

THE POTENTIAL OF AMELASIR TO RESTORING SANDY LAND INTO PRODUCTIVE PADDY FIELDS AT PT PIM FOSTERED VILLAGE

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Abstract

North Aceh district has 12,750 ha of idle land that has the potential to be planted with rice. This unused land becomes rice paddies because it has a large enough area and contains elements needed by rice plants. PT Pupuk Iskandar Muda implemented a program to turn sandy land into fertile rice fields called AMELASIR (Amelioration of Sandy Land) with an area of 278 m². This program is carried out by offering intensive tillage and using ameliorants. The materials added were PIM organic fertilizer, clay, manure, rice straw compost, PIM Polivit and PIM Urea. The results of this program show an increase in rice yield from year to year. In the first growing season the harvest reached 3 tons/ha, in the second growing season it reached 3.45 tons/ha, and in the third growing season the harvest reached 4.5 tons/ha. This area has a faunal biodiversity index H' 3.22 and floral biodiversity H' 2.28. The conversion of idle land into paddy fields also increased the biodiversity of several interesting fauna species, namely 12 bird species, one reptile species, two mammal species, and 20 insect species. The AMELASIR program also made the soil more fertile for some trees so that four tree species, two pole species, eight sapling species and 16 seedling species grew in the area.

Keywords: *amelioration, soil, sandy soil, biodiversity, species.*

1. INTRODUCTION

Rice (*Oryza sativa*. L) is the main food in Indonesia with a population of 255.46 million people and a rice consumption rate of 124.89 kg/capita/year. Thus, maintaining increased rice production is a priority for the government to balance the supply of needs for the community (Nurkholis et al., 2020). North Aceh district has the highest level of rice productivity in Aceh at 6.5 tons/ha. However, rice production in this area is idle at 389,076.30 tons in 2019, 393,477.210 tons in 2020, and decreased to 343,726.19 tons in 2021. In addition, the district has 12,750 ha of idle land that has the potential to be planted with rice. This showed that rice planting in North Aceh District has high potential to be developed. However, the problem is that the characteristics of abandoned land in this area have a sandy soil texture with low water resistance. sandy soil is formed by the smallest or fine particles of weathered rock between 0.05 - 2.0 mm. This soil is known as the poorest type of soil for agriculture and plant growth because it has very low nutritional value and poor water holding capacity (Sukarman, 2020).

Idle land potentially has a sandy texture with a high concentration of silica (Si). This nutrient is needed by rice plants. The Si element is useful for forming upright and straight leaves (not drooping), so that they are effective in capturing light radiation. To overcome these problems, PT PIM implemented the AMELASIR (Sandful Land Amelioration) program in the company's fostered areas. Amelioration is an effort to improve soil fertility by adding certain materials. This activity is carried out with intensive tillage to form rice planting areas.

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Amelioration aims to shape sandy land into productive land for rice planting. This improvement opportunity is seen from the condition of the soil after being processed several times able to provide excellent improvements so that if intensive and focused processing is carried out it will have a more targeted effect. Innovation in processing critical land into planting land that suits the needs of plants. The AMELASIR program can also increase biodiversity because it produces productive land that contains various nutrients as their source of life. Biodiversity (KAYATI) is the various forms of life that exist on land, air and water in a space and time, in the form of plants, animals, and even the smallest living things such as microorganisms (Suwarso, 2019). The Amelioration Program has been implemented since 2020 until now. But until now, the success rate of the program has not been studied. A program will be declared successful when it provides various positive impacts during its implementation. Indicators of the success of a program are needed in the evaluation process and future follow-up. For this reason, the author is interested in conducting research on the impact of the amelioration program for restoring sandy land to productive rice fields in the experimental garden of PT PIM.

2. RESEARCH METHODS

This research used qualitative and quantitative descriptive methods. qualitative descriptive methods are used to see the impact of the AMELASIR program as an alternative way of restoring sandy land to productive rice fields and quantitative methods are used to see the number of KAYATI after the program is implemented using the biodiversity index formula (shannon wiener).

2.1. Location, Scope and Research Object

This research was conducted in North Aceh District. This is because the location of the PT PIM Experimental Garden is in North Aceh District and this district is one of the main rice production centers in Aceh. The scope of this research is limited to the impact of the amelioration program for the restoration of sandy land into productive rice fields and biodiversity (KAYATI) in PT PIM's experimental garden. The object of this research is paddy fields and biodiversity.

2.2. Data Collections Techniques

Data collection techniques used in this study were in-depth interviews, censuses and observations. In-depth interviews were conducted to determine the program's impact on the restoration of sandy land into productive barley land. While observations and censuses were carried out to see the existing biodiversity after the program was implemented. The data used in this study are secondary data and primary data. Secondary data was obtained from literature studies from various academic research, rice production data from various government agencies and others. While primary data is data obtained based on direct observation in the field.

