

## **Yield Improvement of Upland Rice Planted between Oil Palm Using Organic Matter**

*Peningkatan Produksi Padi Gogo di antara Tanaman Kelapa Sawit dengan Pemberian Bahan Organik*

Eliartati Eliartati<sup>1\*)</sup>, RS Anggraini<sup>1</sup>, A Sofia<sup>1</sup>

<sup>1</sup>Agricultural Technology Research Center Riau, Pekanbaru 28284, Indonesia

<sup>\*)</sup>Corresponding author: [eliartati@yahoo.co.id](mailto:eliartati@yahoo.co.id)

(Received: 5 February 2021, Accepted: 31 March 2021)

**Citation:** Eliartati E, Anggraini RS, Sofia A. 2021. Yield improvement upland rice among immature oil palm plant through application of organic matter. *Jurnal Lahan Suboptimal : Journal of Suboptimal Lands*. 10(1): 104-112. DOI: 10.36706/JLSO.10.1.2021.532.

### **ABSTRAK**

Pemberian bahan organik merupakan salah satu cara untuk meningkatkan produktivitas padi gogo yang ditanam di antara tanaman kelapa sawit belum menghasilkan. Telah dilaksanakan kegiatan peningkatan produksi padi gogo di antara tanaman kelapa sawit tetapi belum menghasilkan dengan pemberian bahan organik. Penelitian ini bertujuan untuk mengetahui pengaruh aplikasi bahan organik terhadap produksi padi gogo pada tanaman kelapa sawit yang belum menghasilkan. Kegiatan ini dirancang dengan Rancangan Acak Kelompok dengan 5 perlakuan dan 4 ulangan. Perlakuan meliputi: A) Kontrol, B) Kompos jerami padi, C) Kompos biomas gulma, D) Kompos tandan kosong kelapa sawit dan E) Pupuk kandang sapi. Dosis bahan organik yang diberikan adalah 3 ton/ha. Data yang dikumpulkan meliputi: (1) Tinggi tanaman (cm), (2) jumlah anakan produktif per rumpun (3) Jumlah gabah per malai, (4). Persentase gabah isi per malai. (5). Bobot 1000 biji dan (6) Hasil gabah (t/ha). Hasil kajian menunjukkan bahwa pemberian bahan organik berpengaruh nyata terhadap terhadap komponen hasil dan hasil padi gogo. Secara umum komponen hasil dan hasil terbaik diperoleh pada perlakuan pupuk kandang, yaitu tinggi tanaman 104,7 cm; jumlah anakan produktif 158 butir; persentase gabah isi per malai 85,8% dan hasil gabah 5,6 t/ha atau meningkat sebesar 21,74% dibandingkan dengan perlakuan kontrol (4,6 ton/ha). Jumlah anakan produktif dan berat 1000 butir tertinggi diperoleh pada perlakuan kompos tankos (14,5 dan 28,2 g).

---

Kata kunci: bahan organik, kelapa sawit, padi gogo

### **ABSTRACT**

The application of organic matter is a way to improve upland rice productivity that grows among immature oil palm plants. To improve the yield of upland rice among immature oil palm plants, this study has been carried out by providing organic matter. The research aimed to determine the effect of organic matter application for upland rice production that plant among immature oil palm. The experimental design used in this study was Randomized Block Design with 5 treatments and 4 replications. The treatment includes: control, rice straw compost, weed biomass compost, palm oil empty bunch compost, and cow manure. The dose of organic matter given was 3 tons/ha. The results

showed that the application of organic materials have significant effects on yield component and the production of upland rice. In general, the best yield and yield components were obtained in the manure treatment, namely plant height 104.7 cm; the number of productive tillers 158 grains; the percentage of filled grain per panicle was 85.8% and grain yield was 5.6 tons/ha or increase by 21.74% compared to the control treatment (4.6 tons/ha). The highest number of productive tillers and weight of 1000 grains were obtained in the palm oil empty bunch compost treatment (14.5 and 28.2 g).

