

# Exploration of agricultural waste as biochar to increase soil fertility of Udipsammements in Jember Regency

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# Exploration of agricultural waste as biochar to increase soil fertility of Udipsammets in Jember Regency

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**Abstract:** Jember is the regency that supplies food crops and plantations with the largest supply, thus becoming one of the main agricultural centers in East Java Province. The problem in agricultural production activities that have been found in Jember Regency is the existence of agricultural land function experts with characteristics of productive land with good irrigation channels for various uses. Therefore, it is necessary to use marginal lands for agricultural extension activities, for example by utilizing coastal land with the Udipsammets soil type which has various eradicating factors for agricultural cultivation through the provision of soil amendment material in the form of biochar by utilizing agricultural waste. The purpose of this research is to obtain biochar raw material with high absorption power to store nutrients and a place to develop microorganisms; know the physical and chemical properties of biochar from agricultural waste. This research activity will be carried out from May to November 2020. This research activity begins by looking for agricultural waste that has the potential to be used as a biochar material. Through the pyrolysis process, selected agricultural waste is processed into biochar and then tested for its physical and chemical properties. The analysis results show that the selected agricultural waste can be used as biochar with sufficient quality as an ameliorant for Udipsamment soil.

## 1. Introduction

Jember Regency is the main agricultural zone in East Java Province. Based on data [1], Jember is the district that supplies food crops and plantations with the largest supply of food crops and plantations along with the Bojonegoro and Lamongan regions. The problem in agricultural production activities that have been found in Jember Regency is the existence of agricultural land function experts with characteristics of productive land with good irrigation channels for various uses. The conversion of agricultural land functions is an issue that needs attention because of the dependence of the community on the agricultural sector and a serious threat to national food security with permanent impacts. The impact of this change of function has only been felt for a long time, for example, the occurrence of ecological instability and soil fertility which ultimately affects farmers' income and the socio-economic conditions of the community, not only for land owners but also for smallholders and farm laborers. Based on Sunartomo's research [2], rice fields in Jember Regency during 2005–2013 experienced a decrease in the average area of land by 81.86 hectares / year, while the need for housing, facilities and services, industrial land increased by 72.90 ha / year, 12.10 ha / year and 4.46 ha / year. The area of agricultural land that has undergone land use change is less than 0.5 ha [3]. Therefore, it is necessary to use marginal lands for agricultural extensification activities, for example by utilizing coastal land with Udipsammets soil type which has various eradicating factors for agricultural cultivation [4] [5].

Jember Regency consists of 31 districts, six of which are coastal districts. Efforts to apply technology to improve soil fertility in areas with Udipsamments soil type for agricultural cultivation include providing soil amendment in the form of biochar so that it can support national food security activities and provide benefits for local farmers [6] [7]. Through the provision of biochar, it is hoped that the Udipsamments soil type can be planted with various agricultural commodities such as in previous studies, including cultivation of sorghum [5], shallots [8] [9] [10], chili [11], and corn [12], mustard greens [13], and watermelon [14].

Apart from the problems of land function experts, the level of soil fertility in productive lands has also decreased. Based on the results of research [15], that the organic nutrients contained in the soil are already below 2% which results in decreased land productivity. Whereas ideally, agricultural land can be classified as fertile if the organic nutrients are above 3%. Therefore, efforts are needed in order to optimize the existing potential through agricultural intensification and extensification efforts.

Agricultural extensification efforts include utilizing coastal land which is quite extensive in Jember Regency. According to [11] [16] [17], sand land in Jember Regency, for example Puger District, is classified in the Udipsamments soil type or its equivalent Regosol soil type based on the national Soil Classification has characteristics characterized by sandy soil texture, fast to very fast soil drainage because high macro pore content, very shallow to moderate effective depth, very low salinity, low CEC, acidic to neutral pH, very low organic-C, very low total N and moderate phosphate. In addition, the problem found in this type of soil is the high leaching of nutrients resulting in inefficient fertilization [18].

