The improvement of paddy soil chemical properties following the application of rice husk derived biochar in the Regency of Sijunjung

Hermansah\textsuperscript{1}, NSandi\textsuperscript{1}, and Z Naspendera\textsuperscript{1}\textdagger

\textsuperscript{1}Department of Soil, Faculty of Agriculture, Andalas University. Jl. Kampus Unand Limau Manis, Padang–25163

Email: nofritasandi85@gmail.com

Abstract. The district of Dharmasraya, Sijunjung and Pasaman Barat are the three main locations of illegal gold mining in West Sumatra. This kind of activity triggers a lot of land-use changes and the loss of agricultural land within those areas and creates environmental problems as well. Decreasing agricultural land will bring a significant impact on food availability within the region. To protect the scarcity of food, we conducted remediation of ex-gold mining land on those three locations by using biochar made from rice husk. This study was carried on at Batu Manjulur village, Kupitan sub-district in Sijunjung for four months, where soil sample was analyzed at Soil Science Department, Faculty of Agriculture, Andalas University. The experiment use 6 level of biochar application, run from A [without biochar]; B [fulfil of 2\% soil organic matter content [SOM]]; C [fulfil 3\% SOM]; D [fulfil 4\% SOM], E [fulfil 5\% SOM] and F [fulfil 6\% SOM] with three replication. The result shows the application of rice husk-derived biochar increased soil quality including the chemical properties of the soil and improving nutrient retention and land productivity.

Keywords: ex-gold mining land, rice husk biochar, nutrient retention

1. Introduction
Gold mining activity in West Sumatera can be found in West Pasaman, North Solok, Darmasraya, and Sijunjung districts. There are two methods of mining based on the process; primary gold mining is conducted by grilling stones or rocks and then being continued to separating process gold from other minerals, and alluvial gold mining is conducted by sieving excavated minerals because gold is separated as the rock weathered. In Sijunjung, gold mining is an alluvial one and mined illegally so that there is no report concerning this activity, whether the quantity of gold or the large area mined.

Such illegal gold mining is an economically supporting activity done by people to increase family income. Besides giving a positive contribution to the economic sector, however, it also contributes negatively to some environmental sectors such as destroying natural structures, flora, and fauna, decreasing water quality, creating air pollution, the downing of soil water surface, as well as changing environmental esthetics.

Cultivating of ex-mining field needs some methods or certain treatments in the order it can be reused as a productive farming field, called reclamation. Some studies have been conducted concerning with reclamation of ex-mining fields such as planting some soil covering plants, giving guano fertilizer, compost, and others. However, giving rice husk biochar to ex-alluvial gold mining fields has been never conducted, thus, this study needs to be done. Biochar is supposed to be able to
repair the quality of ex-alluvial gold mining fields and able to reduce field reclamation costs. Besides the high availability of raw materials, giving biochar needs only once at the beginning of the reclamation process due to long-lasting in the soil.

2. Method

Giving biochar of rice husk to ex-alluvial gold mining area that was used for rice field was conducted for 5 months [Mei – September 2020] in Nagari Batu Manjulur of Sijunjung district and then analysis of some soil chemical criteria was conducted in the laboratory of soil program of Agriculture Faculty of Andalas University. Batu Manjulur is a village located in the Sijunjung district of west Sumatera, 104 km from Padang, the capital of West Sumatera Province. Batu Manjulur is one of the illegal alluvial gold mining spots in Sijunjung by switching productive rice fields to open gold mining areas. [Fig. 1].

![Figure. 1. Village of Batu Manjulur seen from Satellite [12 November 2020]](image)

Designs used in this study was completely randomized design with 6 treatment and replicated 3 times of biochar using: a dose of biochar 2 % [19.5 ton/ha], a dose of biochar 3 % [39 ton/ha], a dose of biochar 4 % [58.5 ton/ha], a dose of biochar 5 % [78 ton/ha], dose of biochar 6 % [97.5 ton/ha], and control [without biochar]. Data analysis by analysis of variance using Tabel ANOVA 5%. If F counted more than F table 5%, so test BNJ 5% is conducted.

Field preparation was started from soil cultivation using a hand tractor, after that making research terrace in the large of 2 x 3 meter. Taking soil sample was conducted twice, just after cultivating by using hand tractor and then after giving biochar, after harvesting.