Keywords: oil palm, organic matter, upland rice

## INTRODUCTION

The increasing number of land transfer function of paddy fields, both into plantations and for non-agricultural purposes, has resulted in the decreasing area of existing rice fields. According to Ministry of Agrarian and Spatial Planning/ National Land Agency, Indonesia's rice field area in 2019 is 7.46 million hectares. Compared to 2013 rice field area was shrinking by 287 thousand hectares due to land conversion (Bahfein, 2020).

This condition will lead to the decline in national rice production. Land conversion in DI Yogyakarta during period 2006-2015 reduced rice production by 18,359.27 tons (Prasada & Rosa, 2108). On the other hand, the population increase each year resulting an increase in rice consumption. Ismail (2018) argued that rice consumption increases along with the increase in population as regression equation  $Y = 601.439 + 0.997 X$  ( $Y =$  total rice consumption and  $X =$  total population). An efforts to increase national rice production is by optimizing the use of dry land for upland rice cultivation. Currently, the national upland rice production is still lower than lowland rice production. National rice production is mostly produced from lowland rice production, while upland rice only contributes about 5% of total national rice production (Irawan, 2015).

Improving Rice productivity can be done through 1) technical approach, such as: biotic, abiotic and management; 2) improving plant character through conventional breeding and biotechnology/genetic engineering; 3) utilization of local resources/local varieties with maximum

yield and high quality (Sadimantara & Muhidin, 2015). The availability dry area, which is not optimal for expanding the development of food crops, is estimated at 7.08 million ha (Mulyani & Sarwani, 2013) and 1.42 million ha potential for the development of upland rice which is scattered in various provinces (Hidayat et al., 2008). The level of fertility and land productivity is low, that requires a high enough input (Murtalaksono & Anwar 2014).

Land among immature oil palm plantation is potential dry land to developed upland rice. Oil palm area intense to The area of oil palm plantations tends to increase every year. During 5 years (2014–2018) growth rate of oil palm plantation area in average 7.89% per year (Indonesian Directorate General of Plantations, 2019). Oil palm plantation area in Indonesia in 2018 was 14.33 millions and 2.71 millions ha of which are in Riau Province (Indonesian Directorate General of Plantations, 2019). From total oil palm plantation area in Riau Province, 320,626 ha are immature plantation (TBM) and most of them are smallholder plantations (Indonesian Directorate General of Plantations, 2019). there is open space around 75% on immature oil palm plantation land TBM 1 (0-12 months) and 60% on TBM 2 (13-24 months) (Wasito, 2013).

Dry land in Riau Province is dominated by Ultisol soil. This soil has a very acidic to acidic pH; low organic matter content; very low to low alkaline content, low to moderate P; base saturation (KB) is very low, cation exchange capacity (CEC) is low and Al saturation is high (Yunizar, 2014;

Andalusia et al., 2016; Handayani & Karnilawati, 2018). Sujana and Pura (2015) said that the constraints in utilizing ultisol soil for agricultural development are acidity and Al saturation low nutrient content and organic matter, also land erosion.

Soil quality improvement on dry land is prioritized to overcome the main limiting factor (Dariah & Heryani, 2014). Soil acidity, low C-organic content, low macro nutrient content, and high exchangeable Al content are limiting factors for the growth of food crops on acid dry land (Kasno, 2019). Therefore, In an effort to increase plant productivity, the use of inorganic fertilizers still plays an important role. Efforts to overcome the decline in land productivity are carried out through the management of nutrients and organic matter (Dariah & Heryani, 2014).

Murtalaksono and Anwar (2014) stated that, return and addition of organic matter either by way *in situ* or *ex situ* in the form of litter, compost, organic fertilizers or bioorganic fertilizers as soil amendments are the key to increasing land productivity. The addition of organic matter to the soil will improve the physical, chemical and biological properties of the soil (Dariah & Heryani, 2014; Hartatik et al., 2015). Application of organic matter from chicken manure, cow manure and compost to Entisol soil increases soil pH, C-organic, N-total, available P and K-available soil, as well as NPK uptake, growth and production of sweet potatoes (Afandi et al., 2015). Compost from various sources of organic matter enriched with humic compounds is effective in increasing the soil pH of Ultisols (Subiksa et al., 2014). *Tithonia diversifolia*, *Gliricidia maculate* leaf mixed compost, ground fish bone, and manure enable to can improve soil physical and chemical properties as well as increase tuber weight and sweet potato starch content (Novianantya et al., 2017). Application of green manure with azola can increase rice production in saline land (Arifani et al., 2018).

