Substitution of inorganic fertilizer with organic fertilizer based on poultry waste combined with rice husk biochar

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Abstract. Climate change such as an increase in temperature, a change in rainfall patterns, an increase in extreme weather events, and an increase in sea level will affect the agricultural sector, including land degradation. Land degradation can take the form of a decrease in soil fertility, so the use of suboptimal land needs to be applied technology that can increase nutrient availability, and at the same time mitigate the impacts of climate change. The research objective was to obtain technology that could increase soil fertility through the substitution of inorganic fertilizers with organic fertilizer from poultry combined with rice husk biochar in wet suboptimal land. The research was conducted in Sungai Rengas Village, Sungai Kakap District, Kubu Raya Regency, West Kalimantan Province, Indonesia. The method used in this study was an experimental method in the form of a completely randomized design (CRD). The treatment in this study was the application of 5 tons of poultry manure per hectare with 5 tons of rice husk biochar per hectare, so that 7 treatment combinations were obtained, namely treatment A, B, C, D, E, F, and G. The results showed that the combination of 5 tonnes/ha of quail manure with 5 tonnes/ha of rice husk biochar had a significant effect on increasing soil fertility and growth of corn plants and can reduce the use of inorganic fertilizers by 25% to 75% of the recommended dosage.

1. Introduction
Climate change has an impact on increasing air temperature and sea level, sea water intrusion which increases the salinity of agricultural land, changes in rainfall patterns, increases in extreme events of El Nino and La Nina, thus affecting agricultural production. Agriculture as one of the resources that support the economy of a country is a sector vulnerable to climate change. Climate change has an influence on food security, soil and plant productivity, plant health, plant pests and diseases, water availability, and environmental ecosystems Indonesia has suboptimal land area of 157.2 million hectares (ha). Biophysically and with a touch of agricultural technology innovation, about 58% of the suboptimal land is potential for agricultural land [1]. Suboptimal land naturally has low productivity, so the approach that is commonly used on optimal land cannot be applied to suboptimal land. Suboptimal land consists of two typologies, namely suboptimal wet land and dry suboptimal land. Problems faced in the development of plant cultivation in wet suboptimal land are the high soil acidity, fluctuation of the water regime, various physico-chemical conditions of the soil, the presence of toxic substances, salt water intrusion, and low natural fertility of the soil [2]. The low fertility and soil health are exacerbated by the continuous use of chemical fertilizers which results in the soil drying out quickly, cracking when it lacks water, sticky when processed, shallow layers and difficult production increases even tends to decrease [3].
The decline in rice productivity since 1985 and an increase in the price of inorganic fertilizers as a result of the elimination of fertilizer subsidies, have created important momentum to increase the efficiency of using inorganic fertilizers [4]. So far, the efforts that have been made to overcome these constraints are minimum soil cultivation, no tillage, fertilization, liming/amelioration, introduction of site-specific varieties of rice, water management and improved cultivation techniques [5]. From the results of the preliminary research that the research team has done, the application of compost of 5 tonnes/ha of empty palm oil bunches combined with 10 tonnes/ha of krinyu biomass on acid sulphate soils can increase the pH from 5.26 to 6.22 [6]. Subsequent studies on wet suboptimal soil using rice husk charcoal and biological fertilizers also showed a significant effect on increasing soil pH [7]. The use of biochar as a soil amendment has been carried out by several researchers, including the effect of biochar on plants, partly determined by the specific quality of biochar [8, 9], also strongly influenced by the source of biochar raw materials and pyrolysis conditions [10-12]. From short term biochar application shows its effect on soil quality [13]. For this reason, technological innovation is needed in the use of organic fertilizers from poultry waste as biochar enrichment which is believed to be able to increase the supply of macro main nutrients (NPK), but faced with suboptimal soil that reacts with acid, the organic fertilizer needs to be enriched with biochar of rice husks to increase soil pH. The use of biochar combined with manure from poultry is expected to increase soil fertility and reduce soil fertility degradation by increasing the capacity of the soil to hold nutrients, so that this application can at the same time prevent the effects of climate change.

2. Materials and method
This research was conducted on wet suboptimal soil, namely acid sulphate soils originating from the tidal lands of Sungai Rengas Village, Sungai Kakap, Kubu Raya, Indonesia. The research was carried out in polybags using Pertiwi hybrid corn indicator plants.