2.3. Data Analysis Method

The data analysis method was used to assess the amount of biodiversity referring to SNI 8014:2014 (BSN, 2014) for calculating the biodiversity index (H'). The diversity of macroalgae is calculated using the following Shannon - Wiener (H') index formula:

$$H' = -\sum \frac{ni}{N} \ln \frac{ni}{N} \quad (1)$$

Explanation:

H' = Diversity Index

Ni = Species Individual Total to- (i)

N = All Species Individual Total

With criteria:

- $H' < 1$ = Low diversity; this showed that environmental factors are very influential on the life of organism
- $1 < H' < 3$ = Medium diversity, this showed that environmental factors are very influential on the life of organism
- $H' > 3$ = High diversity, this showed that environmental factors do not affect the life of organisms

Fauna data obtained at the research location was analyzed with reference to SNI 8014: 2014 using the biodiversity index (H'). Analysis of the diversity index (Diversity Index) is used to determine the diversity of fauna species at a sampling location which is accumulated in the amount of value. The Diversity Index formula is as follows:

$$H' = - \sum_{i=1}^n p_i \ln p_i \quad (2)$$

Explanation:

H' = Diversity Index *Shannon-Wiener*

P_i = n_i/N

N_i = Type Individual Total to- i

N = All Type Individual Total

With Criteria:

If $H' \geq 3$ means high diversity; if $H' = 2-3$ means medium diversity, and if $H' \leq 2$ means low diversity

3. RESULTS AND DISCUSSION

Sandy land can be interpreted as land that has low quality because it has several limiting factors if it is used for a particular purpose. In Indonesia, marginal land is found in both wet and dry land. Wetlands are in the form of peatlands, acid sulphate lands and tidal swamps, while dry dry lands are in the form of Ultisols and Oxisols (Erika, 2009). The AMELASIR area is a plant planting area with efforts to improve soil fertility with certain materials. The materials used for amelioration (ameliorant) consist of organic, inorganic, or a combination of both. Organic ameliorants is material from living things that experience composting, has complex nutrients, but in small quantities. Inorganic ameliorants are ameliorants of mineral and organic matter which are chemically processed, having nutrients quickly available to plants because of their ionic reactions. Giving organic matter can improve the biological properties of the soil, because organic matter is the main ingredient for soil microorganisms in carrying out metabolic processes (W. Zhou et al, 2020).

One of riverside location near the PT Pupuk Iskandar Muda's residential is sandy and nutrient poor. The AMELASIR program has been implemented for 2 years in PIM experimental garden with paddy rice as an indicator of success. The research was conducted in the AMELASIR (Amelioration of Sandy Land) area, which is located on the east side of the PT Pupuk Iskandar Muda housing complex (Tambon Tunong Village, Dewantara District, North Aceh Regency). The method used is intensive tillage such as the application of organic matter, the addition of clay, humic acid, irrigation, plowing, and the addition of organic fertilizers. Another method is to conduct repeated planting and the resulting straw is returned to the land so that the soil is increasingly fertile and loose. In addition to rice planting as an indicator of the success of the research, researchers also analyzed the biodiversity caused by the program in the AMELASIR area. This is in line with the research of Leogrande et al (2018) which proves that sandy land can be converted into fertile and potential land using the amelioration process (R. Leogrande et al, 2018). This land is used to grow a variety of economically valuable commodities, especially horticultural

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crops. (S.S Chahal et al, 2018). The amelioration process used is the addition of clay, humic acid, organic fertilizer (compost) and rice straw. The results of studies by several researchers showed beneficial effects of organic matter on soil function and crop yield under high salt conditions (S. el hasini et al, 2019). Addition of organic matter such as crop residues and manure to salt-affected soils has been suggested to decrease electrical conductivity by Na⁺ exchange, increase water infiltration, retain water capacity, aggregate stability (J.A. Antonangelo et al, 2021) and (Y. Fei, et al, 2019) increase microbial biomass and enzymatic activity (Y. Feng et al, 2017).

Soil quality changes are closely related to functioning soil enzymatic activity as a useful indicator for sustainable management of soil stability and the environment. Among all soil quality indices, enzymes react quickly in soil management and therefore remain a good indicator of soil biological changes in soil chemical properties (S.O. Oladele, 2019) The application of rice straw biochar has been shown to increase nutrient and enzymatic cycling of soil (W Wu et al, 2012) The process of ameliorating sandy soil for planting rice can be seen in Figure 1.



Figure 1. Conditions before the program: Conditions of unused land before the AMELASIR program. Sandy soil, still a lot of limestone, and hard to hold water (dry).