Oil palm Empty Fruit Bunch (EFB) compost able to increase upland rice production that plant among immature oil palm area (Silalahi & Wawan, 2017; Silvana et al., 2017). Silvana et al. (2017) reported that, application of chicken manure 10 ton/ha increased upland rice production by 19.6%. This study aimed to determine effect of organic matter application for upland rice production that plant among immature oil palm.

## MATERIALS AND METHODS

This study was conducted in Tandun Sub District, Rokan Hulu Regency of Riau Province from January to December 2015. This study was designed using Randomized Block Design, 5 treatments with 4 replications. The treatments are:

- A. Control
- B. Paddy straw compost
- C. Weed biomass compost
- D. Empty fruit bunch compost
- E. Cow dung manure

The observed variables included plant height, number of productive tillers per clump, number of grains per panicle, percentage of filled grains per panicle, weight of 1000 grains and grain yield per hectare. Observation of plant height and number of productive tillers was carried out one week before harvest. Plant height was measured from the soil surface to the tip of the highest panicle. The data on the number of productive tillers were obtained by counting the number of tillers that produced panicles. Observations of the number of filled grains, the number of empty grains, 1000 grain weight and grain yield were carried out after harvest. Productivity data were obtained by weighing all yields in each experimental plot (15 m<sup>2</sup>) then converted to hectares.

### Research Process

#### Tillage

Before tillage was carried out, the land was cleared of weeds that grow using machetes. The weeds were collected and

will be composted to obtain weed biomass compost. Then made research plots with a size of 15 m<sup>2</sup>. Then, the soil was processed manually using a hoe with a processing depth of 10 cm (shallow soil processing).

### **Treatment application**

Compost treatment applied 2 weeks before planting by sowing the treatment material above the soil surface and stirring evenly with the soil.

### **Planting**

Planting was carried out at the beginning of rainy season. Planting was carried out in “tugal” manner using a tugal equipment with a depth of 3 cm, a spacing of 20 x 20 cm and the number of seeds of 5 seeds per hole. The planting hole was closed again with soil and watered was carried out to maintain soil moisture and stimulate seed germination. After the seeds grow, the plants were reduced by leaving 3 plants per planting hole to be maintained.

### **Plant care**

Plant maintenance that were carried out included watering, fertilizing, weeding and controlling pests and plant diseases. Watering was carried out when there was no rain so that the plants not suffer which causes disruption of plant growth. Fertilization was applied alternately between rows of plants. The fertilizer dosage given was 200 kg urea/ha, 100 kg SP-36/ha and 75 kg KCl/ha. All SP-36 and KCl fertilizers were given at planting time while urea was given three times, each 1/3 the dose at planting time, at 4 MST, 8 MST. Weed control was done in accordance with the growing weed conditions. Manually weeding by pulling out weeds that grow in the planting area. Pest and disease control applies the concept of integrated pest and disease management by consider economic threshold.

### **Harvest**

Harvesting when 90% of the rice plants were physiologically mature, indicated by

yellowing of the grains. Harvesting by cutting the stems of rice plants using a serrated sickle.

### **Data Analysis**

The observational data were analyzed statistically using Analysis of Variance (ANOVA) with the F test at the 5% level. If the treatment has a significant effect, it is continued with the Duncan Multiple Range Test (DMRT) further test at the 5% level.

## **RESULT**

Organic matter application to plant growth, yield component and yield of upland rice (Table 1 and Figure 2). Visually, the growth of upland rice at 30 DAS (day after sowing) and 45 DAS showed good growth (Figure 1).

