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Organic rice farming: an alternative to sustainable agriculture

Hendro Putra Johannes¹, Cindy Rianti Priadi², Herdis Herdiansyah^{1,*}

¹School of Environmental Science, Universitas Indonesia, Jakarta 10430, Indonesia

²Department of Civil Engineering, Faculty of Engineering, Universitas Indonesia, Depok 16424, Indonesia

*Corresponding author : herdis@ui.ac.id

Abstract. As the key to sustainable development, water conducts significant contributions in contemporary environmental development challenges. However, water scarcity is still happening all over the world, including agrarian countries like Indonesia. In Indonesia, agricultural sector takes up to 70% to the national water consumption. In this sector, rice contributes to 69% of national water consumption of crop commodities. To address this issue, organic system comes up as an alternative by its potential in reducing water consumption. Moreover, in achieving sustainable agriculture, organic system is also addressing economic and social aspects. Therefore, this research aims to assess the sustainability status of organic rice farming in Sindangkerta Village, West Bandung, West Java, exploring the environmental, economic, and social aspects. In environmental aspect, organic rice farming consumes less water than the conventional, especially in its agricultural phases. This satisfying breakthrough is correlated with organic materials used, at the same time minimizing chemical substances that relates to less grey water footprint. Less grey water footprint impacts on less total water footprint, meaning less water consumption. Other practices such as water conservation also contribute. Compared to conventional rice farming, it saves about 30–50% of water consumption. In economic aspect the great number of economic valuation of organic rice seems useless because of the absence of market. To conclude, the organic rice farming in Sindangkerta Village is categorized fairly sustainable, therefore it can be a promising alternative to achieve sustainable agriculture.

1. Introduction

Sustainable development is presented to respond exclusive development paradigm on modern age. However, this breakthrough is facing environmental challenges due to the paradigm. Cartesian-Newtonian paradigm developed within past relation of human and nature has structured anthropocentrism, which illustrates human as single subject of rights [1]. Although new perspective of anthropocentrism states about the way to love self [2], it cannot be released from its true perspective as ceaselessly recurring thirst of human egoism [3]. The anthropocentrism is manifested to those environmental challenges happened all over the world. One of the main contemporary environmental challenges faced is water fulfillment.

As center of sustainable development [4], water conducts important contributions towards daily life. Water acts as environmental service to produce human nutritional intake, such as fish and other similar products [5]. Health problems caused by water fulfillment failure lead to loss time and opportunities for education and career [4]. Also, water becomes fundamental elements of industrial processes that produce



waste water which will disrupt the hydrological system [6]. The water fulfillment failure in quality, quantity, and continuity, disturbs the balance of three pillars of sustainable development [7].

However, those significant water contributions are threatened by phenomena of water scarcity. Around 4 billion of world population are facing severe water scarcity [8], centering in Africa and currently spreading to Asia [4]. Facing this issue, tracking around water consumption chain is essential. Agricultural sector takes up to 70% of world water consumption, followed by industrial sector (20%) and domestic sector (10%) [9]. As an agrarian country, Indonesia has similar proportion, especially in agricultural sector, since it covers 22% of the total national land [10]. In this sector as illustrated in Figure 1, rice dominates the proportion of water consumption (69%) among other Indonesia's main crop commodities [11]. Water consumption of Indonesia rice commodity is averaged around 3,473 m³/ton of production, compared to other commodities such as soy bean which is only 1,958 m³/ton, palm oil 853 m³/ton, or cassava 514 m³/ton [11]. The consumption is relatively high if compared with world average which is only 1,450 m³/ton [12]. Therefore, mitigation should be addressed in avoiding this water exploitation.