Treatment conducted during the study involved watering, weeding, and fertilizing. Plant growing observation was conducted to see the growth of productive saplings and the height of the plant by giving biochar. After harvesting, the soil sample was taken to be analyzed to know soil chemical properties criteria in the laboratory of soil program of Agriculture Faculty of Andalas University.
3. Result and Discussion

3.1 Soil Chemistry Criteria of Ex Gold Mining Land before the application Biochar

The result of laboratory analysis shows that soil chemistry criteria in the land of ex gold mining area are very poor [Table 1].

Table 1. Soil chemical properties of rice field in the land of ex gold mining before giving rice husk biochar

| Soil Chemistry          | value | Status * |   |
|-------------------------|-------|----------|---|
| pH H2O                  | 4.35  | Very acid|   |
| Total N[%)              | 0.06  | Very low |   |
| P-available [ ppm ]     | 0.80  | Very low |   |
| Organic-C [ % ]         | 0.07  | Very low |   |
| Exch K [me/100g]        | 0.21  | Low      |   |

*] Soil Research Center staff [1983 cit Hardjowigeno, 2003]

3.2 Soil Chemical Properties of Ex Gold Mining Land after the application of Rice Husk Biochar

Analysis result of soil chemistry criteria of ex-gold mining land that has been reused as rice field by giving rice husk biochar treatment, conducted in the laboratory, shows the result as described in Table 2.

Soil pH value increases along with biochar application, the more biochar is given to the rice field soil of ex-gold mining land, the more soil pH value increased although it is not significant, it is due to the ability of biochar to increase soil pH. Nurida [2014] reported that biochar application can improve soil chemical properties, among them is to increase pH [H2O] and CEC of soil in various sandy soil textures. In drying acid land, the influence of giving biochar is significant to increase soil pH, [Nurida et al. 2012; Nurida et al. 2013; Zhu et al. 2014] however, it did not much influence on non-acidic soil [Nurida et al. 2013].

Besides increasing soil pH, Rice husk biochar application has also contributed to the increasing of Organic Carbon in the soil. Organic Carbon in the soil increases during treatment although it is not much significant for the first period of planting. The result of a study in some areas shows that soil Organic Carbon levels can increase, be constant, or decrease after being given biochar [Nurida, 2014]. Steiner et al. [2007] reported that biochar as a material to repair soil is recalcitrant, more both resistant to oxidation and constant in the soil so that it has a long period of influence on the improvement of soil fertility [Organic Carbon soil and CEC].

The increasing of N and P values in the soil is not derived from biochar given but from inorganic fertilizer given to the rice field as additional nutrients for rice plant. Biochar plays in retaining nutrients to be available for plants. Nisa [2010] states that using biochar in the agriculture sector is due to the relation of nutrients and its high persistency. Nuraida [2014] reported that the increase of N and P unsure varies.

Table 2. Paddy soil chemical properties of ex-gold mining land after rice husk derivied biochar application

| Treatments | pH  | C-Organics | N-Total | P-available | Ca-exch | Mg-exch | K-exch | Na-exch |
|------------|-----|------------|---------|-------------|---------|---------|--------|---------|
| A [2 % BO] | 5.13 | 0.37<sup>vi</sup> | 0.11<sup>i</sup> | 7.37<sup>vi</sup> | 2.91<sup>i</sup> | 2.26<sup>vi</sup> | 0.29<sup>i</sup> | 0.44<sup>vi</sup> |
| B [3 % BO] | 5.43 | 0.77<sup>vii</sup> | 0.23<sup>vi</sup> | 16.29<sup>vi</sup> | 5.58<sup>vii</sup> | 0.93<sup>i</sup> | 0.37<sup>i</sup> | 0.38<sup>i</sup> |
| C [4 % BO] | 5.72<sup>vi</sup> | 0.94<sup>vii</sup> | 0.22<sup>vi</sup> | 12.69<sup>vi</sup> | 5.14<sup>vii</sup> | 0.72<sup>i</sup> | 0.38<sup>i</sup> | 0.38<sup>i</sup> |
| D [5 % BO] | 5.78<sup>vi</sup> | 1.30<sup>i</sup> | 0.20<sup>i</sup> | 17.30<sup>vi</sup> | 5.32<sup>i</sup> | 0.90<sup>i</sup> | 0.40<sup>vi</sup> | 0.33<sup>i</sup> |
Analysis result of Calcium, Magnesium, Potassium, and Natrium of rice field soil of ex-gold mining land treated with rice husk biochar differently shows that there was an increase of nutrient content in every treatment even though it was not significant. This matter goes along with the role of biochar that can increase cation CEC so that factory-made fertilizer given to rice plant can be retained by biochar and be available for the plants. Biochar is alkaline [as synthesized in good condition] and some of them are rich in alkaline components [Ca, Mg, dan K] be able to contribute to acid neutralization and reduce the solubility of poisonous minerals like aluminum in the soil [Gruba dan Mulder 2008].

