

Benefit of Bed Raising to Manage Acid Sulphate Soil Under Industrial Forest Plantations Area

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Abstract: Industrial Forest Plantations (IFP) are intended to increase the productivity non-productive natural forest production. In South Sumatra Province IFP is widely developed in wetlands; one of them is in acid sulphate soils which have major problems with flooding and waterlogging. To solve this problem, the technology other than making drainage canals is Bed Raising. Bed Raising is to make beds to facilitate the implementation of planting, maintenance and harvesting, in addition to maintaining good soil aeration conditions. However, Bed Raising on acid sulphate soil raises a new problem is pyrite oxidation, which affects the chemical properties of acidic sulphate soil. The purpose of this study was to see the benefits of bed raising in the management of acid sulphate land in IFP areas. This study uses survey methods and data are presented in tabulations. The results of this study indicate that the benefits of bed raising in the management of acid sulphate land are no longer flooded or waterlogging. While the results of chemical analysis of soil in bed raising plots are very acidic soil pH (pH <3), Al-dd saturation is very high (> 70%), and high pyrite concentration (> 2.4%). This value is not suitable for plant growth.

Keywords: Flooded, Bed raising, acid sulphate soil

Abstrak (Indonesian): Hutan Tanaman Industri (HTI) dimaksudkan untuk meningkatkan produktivitas hutan produksi alam yang tidak produktif lagi. Di Provinsi Sumatera Selatan HTI banyak dikembangkan di lahan basah; salah satunya adalah pada tanah sulfat masam yang memiliki masalah utama banjir dan genangan. Untuk mengatasi permasalahan tersebut maka teknologi selain pembuatan saluran drainase adalah *Bed Raising*. *Bed Raising* yaitu membuat bedengan untuk memudahkan pelaksanaan penanaman, pemeliharaan dan panen, selain itu juga untuk menjaga kondisi aerasi tanah tetap baik. Namun *Bed Raising* pada tanah sulfat masam ini menimbulkan permasalahan baru yaitu terpaparnya lapisan pirit ke permukaan, yang berpengaruh pada sifat kimia tanah sulfat masam. Tujuan dari penelitian ini adalah untuk melihat manfaat dari *bed raising* dalam pengelolaan lahan sulfat masam pada areal HTI. Penelitian ini menggunakan metode survei dan data disajikan dalam tabulasi. Hasil penelitian ini menunjukkan bahwa manfaat dari *bed raising* pada pengelolaan lahan sulfat masam tidak lagi mengalami kebanjiran atau genangan. Sedangkan hasil analisa kimia tanah pada petak *bed raising* yaitu pH tanah sangat masam (pH < 3), kejenuhan Al-dd sangat tinggi (>70%), dan konsentrasi pirit tinggi (>2,4%). Nilai ini tidak sesuai bagi pertumbuhan tanaman.

Kata kunci : Banjir, bed raising, lahan sulfat masam

1. Introduction

Forest Plantations in general have an increasingly important role, especially to meet timber needs, along with declining timber production from natural forests since the late 1980s^[1]. According to current estimates, the global area of plantations (including semi-natural forests) has increased from 167 million hectares to 280 million hectares from 1990 to 2015, with more than 100 million hectares of productive plantations and 54 million hectares of industrial plantations growing fast^[2].

Plantations in particular are regulated and regulated in Government Regulation No.7 of 1990 concerning Industrial Plantation Forests Concession Rights. This type of forest is intended to increase the

productivity of natural production forests that have been damaged or are no longer productive. Industrial Forest Plantation (IFP) is a production forest area whose management applies an intensive forestry cultivation system to supply and fulfill the availability of raw materials for the forestry industry, both in the form of wood or non-wood^[3].

The area of plantations in Indonesia has only reached 5,042,400 hectares, so various efforts are still needed to increase the realization of plantation development in Indonesia, including in South Sumatra Province^[4]. The area of production forest in South Sumatra is around 1.7 million ha, and there are several companies holding permits for PFTFPU-IFP which develop forestry species on these wetlands^[5].

