APPLICATION OF WATER USED EFFICIENCY TECHNOLOGY AND STRAW COMPOST (SOBARI METHOD) TO ACCELERATE PADDY SOILS HEALTH REMEDIATION AND TO INCREASE RICE PRODUCTIVITY

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ABSTRACT

The vey intensive of paddy soil cultivation and the use of inorganic fertilizers has accelerated the degradation of paddy soils health (low content of org-C and low soil biodiversity) and the occurrence of leveling off for increment of rice yield. Recently, about 70% of paddy soils area in Indonesia has an organic carbon <2% and categorized as sick soils or fatigue soils. An effort to remediate the soil health and to increase the productivity of paddy soils can be conducted by adopting organic based water used efficiency technology, known as system organic based aerobic rice intensification (SOBARI) and using the compost straw as main source organic fertilizers. The rice straw is highly available (about 1.5 X rice grain yield or equivalent to 8 – 12 ton/ha/season or 4 – 6 ton straw compost) and can be used as main source of organic fertilizers for paddy soils. Straw compost is main source of K and Si which are very important for paddy rice and can be used to reduce the application inorganic fertilizers up to 50%. In addition, the returning of straw compost into soils play important role in providing the energy source for soil organism and reactivated soils as a naturally biofertilizers reactor or fabrics in SOBARI methods (aerobic or non permanent flooding paddy rice). Soil organism biodiversity is highly depend on oxygen and the availability of organic matter as source of energy and nutrition. The remediation of paddy soils is occurred by increasing the organic carbon content, soil biological power and revitalized the soil food web in supporting the plant growth and nutrient supply. Review of research and field results of SOBARI method has been conducted since 2007 up to 2010, in some areas in Java, it can increase rice yield significantly, two-fold higher compared with the cultivation of anaerobic and without giving organic material. Results of laboratory tests and pots in the greenhouse in 2010, turned out to aerobic and anaerobic culture systems reveal biodiversity of soil microorganisms vary depending on environment and frequency of application of organic fertilizer. The long duration of compost incorporation on the decomposer formula added effect on soil productivity (C-organic, N-total, C / N and CEC soil). The significant remediation of paddy soils health or quality will be expected within 4 – 6 times application of compost straw or planting season

Keywords : *Water used efficiency technology, straw compost, sobari method, soils health, rice productivity.*

INTRODUCTION

Paddy rice cultivation in agricultural system is a natural resource that can be remediated by environmental friendly farming systems (sustainable agriculture) which is principally intended to maintain a harmonious ecosystem components (human, animals, plants, microorganisms and natural resources) in a continuous and sustainable (Bunning and Jimenes, 2003). Wetland health recovery effort need to be properly implemented in Indonesia, due to the agricultural land in Indonesia, (66%) have a C-organic < 2%, (Kasno, *et. all*. 2003), especially at the intensive rice fields in Java which was supplied by water from irigation channels and efforts to increase the intensification of rice production that relies on external inputs (HEIA = high external inputs of agriculture) by using of inorganic fertilizers and other chemicals continuously has been impact to production stagnant during the last 5 years (Sawit, 2006)

Results of evaluation on soil health by using indicators of C-organic matter content < 2%, pH , high erosion, biodiversity disturbed, indicated that the of wetland ecosystems in Indonesia can be categorized as a sick soil. Indicators of wetland ecosystem health decline can also be seen from decreasing of the soil organisms biodiversity. The healthy and fertile (healthy soils) of wetland ecosystems was indicated by the existence of harmonious interaction between a biotic and biotic components, as well as other biotic components that making a series flow of energy or food chain (food web), and the workings of organisms producers, consumers and decomposers continuously

Paddy rice fields cultivation produce rice grain and straw. The potential of straw is very abundant, approximately 1.5 x grain yield, or about 8-12 t / ha / season, equivalent to about 4-6 tons of straw compost. Straw compost as a source of fertilizer K and Si are very important for rice field. It is able to reduce the use of inorganic fertilizers by 50%. In addition, the use of straw compost also play an important role as an energy source for soil organisms to activate natural fertilizer factory (Simarmata, 2008)

The abundance of soil organisms (biodiversity) is highly dependent on oxygen supply and availability of organic materials as a source of energy and nutrients, especially for aerobic microbes (Turmuktini and Simarmata 2010a). Aerobic cultivation

technique is a technique where water is supplied to the paddy field is not flooded or moisture. SOBARI method (system organic based aerobic rice intensification) is a cultivation technique that has been developed by Tualar Simarmata from the Faculty of Agriculture, Padjadjaran University since 2007.The technology has been adopted in several provinces in Indonesia, which the main objective is the health of wetland restoration techniques that focuses on soil strength as a bioreactor.