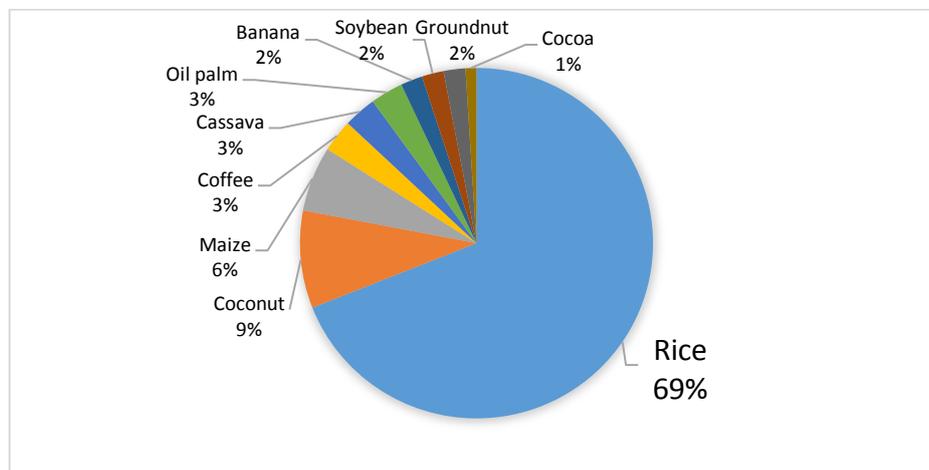


Figure 1. Contribution of water consumption of Indonesia's crop commodities [11]

Mitigation efforts to reduce water consumption in rice commodity have been done in several ways. One of them is integration of diet change and organic rice farming. Evaluation about this effort concludes that organic rice farming is more applicable, especially in Southeast Asia countries such as Indonesia [13][14][15]. The basic idea of organic rice farming involved in farming practices is the minimization of dangerous chemical substances used. It has been proved that intervention of organic farming reduces water consumption, especially amount of water to dilute chemical substances, of crop commodities [13][16]. However, there is little attention in implementing this organic farming, especially in rice commodity as the main crop commodity with the highest water consumption in Indonesia. This mitigation effort is critical to adapt, especially in Indonesia, since organic-based products have low popularity towards the society [17].

Not only supporting the environmental aspect of sustainable agriculture, organic rice farming should also contribute to economic and social welfare of local farmers around the society. To support economic welfare, challenges are varied in different economic attributes. One of them which is most challenging regarding the sustainable agriculture is economic valuation [18]. Meanwhile social welfare considers some social attributes like farmer empowerment, community development, and many more [19][20].

Considering all challenges faced, to gain popularity for being massively implemented, it is essential to assess the sustainability status of organic rice farming. Using the 'triple bottom line' terminology, this research will break the environmental aspect, as well as the economic aspect and the social aspect. In the end, the sustainability status will be generated as a quantification of in-depth interview results

regarding those three aspects. Hopefully, this research may globally contribute to sustainable agriculture implementation and locally inspire different stakeholders to take roles in reducing water consumption as well as improving local socio-economic conditions.

2. Method

The method includes the description of case study location and period. The exact location and period are chosen due to the theoretical need, of course considering all constraints in data accessibility, time availability, and budget supported. Last but not least, the method also includes the data collection and analysis.

2.1. Case study location and period

Considering the ontological reasoning developed in the previous section, this research is conducted as a case study in local society of Indonesia. Due to the limited organic rice farming in Indonesia, the organic rice farming considered in this research is purposively sampled. The case study is located at a 5000 m² rain-fed organic rice field in Sindangkerta Village, West Bandung Regency, West Java Province. The rice field is illustrated in Figure 2. The owner also as the farmer (name initial: SS) has run a fully-organic rice farming combined with System of Rice Intensification (SRI) since October 2007 under the guidance from Balai Besar Wilayah Sungai Citarum (BBWSC) and Agricultural Department of West Bandung Regency. This research is done within the period of October 2018 until March 2019. This is the period for the latest organic rice farming managed by SS in his farm. It includes the land preparation until the harvesting.



Figure 2. Organic rice field owned by SS in Sindangkerta Village

2.2. Data collection and analysis

The data is generally divided into three aspects, environmental aspect (based on water consumption), economic aspect, and social aspect. All aspects will be quantified as sustainability status by adopting scoring method of RAP+/MDS originated from fisheries sector [20][21][22][23]. Environmental aspect will have water consumption as single attribute. Meanwhile, based on initial interview (with initial name: AM, from BBWSC) and literature studies, the economic and social attributes are listed. The economic consists of 12 attributes, which are productivity, market availability, selling price, purchasing power, promotion, product quantity, production cost, revenue, capital independency, rice field area, market distance from rice field, and marketing chain. The social consists of 12 attributes, which are farmer knowledge, farmer awareness, farmer skill, number of farmers, farmer empowerment, social system, farmer community development, farmer communication pattern, role model significance, family support, local society awareness to healthy food, and local society health.