Wetlands have specific characteristics related to the condition of inundated land, so that species can be developed in this area is certain types that can adapt to anaerobic conditions [6]. There are two types of wetlands developed for industrial plantations in South Sumatra, namely peat and acid sulphate fields. Both types of land have a major problem, is with flooding and waterlogging.

To solve the problem of flooding and waterlogging, especially during the rainy season, the technology or management actions taken in the land other than the construction of drainage channels is to apply the Bed Raising method. Bed Raising is meant to make beds to facilitate the implementation of planting, maintenance and harvesting, in addition to maintaining the condition of soil aeration to remain good, between bed raising, drainage canals are usually made [7].

It turns out that the application of raising material on acid sulphate soils raises new problems, namely the exposure of surface pyrite layers, this occurs due to the elevation of soil material from drainage channels containing pyrite, which is placed on top of the soil layer. This pyrite layer is anaerobic or safe if it is reduced (waterlogged or below ground level), but it will be very dangerous for plants if they are in aerobic or oxidized conditions, because it will drastically reduce the soil pH (soil pH below 3) If the soil pH is low not only is the plant growth disturbed, but the plant will die. The oxidation of pyrite compounds produces sulfuric acid and jarosite minerals with a level of acidity that can disrupt plant growth [8]. In

addition, a large amount of plant nutrients is also washed away from the soil. This study aims to see the benefits of bed raising in the management of acid sulphate land in IFP area.

2. Material and Methods

This research was carried out in the area of Industrial Forest Plantations (IFP) in South Sumatra Province. The execution time is from January to March 2019. The materials and tools used for this study are: Basic map of the research location, soil sample, aquadest, H₂O₂ solution. belgie drill, measuring tape, GPS, drop pipette, cup, pH meter, plastic sample and rubber.

This study uses a detailed survey method, with a scale of 1: 10,000 with a grid system per 200 m, survey conducted on plots that have been carried out bed raising. For an area of 10 hectares, you will get 6 drill points or observation points (Figure 1). At each drill point, drilling is done using a belgie drill, 120 cm deep. Then each layer of soil profile taken by the drill will be observed and determined the physical properties of the field and test the pyrite content. For a complete analysis of soil samples composite soil was used from 6 observation points in the treatment plot. The soil sample taken will be analyzed for pH, saturation of Al-dd, pyrite concentration in the laboratory.

The data obtained is processed by a tabulation system obtained from observations and data obtained from analysis in the laboratory.

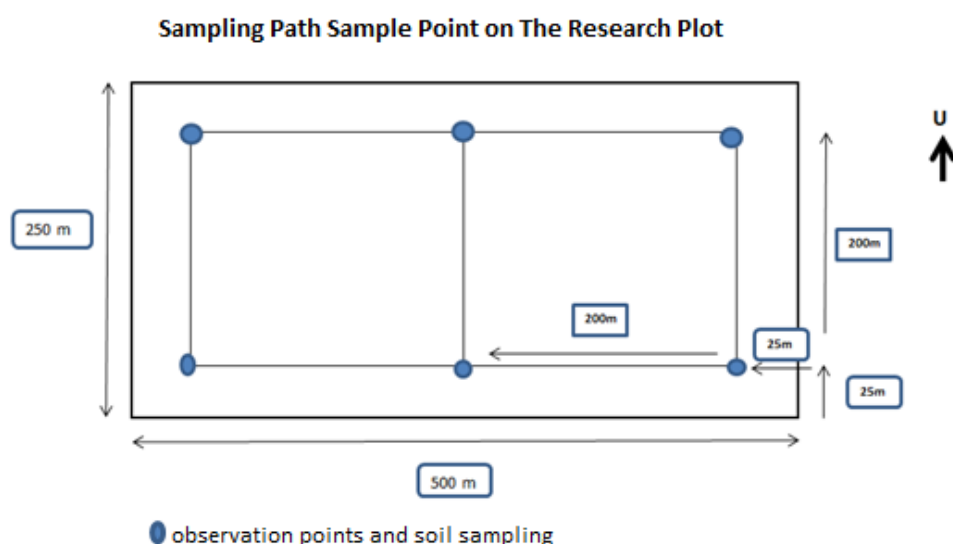


Figure 1. Design of sampling plots in plots

3. Results and Discussion

3.1. Results

From the results of analysis in laboratory samples on bed raising plots it has a very acidic soil pH, with a soil pH range of 2.69-2.74 (Table 1). For Highest value of Al-dd saturation is at layer 1 (0-30cm) with a value of 70.33%. Value of the pyrite concentration in the bed

