

RESEARCH ARTICLE

Environmental Management of Liboganik Organic Fertilizer Plant from Solid Palm Oil Waste in Pauh Village, Bonai Darussalam District, Rokan Hulu Regency, Indonesia

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Abstract

This study was designed to analyze and examined the environmental management strategy of Liboganik solid organic fertilizer factory derived from solid palm oil waste in Pauh Village, Bonai Darussalam District, Rokan Hulu Regency, Riau. The study used a qualitative approach method using questionnaire and interview instruments as well as laboratory tests conducted with samples of company leader, factory employees, communities around the fertilizer factory and palm oil farmers totaling 63 and selected randomly. The results of the study showed that the water quality of the Liboganik organic fertilizer factory waste was polluted, as seen from the data from the physical parameter laboratory tests above, it can be seen that the suspended solids (TSS) content and COD content exceed the standard COD waste standards for organic fertilizer factories according to the standard of the Minister of Environment Regulation No. 5 of 2014 concerning Wastewater Quality Standards. Environmental management can be carried out through the spatial planning of fertilizer factory buildings as well as through the construction of adequate infrastructure and paying attention to its impact on the environment and factory workers in order to encourage the realization of an environmentally friendly fertilizer factory. It is concluded that environmental management of organic fertilizer factories can be done by making a ditch pond to accommodate seepage of residual palm oil factory waste and limiting it so that pollution does not occur to the community environment. In addition, in an effort to reduce high COD and BOD content, wastewater management can be carried out using Phytoremediation techniques and also technology using Vertical Water Circulation (SAV). The results of IFAS and EFAS as well as SWOT analysis concluded that the environmental management strategy of the Liboganik organic fertilizer factory is in the SO quadrant and is included in Aggressive Strategy.

Keywords: Environmental Management, Organic Fertilizer Factory, Liboganik.

1. Introduction

1.1 Research Background

Organic fertilizer is one of the production inputs that plays a very important role in improving soil nutrients, which are currently in a very concerning condition. The types of organic fertilizers used are manure, compost, green manure and agricultural waste. Application of organic fertilizer to plants can increase soil fertility which in turn can increase plant growth and production. This is because organic fertilizer not only improves the soil in terms of chemistry, but also improves the physical and biological properties of the soil (Hartatik and Setyorini, 2012).

Organic materials in fertilizers play an important role in improving the physical, chemical and biological properties of the soil so that they can maintain and improve soil fertility, and reduce dependence on inorganic/chemical fertilizers. The use of organic fertilizers has the advantage of not causing environmental pollution, both soil, water and air pollution and its products do not contain toxins, organic plants have a sweeter taste and generally organic plant products are more expensive. The use of organic fertilizers to increase

land productivity and agricultural production needs to be promoted and encouraged (Sulistiyawati and Nugraha, 2011).

In line with the increasing production of palm oil from year to year, there will also be an increase in the volume of waste. Generally, solid waste from the palm oil industry contains high organic matter, which has an impact on environmental pollution. Improper waste management will pollute the environment. Various efforts have been made to process and increase the economic value of solid palm oil waste. Palm oil waste is the remains of oil palm plants that are not included in the main product or are by-products of the palm oil processing process, either in the form of solid waste or liquid waste. Solid palm oil waste can be in the form of empty bunches, shells and fiber (Haryanti; 2014).

Sustainable development has been established as one of the mainstreaming aspects to provide access to fair and inclusive development, as well as protecting the environment. So that it is able to maintain an increase in the quality of life from one generation to the next. Through this approach, sustainable palm oil development contributes significantly to the achievement of the Sustainable Development Goals (SDGs) (RPJMN, 2020).

Environmental management according to the industrial ecosystem approach for the CPO industry can be implemented through reuse and recycling using solid and liquid waste and proper management. The goal is to achieve almost zero pollution emissions. Such an approach can contribute to the transformation of palm oil mills into more environmentally friendly industrial activities (Septiawan, 2015).

Waste produced by Palm Oil Mills (PKS) consists of solid waste and liquid waste. Each ton of fresh fruit bunches processed produces liquid waste of around 50% compared to the total other waste, and solid waste in the form of empty bunches of around 23% (Wibisono, 2013 in Sutarta et al., 2000). Pollution can be caused by the palm oil industry and organic materials contained in palm oil waste, so that waste produced by the palm oil industry must be managed to avoid environmental pollution. This step is an effort to reduce the negative impact of waste and create an environmentally friendly industry. One of the uses of waste from palm oil mills is as organic fertilizer (Hannum, 2014).

The by-products of the palm oil plantation industry can be fully utilized if the industry players are able to manage them well. Empty oil palm bunches have a chemical composition of 45.95% cellulose, 22.84% hemicellulose, 16.49% lignin, 2.41% oil, and 1.23% ash. So far, the utilization of empty oil palm bunch waste has been very limited, namely being buried (open dumping) and burned in an incinerator (Firmansyah, 2011).

Research conducted by Duaja (2020) stated that NPK fertilizer combined with decanter cake (DC) had a significant effect on the increase in plant height, increase in the number of leaves, leaf area and fresh weight of kale. The combination of 75% NPK fertilizer and 20 tons/ha of decanter cake (DC) showed a significant effect at the beginning of growth, but with increasing plant age, 50% NPK and 15 tons/ha of decanter cake (DC) also showed a significant effect on growth parameters and fresh weight of kale.

Making organic fertilizer from empty oil palm bunches with a fermentation process using EM4 obtained a nitrogen content of 2.003% and phosphorus of 0.107%. The advantages of using organic fertilizer from empty oil palm bunches are that it is high in nutrients, environmentally friendly and the raw materials are easy to obtain (Warsito, 2016). Research conducted by Manurung (2023) showed that there was oil palm productivity where solid waste was more significant in increasing production. The results of this analysis are taken annually in tons/ha where production in 2020-2022 shows a difference with higher solid waste application and production in 2022 shows a difference with higher solid waste application.

In terms of increasing the income of oil palm farmers, the results of research conducted by Situmorang (2021) concluded that the net income received by farmers for one year was IDR 16,891,251.52/ha/year. The RCR value of oil palm farming using a combination of organic and non-organic fertilizers is 3.19 per hectare of oil palm land, meaning that every rupiah spent by farmers generates a profit of 2.19. This shows that oil palm farming that combines organic and non-organic fertilizers is profitable and worth pursuing to increase farmers' income.