Therefore, the management of soil fertility is urgently needed through the application of agricultural intensification by providing organic materials such as providing biochar by utilizing agricultural waste that is not utilized around Jember Regency. Biochar or so-called "activated charcoal" has long been known in Indonesia, especially as a source of energy (fuel and heat). Biochar is a solid in the form of carbon-rich charcoal (C) converted from biomass such as rice husks, straw, coconut shells, used sawn timber, tree branches, wood chips, corn cobs, sago dregs and the like through an incomplete combustion process with minimum oxygen (pyrolysis) [19] [20] [21]. The characteristics of biochar, such as chemical composition, surface chemistry, particle and pore size distribution, as well as physical and chemical stabilization mechanisms of biochar in the soil, determine the effect of biochar on soil function. Biochar has long been known in Indonesia, especially as a source of energy (fuel and heat). The potential for biochar raw materials is relatively abundant, namely in the form of agricultural waste which is difficult to decompose or with a high C / N ratio. Nationally, the potential for agricultural biomass per year that can be converted into biochar is estimated at around 10.7 million tons, which will produce 3.1 million tons of biochar. The highest potential comes from rice husks, reaching 6.8 million tonnes / year and is predicted to produce biochar around 1.27 million t / year or around 56.48% of the total biochar potential [22]. Therefore, Jember as one of the central districts for food storage and plantations has the potential to be able to provide raw materials for making biochar in a sustainable manner.

The benefits of providing biochar for soil fertility are as a soil repairer that can improve soil chemical, biological and physical properties and can improve the quality of agricultural land because it can reduce biomass waste [23]. The addition of biochar is also reported to be able to increase soil pH and soil cation exchange capacity (CEC) and increase nutrient availability in the soil. There are three mechanisms for nutrient availability, namely (1) direct nutrient supply from biochar (2) the ability of biochar to retain nutrients, and (3) dynamics of microorganisms in the soil [24] [25] [26] [27] [28]. The ability of biochar to improve soil physical properties, among others, reduces bulk density and affects the soil pore space, thereby increasing the soil's ability to hold water, especially in sandy and dry soils [26] [27] [29] [30]. The organic compounds present in biochar also act as a substrate for biota in the soil so that the population and activity increases which have an impact on improving the chemical and physical properties of the soil. Another function of biochar administration is to be able to mitigate greenhouse gases by reducing N<sub>2</sub>O emissions due to reduced activity of denitrifying bacteria [31].

## 2. Methods

Exploration of agricultural waste is carried out by observing harvest data for agricultural products published by BPS Kabupaten Jember (<https://jemberkab.bps.go.id/>). Based on these data, it is predicted that the total agricultural waste produced which has potential to be processed into biochar. The tool used to treat agricultural waste is a pyrolysis device, namely the Rotary Drum Pyrolizer. Biochar produced from the pyrolysis process is then analyzed for its physical and chemical properties in the laboratory. The parameters measured were moisture content, organic C, nitrogen, phosphorous, potassium, and CEC.

## 3. Result and Discussion

Exploration from agricultural production data in Jember Regency obtained the result is that some agricultural products produce waste that can be processed into biochar. Agricultural waste includes rice husks, corn cobs, coconut shells and coffee husks.