raising plot has a high value in the range of 2.43-2.92%. Physically, it is found that pyrite has been oxidized on the ground surface (Figure 2). For water table conditions at the bed raising location at the time

of observation that is 80cm, while the water level condition is 30cm (Figure 3).

Table 1. Results of Soil Chemical Analysis at Bed Raising Location Sample Analysis Results

Sample Deep(cm)	Analysis Results		
	pH	Al Saturation (%)	Pyrite Concentration (%)
0-30	2,74(va)	70,33(vh)	2,43(h)
30-60	3,01(va)	2,56(vl)	2,59(h)
60-100	2,69(va)	14,09(l)	2,92(h)

Soil Laboratory in IFP .

Information. : very acidic (va), very high (vh), high (h), very low (vl), low (l).

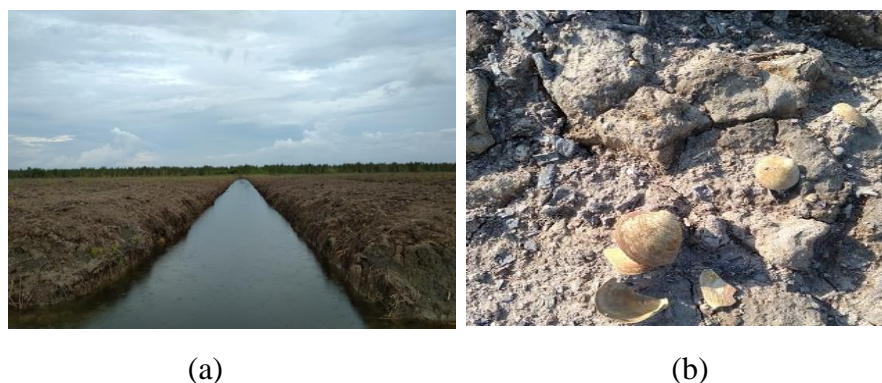


Figure 2. Physical condition (a) study location (b) example of pyrite

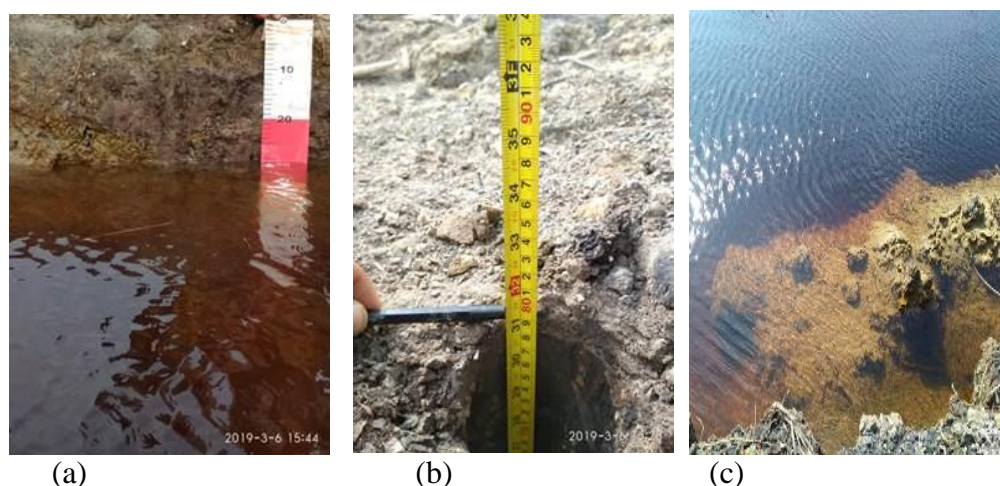


Figure 3. Water depth conditions: (a) water level, (b) water table, (c) canal conditions

3.2. Discussion

From the results of measurements in the field, the condition of the land did not experience waterlogging or flooding despite the rain or the tide conditions, this was also supported by the water table measurement data, was 80cm and the water level data was 30cm.