Based on the quality standards of solid organic fertilizer (SNI 7763-2018) including parameters and requirements for C-organic minimum 15%, C/N maximum 25, Binding material in the form of glass/broken glass, plastic, gravel and metal maximum 2%, Water content 8-

25%, pH 4-9, Macro nutrients (N, P2O2, K2, O). Government policies related to the utilization of solid waste from oil palm for fertilizer, among the government policies that support include: (1) Government Regulation No. 22 of 2021 concerning the Implementation, Protection and Management of the Environment; (2) Decree of the Minister of Manpower in Indonesia No. 187 of 2016 concerning the Establishment of Indonesian National Performance Standards for the Category of Water Procurement, Waste Management and Recycling, Waste Disposal and Cleaning, and Waste Main Group Waste Management Industrial Waste Management Sector; (3) Regulation of the Minister of Agriculture (Permentan) Number: 70/Permentan/SR.140/10/2011 dated 25 October 2011 concerning Minimum Technical Requirements for Solid Organic Fertilizer. Based on the results of initial observations conducted by researchers, theoretical studies, and previous relevant research as mentioned above, researchers are interested in conducting further research to determine the environmental management of the Liboganik solid organic fertilizer factory which originates from solid palm oil waste in Pauh Village, Bonai Darussalam District, Rokan Hulu Regency, Riau.

2. Research Method

2.1 Location and Time of Research

This research was conducted in Pauh Village, Bonai Darussalam District, Rokan Hulu Regency, Riau Province. The research period was from November 2023 to April 2024

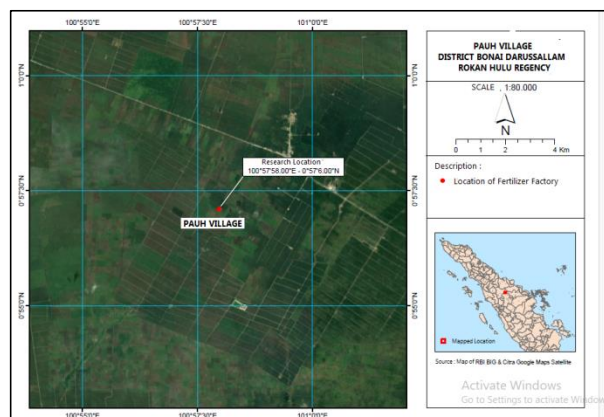


Fig. 1. Map of Research Location

2.2 Research Design

The design of this research was conducted using qualitative methods and analyzed statistically and explained descriptively. The data obtained from the survey results and data collection conducted at the research location in Pauh Village, Bonai Darussalam District, Rokan Hulu Regency, Riau Province were then processed statistically and described descriptively through recapitulation, tabulation and analysis using SWOT based on field findings.

2.3 Sampling Technique

Environmental management data were obtained from interviews and observations at the organic fertilizer factory location. Interviews were conducted with 5 people from the community living around the location not far from the fertilizer factory. The sample determination was based on the consideration that the community living not

far from the location was estimated to feel the impact of the organic fertilizer factory activities. Interviews with 5 workers or employees were conducted to obtain information related to the impact and influence of factory activities on workers and the opinions of the community and workers regarding other fertilizer factory activities.

2.4 Data Analysis

Analysis of water quality around the Liboganik organic fertilizer factory area was carried out using tools and materials according to each parameter tested with reference to the Indonesian National Standard (SNI). There are several environmental quality parameters tested through laboratory analysis, namely 1) Biological Oxygen Demand (BOD), 2) Chemical Oxygen Demand (COD), 4) Total Suspended Solid (TSS), 5) Total Dissolved Solid (TDS) and 6) PH (Acidity). Measurements were taken from water samples taken and analyzed in the UPT LKL laboratory of the Health Service, Riau Province. The method is carried out according to SNI. 06-698911-2019.

3. Findings

3.1 Description of Research Location

Liboganik Organic Fertilizer Factory is located in Pauh Village, which is one of the villages in Bonai Darussalam District, Rokan Hulu Regency. Origin of the Village Pauh Village is a hamlet located in Kunto Darussalam District, Kampar Regency, Riau Province. Pauh Village is one of 7 villages in Bonai Darussalam District which is located approximately 0.7 km to the north of Bonai Darussalam District, Pauh Village has an area of: 7.55 km² (755 Ha), land height above sea level: ± 30 meters above sea level, topography: lowlands, average air temperature: 32 ° C with the lowest temperature of 24 ° C, with a population of: ± 5,370 people with the number of families: ± 2,571. The Liboganik Fertilizer Factory was initiated in 2018 by farmers in Pauh Village, Bonai Darussalam District, Rokan Hulu Regency, Riau Province as a solution to problems in the palm oil industry where in 2018 there was a trade war between America and China which resulted in the collapse of palm oil prices and an increase in the price of chemical fertilizers.

The unfavorable economic conditions in the palm oil industry have caused farmers to have to find solutions to overcome this condition by looking for other alternatives to control the production costs of oil palm plantations. One of the efforts made is to conduct treatment and research to find alternative substitutes for chemical fertilizers and finally a formula was found called Liboganik Organic Fertilizer Plus. Organic fertilizer plus was designed by undergraduate farmers using scientist-based bionic technology and science and technology that has been published by educational institutions publishing research journals.

At first, Liboganik was difficult for the community to accept because it was considered a new product that did not yet have a brand in the agricultural market, but the team never gave up because they knew that science and technology would never lie, so that over time Liboganik was trusted by various parties as an option or solution to reduce agricultural production costs and be able to increase production.

In 2019, the Pauh Village government collaborated with farmers and the Liboganik Team to join at the farmer group level and unite into the Libo Lestari Farmer Group Association (GAPOKTAN) which then through the Pauh

Village Government provided training and coaching and even provided social assistance in the form of work tools for making more sophisticated organic fertilizers.

In 2020, Liboganik's permit was registered through OSS in the name of CV. Libo Farming, but at the time the licensing was constrained in the district because at that time the country was handling the Covid 19 pandemic so that the realization could only be realized in 2022. In 2020, Liboganik had started mass production, the government's labor-intensive program and the recovery of the people's economy which gradually increased in demand along with the increasing price of chemical fertilizers and increasing consumer satisfaction with this organic plus fertilizer.

In 2021, Liboganik became one of the trusted fertilizers in the Pauh Village area and its surroundings due to the increasing price and difficulty in finding chemical fertilizers. The level of satisfaction of the farmers has caused Liboganik to remain in demand by farmers to this day.

Analysis of the quality of fertilizer factory wastewater was taken directly around the organic fertilizer factory location at 3 sampling points. The location of the sampling point was determined based on the location of the waste discharge flow from the factory location. The wastewater taken was water in the ditch around the factory in the shape of a U. Sampling point 1 was taken at the location of the main factory discharge flow which was 5 meters to the right of the factory location. This is designated as location 1, because it has the potential to cause environmental impacts on the waters around the factory. Sampling point 2 is located in the middle of the factory at the back. This location is in the middle of the U-shaped ditch body and is approximately 4 meters from the factory land. While sampling point 3 is on the left side which is approximately 6 meters from the main location of the factory.

