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Impact of Traditional and BIMAS Oriented Practice of Paddy Rice Cropping on Water Environment

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Abstract

In Indonesia, some developing program for agricultural production had been promoted nevertheless still some farmers prefer their traditional paddy farming. This research was conducted to investigate effects of two different types of agricultural practices on surrounding water environment. Field survey was conducted at west Java in 2003. An traditional organic farming site, in Leuwiliang, was hilly and relatively small scale farming. Another site in Darmaga, they use chemical fertilizers and agricultural chemicals. It was medium-size paddy fields in moderately flat area. Water quality and soil properties were analyzed in those paddy fields during rice cropping season. In Leuwiliang, because of insects damage, farmers harvested rice earlier than the best timing and the production of year 2003 was less than the usual. In Darmaga site, there were another problem in 2003. In order to control mud snail outbreak farmers stopped irrigation earlier than the average year. Data collected from those paddy fields suggested some characteristic environmental effect. In Leuwiliang the impact of paddy fields on water environments was little. In general, the nutrients balances on inflow, paddy fields and outflow on both site were neutral. And during beginning of growth stage the nutrients is used for their growth so the nutrients out charge were less than the income, but in stages, the nutrients amount of inlet and outlet were similar. In Darmaga, Ca, Mg, P and N from inlet and outlet water were higher than those of Leuwiliang.

Keyword: paddy field, traditional farming, water quality, environmental effect

INTRODUCTION

Recently multi functionality of paddy fields is attracting public attentions. Obvious differences were observed on the water qualities of paddy fields surface water depending on the form and farming. This shows that the irrigation methods, applying compost, chemical fertilizer and the agricultural chemicals can influence pollutant load on circumference environment. In Indonesia, BIMAS, an Indonesian agricultural program for increasing rice productions, was established in 1965. Starting in 1986, it was extended to become the supra-intensification system, SUPRA-INSUS with certified seed of recommended varieties, integrated pest management, balanced fertilization, and credit availability. The program was implemented throughout the irrigated rice area. In consequences, 100 % of self-sufficiency on rice production was achieved for a short period after 1984. But these paddy fields farming use more chemicals, so environmental impacts have been concerned. Studies on the evaluation of water quality characteristics of the paddy field at the basin level were proceeded with from various point of view. Some of these researches showed the positive effects of paddy fields on surrounding water environment.

The object of this research was to investigate water quality of agricultural water in paddy fields and it's effects on rice production. Moreover, discussions of rice crop possibility in those areas loads to proposal for the sustainable land use by employing the circulation types of agricultural production activity.

MATERIALS AND METHODS

RESEARCH AREA

Site1:Leuwiliang(LW)

The site is consisted with 21 small plots. (Figure.1,2) Objective plot 59.96m^2 with 2 water inlets and 2 water outlets is indicated by the slanted line..

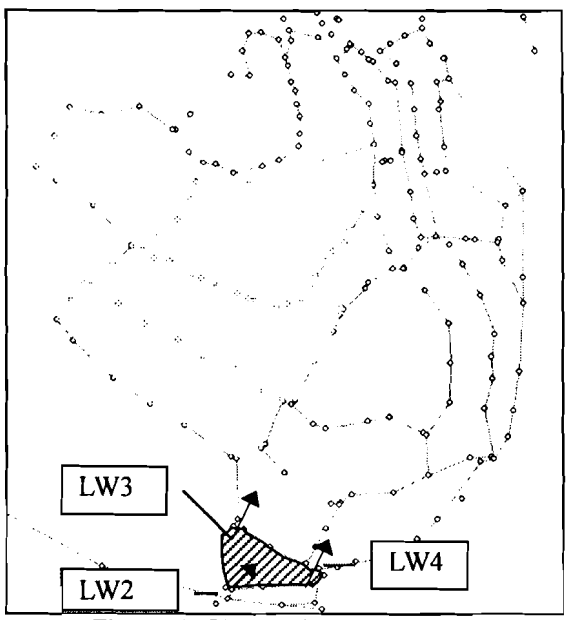

Figure 1. Site1 in Leuwiliang

Figure 2. View of site 1

The small scale paddy fields had been cultivated without any chemical fertilizers nor agricultural chemicals. In a year, two times of wet rice are cultivated;1st season is from September to December and 2nd season is from January to April. Irrigation water is from spring water at the upper cliff. Though, even in a dry season there are abundant water however the owner does not cultivate to fallow the land(Figure.3,4).In normal year, a rice product is 0.7 to 1 t/ha. All agricultural operation (puddling, transplanting and harvesting) is done by only manpower.

Figure 3. Fallow season

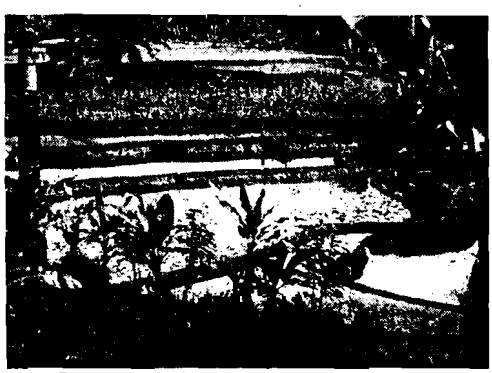

Figure 4. Waiting for transplanting

Site2: Darmaga (DR)

In Darmaga site the paddy fields plots are medium-size in the flat place.(Fig.5,6) The area of the studied plot was 545.88m^2 with 1 water inlet and 1 outlets in the relatively extensive paddy fields as compared to Leuwiliang site.