Application of SOBARI method utilizing organic fertilizer in the form of rice straw compost and controlled aerobic conditions with crop and soil management was to save water, plant seeds, and inorganic fertilizers by increasing levels of oxygen will produce a strengthening of soil biology. In addition the intensively functioning of the food chain, resulted the soil as a natural fertilizer factory and created a good ecosystem. SOBARI (Controlled of aerobic rice intensification technique, it can increase production 1-2 times higher than conventional, which is only 4-6 t $ha^{-1.}$)

The purpose of the study was to present the data from the utilization of water used efficiency saving technology and straw compost (SOBARI method) to accelerate recovery and improve the health of wetland rice productivity.

MATERIALS AND METHODS

The research was conducted in 2007 to 2010 at the some areas in Java. The primary data were descriptive analysis, including: 1. Production, with rice varieties from the demonstration plot and land area varies, 2.Microbial population and 3. greenhouse tests of compost + formula decomposer and duration of incorporation of the chemical content of rice straw compost.

The step of cultivation techniques controlled of aerobic rice intensification (SOBARI method) are:

(1) Plant Management: Selection of seeds, using young seedlings (age 10-14 DBS),

(2) Soil management and fertilization:

a) the organic fertilizer is applied 1-7 DAP on: land nursery (500 g compost + 50 g m^{-2} bio fertilizer), in paddy fields in the form of compost straw / manure applied DAP 1-7, 3-5 t ha^{-1} and of fertilizers bio stimulant: for leaves (age 15,25,35 DAP) and for interest (age 45.55 , and 65 DAP the recommended dose).

b) inorganic fertilizer : N, P, K is applied 1-2 days before planting, supplementary fertilizer given after seeing the leaf color chart as age (21-28 DAP), (35-42 DAP), (48 -50 DAP) with a dose of as recommended by referring to the of controlled of aerobic rice intensification(SOBARI) design.

(3) Planting technique: a square planting pattern (30x30, 35x35, 40x40, 50x50 cm) 1 seed per planting hole, planting the seeds twin (SOBARI TS / Twin Seedling) (4) Management of irrigation were: a) from planting until the plant growth, land left to aerobic / was not flooded. b) land inundation and anaerobic only done 1-2 days ahead of weed control, c) subsequent aerobic soil left d). 15 days left before harvested dried naturally (Simarmata and Yuwariah. 2008).

RESUT AND DISCUSSION

1. Rice production of water used efficiency technology and straw compost (SOBARI method)

Province and District	Year	Harvest Grain Yield (t ha $^{-1}$)	Harvest Grain Yield (t ha $^{-1}$)
		Conventional	IPAT – BO
JABAR **:**			
Bandung, Garut, Bogor, Subang, Sumedang	2007	4 – 7	6 – 11
Bogor	2008	4 – 7	7 – 10,2
Sukamandi	2008	4 - 7	8 – 10
Sumedang	2010	4 - 7	7 – 11
BANTEN :			
Serang	2007	4 - 6	6 – 10
JATENG :			
Sragen, Sukiharjo,	2007	4 – 6	6 – 10
Wonogiri, Karang Anyar,	2008	4 – 6	6 – 10
Purworejo, Magelang	2009	4 - 6	8– 9,5
Semarang			
JATIM :			
Mojokerto, Tulung Agung, Blitar, Jombang, Madium	2007	4 – 6	6 – 10

Table 1. Rice is plant that tolerant of inundaton, sensitive of flooding (anaerobic), but requires aerobic and little water (moisture). Application of water (aerobic) plus the provision of organic fertilizer in the form of rice straw compose, is an effort to create environmental conditions that favored plant. Growth and development of tillers and number of productive tiller number could grow to reach more than 50 seedlings closely related to rooting volume increase significantly. It is seen higher yields 1-2 times as much on the cropping pattern TS: twin seedlings, one seedling per planting hole SOBARI model in the appeal of conventional (1 hole containing 3-6 seed plants). (Turmuktini and Simarmata, 2010 b).

