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Improving the Quality of Irrigation Water to the Implementation of Organic Ecological Agriculture in the *Subak* of High, Medium and Low Flats

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***Abstract* – The application of modern agricultural technology based on chemicals, such as the use of inorganic fertilizers, chemical pesticides and growth regulating substances, turned out to have a negative impact on agricultural resources. This will certainly have implications for the decline in agricultural production per unit area, in addition to other implications, namely the contamination of agricultural products with hazardous chemicals such as pesticide residues. In connection with this, some subaks in Bali who are at different altitudes (high, medium and low altitude) have made efforts to ensure that agricultural resources can be sustained and well maintained by applying organic ecological agriculture. This research was conducted to answer the problems how is the quality of irrigation water (Total Suspendid Soil, Total Disolved Solid, pH, Chemical Oxygen Demand, and Dimand Biochemical Oxygen), due to the application of organic ecological agriculture in the high, medium and low subak? The data collected in this study were sourced from laboratory analysis data, field data, and document studies. Data analysis was carried out with qualitative and interpretive descriptive, through three stages of the process namely data reduction, data presentation and conclusion drawing. Based on the results of the study it can be concluded that the application of organic ecological agriculture in the three subaks, both the highland subak (Subak Wangaya Betan), the medium plains (Subak Babakan) and the lowlands (Subak Bongan), have significant implications for the quality of irrigation water that is good (Total Suspendid Soil, Total Disolved Solid, pH, Chemical Oxygen Demand, and Demand Biochemical Oxygen).**

***Keywords* – Quality, Irrigation, Organic Agricultural, Altitude.**

I. Introduction

The application of modern agricultural technology based on chemicals, such as the use of inorganic fertilizers, chemical pesticides and growth regulating substances, turned out to have a negative impact on agricultural resources. This will certainly have implications for the decline in agricultural production per unit area, in addition to other implications, namely the contamination of agricultural products with hazardous chemicals such as pesticide residues (Reijntjes., at al, 2006). In connection with this, some *subak*s in Bali who are at different altitudes (high, medium and low altitude) have made efforts to ensure that agricultural resources can be sustained and well maintained by applying organic ecological agriculture.

In connection with this, one of the *subak*s in Tabanan Regency, Bali Province, namely Gunung Sari *Subak* and Wangaya Betab *Subak* as a traditional irrigation institution in Bali, has strived to ensure that the sustainability of agricultural resources and the environment can be sustained and well maintained, by re-implementing the ecological environment farming system (organic) (Yuliana, 2011). The application of organic farming can increase grain production by almost 50%, this at least indicates that there has been an improvement in the quality of agricultural resources. The strategy adopted by Gunungsari *Subak* members to maintain the sustainability of their agricultural resources is by applying two primary organic ecological agriculture, namely organic farming without using pesticides (non-pesticides), using 80% organic fertilizer and 20% chemical fertilizers (Yuliana, et al., 2014). Organic farming according to Yuliana (2010), Sutanto (2002) is agriculture which, in addition to being able to return most of what has been produced by nature in the form of organic fertilizer, also organic farming does not burden nature with harmful chemicals that endanger the ecosystem as a whole.

Next, Yuliana and Sitepu (2016) in their study of the effect of organic farming on pesticide residues on rice produced found that there had been an improvement in food quality due to the application of two prime organic farming in *subak* Wangaya Betan. Furthermore, Yuliana and Sitepu (2017), Wiguna et al (2016) declare brown rice and brown rice produced in *subak* Wangaya Betan do not contain harmful chemicals. In other words, hazardous chemicals (pesticide residues) in organic rice produced in the Wangaya Betan *subak*, were not detected and were below the lowest testing limit.

But until now there has been no clear implication of the implications of organic ecological agriculture applied in the two *subak*s both in the Gunungsari *subak* and in the Wangaya Betan *subak*, both of which are *subak* in the highlands, to the improvement of irrigation water. Furthermore, it is not yet known how the implications of the application of organic ecological agriculture will be applied at different altitudes, in this case the highlands, temperate plains, and lowlands, to irrigation water. It is suspected that the more downstream organic ecological agriculture is applied, the more polluted by non-organic wastes that flow together with the irrigation water flow, so that the implications will be different from the application of organic farming upstream. This is a very important and interesting issue to be studied further in order to do a mapping/cluster of organic ecological agriculture that is applied to different altitudes. On the other hand, it is not known how the implications of the application of organic ecological agriculture are applied at different altitudes (high, medium and low) to the quality of agricultural resources (soil and irrigation water) in terms of physical, chemical and biological properties, in order to support food independence. Starting from the above problems, a study was carried out that examined “Improving the Quality of Irrigation Water to the Implementation of Organic Ecological Agriculture in the *Subak* of High, Medium and Low Flats”. In this context the problem to be studied how is the quality of irrigation water (Total Suspendid Soil, Total Disolved Solid, pH, Chemical Oxygen Demand, and Demand Biochemical Oxygen), due to the application of organic ecological agriculture in the high, medium and low *subak* in Bali?

