity, subsidence, and irreversible dryness. The process of drying that cannot be reversed is referred to as irreversible drying (Agus and Subiksa, 2008).

Understanding the peat thickness is crucial for effective agricultural planning. The thickness of the peat has a significant impact on the soil's physical, chemical, and biological qualities, as well as plant development and productivity. Wahyunto et al (2014) classified peat thickness into six distinct categories.

1. Very shallow/thin (<50 cm)
2. Shallow/thin (50-100 cm)
3. Medium (101-200cm)
4. Deep/thick (201-400 cm)
5. Very deep/very thick (401-800 cm)
6. Once/very thick (801-1200 cm).

Within Jambi's peatland, particularly in the recently supported settlements of West and East Tanjung Jabung Regencies, the typical peat thickness ranges from 1 to 2 meters, classified as medium. However, several sections exhibit thin peat layers measuring less than 50 centimeters, while others display significantly thicker layers ranging from 300 to 700 centimeters.

Maturity, in this context, refers to the degree of decomposition of organic matter, such as litter, which constitutes the primary component of peat soil. The fertility of peat soil increases proportionally with its maturity. The productivity of the land is directly influenced by the age of the peat soil, as it leads to an increase in nutrient availability and soil fertility. Peat soils are categorized into three types based on their maturity: capric (ripe), hemic (half-ripe), and fibric (unripe). The maturity of peat is determined based on its specific properties (Table 1).

Table1.Characteristic of peat maturity soil

Types	Fibric	Hemic	Sapric
Maturity	Raw	Half-cooked (transition)	Ripe
Fibre / fibre content	>66%	33-66%	<33%
Fill weight	<0.1gcm ⁻³	0.1-0.19 g cm ⁻³	≥0.2 g cm ⁻³
water volume	>850%	450-850%	<450%
Color	light yellow-reddish brown	dark grey brown-dark reddish brown	very dark grey black
Picture			

Source: Masgantiet al (2017)

Bulk density refers to the measure of the mass of a substance per unit volume, typically expressed in kilograms

per cubic meter (kg/m³). Bulk weight or volume weight refers to the measurement of the weight of a solid mass within a specific volume. The minimum bulk density of fibric peat

soils is less than 0.1 g cm⁻³ in the lowermost layer. Peat with a high bulk density (> 0.2 g cm⁻³) is typically found along the beach or in the vicinity of a river. This is due to the presence of dissolved mineral substances in the water, although their density is still lower than that of mineral soils, which typically varies from 0.7 to 1.4 g/cm³.

According to Dariah et al (2012), there is a positive correlation between the maturity of peat and its bulk density. Based on Sukarman et al (2012) research, the bulk density of peat in Jambi varies from 0.18-0.43 g, with an average of 0.27 g. Thus, it may be inferred that the bulk density of peat soils in Jambi falls within the medium-high range.

Peat has the capacity to absorb water ranging from 300-3000% of its dry weight, whereas mineral soils can only absorb around 20-35% of water relative to their mineral weight. The water absorption capacity is also contingent upon the soil's porosity. Good water absorption and holding capacity are achieved when water is held in micro (tiny) pores, since the limited channel makes it more difficult for water to escape, resulting in a highwater holding capacity. Conversely, when water is kept in macro (large) pores, there is a higher likelihood of water flowing out and being lost, leading to a diminished water holding capacity.

In addition, the macro water system has the ability to effectively manage pest, disease, and flood control. This makes the land in the area highly suitable for agricultural activities, including the cultivation of food crops, vegetables, fruits, and plantations (Suriadikarta, 2008). In their study, LT Karamoy et al (2016) found that the counseling process, which incorporates elements of the environment, economy, and technology, has a significant impact on the transformation of farmers' knowledge, skills, and attitudes.

Peatland utilization for Cultivation

Liberica coffee, scientifically known as coffee, is a type of coffee that is well-suited for growth on acidic soils, particularly peat soils. This distinguishes it from other varieties of coffee, such as arabica and robusta coffee (Hulupi., 2014). This coffee possesses the benefit of being very adaptable to peatlands and exhibits resistance against pests and illnesses. Liberica coffee has notable features such as expansive crowns measuring up to 3.5-4 m in diameter, robust foliage, and vigorous, compact growth. If left unpruned, these plants can to a height of 5 m.

Liberica blooms are found specifically in the axils of the leaves and their quantity is restricted. The blooms are grouped together in clusters consisting of 4 to 6 blossoms. According to Budiman (2013), every leaf axil has the potential to generate 8-18 flower buds. Coffee beans exhibit a greater size in comparison to other varieties of coffee. The coffee beans are oval in shape, measuring 0.83-1.10 cm in length and 0.61 cm in width. On average, they yield 9.03%. After being harvested, the typical seed yield ranges from 50% to 80%, with an average productivity of 1.2 kg of seeds per

tree or approximately 1.1 tons of seeds for every 900-1,000 trees per hectare (Directorate General of Plantations, 2013).