From the data from observations and analyzes in this laboratory on soil chemical properties, it can be seen the chemical properties of soil in acid sulphate fields with the bed raising activities, especially some chemical properties that are harmful to plant growth.

From the results of measurements and analysis of soil pH, it was found that the soil pH of the three soil layers was very acidic with a pH range of 2.69 -3 [9]. The cause of this very acidic pH is because sulfidic or pyrite (FeS₂) material when exposed to air will form H₂SO₄ which can acidify the soil environment, so that

the soil cannot be used for crop cultivation [10], very acidic soil pH condition at the location of this research because of pyrite oxidation on the land due to the making of bed raising and canal excavation. Due to a decrease in groundwater, the pyrite at the top is open in an aerobic environment, and pyrite undergoes oxidation, the reaction of pyrite with Oxygen, which causes the release of a large amount of sulfate ions and hydrogen, so that the soil pH becomes very sour [11].

Soil pH greatly determines plant growth and production. If the soil pH is lower than 4.0 in general there will be an increase in Al³⁺ in soil solutions which will have an impact on physically damaging the root system of plants, especially young roots, so that plant growth becomes obstructed [12].

From the results of the Al-dd analysis it was found that the saturation level of Al-dd at layer 1 (0-

30cm) was very high, while the second layer (30-60cm) and the third layer (60-100cm) had a low to very low range. The high level of saturation of Al-dd in the coating (layer 1) is due to the low soil pH (very acidic) which triggers an increase in Al^{3+} in the soil solution^[12]. On acid sulphate soils the process of soil soaking, because of the presence of pyrite compounds in the soil layer, which if oxidized due to being lifted to the surface or drought will result in the release of clay mineral gratings and produce Al^{3+} ions which are highly toxic to plants^[13].

Due to the high level of saturation of Al-dd at the location of this study, it can cause plant growth to be hampered, because nutrients, especially P elements that play a role in plant growth will be fixed and cannot be available to plants. The most nutrient problem that occurs in acid sulphate fields is the low level of P nutrient availability and high P fixation by Al. P nutrients are one of the nutrients needed by plants. This nutrient functions for root growth, energy transfer in photosynthesis and respiration, fruit and seed development, stem strength and disease resistance^[10].

High Al content will cause poisoning for plants, including disruption of photosynthesis, development of chloroplast and biosynthesis of proteins, high Al will also interfere with the process of composing enzymes such as cytochrome, catalase and feroxidase^[14].

From soil chemical analysis, the results of all soil layers in this bed raising activity, both layers 1, 2 and 3, have high concentrations of pyrite ranging from 2.43-2.92%. This is caused by pyrite oxidation due to bed raising activities that lift the soil layer material containing pyrite to the surface, and also supported by the decrease / distance of the groundwater due to elevation in the bed raising plot (water table value 80cm at observation), so that when water the ground decreases, the pyrite layer will oxidize automatically. These pyrite compounds will be stable and harmless in anaerobic or inundated conditions. However, if the surface of the subsurface (groundwater) decreases to exceed the depth of the pyrite layer itself can cause the pyrite to oxidize and the soil becomes very acidic, this condition occurs because the reclamation carried out is not quite right^[15].

The high concentration of pyrite is clearly not very supportive for plant growth, because when the concentration of pyrite is high on the soil, it will affect the decrease in soil pH and help increase the saturation of Al-dd. Pyrite concentrations >1.03% include the N1 class (Conditionally Suitable) for the Acacia mangium plant^[16].

4. Conclusion

The conclusions from the results of this study indicate that the benefits of bed raising in the management of acid sulphate land are no longer flooding and waterlogging. While the results of chemical analysis of soil in bed raising plots are very

acidic soil pH (pH <3), Al-dd saturation is very high (> 70%), and high pyrite concentration (> 2.4%). This value is not suitable for plant growth.

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