1.2 Existing Condition of Environment

Table 1. Results of Wastewater Parameter in each station

Parameter	Unit	Station 1	Station 2	Station 3	Highest Risk Level (Kg/ton)
Physical					
1. Temperature		25	25	25	-
2. TDS (Total Dissolved Solid)*	mg /L	814	524	302	-
3. TSS (Total Suspended Solid)	mg /L	302	98	24	0.15
Chemical					
1. Ph	-	7.3	7.6	6.8	6.0-10
2. COD	mg /L	367	302	287	0.30 (300 mg/L)
3. BOD ₅ *	mg /L	238	197	186	-

Source : Test Results of Health and Environment Laboratory (2024)

From the results of wastewater analysis at Station 1 of the Liboganik Organic Fertilizer Factory above, the results obtained on the Physics parameters are temperature of 25oC, Dissolved Solids (TDS) of 814 mg/L and Suspended Solids (TSS) of 302 mg/L. While the Chemical parameters are pH of 7.3%, COD of 367 mg/L and BOD₅ of 238 mg/L. From the values that exceed the threshold are Suspended Solids (TSS) the results of the laboratory test the value obtained is 302 mg/L while the threshold is 150 mg/L (0.15 kg/ton) and COD levels where from the results of the laboratory test the value obtained is 367 mg/L while the

threshold (Minister of Environment Regulation No. 5 of 2014 concerning Wastewater Quality Standards) is 300 mg/L (0.3 kg/ton). The results of wastewater analysis at Station 2 above obtained results on the Physics parameters, namely temperature of 25°C, Dissolved Solids (TDS) of 524 mg/L and Suspended Solids (TSS) of 98 mg/L. While the Chemical parameters are pH of 7.6%, COD of 302 mg/L and BOD5 of 197 mg/L. From the values that exceed only the COD level where the lab test results obtained were 302 mg/L while according to Permen LH No. 5 of 2014 the threshold value for COD is 300 mg/L (0.3 kg/ton). Meanwhile, the results of wastewater analysis at Station 3 obtained results on the Physics parameters, namely temperature of 25°C, Dissolved Solids (TDS) of 302 mg/L and Suspended Solids (TSS) of 24 mg/L. Meanwhile, the chemical parameters are pH of 6.8%, COD of 287 mg/L and BOD5 of 186 mg/L. The results of laboratory tests on all parameters obtained at Station 3 are still below the threshold of Permen LH No. 5/2014.

1.3 Distribution and Marketing Activities

In distribution and marketing activities, the company has taken active steps through 1) Providing information about Liboganik organic fertilizer to the oil palm farmer community, 2) Providing affordable prices for Liboganik organic fertilizer, 3) Creating a sales system for Liboganik organic fertilizer that is carried out individually, online and directly, 4) Delivering Liboganik organic fertilizer according to the order time, 5) Distributing or distributing Liboganik organic fertilizer to each oil palm plantation area, 6) In addition, if there is an error in the order, the distributor or company will replace the organic fertilizer, 7) Organic fertilizer sent to oil palm plantations is carried out using adequate transportation, 8) Payment for Liboganik organic fertilizer that has been purchased by customers or fertilizer buyers is carried out smoothly, 9) After Liboganik organic fertilizer is paid for, the fertilizer order is distributed directly or indirectly, and 10) If there are problems in the delivery or distribution of fertilizer to farmers or problems related to the settlement of payments for Liboganik organic fertilizer, oil palm farmers and the company or distributor resolve them through deliberation. or complete it well.

In general, the marketing and distribution activities of Liboganik organic fertilizer carried out are included in the very good category with a percentage of 90.6%. The optimal efforts made by this company should be maintained or perhaps also improved through online promotions.

1.4 Social Participation of Community

In involving community participation, the company has taken positive steps including: 1) The community is involved in the management of Liboganik organic fertilizer such as in the production of organic fertilizer, then 2) Employees who work at the Liboganik fertilizer factory are partly from the community around Pauh Village, Bonai Darussalam District, Rokan Hulu Regency, 3) The involvement of community organizations in the fertilizer factory environment is involved in the management of Liboganik organic fertilizer, 4) In participation related to fertilizer quality, the community, especially organic fertilizer users, also monitors the effect of fertilizer on increasing the growth of oil palm plants, 5) The community, especially farmers who use organic fertilizer, are also involved in paying attention to the quality of Liboganik fertilizer used by users, 6) The community also

monitors the environmental impact around the Liboganik fertilizer factory, 7) The existence of the Liboganik fertilizer factory has a positive impact on the surrounding community such as road paving, 8) The existence of the Liboganik fertilizer factory provides assistance to the community around the fertilizer factory in the form of social assistance, funds and also physical development, in addition also 9) The community also provides suggestions and input on the quality of fertilizer produced and the existence of the fertilizer factory, 10) The existence of the Liboganik organic fertilizer factory provides real benefits to the community. In general, activities involving community participation in the management of Liboganik organic fertilizers that are carried out are also included in the very good category with a percentage of 91.8%. This indicates that the existence of this organic fertilizer factory is very beneficial for the surrounding community.

1.4 Government Policies of Environments

Government policies related to the environment, especially in the management of the fertilizer factory environment from solid waste from palm oil for fertilizer, then among the government policies that support include:

- 1) Law of the Republic of Indonesia Number 32 of 2009 concerning Environmental Protection and Management;
- 2) Government Regulation No. 22 of 2021 concerning the Implementation, Protection and Management of the Environment;
- 3) Decree of the Minister of Manpower in Indonesia No. 187 of 2016 concerning the Establishment of Indonesian National Performance Standards for the Category of Water Procurement, Waste Management and Recycling, Waste Disposal and Cleaning, and Waste Main Group of Waste Management in the Field of Industrial Waste Management;
- 4) Regulation of the Minister of Agriculture No. 70/Permentan/SR.140/10/2011 dated October 25, 2011 concerning Minimum Technical Requirements for Solid Organic Fertilizer.
- 5) Government Regulation Number 82 of 2001 Concerning Water Quality Management and Water Pollution Control
- 6) Regulation of the Minister of Environment of the Republic of Indonesia No. 5 of 2014 Concerning Water Quality Standards, especially Wastewater Quality Standards for Fertilizer Industry Businesses and/or Activities
- 7) Regulation of the Minister of Environment and Forestry of the Republic of Indonesia in 2014 with Number. P.68/Menlhk/Setjen/Kum.1/8/2016 Concerning Domestic Wastewater Quality Standards

Based on the results of initial observations conducted at the CV. Liboganik Organic Fertilizer Processing Unit, it can be seen that palm oil waste can be recycled so that it can provide benefits as one of the materials for making organic fertilizer. This fertilizer also provides benefits for farmers because it can increase the productivity of oil palm plants. Utilization of solid PKS waste as organic fertilizer can reduce waste and have an effect on the lives of people around the oil palm plantation area. However, it is necessary to know whether the quality of the organic fertilizer produced is in accordance with the quality standards, further study is needed.