Cow dung manure application shown the best plant growth and yield of upland rice, then followed by EFB compost treatment, biomass compost and paddy straw compost. Statistically, organic matter application had significant effect to plant height, number of productive tillers, number of grains per panicle, percentage filled grains and grain yield, though not significantly affect weight of 1000 grains (Table 1 and Figure 2). The highest plant height was obtained in the cow dung manure treatment at average height 104.8 cms, and the lowest plant height was obtained in the control treatment at average height 95.5 cms.

Furthermore, the highest number of productive tillers was obtained in the EFB compost at average height 14.5 stems and the lowest was obtained in the control treatment at average height 8.4 stems. Moreover, the highest number of grains and percentage filled grains were obtained in the cow manure treatment respectively 158 grains and 91.6%; the lowest was obtained in the control treatment respectively 120 grains and 85.8%. Weight of 1000 grains, statistically was not affected by treatments (Table 1).



Figure 1. Growth of upland rice plants aged 30 DAS (a) and 45 DAS (b)

Table 1. Effect of organic matter to yield component and yield of upland rice

Treatments	Plant Height (cm)	Number of Productive Tillers	Number of Grains/Panicle (grains)	Percentage Filled Grains/Panicle (%)	Weight of 1000 Grains (g)	Grain Yield (ton/ha)
Control	95.5 <sup>b</sup>	8.4 <sup>d</sup>	120 <sup>c</sup>	85.8 <sup>c</sup>	28.2 <sup>a</sup>	4.6 <sup>c</sup>
Paddy Straw Compost	97.4 <sup>b</sup>	11.1 <sup>c</sup>	137 <sup>b</sup>	87.2 <sup>d</sup>	28.7 <sup>a</sup>	5.0 <sup>b</sup>
Biomass Compost	98.4 <sup>b</sup>	11.6 <sup>c</sup>	137 <sup>b</sup>	90.1 <sup>bc</sup>	28.6 <sup>a</sup>	5.1 <sup>b</sup>
EFB Compost	102.2 <sup>a</sup>	14.5 <sup>a</sup>	157 <sup>a</sup>	90.8 <sup>ab</sup>	28.8 <sup>a</sup>	5.3 <sup>ab</sup>
Cow Dung Manure	104.8 <sup>a</sup>	13.6 <sup>b</sup>	158 <sup>a</sup>	91.6 <sup>a</sup>	28.7 <sup>a</sup>	5.7 <sup>a</sup>