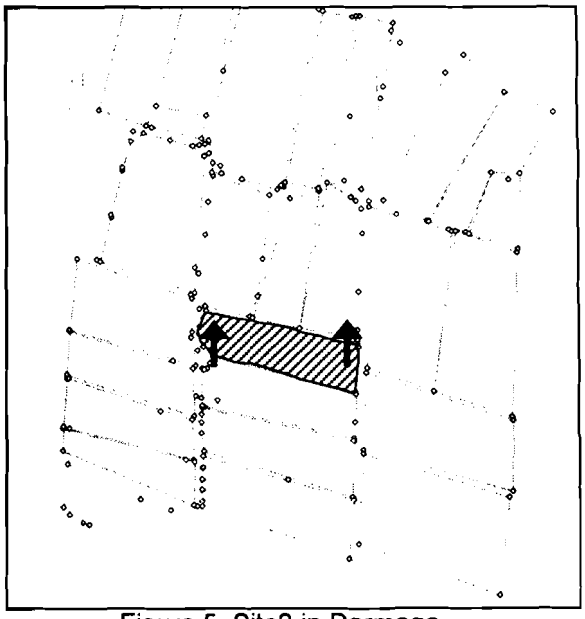

Figure 5. Site2 in Darmaga

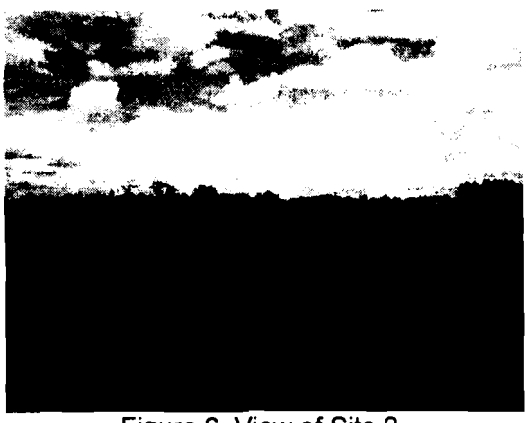

Figure 6. View of Site 2

The paddy fields, the employed farmer cultivates 8 plots. He uses some kinds of chemical fertilizers and agricultural chemicals. And the harvest is for sale at market. Except puddling by cow, all other agricultural managements (transplanting, weed control, application) are conducted by labor. (Figure 7) Irrigation water is abundant whole season so the farmers are able to start their cultivation at any time. Therefore many stages of paddy can be seen in this area at the same time (Figure 8)

Figure 7. Paddling with caws

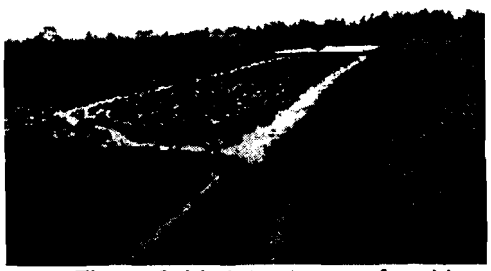

Figure 8. Variety stages of paddy

Methods

Once before transplanting and every week after transplanting, pH, EC and NO_3^- were monitored at the site and soil and water analysis were done in laboratory. We have taken samples at inlet and outlet of each plot for water quality and soil chemical properties. Some laboratory in Faculty of Soil in Bogor Agricultural University conducted soil chemical properties and water quality analysis. The analyzed constituents for soil chemical properties and water quality are in Table 1.

Table 1. Analyzed chemical constituents (every week)

Water quality	Soil chemical
Total-N	Total-N
Ca	Ca
K	K
Mg	Mg
P	Na
Fe	Al
	H
	pH
	EC
	Organic-C

RESULTS AND DISCUSSIONS

In 2003, locusts damaged paddy rice of the whole village in Leuwiliang including study plot. In consequence, farmers harvested rice earlier than the best timing for preventing further damage. The yield of rice in 2003 was less than the usual. In Darmaga site, because of mud snail outbreak farmers stopped irrigation earlier than the normal year. This made water quality monitoring was not long enough.

1) Soil Chemical Properties

The results of soil chemical properties are shown below. Soil chemical properties except EC (both sites), K (Darmaga only) and P (both sites) did not change through cultivation term. The concentration of P of the both sites showed sharp decline during growth stage. (Figure 9) In both fields they did not apply phosphorus fertilizer. It was expected lack of P. Locusts damage and mud snail outbreaks were the main reason of low yield of this year but the average unit harvest is also low. So the lack of phosphorus could be also a reason of low yield of rice.