1.5 Analysis of Community Income

Analysis of farmer income is obtained based on the

results of field observations carried out using qualitative analysis methods which are carried out to describe the picture of oil palm farming activities and for quantitative analysis to calculate the amount of income. (Soekartawi, 2010) the following formula is used :

$$\pi = TR - TC$$

$$TR = (Y \cdot Py)$$

Description:

Π = Income (IDR/Month/Ha)

TR = Income (IDR/Month/Ha)

TC = Total Cost or Total Farming Cost (IDR/Month/Ha) including fertilizer costs

The results of the analysis of income data obtained from oil palm farmer respondents produced a total income or gross income of IDR 5,719,048/month/ha with a total cost of IDR 1,992,063/month/ha so that the net income of oil palm farmers in Pauh Village was obtained as follows:

$$\pi = TR - TC$$

$$= 5.719.048 - 1.992.063$$

$$= \text{Rp } 3.726.984 / \text{month} / \text{ha}$$

Next, to find out the size of the R/C Ratio, the formula used is

$$R/C \text{ ratio} = TR/TC$$

Description:

R/C ratio = Revenue Cost Ratio

TR = Total Revenue / Total Income

TC = Total Cost / Total Cost

For the amount of R/C Ratio with the formula above, the following comparison results are obtained:

$$R/C \text{ ratio} = TR/TC$$

$$= 5.719.048 / 1.992.063$$

$$= 2,87$$

Based on the R/C ratio criteria, if $R/C > 1$, it is concluded that oil palm farming using Liboganik organic fertilizer is financially feasible and profitable.

4. Discussion

4.1 Analysis of Sewage Water Quality from Fertilizer Factory

The results of laboratory test analysis of samples taken at 3 sampling stations conducted by researchers for physical parameters showed that the content of suspended solids (TSS) at Station 1 contained the highest TSS of 302 mg/L and exceeded the threshold permitted according to the Regulation of the Minister of Environment No. 5 of 2014 concerning Wastewater Quality Standards, while at the other two stations, 98 and 24 mg/L were still below the threshold, where the TSS content of 302 exceeded the standard value of the content of liquid waste from organic fertilizer factories which had a permitted TSS content of 150 mg/L (0.15 kg/ton). Meanwhile, the results of laboratory tests for the chemical parameters above showed that the pH content was between 6.8 and 7.6 and did not exceed the highest pH content for organic fertilizer factory waste. The pH value is an important characteristic of wastewater because it affects reactions. The size of the pH value of wastewater is influenced by the chemicals contained. Therefore, the pH of wastewater will vary according to the content of chemical compounds. Wastewater treatment, both biologically and chemically, can run well if carried out at the right pH. Pure water is neutral, with its pH at a temperature of 25 ° C set at 7.0. Solutions with a pH of less than seven are called acidic, and solutions with a pH of more than seven are said to be basic

or alkaline. pH measurement is very important in fields related to life or the chemical processing industry (Zulius, 2017).

For the COD content, the content can be seen at Station 1, Station 2 and Station 3, respectively, at 367, 302 and 287 mg/L and which exceeds the COD content standard from waste from an ammonia organic fertilizer factory of 300 mg/L (0.3 kg/ton). The large COD content at Station 1 compared to the other 2 sampling stations is because Station 1 is the main outlet for the Liboganik organic fertilizer factory, such as the disposal of unused jangkos ash and boiler ash (exposed to rainwater) and close to solid mud.

The high organic matter in the waste results in a greater pollution load, high COD will have an impact on the oxygen deficit in river water which can cause death in fish and aquatic plants. High COD values indicate that the water is polluted (Dewa and Idrus, 2017). Polluted water, for example by domestic waste or industrial waste generally has a high COD value, conversely unpolluted water has a low COD because of this, greater degradation of organic matter is needed. In addition, ammonia factory liquid waste also contains high organic compounds including in the form of carbon, nitrogen, and phosphate compounds that can pollute the environment. Meanwhile, when viewed from the BOD or Biochemical Oxygen Demand value which is a characteristic that shows the amount of dissolved oxygen needed by microorganisms (usually bacteria) to decompose or decompose organic matter under aerobic conditions (Umaly and Cuvin, 1988) and COD or Chemical Oxygen Demand is the amount of oxygen needed to decompose all organic matter contained in water (Boyd, 1990). So it can be said that the higher the COD and BOD values, the higher the organic matter contained in the wastewater. So it can be concluded that the waste in the ditch around the factory land has not been managed properly. So the management of residual wastewater from the fertilizer factory is needed in order to reduce the pollution content.

4.2 Environmental Management of Liboganik Plant

From the existing condition, it was found that some of wastewater condition exceeded the threshold standard value. Therefore it is recommended that the factory can manage the environment accordingly by providing several environmental efforts as :

- 1) To make sure that the location of the community's houses are relatively far from the fertilizer factory surrounding area.
- 2) To manage wastewater by reducing the values of suspended solids, COD and BOD with Phytoremediation techniques
- 3) To use Vertical Water Circulation (SAV) in order to control and prevent population explosions of blue-green algae in water bodies.
- 4) To prepare a waste disposal flow from rainwater flow to a ditch in a closed condition. This is intended so that water does not spread to residential areas around the factory.
- 5) Toilets and water wells should be well managed for workers or employees who work in the factory.
- 6) To encourage the efforts to manage the facilities of fertilizer factory that concern with the environments

During the second observation result conducted on wastewater area around the factory location, it was showed the water surface turning green. This is one of the

signs that the water is not suitable and is polluted due to excessive growth of green algae in the waters of this ditch.



Fig. 2. Waste Ditch of Fertilizer Factory

Green lakes or river waters are a sign that green algae are growing in the pool of water. This is known as algae bloom. Algae bloom occurs when the food available for algae is abundant in the body of water, namely nutrients, nitrogen and phosphorus. Algae are unicellular microorganisms that live by photosynthesis. Their color is generally green, because they contain chlorophyll. Algae consume nutrients (nitrogen and phosphorus), CO₂ and sunlight to grow and reproduce. If they are in lakes, their presence is undesirable and dangerous. On the other hand, algae are cultivated for various products because of their high lipid and protein content, such as for food supplements and others. This condition is commonly called Eutrophication. These nutrients can come from various pollutants, such as fertilizers, toilet and kitchen wastewater, etc. The green of this body of water is a danger sign, that the water is polluted by excessive algae, so that the oxygen levels in the water will decrease and the lives of aquatic animals (fish and others) are threatened (Saraswati, 2019).

One method to control and prevent population explosions of blue-green algae in water bodies without having to control the input of N and P is to use Vertical Water Circulation (SAV). SAV circulates water at a depth below the limit of sunlight penetration using a secchi depth tool. (Pusair, 2018). The principle of water circulation technology is to circulate water from a depth that is not penetrated by sunlight towards the surface or an area that is still penetrated by sunlight, and vice versa, so that algae life will be disrupted, and cause the algae population to decrease. So the reservoir water circulation method which is carried out by rotating the reservoir water in a vertical direction, can control and prevent population explosions of blue-green algae in water bodies without having to control the input of N and P to the reservoir (Pusair, 2012).