Numbers in column followed by same letter no significance at level DNMRT 0,05

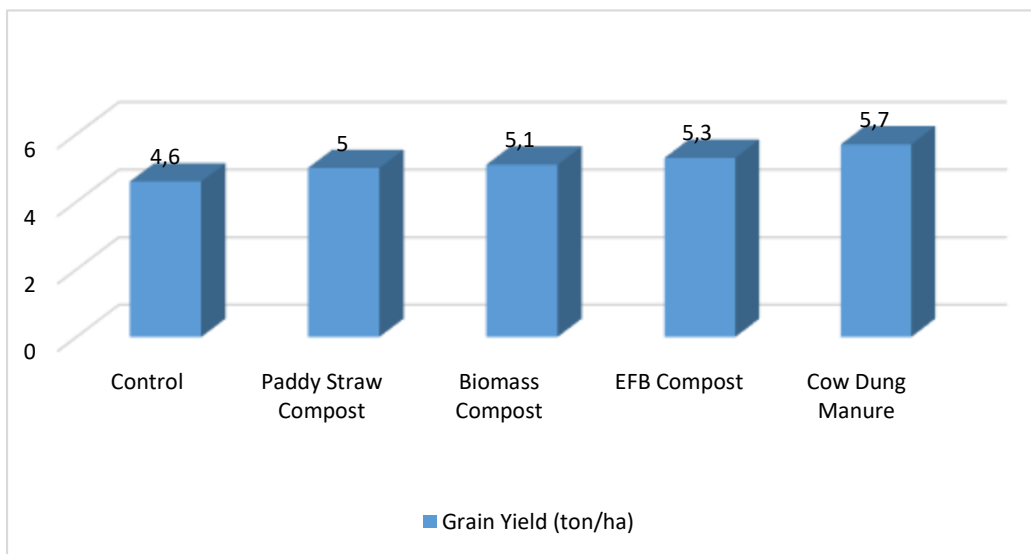


Figure 2. Upland rice grain yield at various compost treatments

However, in numerical term the heaviest weight of 1000 grains was obtained in the EFB compost at average weight 28.8 g and the lightest in the control treatment at 28.2 g (Table 1). Statistically, organic matter application also significantly affect to grain yield per hectare (Figure 2) The highest grain yield was obtained in the cow dung manure treatment at average yield 5.7 ton/ha and the lowest in the control treatment at average 4.6 ton/ha. Therefore, there was production increase 23.9%.

## DISCUSSION

Application of four kinds of compost to the soil improves growth and promotes the yield of upland rice which planted among immature oil palms. This was presumably caused the application of organic matter will improve the physical (Lawenga et al., 2015; Rauf et al., 2020), chemical (Pane et al., 2014; Afandi et al., 2015; Masni et al., 2015; Putra dan Jalil, 2015; Haitami dan Wahyudi, 2019) and biological properties of soil (Handayani et al., 2015). This is an ideal condition for plant roots growth and development, where the plant will grow and develop optimally. Moreover, fertile soils allow the root to explore a greater volume, that enable the root retain more water and plant nutrients (Gatiboni, 2018). Therefore, the plant will grow well and produce high, with the condition that the plant nutrient fulfill sufficiently.

Barus (2012) shown that manure application 4 ton/ha increases the upland rice production  $\pm$  11.64%. Application of compost, manure and custom-bio increase sugar cane yield (Zulkarnain et al., 2013). Application of cow dung manure, *azolla* compost, and municipal wate compost affect to growth and the yield of sweet potato (Susanto et al., 2104). Along with, the application green fertilizer *Tithonia diversifolia* increases corn growth and yield (Hutomo et al., 2015). Providing compost and manure increases wheat growth and production (Irawan et al., 2016). A mixture of *Tithonia diversifolia* leaves, *Gliricidia*

*maculate* leaves, ground fish bones, and manure enable to increase tuber weight and sweet potato starch content (Novianantya et al., 2017). Silvana et al. (2017) show that by giving EFB compost and chicken manure at 10 ton/ha each enable to increase upland rice production among immature oil palm plants by 16.8% and 19.6%, respectively. Giving compost 10 ton/ha from a mixture of *titionia* and rice straw on ultisol soil enable to increase dried weight of maize by 388.5% (Gusnidar et al., 2019).

Growth improvement and upland rice yield enhancement had occur in consequence of application organic matter. Organic matter enable to improve soil physical, chemical and biological properties. Improving soil properties will increase the effectiveness and efficiency of fertilization and land productivity (Kasno, 2019) which leads to increased nutrient availability for plants. In addition, application of compost from a mixture of *Tithonia* and rice straw on Ultisol soil increases pH, C-organic, N-total, P-available, interchangeable bases (K, Na, Ca and Mg), CEC and KB and reduces Al-dd and saturation of Al Gusnidar et al. (2019). On the aother hand, Zulkarnain et al. (2013) reported that the application of compost, manure, and custom-bio enable to increase the content of C-organic, N-total, soil porosity, soil aggregate stability, soil moisture content at pF 4.2, reduce soil density and soil density of Entisol. Application of compost mixture of *Tithonia diversifolia* leaves, *Gliricidia maculate* leaves, ground fish bones and K-total fertilizer, CEC, and Ca-dd (Novianantya et al., 2017). Soils with high clay content require organic matter to stabilize soil aggregates. In addition to produce simple minerals and compounds, BO weathering also produces colloidal humus which plays a very important role as a binding agent for soil grains. The application of organic matter increases soil aggregate stability (Mustoyo et al., 2013; Utomo et al., 2015; Bahri, 2018). In addition, cow manure reduces soil bulk density and

increases soil porosity (Mustoyo et al., 2013; Adijaya dan Yasa, 2014; Ramli et al., 2016; Bahri, 2018).