The majority of individuals cultivate coconut trees in the peatlands surrounding their communities. Regarding them, they also cultivate plants in the yard surrounding their house. Thecoconut fruit is renowned in Jambi Province due to its significant coconut potential. Furthermore, it can be transformed into a variety of processed goods.

The coconut industry possesses numerous prospects that can significantly influence the regional economy. Some of these possibilities encompass optimal cultivation conditions on peatlands. The coconut can be processed into many products such as virgin coconut oil (VCO), palm sugar, coconut shell crafts, and coconut coir. Accessing several markets, including both offline and online platforms, greatly facilitates the selling process for farmers in the field of marketing.

Watermelon, scientifically known as *Citrullus Vulgaris* Shard, is a horticultural commodity that is only available during certain seasons. It has the ability to be cultivated on peatlands. Watermelon is a valuable horticultural item belonging to the gourd family (Cucurbitaceae) with significant commercial worth. Watermelon is a herbaceous plant that grows in trailing or climbing vines. The watermelon production in Indonesia in 2020 amounted to 414,242 tons. The watermelon production hubs in Indonesia are located in East Java, Central Java, North Sumatra, West Sumatra, South Sumatra, Lampung, South Sulawesi, NTB, and Bali. Watermelon possesses significant economic and lucrative prospects for growers. The price of watermelon per kilogram can range from IDR 5,000 to IDR 10,000. Watermelon production has the capacity to enhance the well-being of farmers due to its significant economic potential.

Cucumbers, scientifically known as *Cucumis sativus*, are a type of plant that can be cultivated in peatlands, which are areas of soil consisting of decomposed plant material. Cucumber is a horticultural crop with significant commercial prospects. The cost per kilogram of cucumbers can range from IDR 6,000 to IDR 10,000. According to Simanungkalit et al. (2006), the yield of cucumbers per planting season in peatlands can reach 9 ton/ha. However, by using inputs optimally, cucumber productivity can be increased to 31 ton/ha. The high productivity of cucumber production on peatlands has the potential to enhance farmers' welfare.

Rice is an essential item that is indispensable to civilization, particularly the inhabitants of Jambi Province. Rice undergoes processing to yield grains, which are further dried to obtain the final dry grain. Rice is derived from dehydrated, unhusked grains through mechanical processing. Rice is the end result of the rice plant, which can be prepared and cooked into a dish known as rice. Hence, the community's reliance on rice is exceedingly robust as rice serves as the primary sustenance for the community. The mean rice productivity is 6-7 tons per acre per

harvest. Rice has the capability to be transformed into several products through processing.

The Economic Potential of Agriculture Product

Liberica coffee possesses qualities that appeal to discerning coffee enthusiasts, including a taste that is less bitter than robusta and an aroma reminiscent of sour jackfruit, akin to arabica and chocolate (Ardiyani, 2014). The output of coffee can reach 15-20 kg of coffee cherries per tree. Under optimal conditions, coffee plants can be harvested every 20 days (Prasetyo et al., 2019). The market price for wet coffee cherries (cherries) varies between IDR 2,500 and IDR 4,000 per kilogram (Table 2).

The cost of rice fruit, specifically the peeled seeds, falls within the Rp range. The price of 30,000-40,000 is higher than that of Robusta coffee. If the green coffee beans

have undergone processing and are of high grade, their price can approach Rp. The price ranges from 90,000 to 120,000 per kilogram and can reach Rp. The price per kilogram is 200,000 when the product is roasted.

The price range for coffee powder, which is the result of coffee processing, is approximately IDR 250,000-270,000 per kilogram. Despite the transformation of coffee into civet coffee, the price can become even more exorbitant. The price of roasted. mongoose is approximately IDR 600,000 per kilogram, while ground coffee is priced between IDR 1,000,000 and IDR 1,300,000 per kilogram. The cost of this coffee rises with each subsequent step as the weight of the coffee fruit (cherry) declines. The green beans shrink by 50-60% throughout processing, and when roasted, they further reduce in weight by approximately 10-15% (Prasetyo et al., 2019).