Meanwhile, the results of the analysis of the factory building layout are also described to analyze the right steps in managing the factory environment in order to encourage the realization of a good, sustainable and environmentally friendly organic fertilizer factory environment. From the results of measuring the location of residential areas of people who live not far from the fertilizer factory in the field, it is known that this organic fertilizer factory has a distance of about 300 to 320 meters from the residents' housing. The location of the fertilizer

factory coordinates is at the coordinate point 1000.57'58.00 "E - 0057'6.000 N and the closest residential area is 320 meters from the fertilizer factory with the coordinate point 1000.58'8.15" E - 0057'5.770 N which is shown from the satellite mapping map which can be seen in the following image

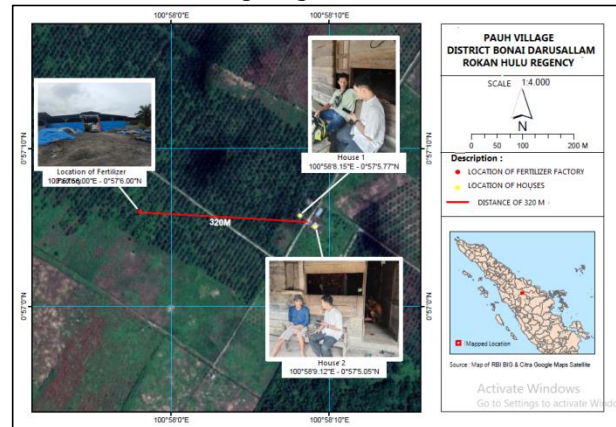


Fig. 3. Location of the Nearest Community Settlement

A review of the location of the community's houses shows that the factory location is relatively far from the housing around the factory. From the results of interviews with the community around the organic fertilizer factory, information was obtained that the location of the fertilizer factory is quite far from the factory location and there was no indication of direct impact from the fertilizer factory activities on the local community, but one of the residents said that there was a disturbance from vehicle noise when cars or trucks transporting raw materials and fertilizers to be taken out of the factory were quite noisy when passing the houses of the local community that were passed. However, the wastewater from the fertilizer factory did not have an impact, because the factory's wastewater drainage ditch was made closed and did not flow into the ditches of residents living around the factory.

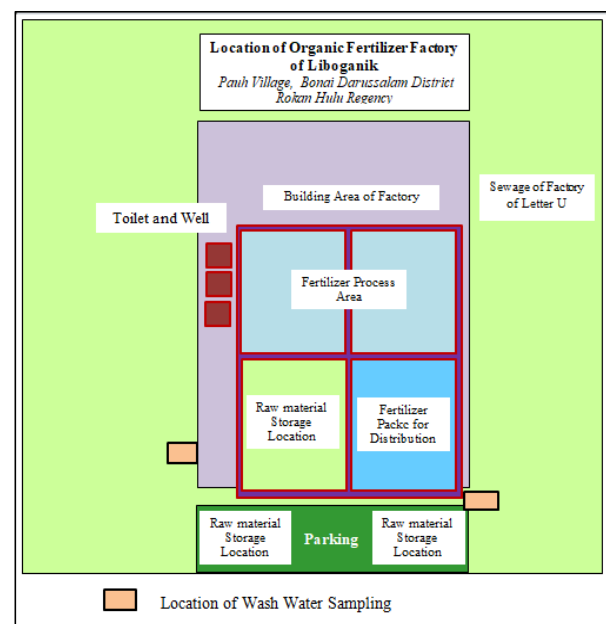


Fig. 4. Fertilizer Factory Site Plan

From the fertilizer factory site plan above, it is known that the factory land has a land area of 3,500 m² and with a land area and buildings for fertilizer factory operations

of 1,800 m². At the location around the factory land there is a ditch surrounding the factory in the shape of the letter U which is 3 m wide and 5 m deep as seen in Figure 4. The facilities available in this factory include a space for a land for storing raw waste materials of 1,400 m² located on the front left of the organic fertilizer factory which is covered by a tarpaulin and 3 toilets, each measuring 2x3 meters as seen in Figure 5. where the toilet has a special well located to the left of the toilet and a septic tank used to accommodate waste from the toilet. This condition is also estimated to cause potential environmental disturbances to well water adjacent to the toilet.

Related to waste disposal carried out through the toilet by workers also has a direct impact on water quality in the organic fertilizer factory environment. Even though the amount is not much, because it is only used by 15 factory workers, it can also pollute the aquatic environment. In addition to water, the presence of water wells in the factory environment also has the potential to be polluted by domestic waste discharged around the factory. One that can also have an impact is groundwater and well water. Many factors can affect the quality of groundwater. From the notes made by Effendi (2003), water quality can be influenced by physical, chemical and biological factors. The physical requirements for clean water are that the water is colorless, tasteless and odorless. The chemical requirements for clean water are that the water does not contain chemicals that are harmful to human health. The biological requirements are that the water does not contain microorganisms or germs. While the radioactive requirements are that the water does not contain radioactive elements that can be harmful to health.

Some sources of groundwater pollution are such as waste from industrial activities, both solid and liquid, because the waste produced from these industrial activities if not handled properly will be very dangerous for the environment, especially the quality of groundwater (Ginting, 2007), waste from fisheries and agriculture also has the potential to pollute groundwater, and the most common occurrence in residential areas is the disposal of domestic waste that does not comply with proper sanitation regulations.

Efforts to manage wastewater to reduce the values of suspended solids, COD and BOD can use Phytoremediation techniques. Phytoremediation can be interpreted as the use of plants to remove or eliminate, stabilize or destroy pollutants originating from organic and inorganic materials (Herman et al., 2017). Because the water in the ditch around the factory is seepage from rainwater that carries palm oil waste so as not to pollute the area around the community and this wastewater is not recycled so that phytoremediation techniques can be used to reduce water pollution in the factory ditch.

One of the plants that can be used is the water hyacinth plant. Water hyacinth (*Eichornia crassipes*) because this plant has a high growth rate so that this plant is considered a weed that can damage the aquatic environment (Audyanti et al., 2019). Although often considered a weed, water hyacinth (*Eichornia crassipes*) can be used to treat waste. This is because water hyacinth (*Eichornia crassipes*) has the ability to form phytochelatin where the peptide compound produced by the plant is able to accumulate metals in large quantities (Herman, 2017). The potential of water hyacinth (*Eichornia crassipes*) as a phytoremediator agent in the waste processing process is supported by the nature of water hyacinth (*Eichornia*

crassipes) which is easy to obtain, fast growth rate, cheap, and easy handling.