Figure 2. Conditions after the AMELASIR program was carried out on sandy land for planting rice plants

The flora inventory carried out in the AMELASIR area generally consists of horticultural plants in the form of: vegetable plants, fruit plants, and ornamental plants. In addition, there are also shade plants, at the level of trees and poles. Observations on flora in the AMELASIR area found a large number of rice species (*Oryza sativa*) as many as 198 individuals because the small structure and close spacing of the cultivated land made this species dominant in the number of individuals compared to other species. The condition of the sandy land before the implementation of AMELASIR was very neglected, difficult to use as planting land due to the degraded physical, chemical and biological conditions of the soil. The soil is dry, light in color, hot in temperature, doesn't hold water well, and has low nutrient content (evidenced by the plants planted in the land don't develop properly).

The condition after the implementation of AMELASIR were that the land gradually became moister, darker in color (indicating higher soil organic matter), holding water longer, and increasing nutrient content (evidenced by higher crop productivity). By implementing this

innovation, the idle land can be used as fertile planting land. This land can be planted with various plants and can increase the biodiversity in the area. The environmental impact is an increase in the biodiversity index in 2022. According to Law Number 05 of 1990, biodiversity is defined as diversity among living things from all sources, including land, sea and other aquatic (water) ecosystems; as well as the ecological complexes that are part of their diversity, including diversity within species as well as between species and ecosystems. The flora diversity index of the AMELASIR region has a moderate diversity index value of 2.28. Moderate diversity indicates that environmental factors affect the life of organisms.

Calculation of the flora diversity index for 2022 in the AMELASIR area: Number of flora in the AMELASIR area = 733 individuals. With the Press. 1, then the flora index in the AMELASIR program is obtained:

$$H' = -\sum ni/N \ln ni/N$$

$$Pi = ni/N = 1$$

$$\ln pi = -105,8082$$

$$\text{then, } H' \text{ flora AMELASIR program} = -\sum pi \ln pi = 2,28$$

If we review the biodiversity in each stand (trees, poles, stakes, and seedlings), a high level of biodiversity is obtained as shown below:

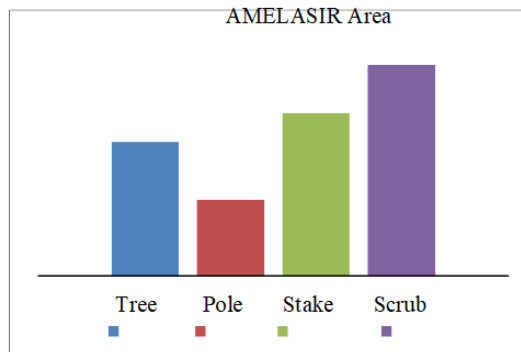


Figure 3. Biodiversity index in the AMELASIR area

The fauna diversity index of the AMELASIR area has a high diversity index value of 3.22. Calculation of the fauna diversity index for 2022 in the AMELASIR area: Number of fauna in the AMELASIR area = 174 Individuals With Eq. 2, then the fauna index in the AMELASIR program is obtained:

$$H' = -\sum_{i=1}^n pi \ln pi \quad (2)$$

$$\ln pi = -134,086$$

$$\text{then, } H' \text{ fauna AMELASIR program} = -\sum pi \ln pi = 3,22$$

If we review biodiversity in each species (aves, reptiles, mammals, and insects), a high level of biodiversity is obtained as shown below:

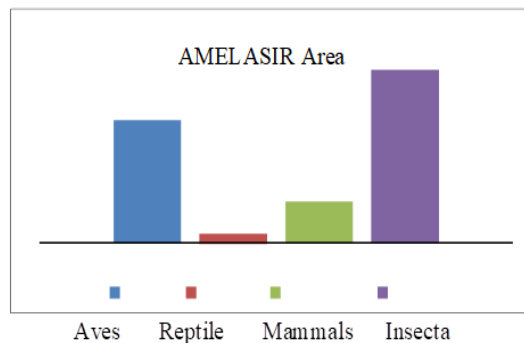


Figure 4. Biodiversity index in the AMELASIR area

Biodiversity refers to the overall aspects of life support systems, which include social, economic, environmental aspects as well as aspects of knowledge and ethical systems.