Table 2. The Economic Potential of Coffee Processing

Coffee	The Market Price (IDR/USD)	Margin by processing (IDR /USD/ kg)
Coffee fruits (1 Kg)	30000/2	0
Peeled seeds coffee (5 ons)	38000/2,5	8000/0,5
Drying Green beans coffee (4 ons)	45000/3	7000/0,45
Roasted coffee (4 ons)	82000/5,5	37000/0,25
Coffee powder (4 ons)	950000/6,3	13000/0,9
Total benefit from coffee fruits to coffee powder		65000/4,3

The Areca nut possesses a linear and slender stem, capable of attaining a maximum height of 25 meters and a diameter of 15 centimeters. The tree has an approximate height of 25 meters. The stem is upright and made of wood, with a diameter of around 15 cm. The leaves are compound and arranged in a rosette formation, with ripped ends and serrated edges. Compound inflorescences consisting of florets are located in the leaf axils, with female and male florets grouped in two parallel rows. The Areca nut fruit is characterized by its oval form and red-orange color, containing a single brownish-yellow seed (Noor, 2018).

Currently in IDR, the cost of a sack of betel nuts has risen to 500-600 thousand, whereas previously it was priced at 300-400 thousand. Therefore, it is necessary to set a high selling price for consumers in order to maintain profitability, despite the decreasing profit margins. Between January and June 2021, the retail price of areca nut is approximately 8,000/kg, resulting in a profit of around 4,000/kg for the trader. Due to the current increase in the price of areca nut, the trader is only able to sell it for 10,000/kg, resulting in a profit of just 2,000/kg. This is because the current cost of purchasing the nut is 8,000/kg. Currently, the price of areca nut is high, amounting to 10,000/kg. Areca nut is available for purchase in both moist and desiccated forms. The price of wet seeds is 7,000/kg, whereas dry seeds are priced at 21,000/kg (Directorate General of Plantation, 2013).

Utilization and processing of agricultural product waste in peatlands

Coffee waste comprises coffee skins and coffee cherries. Coffee cherries typically require peeling with a coffee skin peeler. Currently, coffee husks have not been effectively utilized to create a valued commodity. Consequently, the utilization of coffee skins is suboptimal, since it contributes to the escalation of waste accumulation in rural communities.

Possible solutions to prevent coffee husks from being wasted involve their utilization as compost. If the material has undergone composting, other farmers can mitigate the expenses associated with compost production. Furthermore, coffee skin can serve as a viable ingredient for the production of animal feed. The utilization of coffee skins as animal feed is not the primary source of nutrition, but rather a supplementary feed that can enhance the appetite of animals, particularly goats.

The local community in Jambi Province lacks adaptability in processing areca trash. The composting of areca waste is the most promising method for using processed products. Indeed, compost derived from areca waste has the potential to expedite plant growth in peatlands. Furthermore, it can be utilized on peatlands. Compost fertilizer obtained from areca palm waste can also be utilized for the enrichment of both paddy crops and dry areas. Processing can decrease the amount of unregulated areca trash in rural communities.

Various processed goods are derived from the coconut processing procedure. Indeed, the primary utility of coconuts lies in their application for beverages, usually referred to as *degan*, *kopyor* ice, *menado* ice, and other others. Old coconuts can be utilized for the production of coconut milk. Furthermore, coconut shells have diverse applications in the realms of fine art and crafts, as well as in the production of glasses, cups, crab spears, and other cooking utensils. Furthermore, coconut coir, also known as *sepet*, can be utilized for the production of carpets, placemats, and flower pots. These processed goods demonstrate the abundant potential and ease of diversification of the coconut fruit.

The waste generated by watermelons has the potential to be utilized in the production of confectionery and for various occasions. It is not often known that confections derived from watermelon byproducts provide a pleasant and invigorating flavor. Furthermore, the product's distinctiveness can be observed when it has been extensively disseminated throughout Jambi Province. In addition, it can also serve as a symbol of Jambi province.

Cucumber trash can be converted into compost, while cucumbers can also be utilized to produce facial wash material. The method of collecting cucumber trash is arbitrary, as it does not ascertain the cucumber's size, shape, or specific portion. The cucumber waste is subsequently thoroughly cleansed to separate it from the soil that is intermingled with the trash, resulting in a weight of 500 g.

Straw is one type of rice waste that remains unused. Typically, farmers burn straw as a means of disposing it, which leads to undesirable consequences such as increased gas volume and carbon emissions in the atmosphere. One such option that farmers can use is the conversion of straw into animal feed, particularly for cow farms. Supplementary components for animal feed made from straw basis consist of b-complex, molasses, urea, EM 4, and other additives. A portion of these ingredients are combined with straw, allowing the straw to undergo a process of softening before it becomes suitable for feeding the cows. Furthermore, this supplementary feed has the capacity to enhance hunger and expedite the growth of cows.