According to Syahrul (1998), water hyacinth is able to grow well and absorb non-biodegradable organic substances contained in domestic wastewater with a COD level of approximately 400 mg COD/L on condition that the required nutrients are met and the acidity level is set to a maximum pH of approximately 8. Based on research by Mutmainah et al., 2019 on the effectiveness of using water hyacinth in reducing COD and BOD levels in palm oil mill liquid waste, it was found that water hyacinth plants (*Eichornia crassipes* (Mart), Solms) are effective in reducing Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) levels in Palm Oil Mill Waste (LCPKS), the more water hyacinths, the higher the reduction in BOD and COD levels. So that the use of water hyacinth can be useful in reducing pollution due to waste produced by the factory. In addition, to reduce water pollution in the ditch channels around the factory, especially for the basic materials for making organic fertilizers, they can be placed in a special place that is protected from weather disturbances such as rain. However, with the opportunity for the fertilizer factory to grow bigger, the company can make efforts to reduce the levels of polluted water due to fertilizer factory activities by using technology using Vertical Water Circulation (SAV). SAV circulates water at a depth below the limit of sunlight penetration using a secchi depth tool. Currently, water circulation tools in Indonesia still use foreign production at relatively expensive prices so that the development of vertical water circulation technology with domestic production is needed. The results show that the performance of the tool can reduce the level of water eutrophication so that algae growth is reduced, in addition, N and P parameters decrease (Putro, 2020).

The management of the organic fertilizer factory environment is carried out through the results of environmental data analysis around the factory, including the results of wastewater analysis, observation results and from interviews conducted with company leaders, factory workers or employees and the community living around the Liboganik organic fertilizer factory. For environmental management, based on Law No. 32 of 2009 concerning Environmental Protection and Management, environmental management activities include planning, utilization, control, maintenance, supervision, and law enforcement.

From the interviews conducted with the company's management, it is known that the company has made efforts to plan environmental management, considering that this fertilizer factory uses raw materials derived from solid palm oil waste. Planning is carried out on the transportation of solid waste from the palm oil factory company to the accumulation of waste at the fertilizer factory location. Furthermore, in the solid waste utilization activity, the company mixes solid waste with other materials that are adjusted to the needs. After being mixed, in the control process, the organic fertilizer produced is analyzed in the laboratory to ensure that the levels contained in the fertilizer are able to encourage increased plant growth, especially oil palm. From the environmental side, control is carried out by the company by preparing a waste disposal flow from rainwater flow to a ditch in a closed condition. This is intended so that water does not spread to residential areas around the factory. In addition, toilets and water wells are provided for workers or employees who work in the factory.

In terms of maintenance, according to the factory management, the raw materials in the form of solid waste that accumulates in the factory are covered with tarpaulins, so that solid waste in the form of jangkos ash and boiler ash does not spread into the air and disturb the air for workers in the factory environment. In addition, to maintain employee health, the company provides masks, boots and helmets for employee safety and health. For supervision in environmental management, it is carried out by the factory management and manager towards employees regarding the use of tarpaulins on solid waste raw materials, the use of occupational safety and health equipment and the placement of organic fertilizers that are ready to be marketed.

For law enforcement, the company prepares an SPPL which is an environmental document prepared by the company. This form of SPPL is required because this fertilizer factory is still categorized as a low-risk company. To avoid environmental impacts related to factory wastewater that is discharged into the ditch, it is made closed and far from residential areas. However, regarding the finding that the quality of wastewater in the factory environment is starting to be polluted, the company management is ready to take steps to control wastewater so as not to endanger the factory environment.

The development of residential, industrial or plantation areas often ignores environmental sustainability and only considers aspects of economic profit alone. Further management errors, the environment can at least be caused by various factors such as education level, economic problems, lifestyle, weaknesses in the regulatory system and weak supervision of environmental management, resulting in pollution and damage to the environment. However, there has still not been any real legal action taken against perpetrators of environmental pollution (Herlina, 2022).

Meanwhile, from the results of observations and interviews conducted with fertilizer factory employees, it is known that the company has provided occupational safety and health equipment such as masks, boots and helmets for worker activities in the factory. However, there are still employees who have not used the equipment provided because they are considered troublesome. The flow of solid waste from fertilizer raw materials that is channeled into the ditch is carried out without first being processed or collected for processing before being disposed of into the ditch. This should be done so that the content of materials that pollute the factory environment can be reduced or overcome through processing factory wastewater before being disposed of into the ditch around the factory. The raw materials for making fertilizer that are processed per day are 5-10 tons. This will certainly affect the potential for pollution in the factory environment if not processed properly.

Regarding the environmental supervision carried out, since 2020 Liboganik has obtained a permit in the name of CV. Libo Farming registered through OSS. OSS is a business licensing system that is electronically integrated with all ministries/institutions (K/L) of the country to local governments (pemda) in Indonesia. The OSS system will conduct an examination of environmental provisions and documents that must be processed by business actors based on business activities or the Indonesian Standard Classification of Business Fields (KBLI) and environmental parameters. Every business plan and/or activity that has an impact on the environment must have environmental documents in the form of an environmental impact

analysis (AMDAL), Environmental Management Efforts - Environmental Monitoring Efforts (UKL-UPL) and an Environmental Management Statement (SPPL). The documents owned by the company are in the form of an Environmental Management Statement (SPPL), because the Liboganik organic fertilizer factory company is categorized as a business that has a small risk (low risk).

4.3 Environmental Management Strategy through IFAS, EFAS and SWOT Analysis.

Through the recognition of existing strengths and weaknesses and understanding of threats and opportunities is something that is very important to do in describing the fertilizer factory strategy into strategic steps in the management of the company's environment. This is mainly intended to find out more details about each business environment more specifically. In recognizing the characteristics of the business environment, it is hoped that every activity in environmental management with core competencies, both strengths and weaknesses owned by the company, is able to take advantage of every opportunity that arises and can anticipate every bad possibility that will be faced by the fertilizer factory.

IFAS analysis of fertilizer factory environmental management is explained in the following table:

Tabel 2. IFAS of Environmental Management of Factory

No	Decription	Internal Factors		
		Weight	Rating	Score
A Strength				
1	Fertilizer factories use palm oil waste as raw material	0,20	4	0,80
2	Availability of employee occupational safety and health equipment such as masks, shoes and helmets	0,20	4	0,80
3	Organic fertilizer has good quality according to quality standards	0,15	4	0,60
4	The location of the fertilizer factory is relatively far from residential areas	0,15	4	0,60
5	There is road access to the factory location to facilitate transportation of raw materials and distribution.	0,10	4	0,40
6	There is an adequate location for loading and unloading and adequate placement of raw materials and fertilizers.	0,10	3	0,30
7	There is supervision of workers in the fertilizer factory environment	0,10	3	0,30
Total		1,00		3,80
B Weakness				
1	Parking and office areas are not yet available at the factory location.	0,20	2	0,40
2	Discharge of wastewater to a closed location	0,20	2	0,40
3	Wastewater treatment units are not yet available	0,10	2	0,20
4	The negative impact of water pollution on the surrounding environment	0,15	2	0,30
5	There is no environmental management guide for fertilizer factories	0,10	2	0,20
6	The bathroom is located close to the toilet and well.	0,10	3	0,30
	Lack of employees responsible for environmental management	0,10	2	0,20
Total		1,0		2,00
			Difference	1,80

Source : Research Data (2024)

So the total strength value is 3.8 and the weakness is 2.0. Furthermore, from the details of the table above, it is known that the difference between strength and weakness is 1.8.