The scoring options are varied such (0, 1), (0, 1, 2), and (0, 1, 2, 3) with 0 as the lowest score and 1, 2, and 3 as the highest score respectively. Meanwhile, the indicators for scoring are varied based on the

attributes. Every attribute is scored after direct observation in rice field and in-depth interview with the owner (SS), field extension officer of Agricultural Department of West Bandung Regency (initial name: AAS), and several local farmers (initial name: T, S, M, D, and Y). Each attribute will then generate attribute value with Equation 1. Attribute weight for single environmental attribute is 33.33, for each economic and social attribute is 2.7775 (assuming equal weighting for three aspects and for each 12 attributes). The sum of all attribute values becomes sustainability value which must be converted to sustainability status based on Table 1.

$$\text{Attribute value} = \frac{\text{Attribute score}}{\text{Maximum attribute score}} \times \text{Attribute weight} \quad (1)$$

Table 1. Sustainability status category based on sustainability value [24]

Sustainability value	Sustainability status
0.00–25.00	Not sustainable
25.01–50.00	Less sustainable
50.01–75.00	Fairly sustainable
75.01–100.00	Very sustainable

3. Results and discussion

3.1. Environmental aspect

Previous studies have proved that crop commodities produced from organic farming consumes less water. Those studies indicate that less water consumption is achieved by less grey water footprint and water management.

Grey water footprint is calculating amount of water polluted regarding the farming process, especially due to the use of dangerous chemicals [25][26]. It becomes the water consumption which is eliminated by applying organic farming. In implementation for soy bean commodity in Canada, cultivation of organic soy bean saves up to 36.2% of water consumption of inorganic soy bean [13]. The use of chemical fertilizer and pesticides consumes lots of water, even dominating the total water consumption [27]. This is a significant invention towards the issue of water scarcity.

Another organic farming practice that correlates to water saving is water management. Not only managing the irrigation schedule towards the rice field, water management also includes water conservation and evaporation control [28][29]. Evaporation is vaporization from outside crop physiology. Organic materials contained inside soil act as storage for water. Therefore, crop will have enough water especially while facing dry season. This is a very simple practice of water conservation. Meanwhile, evaporation can be controlled by implementing mulch and shallow digging. Mulch will reduce evaporation and increase infiltration due to its coverage in top soil layer. Shallow digging will help to reduce the dry up of top soil layer. It is beneficial to stabilize the soil hydrology. These practices really support the way organic farming reduce water consumption. With such practices, it will be able to save around 30–50% of crop water consumption [30].

The results of this research are consistently in line with those studies. This claim is supported by informant AM, SS, and AAS. Informants agree that organic rice farming consumes less water than the conventional. Organic materials are essential to enhance naturalization of the soil after being massively polluted due to exploitation for years. To gradually enhance this movement, according to SS, farmers are empowered to use easy-to-find organic materials in small scale, then expanse the scale step by step. They may start using poultry manure as fertilizers since most of them raise chickens and sheep. Poultry manure will be a good substitute for cattle manure. To complete this organic materials, farmers may try organic pesticides simply fermented from indigenous plants around the organic rice field. The idea is to use natural enemies to prevent killing natural predators from the field. In other words, this organic materials prevention will conserve the natural food chain happened in the field. The most familiar species to use as organic pesticide around the field is *Mucuna pruriens* (velvet bean, Figure 3). This species can be easily cultivated and has high resistance because of the suitable topography of the field.



Figure 3. Velvet bean cultivated around organic rice field

Informant AM said that the organic farming practice includes water minimization due to soil conservation. The saving is not about the direct water consumption from rain water, but about how the water can be stored as long as possible in soil to fulfill the farming needs. The argumentation is also completed by SS after explaining about the phenomena of top soil crack. Before applying organic farming, SS used to experience top soil crack while still adopting the conventional farming. The rain water supply is not used optimally and just becoming run-off. When the rain was stopped for 1 weeks, the soil then dried out and ended to crop failure. Last but not least, AAS stated that the organic farming helps soil to maintain the water reserves. Also, AAS implicitly argued that organic farming will minimize the dangerous chemical expose through water. To sum up, the attribute value and sustainability value for this attribute are stated in Table 2.