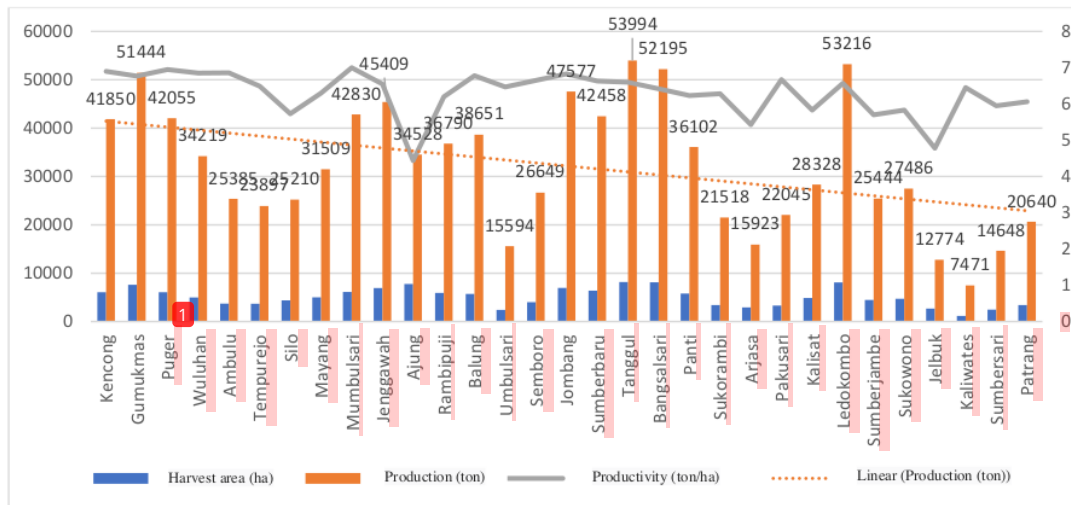
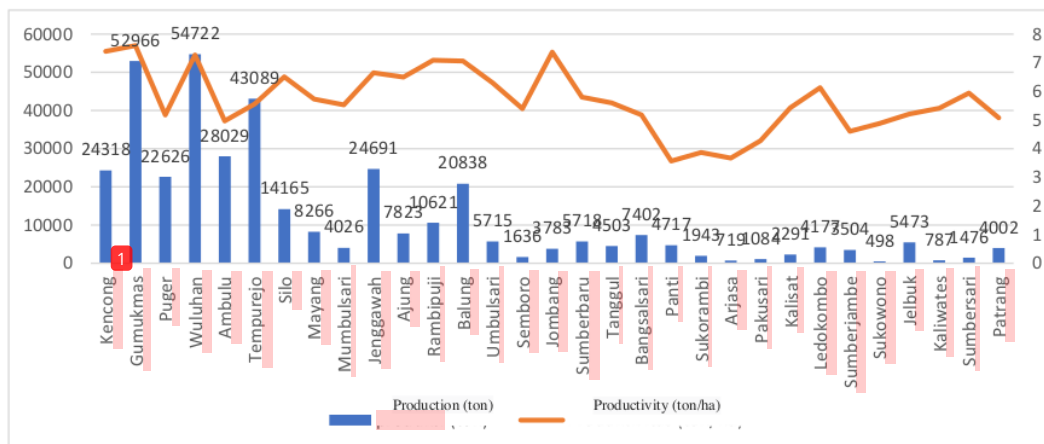
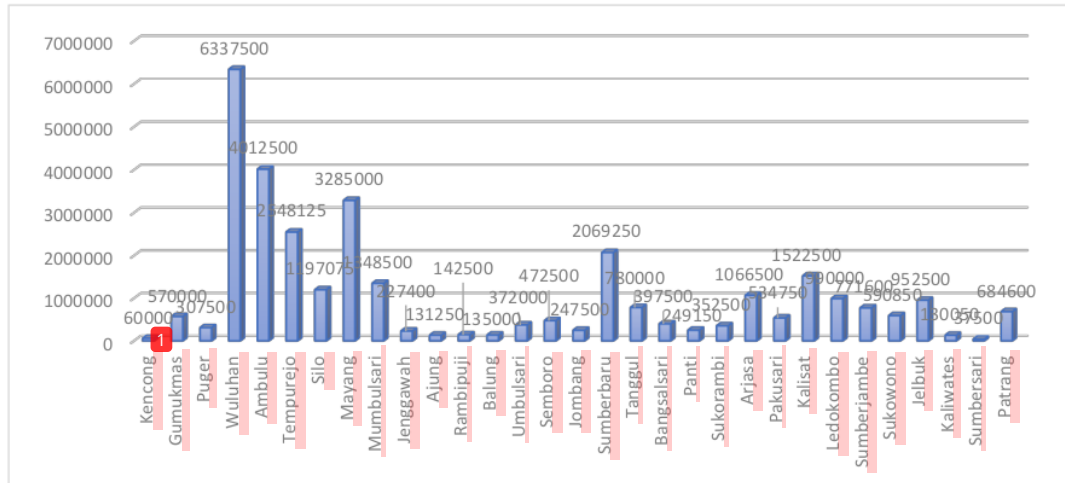