Furthermore, the EFAS analysis is described in the following table:

No	Description	External Factors		
		Weight	Rating	Total
C Opportunity				
1	Creating an environmentally friendly factory environment	0,30	4	1,20
2	Government support for the existence of fertilizer factories	0,20	4	0,80
3	Market development and wider distribution of fertilizers	0,10	4	0,40
4	Efforts to manage wastewater using phytoremediation techniques	0,15	4	0,60
5	Global economic conditions improve post Covid 19	0,10	3	0,30
6	Increasing community income through the development of fertilizer factories	0,15	3	0,45
Total		1		3,75
D Threats				
1	There is an environmental impact due to the disposal of factory waste water	0,25	2	0,50
2	There is competition from other fertilizer producers	0,15	2	0,30
3	There are local communities affected by environmental impacts	0,10	2	0,20
4	The existence of unstable and ever-changing weather and climate conditions	0,20	2	0,40
5	Settlement of problematic and unscheduled fertilizer payments	0,10	3	0,30
6	There is a negative image of fertilizer factories that do not manage the environment well.	0,20	2	0,40
Total		1		2,10
		Difference		1,65

Source : Research Data (2024)

For the total value of opportunities of 3.75 and threats of 2.1. Furthermore, from the details of the table above, it is known that the difference between opportunities and threats is 1.65.

From the IFAS and EFAS tables, there are results of internal factor assessments by considering aspects of strengths and weaknesses and external factors by considering aspects of opportunities and threats, the following scores can be obtained:

- 1) The strength score (S) is 3.80 while the weakness (W) is 2.00 so that if S - W is the X axis it is 1.8.
- 2) The opportunity score (O) is 3.75 while the threat (T) is 2.10 so that if O - T which is the Y axis is 1.65.

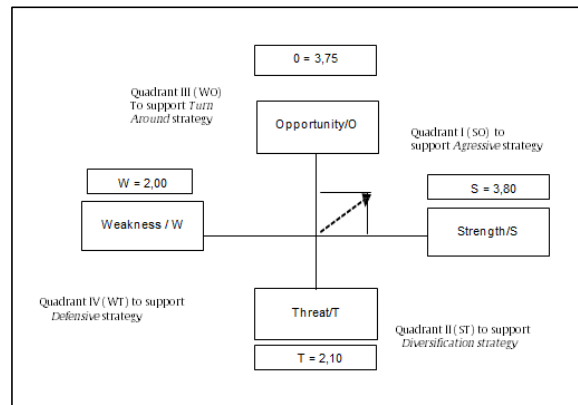


Fig. 5. Results of SWOT Strategy

Table 4 SWOT Matrix of Environmental Management of Liboganik Fertilizer Factory.

IFAS EFAS	Strength (S) 1. Fertilizer factories use palm oil waste as raw material 2. Availability of employee occupational safety and health equipment such as masks, shoes and helmets 3. Organic fertilizer has good quality according to quality standards 4. The location of the fertilizer factory is relatively far from residential areas. 5. There is road access to the factory location to facilitate transportation of raw materials and distribution. 6. There is an adequate location for loading and unloading and adequate placement of raw materials and fertilizers. 7. There is supervision of workers in the fertilizer factory environment	Weaknesses (W) 1) Parking locations and office areas are not yet available at the factory location. 2) Disposal of wastewater to a closed location 3) Wastewater treatment units are not yet available 4) There are negative impacts of water pollution on the surrounding environment 5) There is no guideline for handling the environment in fertilizer factories 6) The toilet is located next to the bathroom and well. 7) There are no employees responsible for environmental management.
	Opportunities (O) 1) Creating an environmentally friendly factory environment. 2) Government support for the existence of fertilizer factories. 3) Market development and wider distribution of fertilizer. 4) Efforts to manage wastewater using phytoremediation techniques. 5) Global economic conditions improve post Covid 19. 6) Increasing community income through the development of fertilizer factories.	SO Strategy 1) Improve sustainable environmental management of organic fertilizer factories. 2) Utilizing palm oil factory waste as a material for making organic fertilizer. 3) Increase the promotion of organic fertilizer which has been proven to increase farmers' income. 4) Increase efforts to reduce factory pollution through filtration and phytoremediation techniques to improve the aquatic environment. 5) Increase supervision in carrying out work according to standards. 6) Increase community social participation in fertilizer factory activities.
Threats (T) 1) There is an environmental impact due to the disposal of factory waste water. 2) There is competition from other fertilizer producers. 3) The existence of local communities affected by environmental impacts. 4) The existence of unstable and ever-changing weather and climate conditions. 5) Settlement of problematic and unscheduled fertilizer payments. 6) There is a negative image of fertilizer factories that do not manage the environment well.	ST Strategy 1) Maintain good fertilizer quality. 2) Improve road access so that it can be used when weather conditions are unstable due to rain. 3) Place factories far from residential areas to avoid the impact of factory waste. 4) Improve environmental management of fertilizer factories by placing environmental experts.	WT Strategy 1) Improve factory facilities to be able to compete with competitors. 2) Handle a good waste disposal system. 3) Improve the quality of human resources to optimally increase the development of environmentally conscious businesses. 4) Increase wider promotion of fertilizer.

Source : Research Data (2024)

Then the X and Y axis coordinates are applied to the SWOT analysis diagram so that it can be seen that the

environmental management strategy of the Liboganik organic fertilizer factory occupies the SO quadrant, which means occupying an Aggressive Strategy, namely a strategy in the SWOT analysis is an approach used by organizations to maximize the strengths (Strengths) that exist in the company, improve existing weaknesses (Weaknesses), exploit emerging opportunities (Opportunities), and face existing threats (Threats). In this strategy, the fertilizer factory uses an aggressive approach to achieve competitive advantage and achieve its company goals in environmental management of the Liboganik organic fertilizer factory.

Furthermore, the formulation of environmental management of the Liboganik organic fertilizer factory in Pauh Village, Bonai Darussalam District, Rokan Hilir Regency was carried out through a SWOT Matrix from the results of the internal factor assessment by considering the aspects of strengths and weaknesses as well as external factors in the form of aspects of opportunities and challenges, then the SWOT Matrix was compiled as above (Table 4).