Moreover, the availability of ground water is also a determining factor for plant growth in dry land. Lack of water will inhibit plant growth. Prolonged dehydration can be fatal or cause leaf death. The availability of water during the dry season can be increased by adding organic matter to the soil. The organic matter application will increase water holding capacity of the soil. Giving cow manure 15 ton/ha was able to increase the soil water content to 35.17% (Adijaya dan Yasa, 2014).

### CONCLUSION

The provision of organic materials in the form of rice straw compost, weed biomass compost, tankos compost and manure affects the growth and yield of upland rice planted among immature oil palm plants. The application of cow manure can increase the yield of upland rice by 23.91% from 4.6 up to 5.7 tons/ha. Cow manure can be replaced with tankost compost, weed biomass compost or straw compost if availability is limited or difficult to obtain.

### ACKNOWLEDGEMENT

Thank you to Mr. Ir. Yunizar, MS for his guidance in the field and writing reports.

### REFERENCES

- Adijaya IN, Yasa IMR. 2014. Effect of organics fertilizers on soil properties, growth and corn yield. *In: Prosiding Seminar Nasional Inovasi Teknologi Pertanian Spesifik Lokasi*, Banjarbaru 6-7 Agustus 2014. p. 299-310.
- Afandi FN, Siswanto B, Nuraini Y. 2015. The effect of giving various types of organic matter on soil chemical properties on sweet potato growth and production in entisol ngrangkah pawon, Kediri. *Jurnal Tanah dan Sumberdaya Lahan*. 2(2): 237-244.
- Andalusia B, Zainabun Z, Arabia T. 2016. Soil characteristics on the ultisol order in the oil palm plantation of PT. Perkebunan Nussantara I (Persero) cot girek kabupaten Aceh Utara. *Jurnal Kawista Agroteknologi*. (1): 45-49.
- Arifani NA, Kurniasih B, Rogomulyo R. 2018. Effect of organic matter on growth and yield of paddy (*Oryza sativa* L.) gripped by salinity. *Vegetalika*. 7(3): 30-40.
- Bahfein S. 2020. Due to land transfer function, the area of rice field decreases by 287.000 ha *Kompas.com*, 04/02/2020, 15:49 WIB. <https://properti.kompas.com/read/2020/02/04/154930721/akibat-alih-fungsi-lahan-luas-sawah-susut-287000-hektar>. Download 17 Maret 2021.
- Bahri S. 2018. Imperata management and application of soil conditioner affected changes in several physical properties and yield of maize. *Agrosamudra, Jurnal Penelitian*. 5(1): 67-81.
- Barus J. 2012. Effect of manure application and cropping systems on yields of superior upland varieties on acid dry land in Lampung. *Jurnal Lahan Suboptimal : Journal of Suboptimal Lands*. 1(1): 102-106. DOI: 10.33230/JLSO.1.1.2012.13.
- Dariah A, Heryani N. 2014. Empower suboptimal dry land to support food diversification and food sufficiency policy. *Jurnal Sumberdaya Lahan*. Special Edition: 1-16. DOI: 10.21082/jsdl.v8n3.2014.%25p.
- Indonesian Directorate General of Plantations. 2019. *Indonesian Plantation Statistics 2018-2020: Oil Palm*. Direktorat Jenderal Perkebunan: Jakarta.
- Gatiboni L. 2018. *Soils and plant nutrients from the extension gardener handbook*. NC State University. North Carolina: USA.
- Gusnidar, Fitri A, Yasin S. 2019. Titonia and rice straw compsted on chemical soil