Optimizing the Peatland Potential for Rural Development

Different farmer programs have led to new ways of developing rural areas that focus on using existing peatlands, such as using them to grow local products that help farmers work better. These productive activities will provide fresh economic resources that can stabilize the farmer's family income. Furthermore, it is supported by initiatives to manage agricultural waste as an alternative enterprise that might enhance farmers' revenue. If these three primary activities continue in their development, communities with peatland potential will become progressively independent and empowered from external dependencies (Figure 1).

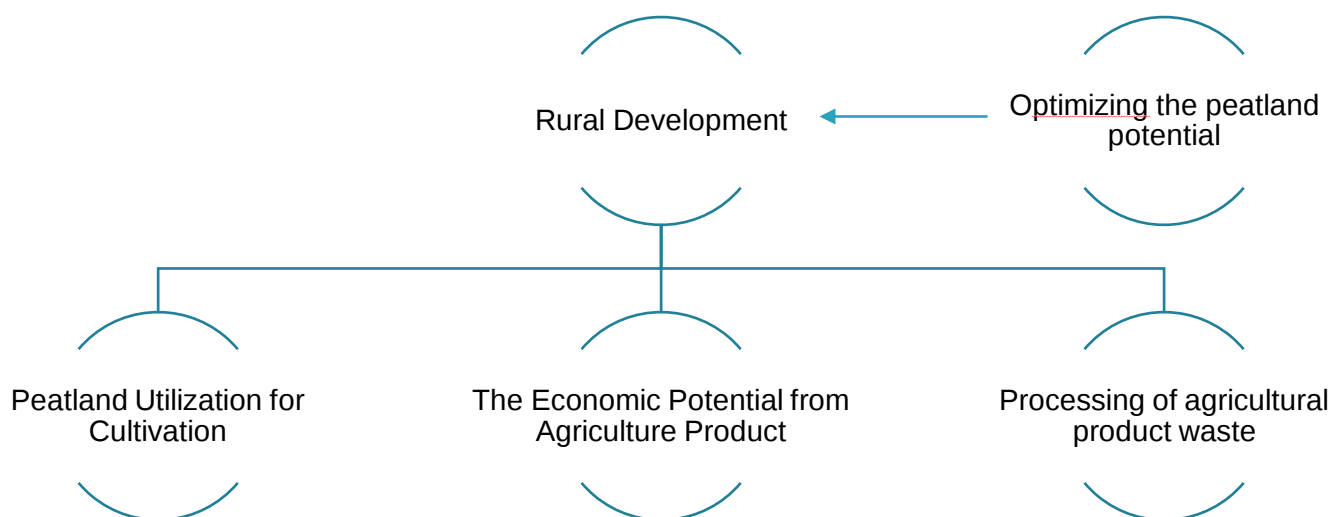


Figure 1. The Model of Optimizing the Peatland Potential for Rural Development

4. Conclusion

The inherent capacity of Jambi Province allows farmers the autonomy to cultivate a diverse range of agricultural commodities. Consequently, this stimulates farmers to engage in excessive planting practices, which includes the exploitation of peatlands for oil palm cultivation. Annual crops such as coffee and coconut can serve as a viable alternative for farmers to replace oil palm cultivation, which is

known for its exploitative impact on peatlands. This shift would help ensure a more balanced approach to agriculture. Additionally, the local economy of the Jambi people can be enhanced by the cultivation of seasonal crops such as watermelon, cucumber, and rice. The favorable physical circumstances, along with the maturity and thickness of the soil solum, enable farmers to cultivate a wide range of plant species.

The peatland conditions at Jambi are conducive for cultivating a wide range of annual and seasonal crops. Optimal annual crops for cultivation on peatlands include coffee, coconut, and areca nut. Liberica coffee is well favored among the residents of Jambi. The high market value and strong demand for coffee throughout Indonesia, notably Jambi, serve as strong incentives for farmers to plant this particular kind. Liberica coffee is a customary souvenir from Jambi. Watermelons, cucumbers, and rice are the most suitable crops to cultivate in peatlands. Rice is the primary agricultural product cultivated to fulfill the dietary requirements of the inhabitants of Jambi and its neighboring areas.

Peatland-cultivated products provide suboptimal waste management. From the waste processing activities conducted, it has been determined that coffee leaves and coffee husks can serve as suitable feed for goats. Coconut shells are transformed into coconut shell crafts, utilizing the waste generated by coconuts. Coconut fiber has applications as both rugs and plant pots. Vegetable waste, such as that from watermelons and cucumbers, can be utilized for composting. Subsequently, the rice straw waste can undergo fermentation and be utilized as livestock fodder. Thus, this waste management endeavor transforms into a sustainable economic initiative that brings benefits to the local community. Furthermore, the aim is to stimulate sustainable and productive agricultural initiatives in order to enhance the economic stability of the hamlet.

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