The method used in this research is an experimental method in the form of a completely randomized design (CRD). The treatments to be applied consisted of 7 treatment combinations, namely A = 100% inorganic fertilizer, B = 75% inorganic fertilizer + 5 tons/ha chicken manure + 5 tons/ha of rice husk biochar, C = 75% inorganic fertilizer + 5 tons/ha quail manure + 5 tonnes/ha biochar rice husk, D = 50% inorganic fertilizer + 5 tonnes/ha chicken manure + 5 tonnes/ha rice husk biochar, E = 50% inorganic fertilizer + 5 tonnes/ha manure quail + 5 tonnes/ha of rice husk biochar, F = 25% inorganic fertilizer + 5 tonnes/ha of chicken manure + 5 tonnes/ha of rice husk biochar, G = 25% inorganic fertilizer + 5 tonnes/ha of quail manure + 5 tonnes/ha of rice husk biochar. Each treatment will be repeated four times so that 28 experimental units would be obtained. Corn was planted in polybags with a soil weight of 10 kg per polybag. Research starts August 2020 until January 2021. The data from the research was analyzed of variance (ANOVA), if the results of the ANOVA showed a significant effect, then the data was continued to be tested with an honesty significant difference test (HSD) at the level of 5%.

3. Results and discussion

3.1. Soil fertility variables

| Treatments | Soil pH | C-Organic (%) | Available P (ppm) |
|------------|---------|---------------|-------------------|
| A          | 4.12 a  | 4.89 a        | 9.41 a            |
| B          | 4.18 ab | 5.57 ab       | 27.51 ab          |
| C          | 4.63 b  | 5.57 ab       | 102.43 ab         |
| D          | 4.11 a  | 5.83 b        | 36.70 ab          |
| E          | 4.61 b  | 5.47 ab       | 66.85 ab          |
| F          | 4.07 a  | 5.43 ab       | 26.54 ab          |
| G          | 4.29 ab | 5.51 ab       | 67.74 ab          |

Mean followed by the same letters is non significantly different at α = 5%
Acid sulphate soils sampling for variable soil acidity, especially pH H$_2$O, was carried out 48 days after treatment application. The results of the analysis of the initial soil pH (before the treatment application) was 3.54 and after 48 days of treatment there was an increase in soil pH. For this reason, a diversity analysis has been carried out on soil pH after treatment, the results of the analysis of diversity show that the application of poultry (chicken or quail) fertilizer combined with rice husk biochar has a very significant effect on the pH of alluvial soil H$_2$O. Table 1 shows that giving a combination of 5 tonnes/ha of quail manure with 5 tonnes/ha of rice husk biochar and the use of inorganic fertilizers 75% of the recommended dose (treatment C) can increase the soil pH from 3.54 to 4.63. This treatment was able to increase the highest soil pH compared to other treatments and was significantly different from treatments A, D and F.

Previous studies indicated that the combination treatment of sugarcane biochar 5 tonnes/ha with cow manure 5 tonnes/ha was able to increase soil pH from 5.51 to 5.90 [14]; and application of 10 tonnes/ha of cow manure can increase soil pH from 4.73 to 4.95 [15], application of rice husk ash as much as 150 grams and application of Trichoderma showed the best effect on increasing soil pH, namely 4.92. There was an increase in pH of 1.14, from the initial pH of the soil before application of 3.78 to 4.92 after application [16]. An increase in soil pH can occur when the organic material added to the soil has been further decomposed (ripe), because the mineralized organic material will release minerals in the form of alkaline cations. In addition, there is contribution of bases from rice husk biochar, especially Ca and Mg.

Acid sulphate soil samples were taken for soil organic C-variable was carried out 48 days after treatment application. The result of initial soil organic C-analysis (before treatment application) was 4.56% and after 48 days of treatment there was an increase in C-organic. For this reason, a diversity analysis of soil organic C has been carried out after treatment, the results of the analysis of variability showed that the application of poultry (chicken or quail) fertilizer combined with rice husk biochar had a very significant effect on alluvial soil organic C content. Table 1 shows that giving a combination of 5 tonnes/ha of chicken manure with 5 tonnes/ha of rice husk biochar and the use of inorganic fertilizers 50% of the recommended dose (treatment C) can increase soil Organic C from 4.56% to 5, 83%; this treatment was able to increase the highest soil organic C compared to other treatments and was significantly different from treatment A. Research conducted by [17] showed that the treatment of cow manure and custom bio was able to increase the highest soil organic C compared to other treatments. From Table 1, it can be seen that an increase in soil organic C is due to the addition of soil organic matter due to the addition of chicken manure combined with rice husk biochar.

Soil samples were taken for the available soil variable P was carried out 48 days after the treatment application. The results of the P analysis of the initial available soil (before treatment application) was 8.35 ppm and after 48 days of treatment there was an increase in the available P of the soil. For this reason, a diversity analysis has been carried out on the available P of the soil after treatment, the results of the analysis of diversity show that the application of poultry (chicken or quail) fertilizer combined with rice husk biochar has a very significant effect on the P content of alluvial soil available. Table 1 shows that giving a combination of 5 tonnes/ha of quail manure with 5 tonnes/ha of rice husk biochar and the use of inorganic fertilizers 75% of the recommended dose (treatment C) can increase the available P2O5 of soil from 8.35 ppm to 102.43 ppm. This treatment was able to increase the highest available soil P2O5 compared to other treatments and was significantly different from treatment A.