Table 2. Attribute score and value of environmental aspect

Attributes	Score options	Indicators	Score	Attribute value
Water consumption	0, 1	(0) organic > conventional; (1) organic < conventional	1	33.33
Total attribute value for environmental aspect				33.33

3.2. Economic aspect

The attribute value and sustainability value for attributes of economic aspect are stated in Table 3. Some attributes have the highest score such as productivity, selling price, and production cost. In the other sides, several attributes have the lowest score such as purchasing power and rice field area. The rest vary in the middle value of score options. This score variation indicates fundamental problem in achieving economic for sustainable agriculture.

Organic rice farming owned by SS has no problem about the productivity. As implied by BBWSC (BBWSC, 2012), AM, and AAS, productivity will decrease in the phase of transition from conventional to organic farming. It takes up to 3-year period (with biannual plantation period) before it goes back to normal productivity. The normal productivity itself is much higher than the conventional. According to SS and D, organic rice farming has productivity more than 3 tons per 5000 m³ (equals to 6 tons per ha) in form of dried grain. This statistic is much higher compared to local conventional farming productivity which is at the maximum rate of 4 tons per ha. In correlation with this, organic rice also has higher selling price compared to the conventional. According to a simulation of economic valuation, organic rice has selling price more than IDR 11,538.46 compared to the conventional which is only above IDR 8,461.54. This valuation corresponds to fewer production cost and higher revenue for farmers. As explained by SS, T, D, and Y (at different times), production cost is minimized due to the use of organic

materials, produced by the farmers. In other words, it will eliminate the cost for purchasing chemical fertilizers and pesticides. Organic materials used are cattle manure for compost as solid fertilizer; cattle urine, rabbit urine, together with bamboo shoots, banana pudding, or fruit waste fermented in coconut water as liquid fertilizer; organic pesticides made from *Mucuna pruriens* (velvet bean, illustrated in Figure 3), *Dioscorea sp.* (yam), *Zingiber cassumunar roxb* (bangle), or tobacco; also the use of fuchsia flowers to invite insects that are natural enemies of local pest. The philosophy in applying the organic materials is prevention not treatment. In other words, the materials should be as along the farming as a preventive action.

Table 3. Attribute score and value of economic aspect

Attributes	Score options	Indicators	Score	Attribute value
Productivity	0, 1, 2	(0) organic < conventional; (1) organic = conventional; (2) organic > conventional	2	2.7775
Market availability	0, 1, 2, 3	(0) no market; (1) limited domestic market; (2) guaranteed domestic market; (3) international market	1	0.9258
Selling price	0, 1, 2	(0) organic = conventional; (1) organic is higher 0–25% from conventional; (2) organic is higher >25% from conventional	2	2.7775
Purchasing power	0, 1, 2, 3	(0) very low; (1) relatively low; (2) relatively high; (3) very high	0	0
Promotion	0, 1, 2, 3	(0) no promotion; (1) mouth-to-mouth; (2) social media; (3) varied promotion media	1	0.9258
Product quantity	0, 1, 2, 3	(0) no stock; (1) few; (2) moderate; (3) many	1	0.9258
Production cost	0, 1, 2	(0) organic > conventional; (1) organic = conventional; (2) organic < conventional	2	2.7775
Revenue	0, 1, 2, 3	(0) organic < conventional; (1) organic = conventional; (2) organic slightly > conventional; (3) organic far > conventional	2	1.8517
Capital independency	0, 1, 2	(0) still depends on external capital; (1) depends partially on external capital; (2) not depend on external capital	1	1.38875
Rice field area	0, 1, 2, 3	(0) very few; (1) few; (2) quite many; (3) many	0	0
Market distance from rice field	0, 1, 2	(0) far (>2 km or >60 minutes); (1) moderate (1–2 km or 30–60 minutes); (2) close (<1 km or <30 minutes)	1	1.38875
Marketing chain	0, 1, 2	(0) no marketing; (1) retailing in local markets; (2) partnership with supermarkets	1	1.38875
Total attribute value for economic aspect				15,27625

However, the ‘great’ statistic before is not supported by the market. The market is still limited to the local market. Market still finds no significant factor in economic development. The health and environmental reasoning are still not effective to gain more consumers, especially local consumers who are still struggling for life. The socio-economic condition has become the biggest constraint in implementing organic rice farming further consuming organic rice. Local farmers as said by T, S, and M, only have the ability to purchase the cheapest price for daily consumption. This reality is captured by the organic rice field area which is very few in that area (as stated by SS, he is the only farmer who

consistently runs this practice in the village). This reality tends to be the biggest challenge since the promising economic valuation of organic rice becomes useless because of the absence of market.