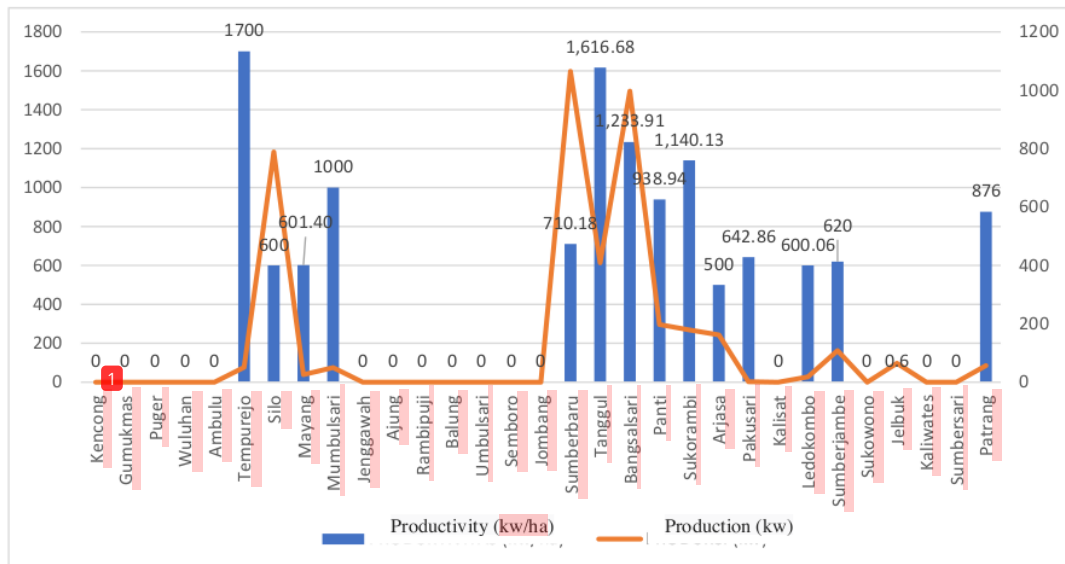
Figure 1. Average area of land, production and productivity of rice in Jember Regency in 2019



**Figure 2.** Average maize production and productivity in Jember Regency in 2019



**Figure 3.** Average coconut production (ha) in Jember Regency in 2019



Biochar produced from agricultural waste, namely rice husks, corn cobs, coconut shells, coffee skins. The results of laboratory analysis showed that the physical and chemical characteristics of the biochar showed that the quality of the biochar was suitable for use as soil ameliorant including sandy soil (Udipsamments).

**Table 2.** Results of physical and chemical characteristic of biochar.

No.	Source of biochar	Parameters					
		Water Content (%)	C-Org (%)	N (%)	P <sub>2</sub> O <sub>5</sub> (%)	K <sub>2</sub> O (%)	KTK (cmol/kg)
1	Rice husks	3,08	8,94	0,77	0,26	0,85	34,96
2	Corn cobs	3,98	11,46	1,20	0,19	1,43	38,49
3	Coconut shells	0,95	12,12	0,94	0,29	1,39	24,23
4	Coffee husks	0,98	13,8	0,94	0,22	2,18	34,34

Source: Pusat Penelitian Sukosari

#### 4. Conclusion

Nutrient content in the soil used is classified as very low for example related to the total N, P and K elements and those available to plants. The low content is also influenced by the low C/N ratio of the soil due to the organic matter content of the soil and the texture of the sandy soil which causes easy washing of organic matter and nutrients in the soil. Giving a combination of organic fertilizer, zeolite and cane blotong treatment in increasing the fertility of the soil for cloudy plant growth showed a significant effect on plant height parameters 2 weeks after the treatment and the time of emergence of flowers on the chili.

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#### Acknowledgment

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