II. Research Methods

The approach used in this study is a quantitative approach combined with a qualitative approach. The study was conducted on three *subak*s who carried out organic ecological agriculture, each *subak* Wangaya Betan, Mengesta Village, Penebel Subdistrict, Tabanan Regency representing the *subak* in the highlands. *Subak* Babakan, Wanasari Village, Penebel Subdistrict, Tabanan Regency in the mediumlands. *Subak* Bongan, Bongan Village, Tabanan District, Tabanan Regency in the lowlands. The type of data collected in this study is quantita--tive data supported by qualitative data as supporting data. Data collection was done through techniques (1) laboratory analysis, (2) observation, (3) in-depth interviews, (4) document study. Samples of irrigation water are taken composite from a collection of populations (to three *subak*s). Laboratory analysis of irrigation water was carried out in the laboratory of Seameo Biotrof Bogor and UPT of the Bali Provincial Health Laboratory. Data analysis was carried out in descriptive qualitative and interpretive ways. The results of data analysis are presented informally in the form of descriptive analysis with descriptions/narratives, words, expressions, sentences that are good in accordance with scientific language that is easily understood and understood. Besides the data presented informally, the data is also presented formally such as the inclusion of maps, tables, photos and charts.

III. Result and Discussion

Water sampling for analysis was carried out on the irrigation water flow found in the highland *subak* (*subak* Wangaya Betan) seen in Figure 1, the medium land *subak* (Babakan *subak*) seen in Figure 2 and the lowland *subak* (Bongan *subak*) seen in Figure 3.

Fig. 1. Irrigation Water in *Subak* Highlands (Photo Documentation of Euis Dewi Yuliana, June 2018).

Fig. 2. Taking Irrigation Water in *Subak* Medium Land (Documentation Photo Euis Dewi Yuliana, June 2018).

Fig. 3. Irrigation Water in *Subak* Lowland (Photo Documentation of Euis Dewi Yuliana, June 2018).

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Based on the results of the analysis of irrigation water in the *subak* sourced from springs and the upper stream of Yeh Empas which then flowed as small rivers (Yeh Empas watershed), has been done with 9 different retrieval points (3 points in the upstream, 3 points in middle, and 3 points downstream) in each *subak* both in the high, medium and low *subak*. From 9 points of collection, then it is composite so that the research sample is obtained. Analysis of irrigation water is carried out at the UPT. Bali Provincial Health Laboratory Center, and obtained the analysis results presented in Table 1 below.

Table 1. Quality of Irrigation Water in *Subak* Highlands (*Subak* Wangaya Betan), *Subak* Dataran Moderate (*Subak* Babakan) and *Subak* Lowland (*Subak* Bongan).

Description	TSS (mg/l)	TDS (mg/l)	pH	BOD_5 (mg/l)	COD (mg/l)
Plateau	13 (S)	60.74 (S)	7.51 (N)	6.98 (S)	9.76 (S)
Medium Plains	20 (S)	90.16 (S)	7.80 (N)	14.98 (S)	29.28 (S)
Lowland	25 (S)	138.70 (S)	7.96 (N)	4.57 (S)	39.04 (S)

Source: Results of Research Data Analysis.

Information : S : Safe to use. N : Neutral.