- characteristics and maize production on ultisol. *J. Solum*. 16(1): 11-18. DOI: 10.25077/jsolum.16.1.11-18.2019.
- Haitami A, wahyudi. 2019. Effect of various dosages of oil palm empty bunch compost in improving the chemical properties of ultisol soil. *Jurnal Ilmiah Pertanian*. 16(1): 56-63. DOI: 10.31849/jip.v16i1.2351.
- Handayani, Sufardi, Hakim L. 2015. Tofu waste to improve soil chemical and biological properties and sweet corn (*Zea mays* var. *saccharata* sturt L.) yield. *Jurnal Manajemen Sumberdaya Lahan*. 4(1): 572-578.
- Handayani S, Karnilawati. 2018. Characterization and classification of ultisol soil in Indraya sub district, Pidie district. *Jurnal Ilmiah Pertanian*. 14(2): 52-59. DOI: 10.31849/jip.v14i2.437.
- Hartatik W, Husnain, Widowati LR. 2015. The role of organics fertilizers in increasing soil and crop productivity. *Jurnal Sumberdaya Lahan*. 9(2): 107-120. DOI: 10.21082/jsdl.v9n2.2015.%25p.
- Hutomo IP, Mahfudz, Laude S. 2015. Effect of green fertilizers *Tithonia diversifolia* to Corn (*Zea mays* L.) growth and production. *e-J. Agrotekbis*. 3(4): 475-481.
- Irawan B. 2015. The dynamics of lowland and upland rice production and the implication to increase rice production *In: Pasandaran E et al.* (eds), Strengthen Food Self Sufficiency Ability. Agricultural Research and Development Agency. IAARD Press, p. 68-88.
- Irawan A, Jufri Y, Zuraida. 2016. Effect of organics matter application to andisol chemical properties on growth and production of wheat (*Triticum eastivum* L.). *Jurnal Kawista*. 1(1): 1-9.
- Ismail I. 2018. Corelation between population to rice consumption in asparaga subdistrict of Gorontalo district. *Gorontalo Development Review*. 1(1): 74-85.
- Kasno A. 2019. Soil improvement to increase efectiveness and efficiency of balanced fertilizer on acid dry land productivity. *Jurnal Sumberdaya Lahan*. 13(1): 27-40. DOI: 10.21082/jsdl.v13n1.2019.27-40.
- Lawenga FF, Hasanah U, Widjajanto D. 2015. Effect of organic application on phisical soil properties and tomatoes yield in Bulupountu district Sigi Biromoru subdistrict Sigi District. *e-J. Agrotekbis*. 3(5): 564-570.
- Masni ER, Bintang, Marpaung P. 2015. The Interaction between minerals and organics meterials on the chemical properties of ultisols and the production of mustard greens. *Jurnal Online Agroekoteknologi*. 3(4): 1489-1494.
- Mulyani A, Sarwani M. 2013. Characteristict and potensi og suboptimal land for agricultural development in Indonesia. *Jurnal Sumberdaya Lahan*. 7(1): 47-58. DOI: 10.21082/jsdl.v7n1.2013.%25
- Murti Laksono K, Anwar S. 2014. Potentials, constraints, and strategies for the use of dry and acid dry land for agriculture (rice, maize, soybean), animal husbandry, and plantations using appropriate and location-specific technology. *In: Herlinda S et al.* (eds), Inclusive Agricultural Technology Development to Advance Sub-Optimal Land Farmers. *In: Proceedings of the National Seminar on Suboptimal Land 2014; Palembang 26-27 September 2014*. Palembang: Unsri Press p. 17-28.
- Mustoyo, Simanjuntak BH, Suprihati. 2013. Effect of manure dose on soil aggregate stability in organic farming systems. *Agric*. 25(1): 51-57. DOI: 10.24246/agric.2013.v25.i1. pp.51-57.
- Novianantya AC, Fardany NK, Nuraini Y. 2017. Improvement of sweet potato yield using mixtures of ground fish bone and plant residues. *J. Degrade. Min. Land Manage*. 4(2): 759-765. DOI: 10.15243/jdmlm.2017.042.759.
- Pane MA, Damanik MMB, Sitorus B. 2014. Provision of organic rice straw compost