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Table 1. The positive impact of biodiversity in the AMELASIR area at PT PIM on environmental factors

No.	Tools/Materials	Average of Environmental Conditions	Standart	Unit
1.	Temperature	32	18 – 30 ¹	0 _C
2.	Humidity	75	40 – 60 ¹	%
3.	Soil Moisture	55	60-80 ²	%
4.	pH of Soil	6,8	4,5 – 8,5 ³	-

Sumber: *primary data (2022)*

Based on Table 1, the average microclimate environmental conditions in nature conservation areas, biodiversity protection are in accordance with quality standard requirements, and some are above or below quality standard standards. For soil quality in the form of pH and soil moisture in accordance with quality standards. The process of photosynthesis in plants with a neutral pH will facilitate the absorption of essential nutrients. As for air quality in the form of air temperature and air humidity through quality standards. Changes in microclimate environmental conditions in the region are inseparable from the condition of flora vegetation in the area which affects the surrounding conditions that have an impact on the environment (D. Mulyana at al, 2011) Biodiversity also has a positive impact on other biotic components and can present other flora and fauna in the area, namely:

Table 2. The Total of Flora Dan Fauna Species in AMELASIR area

KAYATI Flora	Quantity	KAYATI Fauna	Quantity
Tree	4	Aves	12
Pole	2	Reptile	1
Stake	8	Mammals	2
Scrub	16	Insecta	20
Total	28		35

Sumber: *primary data (2022)*

In addition, There are some of the positive impacts of the AMELASIR area in terms of ecology, economy, social and culture:

- a. Increase soil fertility, turning nutrient-poor land into productive land by adding macronutrients (inorganic) that are beneficial to soil and plant fertility.
- b. As a shelter and windbreak, there are tree vegetation and poles that function as shade and add coolness to animals and humans.
- c. Tree vegetation and poles as an ecosystem buffer, tree canopy can absorb carbon dioxide and dust.
- d. Habitat and food sources for animals, fruit plants and flowering plants become places to find food and help pollinate and disperse seeds for birds and insects.
- e. The place of food supply, the results of this plantation that produce vegetable and fruit products can be used as daily food consumption.
- f. Supporting the economy and business development, producing various kinds of horticultura crops (such as: vegetables) that increase economic income.
- g. It has aesthetic value, the presence of flower and ornamental plants that add aesthetic value and social and cultural value that attract attention.
- h. As a means to support education, research, and development of science, there is an on farm tour that can provide information and education to the community regarding methods of processing critical land into cultivated land. In addition, this program can increase public awareness of the importance of biodiversity protection so that in the future it is hoped that in the future the community can contribute to becoming environmental cadres for biodiversity conservation in their environment.

- i. Community resource capacity, through training on horticultural crop management and AMELASIR (Sandy Land Ameliorization) practices organically or inorganically or a combination of the two.



Figure 5. On farm tour with students and lecturers from Malikussaleh University
Source: Pupuk Iskandar Muda (2022)

AMELASIR program, the company can increase the area of cultivated land in housing complexes and improve the company's good name because it has participated in increasing biodiversity in sleeping land. The conversion of idle land into cultivated land forms behavioral changes such as the mindset to optimize idle land into cultivated land. The community also benefits from piloting methods in processing idle land, critical land, so that it can be implemented on farmers' land. Marginal land that originally could not be overgrown with cultivated plants, can now be overgrown with cultivated plants, and even become rice fields. The soil is increasingly fertile with constantly increasing crop yield indicators. The first harvest in June 2021 got a yield of 84 kg, the second harvest in December 2021 got a yield of 96 kg and the third harvest in May 2022 got a yield of 126 kg. The formation of new ecosystems also occurs in rice fields, such as fish, crickets, grasshoppers and birds. Broadly speaking, the impact of the AMELASIR program implemented by PT. PIM is as follows:

Table 3. Impact of AMELASIR Program PT. Pupuk Iskandar Muda (PIM) for 2 years

No	Conditions Before the AMELASIR Program	Impact After AMELASIR Program
1	Barren and abandoned land conditions	The condition soil begins to loosen
2	Water absorption in soil is very low	Water conditions have begun to be flooded longer
3	Planting of rice crops cannot be carried out	Planting of paddy rice plants after the program can be implemented properly
4	Amount Biodiversity (KAYATI) not diverse	Biodiversity Amount (KAYATI) increased

4. CONCLUSION

AMELASIR (Sandy Land Amelioration) is an intensive tillage program into productive land and can become a land for crop planting. Rice planting as an indicator the success of the study resulted in the first harvest in June 2021 getting a yield of 84 kg, harvest the second in December 2021 got a yield of 96 kg and the third harvest in May 2022 got a yield of 126 kg. Biodiversity generated by the program in the AMELASIR area are H' flora 2.28 and H' fauna 3.22. Biodiversity also has a positive impact on other biotic components and can present other flora and fauna in the region, namely 28 species of flora and 35 species of fauna. Meanwhile, the AMELASIR program also has a positive impact in terms of ecology, social, and economy and culture, such as increasing soil fertility, as a shelter and windbreak, tree vegetation and poles as an ecosystem buffer, habitat and feed source for animals, a place for providing

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food, supporting the economy and business development, having aesthetic value, as a means to support education, research, and development of science, and increasing the capacity of community resources.

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