3.1. *Total Suspendid Solid (TSS)*

Suspended solids or Suspended Solids (TSS) are insoluble solids, cannot settle directly, but cause turbidity. The amount of suspended solids is very dependent on the number of solid particles in irrigation water, which indicates the level of irrigation water pollution. Suspended solids consist of particles of smaller size and weight than sediments, such as clay, certain organic materials, microorganism cells, and others. Irrigation suspended solids in the highlands (*Subak* Wangaya Betan) 13 mg/l, in the lowland *subak* (*Subak* Babakan) 20 mg/l, and in the lowland *subak* (*Subak* Bongan) 25 mg/l seen from table 1 above. This means that irrigation water in the three *subak* above, has not experienced pollution due to the relatively small TTS content. Irrigation water TTS in the three *subak*s is much lower than the Class IV water quality standard for irrigation water that is permitted under the Bali Governor Decree No. 8 of 2007, which reached 400 mg/l. Even the TTS content of irrigation water in the three *subak*s above is also much lower than the water quality standards for Class I, II, and III, as stated in the Decree of the Governor of Bali No.8 of 2007, each of which is 50 mg/l, 50 mg/l, and 400 mg/l.

Whereas if we look at the TSS value from the highland *subak* to the lowland *subak*, there is an increase in TSS values from 13 mg/l in the highland *subak*, 20 mg/l in the temperate plains *subak*, and 25 mg/l in the lowland *subak*, occurring the increase in TSS value from upstream to downstream is thought to be due to the accumulation of suspended solids, but the TSS value is still below the quality standard (400 mg / l). The increase in the TSS value of irrigation water from upstream to downstream is due to the fact that the three *subak*s are *Subak* Wangaya Betan, *Subak* Babakan and *Subak* Bongan (from the highlands, medium to low), are in the same stream, namely the watershed (DAS) Yeh Empas.

3.2. *Total Disolved Solid (TDS)*

Total Disolved Solid (TDS) is a solid that has a smaller size than suspended solids. Inorganic and organic compounds which are soluble in water, minerals and salts including dissolved solids. Waste water generally has high TDS because of the many inorganic and organic compounds that dissolve in water, not even a few different types of heavy metals that dissolve in water can cause high TDS of water. The total dissolved solids of irrigation water in *Subak* Wangaya Betan are 60.74 mg / l, *Subak* Babakan 90.16 mg / l, and *Subak* Bongan 138.70 mg / l (Table 1).

Judging from the content of TDS in water, irrigation water in the three *subak*s both in the highlands (*Subak* Wangaya Betan), medium (*Subak* Babakan), and low (*Subak* Bongan) can be declared as not having experienced pollution, because the TDS value is much lower than the quality standard Class IV water is permitted under the Decree of the Governor of Bali No. 8 of 2007, which reached 2000 mg / l. Even the TDS content of irrigation water in the three *subak*s is also much lower than the water quality standards for Class I, II, and III, as stated in the Decree of the Governor of Bali No.8 of 2007, each of which is 1000 mg / l. The occurrence of an increase in the TDS value of irrigation water from the highland, medium to lowland *subak*, is thought to be caused by the accumulation of dissolved solids in irrigation water from upstream to downstream due to being in the same stream, namely the Yeh Empas watershed.

3.3. *Degree of Acidity (pH)*

The degree of acidity (pH) is one of the most important indicators in determining water quality, including irrigation water. The degree of acidity (pH) of water is very influential on all chemical reactions in water and at the same time to all life activities in the water, including aquatic plants and the growth of rice plants. According to the decision of the Governor of Bali No. 16 of 2016, concerning Environmental Quality Standards in the Bali Region, states that for Class IV water or water for irrigation purposes, it is permissible to have a pH between 5-9.

While the pH of irrigation water based on the results of the analysis of the three *subak*s with different altitudes has a neutral pH. Irrigation water *Subak* Wangaya Betan in the highlands has a pH of 7.51, the water of the *Subak* Babakan irrigation in the temperate plains has a pH of 7.80, while the *Subak* Bongan irrigation water in the lowlands has a pH of 7.96 (Table 1). The pH conditions of the irrigation water in the three *subak*s at different heights have increased from pH 7.51 (in the highlands), pH 7.80 (in the mediumlands), and pH 7.96 (in the lowlands), increasing the pH of the soil due to decreasing altitude in one watershed flow, presumably due to an increase in dissolved salt concentration along with the accumulation of dissolved salt in the lower plains, but all are in the normal range (neutral water pH), meaning that the water meets the requirements as irrigation water. In line with these conditions, it indicates that irrigation water in the Yeh Empas watershed (DAS) based on pH value can be declared safe for use as irrigation water.