- and rice husk ash in improving the chemical properties of ultisol soil and the growth of maize plants. *Jurnal Online Agroekoteknologi*. 2(4): 1426-1432.
- Prasada IMY, Rosa TA. 2018. The impact of land transfer function of paddy fields on food security in Special Region of Yogyakarta. *Jurnal Sosial Ekonomi Pertanian*. 14(3): 210-224. DOI: 10.20956/jsep.v14i3.4805.
- Putra I, Jalil M. 2015. Effect of organic matter on several soil chemical properties in acid dry land. *Jurnal Agrotek Lestari*. 1(1): 27-34 DOI: 10.35308/jal.v1i1.433.
- Ramli, Paloloang AK, Rajamuddin UA. 2016. Changes in soil physical properties due to the application of manure and mulch to purple eggplant plantations (*Solanum melongena* L), Entisol, Tondo Palu. *e-J. Agrotekbis*. 4(2): 160 – 167.
- Rauf A, Supriadi, Harahap FS, Wicaksono M. 2020. Physical characteristics of Ultisols due to the provision of biochar made from palm oil plant residue. *J. Solum*. 12(2): 21-28. DOI: 10.25077/jsolum.17.2.21-28.2020.
- Sadimantara HGR, Muhidin. 2015. Efforts to increase rice productivity towards sustainable food self-sufficiency. Inside: Siregar H. et al. (eds), Indonesia Towards Food Self-Sufficiency in the Next Three Years Conceptual, *In: Theoretical and Empirical Reviews, Proceedings of the National Seminar on Food Self-Sufficiency*. Indonesia. p. 51-58. DOI: 10.37149/3126.
- Silalahi JD, Wawan. 2017. The effect of oil palm empty bunch compost and soil processing methods on the growth and production of upland rice (*Oryza sativa* L.) among immature oil palm plants. *Jom Faperta Ur*. 4(1): 1-15.
- Silvana F, Yulia A, Masri N. 2017. Application of various organic fertilizers to the growth and production of several upland rice varieties (*Oryza sativa* L.) planted among immature oil palm plants. *Dinamika Pertanian*. 33(3): 231-242.
- Subiksa IGM, Dariah A, Rochayati S. 2014. Development of non-lime ameliorant to improve productivity of acid upland. *In: Prosiding 11<sup>th</sup> International Conference The East and Southeast Asia Federation of Soil Science Societies*. p. 171-176.
- Sujana IP, Pura INLS. 2015. Ultisol soil management by providing biochar organic repairer towards sustainable agriculture. *Agrimeta*. 5(9): 1-9.
- Susanto E, Herlina H, Suminarti NE. 2014. Response to growth and yield of sweet potato (*Ipomoea batatas* L.) at several types and application times of organic matter. *Jurnal Produksi Tanaman*. 2(5): 412-418.
- Utomo BS, Nuraini Y, Widiyanto. 2015. Study of soil aggregate stability on the provision of several types of organic matter in robusta coffee plantations. *Jurnal Tanah dan Sumberdaya Lahan*. 2(1): 111-117.
- Wasito. 2013. Diversification of Food Based on land use between oil palm plantations and food plants in langkat regency, North Sumatra. In Ariani et al. (editor) Food Diversification and Agricultural Development Transformation. 2013. *Agricultural Research and Development Agency, Ministry of Agriculture*. IAARD Press. Jakarta. p. 527-545.
- Yunizar. 2014. Study of water-saving technology in upland rice on acid dry land in anticipation of climate change in Riau Province. In: Herlinda S et al. (eds), Inclusive Agricultural Technology Development to Advance Sub-Optimal Land Farmers. *In: Proceedings of the National Seminar on Suboptimal Land*. Indonesia. p. 629-636.
- Zulkarnain M, Prasetya B, Soemarno. 2013. Effect of compost, manure, and custom-bio on soil properties, growth and yield of sugarcane (*Saccharum officinarum* L.) on Entisol in Ngrangkah-Pawon garden, Kediri. *Indonesian Green Technology Journal* 2(1): 45-52.