From the SWOT Matrix table in the S-O Strategy above, the aggressive strategy carried out by the Liboganik organic fertilizer factory in managing the environment is carried out through:

- 1) Improving sustainable management of the organic fertilizer factory environment. This is done by ensuring that the organic fertilizer factory activities do not threaten the surrounding environment. Placing the factory location so that it does not cause potential disturbances for workers is also a step that must be taken, such as providing masks, boots and helmets for workers. The quality of the environment, especially water, also needs to be a concern for the factory because it has shown signs of pollution in the surrounding waters.
- 2) Utilizing palm oil factory waste as a material for making organic fertilizer. This is done by the company through the utilization of solid palm oil waste, so that it can reduce environmental pollution caused by solid waste produced by the palm oil industry which continues to grow.
- 3) Increasing the promotion of organic fertilizers which have been proven to increase farmers' income. Efforts to develop a wider market and fertilizer distribution are always carried out by the company to increase the company's income and profits. This is an important opportunity aspect for the company considering that the company currently has a fertilizer distribution permit and has the opportunity to expand fertilizer marketing to a wider area, so that it is expected to be able to increase the potential for increasing the profits of the fertilizer factory company to be better.
- 4) Increase efforts to reduce factory pollution through filtration and Phytoremediation techniques so that the aquatic environment improves. The presence of water in the ditch channels around the factory is seepage or spillage from rainwater carrying fertilizer factory waste that uses solid palm oil waste, therefore in order to reduce pollution around the factory environment so that through phytoremediation techniques it is very potential to reduce water pollution in the Liboganik fertilizer factory ditch channels.
- 5) Increase supervision in the implementation of work according to standards. This is also an important strength for fertilizer factory managers, because with supervision from company management and the community, the management of the fertilizer factory is getting better and more controlled.
- 6) Increase community social participation in fertilizer factory activities. From the results of the study it was also found that activities in involving community participation in the Liboganik organic fertilizer management activities that were carried out were also included in the very good category with a percentage of 91.8%. This is a sign that the existence of this organic fertilizer factory is very beneficial for the surrounding community in Pauh Village.

From the research conducted by Lestari and Purnamawani (2023) on the management of organic fertilizer factories in Jambi, it was concluded that the strategy for developing organic fertilizers in Jambi Province includes: Increasing farmers' understanding of the benefits of using organic fertilizers through farmer groups, providing awards for farmers/farmer groups who are committed to using/producing organic fertilizers, the price of organic fertilizers is cheaper and more environmentally friendly than chemical fertilizers, and providing a special place that provides solid and liquid organic fertilizers. Meanwhile, from the research conducted by Nasution and Yoman (2021), it is known that a company engaged in the manufacturing sector that produces a variety of fertilizers such as dolomite fertilizers and lime fertilizers in Jambi with a SWOT analysis to systematically identify various factors in order to formulate a company strategy that is depicted in the Cartesian diagram in quadrant I with a value of 1.54; 0.97. The main strategy of the company PT. XYZ is Growth Oriented Strategy. Where PT. XYZ can maintain and improve product quality so that the public continues to trust PT. XYZ products. Then deepen the network with partners to create good relationships and create attractive promotions to increase public awareness of the importance of maintaining plantations. This position indicates that the company from the SWOT analysis conducted related to the feasibility study and potential development of the fertilizer factory is to maintain and improve the quality of fertilizer so that many loyal customers always make transactions to meet the needs of their company. Another study conducted by Sungkono (2016) that based on the results of the analysis of factors, it can be seen that the results of the internal factor analysis are the strengths of 1.793 and the weaknesses of PT Pupuk Kujang Cikampek are - 1.291. While the results of the external factor analysis, the opportunities are 1.930 and the threats are - 1.456. The strategy obtained is an aggressive strategy as in this thesis research. The results of the analysis with standard deviation obtained several criteria where the implementation of CSR on profit allocation, community empowerment, and environmental preservation with good criteria; Implementation of CSR for corporate reputation with good criteria; Implementation of CSR to overcome the constraints of corporate reputation with good criteria; CSR Implementation Strategy improves corporate reputation with good criteria. Implementation of CSR of PT Pupuk Kujang Cikampek, related to the level of profit for community empowerment and environmental preservation for the implementation of CSR, has been considered good, but there are still aspects that are not optimal, including: 1) Allocation of profits for the

implementation of CSR programs by PT Pupuk Kujang Cikampek, the management of which has not been entrusted to a third party. 2) Community empowerment by PT Pupuk Kujang through partnership programs, is still limited to capital loans for small entrepreneurs, 3) Environmental preservation by PT Pupuk Kujang Cikampek is only limited to planting trees, but air pollution is sometimes still felt by the community in the form of unpleasant odors from the production process.

5. Conclusions

5.1 Summary

- 1) The results of the water quality analysis of the Liboganik organic fertilizer factory waste showed that the water quality was polluted, as seen from the data from the physical parameter laboratory tests above, it can be seen that the suspended solids (TSS) content of 302 at Station 1 exceeded the standard value of the liquid waste content from the organic fertilizer factory. Meanwhile, the COD content was seen at Station 1 and Station 2, respectively, at 367 and 302 mg/L, exceeding the COD standard for waste from the organic fertilizer factory of 3.0 mg/L according to the standard of the Minister of Environment Regulation No. 5 of 2014 concerning Wastewater Quality Standards and Class III water quality standards for freshwater fish farming according to Government Regulation No. 82 of 2001.
- 2) Spatial management of fertilizer factory buildings is also needed through the construction of adequate infrastructure and paying attention to its impact on the environment and factory workers in order to encourage the realization of an environmentally friendly fertilizer factory. Environmental management of organic fertilizer factories can be done by making a ditch pond to accommodate seepage of residual palm oil factory waste and limiting it so that there is no pollution to the community environment. In addition, in an effort to reduce high COD and BOD content, wastewater management can be carried out using Phytoremediation techniques which are estimated to be able to reduce the content of materials that pollute the waters in the Liboganik organic fertilizer factory environment. One technology that can be used by adopting technology from abroad is to use Vertical Water Circulation (SAV).
- 3) The results of IFAS and EFAS contain the results of internal factor assessments by considering aspects of strengths and weaknesses and external factors by considering aspects of opportunities and threats. The X-axis score can be obtained as 1.80 and the Y-axis score as 1.65. Then the X-axis and Y-axis coordinates are applied to the SWOT analysis diagram so that it can be seen that the environmental management strategy of the Liboganik organic fertilizer factory occupies quadrant I SO, which means occupying the Aggressive Strategy

5.2 Recommendations

Here are some suggestions and recommendations that can be explained as follows:

- 1) Fertilizer factories should first carry out better environmental management, considering that currently there is no waste processing before the waste is discharged into the surrounding waters.

- 2) It is better to establish a factory that is not far from the location of the oil palm plantation to save transportation costs, so that the price of fertilizer is more affordable.
- 3) Conduct further research related to sustainable palm oil waste management strategies.

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