3.3. Social aspect

For social aspect, the attribute value and sustainability value for the attributes are stated in Table 4. Most of the attributes are scored as the minimum score and as the maximum score. The maximum scores are generated from farmer knowledge, farmer skill, farmer empowerment, social system, role model significance, and local society health. In contrast, the minimum scores are driven from farmer awareness, number of farmers, and local society awareness to healthy food.

Table 4. Attribute score and value of social aspect

Attributes	Score options	Indicators	Score	Attribute value
Farmer knowledge	0, 1, 2	(0) not enough; (1) enough; (2) more than enough	2	2.7775
Farmer awareness	0, 1, 2	(0) not enough; (1) enough; (2) more than enough	0	0
Farmer skill	0, 1, 2	(0) no skill; (1) limited skill (need assistance); (2) very skillful (no need assistance)	2	2.7775
Number of farmers	0, 1, 2	(0) few; (1) moderate; (2) many	0	0
Farmer empowerment	0, 1, 2, 3	(0) no empowerment; (1) rarely; (2) frequently; (3) routinely	3	2.7775
Social system	0, 1, 2	(0) individual; (1) family-engaged; (2) community-engaged	2	2.7775
Farmer community development	0, 1, 2	(0) less developing, no significant activities; (1) quite developing; (2) engaged in distribution to the market	1	1.38875
Farmer communication pattern	0, 1, 2	(0) ineffective communication; (1) local communication; (2) cross-regional communication	1	1.38875
Role model significance	0, 1, 2	(0) no significant contribution; (1) ordinary contribution; (2) significant contribution	2	2.7775
Family support	0, 1, 2, 3	(0) no support; (1) less support; (2) support; (3) very support (proactive)	2	1.8517
Local society awareness to healthy food	0, 1, 2	(0) no awareness; (1) still low awareness; (2) high awareness	0	0
Local society health	0, 1, 2	(0) there is an event of death or disability due to dangerous pesticides exposure; (1) there are symptoms of health problems regarding dangerous pesticides exposure; (2) no significant health problems in past years	2	2.7775
Total attribute value for social aspect				21.2942

The maximum scores indicate that local farmers have enough social capital to implement organic rice farming by themselves. According to SS and T, farmers have knowledge, skill, empowerment, social system, also supported by role model and family. However, the most challenging problem is the awareness. All farmers interviewed (T, S, M, D, and Y) has limited awareness to apply organic farming even to consume organic products. Movement always done by government by giving support on seeds

and fertilizers, but it remains only as short-term movement. This kind of movement remains unsustainable, farmers come back to the conventional way. Unfortunately, this is the reality. They do not have enough trust to join the movement and have no brave to take the risk. Although this movement has been proved successful by SS, too much obstacles are guarded them in doing transition.

3.4. Sustainability status

Based on the total attribute value for the three aspects (calculated from Table 2, Table 3, and Table 4), it comes the final result of sustainability value of 69.90045. According to Table 1, the value can be converted to sustainability status of fairly sustainable. Although this result is quite satisfying, there are too much rooms for future improvement. Sustainable agriculture is not always about environment. The optimum balance of the three aspects is the key. Economic and social aspects should be engaged more effectively by understanding the real society condition and improving local knowledge as basis. Society is the only one who knows their own condition. Movement should be managed bottom-up, by enhancing local role models as agents of changes.

4. Conclusion

From the literature studies, direct observation, and in-depth interview conducted, it can be concluded that the organic rice farming in Sindangkerta Village has sustainability value of 69.90045 and categorized as fairly sustainable. Further improvements should focus on economic aspect as well as social aspect to be able to create an optimum balance. However, organic rice farming that utilizes organic materials has been proved as a promising alternative to sustainable agriculture.

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