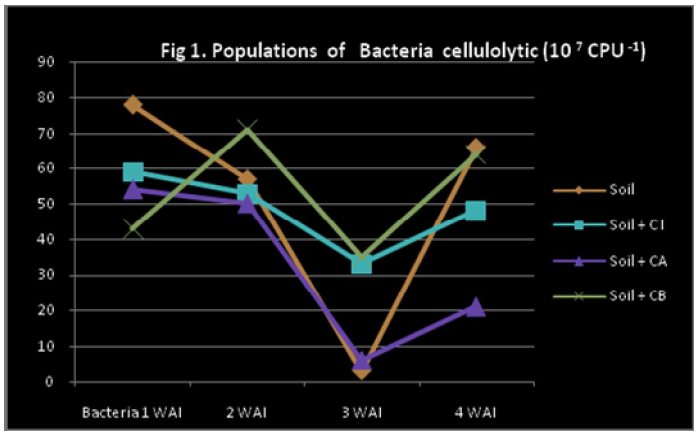
Water application by aerobic (moist) resulted oxygen circulation freely into the soil. The presence of oxygen is important to plants for cell division in root tips. According to Mao Zhi (2002), the growth of root system marked by increasing rooting volume, the percentage of active roots (the roots are characterized by white color which is not black and yellow) and root diameter. This was obtained in rice plants after using the technique WEI (Water Efficiency Irrigation / aerobic) in comparison TRI (Traditional Rice Irrigation = continuous submergence / anaerobic). The roots of rice on flooded land shorter than not flooded, because the inhibition of the acquisition of oxygen (Yoshida, 1981). Effect of stagnant water (an aerobic) can reduce the percentage of productive tillers, number of productive tillers and root dry weight in the appeal was not flooded. Efficiency of water use on land not inundated 19.58% better than the stagnant efficiency of only 10907% (Sumardi, *et. all*, 2007). Intermittent water management can increase the biomass, plant height, leaf area and number of productive tillers. Rice yields increased by 8% - 10% in intermittent compared to the stagnant (Shi, *e.t all*. 2002). Increased sink, which strive to increase the number of productive tillers more than 80%, the number of spikelet per panicle, panicle length, and percentage of fertile spikelet. While the power source that is, increasing the number of tillers, so that leaf area increased (Venkasteswarlu and Visperas, 1997).

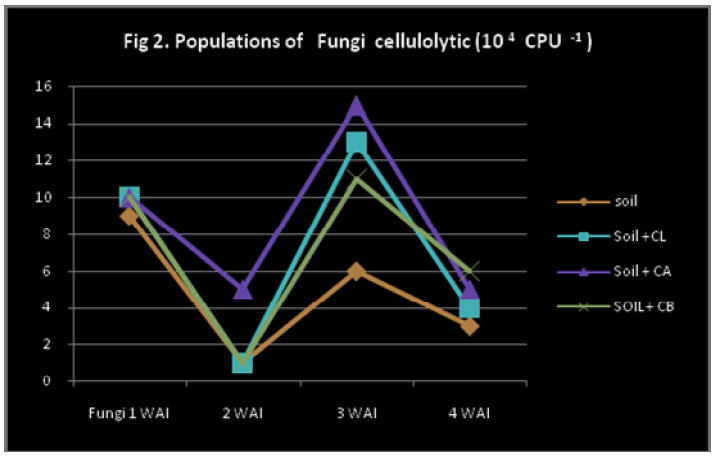
Application rice of straw organic matter on land was not flooded with SOBARI method could increase rice yield. According to Longs Xin *et. all*. (2002), that 7.5 t ha $^{-1}$ of compost, resulting in an increased root system. Application the organic material 24 t ha-1 is very influent on the increase of grain per hill (15.30%), root dry weight (9.84%) and number of panicles per hil increased (35.99%) (Sumadi, *et. all*. .2007). The optimal growth and yield components obtained from the source and sink relationship due to environmental obtained growth roots in aerobic condition / not flooded and the provision of organic materials.

2. Application of water used efficiency technology and straw compost (SOBARI method) on soil microbial populations

The treatment resulted of microbial populations (bacteria and fungal cellulolytic from soil pot experiment with rice straw compost treated (C: 5 t ha-1) + decomposer

(CL, CA, CB: Compost + formula decomposer local / onsite, A and B) with different incubation times (1,2,3 and 4 WAI: Weeks After Incubation) contained in Figure 1 and 2.