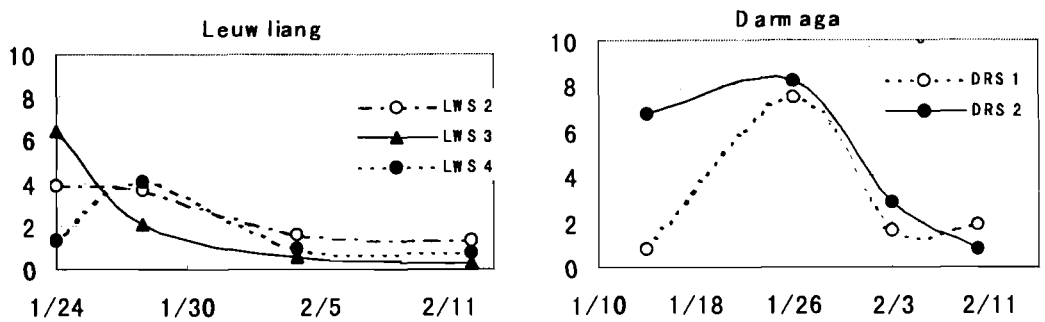

Figure 9. Phosphorus concentration of Soil

Other parameter did not have any characteristic trend. The ranges were 5.0 to 5.6, 1.5 to 3.0, 0.1 to 0.2, 1 to 3, 0.7 to 1.1 4 to 8, the concentration of pH, Organic-C, Total-N, Mg, Na and Ca for Leuwiliang. The ranges were 5.8 to 6.2, 1.5 to 2.5, 0.15 to 0.25, 3 to 5, 0.8 to 1.1, 9 to 12, the concentration of pH, Organic-C, Total-N, Mg, Na and Ca for Darmaga.

2) Water quality

As shown in Figure 11 NO_3^- concentration of both sits was high. In Leuwiliang, high

concentration of NO_3^- could be due to upstream paddy fields. Fertilizer derived NO_3^- might be infiltrated into shallow ground water, which was source of spring water used for the monitored field.

In Darmaga, irrigation water flowed through residential area to the experimental plot. Thus, domestic wastewater polluted the irrigation water. As a result, the concentration of NO_3^- in Darmaga is high. Except NO_3^-, Ca and Mg all parameters are low.

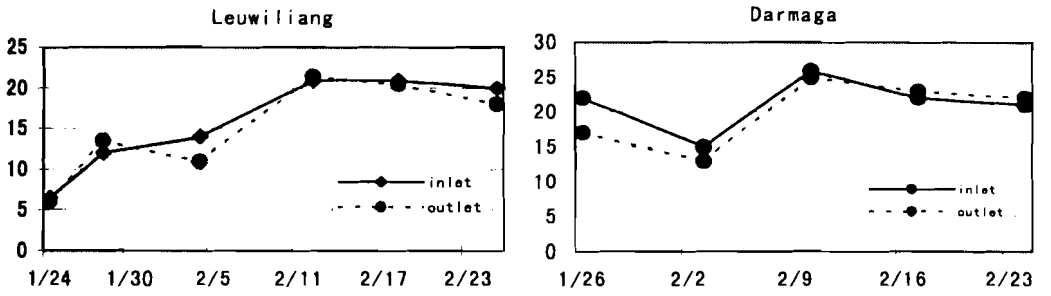

Figure 11. NO_3^-

In Leuwiliang impact of the paddy fields on water environments seemed to be also small. The concentration of water at inlet and outlet and also differences between inflow and outflow of nutrients on this field for P, K, Mg and Fe for Ca and Mg were quite small. This suggested that irrigation water did not supply nutrients to the crops as well as that the paddy fields were not source of nutrients load to down stream environment

Relative difference in concentration of inflow and outflow were o.71, -0.06, -0.01, 0.2, 0.11 and -0.01 in average respectively for NO_3^-, P, K, Ca, Mg and Fe for Leuwiliang. Relative difference in concentration of inflow and outflow were 1.2, 0.24, 1.68, 0.08, 0.49 and 1.17 in average respectively for NO_3^-, P, K, Ca, Mg and Fe for Darmaga.

A low unit harvest and sterility of rice in both fields cold be one of reason of these small differences of nutrients concentration. Considering with discussion of soil chemical properties, applying P may increase the harvest and decrease of sterility of rice. Furthermore, the good growth of rice cause more nutrients absorption then paddy fields have possibly to have good and positive effect for the water quality conservation.

CONCLUSION

Though monitoring period was not long enough, some characteristic trend from two different types of farming, Leuwiliang and Darmaga, was observed. In both sites NO_3^- concentration of inlet and outlet are high but differences of input and output mean balance, is small. So on both sites, neither adsorptions nor run off were occurred. In particular, water quality conservation effects and negative effects were not observed.

P of both sites shows sharp decline during growth stage. Moreover their fertilizer did not contain P; since farmer use organic manure for fertilizer in Leuwiliang and in Darmaga, farmer apply Urea. P could be one of the limiting factors of low unit harvest and sterility of rice in both site. Therefore applying P may increase the harvest and decrease of sterility of rice. Furthermore, the good growth of rice cause more nutrients absorption then paddy fields have possibly to have good and positive effect for the water quality conservation.

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