The increase in P available in C treatment was due to the addition of P from quail manure and from a small amount of rice husk biochar. Poultry manure contains 1.9% P$_2$O$_5$, this P value is 11 times greater than the P of cow manure which is only 0.17% [18]. Several research results stated that after giving chicken manure at a dose of 25 tonnes/ha there was an increase in P in the soil, the highest was 30.64 mg/ 100 g of soil [19], the impact of giving TSP and chicken manure on the availability of P showed, that the increase in available P in soil was caused by the application of TSP fertilizer which contained 46% P$_2$O$_5$ which was made from a mixture of phosphate rock with sulfuric acid and the application of chicken manure which had a very high P$_2$O$_5$ content [20].
3.2. Plant growth variables
Observation of plant variables was carried out on corn plants aged 36 days, measuring plant height starting from the base of the stem to the tip of the highest leaf using a meter. The results of the analysis of diversity showed that the application of a combination of poultry (chicken or quail) fertilizers combined with rice husk biochar had a very significant effect on the height of corn plants.

Table 2. Corn plant height (cm), number of leaves (strands), and amount of chlorophyll (units) in various treatments.

| Treatments | Plant Height (cm) | Number of leaves (leaf blade) | Amount of Chlorophyll (units) |
|------------|------------------|------------------------------|------------------------------|
| A          | 60.93 a          | 5.75 a                       | 34.70 b                      |
| B          | 13.63 b          | 8.25 b                       | 41.21 b                      |
| C          | 132.88 b         | 7.50 ab                      | 38.57 b                      |
| D          | 10.63 ab         | 7.25 ab                      | 35.68 b                      |
| E          | 126.00 b         | 8.25 b                       | 32.98 ab                     |
| F          | 117.00 b         | 8.00 ab                      | 33.95 ab                     |
| G          | 118.00 b         | 7.75 ab                      | 28.65 a                      |

Mean followed by the same letters is non significantly different at α = 5%

The results showed that giving a combination of 5 tonnes/ha of quail manure with 5 tonnes/ha of rice husk biochar and application of inorganic fertilizers 75% of the recommended dose resulted in the highest plant height growth of 132.88 cm on acid sulphate soils. Quail organic fertilizer contains N₂0.061-3.91%, P₂O₅ of 0.209-1.37% and K₂O of 3.13% [21] when compared to chicken manure containing 1.70% N nutrients; 1.90% P₂O₅ and 1.50% K₂O [18]. From the nutrient content, it can be seen that the N content in quail manure has a higher range, which can reach 3.91%, so that the availability of this N nutrient can spur plant vegetative growth (including plant height).

Observation of the number of leaves of maize was carried out at the age of 36 days after planting, namely by counting the number of leaves that had opened completely. From the data obtained from the observation of the number of leaves, a diversity analysis was then carried out, from the results of the diversity analysis, it was found that the application of poultry fertilizer (chicken or quail) combined with rice husk biochar had a significant effect on the number of corn leaves planted in sulfate soils.

Table 2 shows that treatment B (inorganic fertilizer 75% of the recommended dose + combination of 5 tonnes/ha of chicken manure with 5 tonnes/ha of rice husk biochar) and, and E (inorganic fertilizer 50% of the recommended dose + combination of 5 tonnes/ha quail manure with 5 tonnes/ha of biochar rice husk) produced the highest number of leaves of corn plants on alluvial soils, namely 8, 25 strands. In terms of efficiency, the use of inorganic fertilizers, treatment E is more efficient, considering the use of inorganic fertilizers is only 50% of the recommended dose, while treatment B uses 75% of organic fertilizers.

From the data obtained from the observation of the amount of chlorophyll, then a diversity analysis was carried out, from the results of the analysis of diversity, it was found that the application of poultry fertilizer (chicken or quail) combined with rice husk biochar had a very significant effect on the amount of chlorophyll in the leaves of corn plants. Table 2 shows that treatment B (75% inorganic fertilizer of the recommended dose + a combination of 5 tonnes/ha of chicken manure with 5 tonnes/ha of rice husk biochar) produced the highest amount of chlorophyll from corn leaves on alluvial soils, namely 41.21 units.

4. Conclusion
Based on the results of the research that has been done, it can be concluded that the application of 5 tons of poultry manure (chicken manure or quail manure) combined with 5 tons of rice husk biochar per hectare can reduce the use of inorganic fertilizers 25% to 75% of the recommended fertilizer.
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