In figure 1 and 2 addition of organic matter with or without decomposer significantly improved the growth of soil microbial populations (bacteria and cellulolytic fungi), compared to land without any organic material (control: soil). Composting of straw is a series of aerobic thermophilic decomposition of organic material constituents with microbe helper, including bacteria, fungi and actinomycetes. The result of decomposition of organic material on land is not flooded a steady organic material , CO_2, NO_3 and SO_4^{-2}, while in land flooded by CO_2, NH_4^{+}, H_2S, CH_4, amines (Sanchez, 1993).

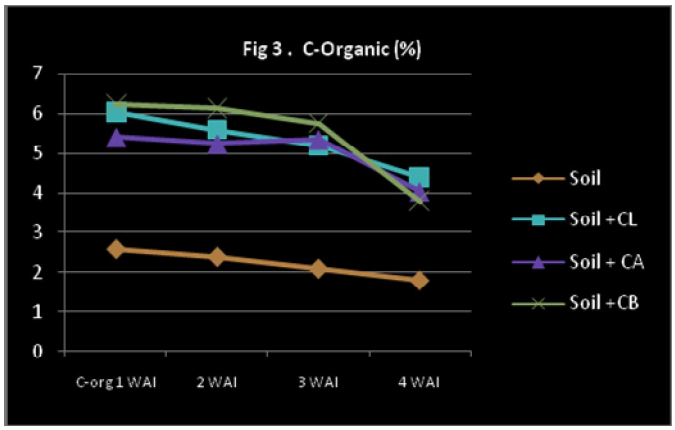
The process of decomposition of organic material in aerobic conditions will run faster, because many types of aerobic microbes involved.Most of Aerobic microbes live on ground surface (Alexander, 1977). Bacteria, fungi and algae are catagorized as the

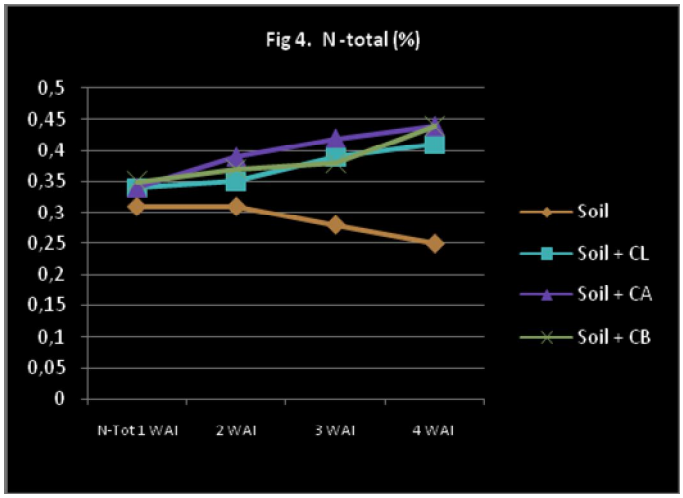
soil micro flora that can serve as one marker (markers) indicators of damage ecosystem area (Sarifudin, 2004).

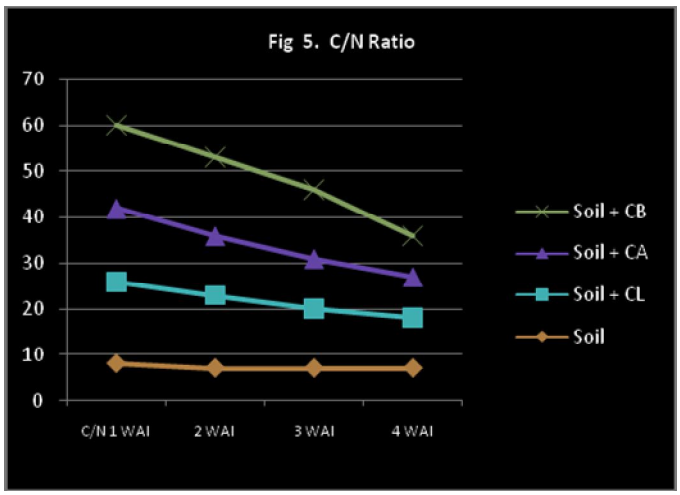
The occurrence of antagonism among bacteria and fungi closely related to the each function in the food chain (food web). In a healthy wetland ecosystem will be an interaction between biotic factor with a biotic or among fellow components. Thermophilic Bacteria will brake down material like proteins, lipids and fats in the and produce heat energy. Actinomycetes and fungi break down organic compounds that are like cellulose in complex condition thermophilic and mesophilic. In addition, many microorganisms could be as, chelating agents, biological agents, producers' phyto hormone, and improve soil fertility (Nelson, 2004). According Gunardi, (1977), that soil fertility has a 55% contribution towards the success of such production. With biological soil fertility is closely related to its existence, with soil fertility