3.3 Rice Plant Growing following the application of Rice Husk Biochar

Observation of rice growth planted in the rice field of ex-alluvial gold mining land was conducted only three times; weeks 5, 9, and 12 after planting.

Table 3. Paddy soil chemical properties of ex-gold mining land after rice husk biochar application

| Treatment | saplings [tree] | Plant Height [cm] |
|-----------|-----------------|------------------|
|           | Observation at  | Observation at   |
|           | 1   | 2   | 3   | 1   | 2   | 3   |
| A [2 % BO] | 19  | 20  | 18  | 48  | 63  | 75  |
| B [3 % BO] | 17  | 23  | 22  | 53  | 58  | 85  |
| C [4 % BO] | 26  | 28  | 25  | 58  | 72  | 87  |
| D [5 % BO] | 25  | 31  | 29  | 52  | 69  | 97  |
| E [6 % BO] | 33  | 41  | 35  | 62  | 74  | 112 |
| Controlled | 8   | 12  | 10  | 51  | 55  | 66  |

Giving rice husk biochar to rice fields of ex gold mining land has a variety in the influences to the growing rice plant. Even though it varies, the difference in the number of rice buds is very significantly different between controlled and treated plants high dose performed on biochar application of agricultural land for the former gold mining. Biochar plays important role in increasing pH value, increasing Organic Carbon, and retaining soil nutrients so given inorganic fertilizer can be available for the plant as its growing nutrients.

4. Conclusion

The improvement of paddy soil chemical properties of ex-gold mining area after being given biochar varies based on the dose given, it can be known from soil chemistry criteria changing, such as the increase of soil pH, C-organic unsure, P available, N- total as well as increased alkaline cation unsure. The increase of soil chemistry criteria is also due to the role of rice husk biochar that was given to the soil of ex gold mining land, able to increase soil pH and retent nutrients giving to the soil through inorganic fertilizer so that available for the plants.

Conflict of Interest

No potential conflict of interest was reported by the authors.
References

[1] Gruba, P., J. Mulder. 2008. Relationship between Aluminum in Soils and Soil Water in Mineral Horizons of a Range of Acid Forest Soils. Soil Science Soc. Amer. J. 72: 1150-1157.

[2] Nisa, K., 2010. Pengaruh pemupukan NPK dan biochar terhadapsifat kimia tanah, serapan hara dan hasil tanaman padisawah. Thesis. Banda Aceh: Universitas Syiah Kuala.

[3] Nurida, N.L., dan A. Rachman. 2012. Alternatif Pemulihan Lahan Kering Masam terdegradasi dengan Formula Pembenah Tanah Biochar di Typic Kanhapludults Lampung. Prosiding Teknologi Pemupukan dan Pemulihan Lahan terdegradasi.2012. Hal 639-648.

[4] Nurida., N.L., A. Rachman dan Sutono. 2012. Potensi pembenah tanah biochar dalam pemulihan sifat tanah terdegradasi dan peningkatan hasil jagung pada Typic Kanhapludults lampung. Jurnal Penelitian Ilmu-Ilmu Kelaman: Buana Sains. Tribhuana Press. Vol 12:No. 1. Hal: 69-74.

[5] Nurida, N.L., A. Dariah dan A. Rachman. 2013. Peningkatan kualitas tanah dengan pembenah tanah biochar limbah pertanian. Jurnal tanah dan Iklim 37[2]; 69-78.

[6] Nurida, N.L. 2014. Potensi Pemanfaatan Biochar untuk Rehabilitasi Lahan Kering di Indonesia. Jurnal Sumberdaya Lahan Edisi Khusus, Desember 2014; 57-68.

[7] Steiner, C. 2007. Soil charcoal amendments maintain soil fertility and establish carbon sink-research and prospects. Soil Ecology Res Dev.1-6.