3.4. *Biochemical Oxygen Demand (BOD_5)*

Biochemical Oxygen Demand *(BOD5)* shows the amount of dissolved oxygen needed by living things to break down or oxidize waste materials in the water. Aerobic creatures need oxygen for several biochemical reactions, to oxidize organic matter, cell synthesis and cell oxidation. Organic components containing nitrogen compounds can be oxidized to nitrates, while organic components containing sulfur can be oxidized to sulfate. The need for oxygen to oxidize the compound in water at a temperature of 20˚C for 5 days is called BOD5, which only counts 68% of the organic material oxidized. Thus the higher the water BOD5, indicating the more oxygen used to oxidize, in other words the water is increasingly polluted. According to the decision of the Governor of Bali No. 16 of 2016, concerning Environmental Quality Standards in the Bali Region, states that for irrigation water, the maximum allowable BOD5 value is 100 mg / l.

Based on the results of the analysis of irrigation water carried out in the laboratory, the BOD5 value for each irrigation water in the three *subak*s (Table 1) is 6.98 mg / l in *Subak* Wangaya Betan (*subak* in the highlands), 14.98 mg / l in *Subak* Babakan (*subak* in the middle plain), 4.57 mg / l in *Subak* Bongan (*subak* in the lowlands). This condition illustrates that irrigation water in all three *subak*s at different altitudes has a BOD5 value well below the maximum allowable limit (100 mg / l). Thus this water cannot be used as drinking water directly, but it is not problematic if it is used as irrigation water.

If the concentration of dissolved oxygen in irrigation water is low, followed by high BOD5, it can cause disruption of aquatic life, especially living things that are aerobic (need oxygen). In the end it will lead to increased life activities of creatures that are anaerobic (do not need oxygen), which will produce toxic substances such as ammonia, H2S and others, which often cause foul odors. This condition is clearly less profitable both from the aspects of productivity of agricultural land, and environmental health. The low oxygen in irrigation water also causes the low supply of oxygen into the soil so that it will disrupt the process of plant respiration, disrupting the life of soil fertilizers, such as earthworms and other microbes.

3.5. *Chemical Oxygen Demand (COD)*

Chemical Oxygen Demand (COD) is the amount of oxygen needed to break down all organic matter contained in water. COD describes the total amount of organic material in the water in this case in irrigation water. The difference in value between COD and BOD illustrates the amount of organic material that is difficult to decompose in the water. The value of COD is a measure of water pollution by organic substances which can naturally be oxidized through biological processes and can cause reduced oxygen dissolved in water. According to the decision of the Governor of Bali No. 16 of 2016, concerning Environmental Quality Standards in the Bali Region, states that for irrigation water, the maximum allowable COD value is 100mg/l.

Based on the results of the analysis of irrigation water carried out in the laboratory, the COD values for each irrigation water in the three *subak*s (Table 1) were 9.76 mg/l in *Subak* Wangaya Betan (*subak* in the highlands), 29.28 mg/l in *Subak* Babakan (*subak* in the middle plain), 39.04 mg/l in *Subak* Bongan (*subak* in the lowlands). This condition illustrates that irrigation water in all three *subak*s at different altitudes has a COD value well below the maximum allowable limit (100 mg/l). Thus this water is not problematic if it is used as irrigation water. The occurrence of an increase in the COD value of irrigation water from the highland, medium to lowland *subak*, is allegedly caused by the accumulation of dissolved solids (organic matter) in irrigation water from upstream to downstream due to being in the same stream, namely the watershed (Yeh Empas Watershed).

IV. Conclusions and Suggestions

4.1. *Conclusions*

The conclusions of this study are as follows. The application of organic ecological agriculture in the three *subak*s, both the highland *subak* (*Subak* Wangaya Betan), the medium plains (*Subak* Babakan) and the lowlands

(*Subak* Bongan), has significant implications for the quality of irrigation water (Total Suspendid Soil, Total Disolved Solid, pH, Chemical Oxygen Demand, and Dimand Biochemical Oxygen). Suspendid Soil Total Value is below quality standard (safe to use), Total Disolved Solid is below quality standard (safe to use), neutral pH, below quality standard (safe to use), Dimand Oxygen Biochemical is below quality standard (safe to use).

4.2. *Suggestion*

The suggestions from this study are as follows.

1. Considering the degradation of irrigation water quality, the application of environmental ecological agriculture must be implemented to improve the quality of irrigation water.
2. Further research is needed on the production and quality of rice produced.

Environmental ecological agriculture needs to be implemented in other *subak subak* in Bali, in addition to the three *subak*s where the research was conducted, in different watersheds.

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