3. Application water used efficiency technology and straw compost (SOBARI method) of soil chemical analysis

Data analysis of soil chemical treatment of C-organic (%), N-total (%), C / N ratio and CEC (c mol / kg) of soil pot experiment with rice straw compost treated (C: 5 t ha-1) + decomposer (CL, CA, CB: Compost + decomposer Local, formula A, B) with different incubation times (1,2,3 and 4 WAI: Weeks After Incubation) contained in Figure 3,4,5, and 6







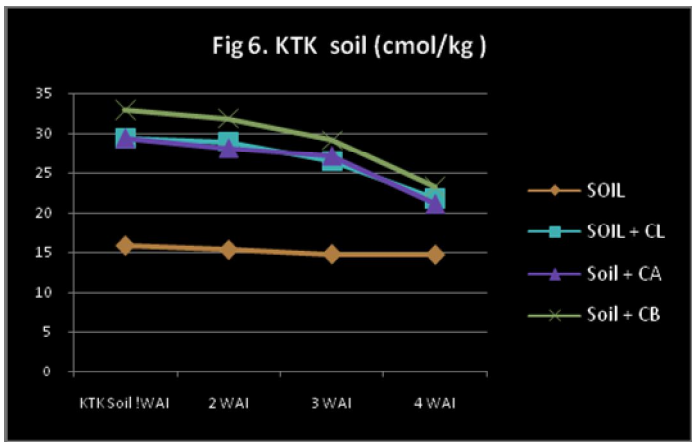


Figure 3.4,5,6. Compost straw given to the media to improve the C-organic, C / N ratio and CEC and N - total. Giving the compost + formula B (Soil + CB), yielding the highest values of incorporation and the lowest every time there is in control (Soil) for all parameters during the 3 WAI, but may vary in value at 4 WAI.

Provision of organic material with the help of decomposer microbial activator, was able to increase C-organic (> 3%) is indicative of microbes able to break down, healthy soil so the soil is categorized (Sukarno, 2001). C / N ratio is good for organic fertilizer based on a minimum standard of quality organic fertilizer is > 12%.

If the percentation between 7% and 12% can be catagorized as soil conditioner (Simanungkalit, *et all,* 2006). The results of this experiment it appears that C / N ratio value of 16% at the beginning of the incorporation and > 8% at 4 WAI, higher than the control. It means that this treatment successfully categorized as organic fertilizer. Carbon is the material energy for microorganisms for growth and nitrogen for protein synthesis.

Composting helps organic matter increases soil CEC 2 -30 times larger than the colloidal minerals covering 30% -90% of mineral absorption. Increase in CEC due to weathering produces colloidal organic (humus) which has the ability to withstand surface water and nutrient elements, thereby increasing the ability of soil to hold nutrients and water loss (Sanchez, 1993). Organic material provided to the soil, either naturally experienced composting with the help of the local microbes and microbial activator of the formula given in the form.

Turmuktini and Simarmata (2010c). Mentioned that straw compost using i*n situ* microorganism more effectively and generate C-organic, C / N ratio, low CEC, N-high total in line with the long incubation period of composting. compared to formula A and B.

SOBARI technique has been successfully accelerate the revitalization of the land, increasing the ecosystem that support for the life of the rice plant, the interaction of biotic and a biotic components, it can be seen from the indicator in chemical analysis, and biological analysis (microbial populations), showing a healthy land productivity at the same time increased yield in a sustainable manner. The use of rice straw compost in paddy fields in the 4-6 seasons was expected to restore health and fertility with a significant wetland.

CONCLUSION

1. Application water used efficiency technology and straw compost (SOBARI method) was found to increase rice yields one to two times higher than conventional practice

2. Application straw compost increased total soil microbial population. Presence of bacteria cellulotic inversely with fungal cellulolytic numbers in line with the increase in the incorporation. Use formula activator decomposer A and B affect the number of fungi and bacteria cellulolytic is varied

3. The long duration of compost incorporation on the decomposer formula added effect on soil productivity (C-organic, N-total, C / N and CEC soil l).

4. Application water used efficiency technology and straw compost (SOBARI method) are expected to improve seed cultivation techniques, to speed up the recovery, to accelerate restoration of wetland health to increase productivity of rice straw compost from the paddy fields cultivation in a 4 - 6 season and to restore health fertility with a significant wetland.

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