Organic farming system of cocoa plantations in South Malang, Indonesia

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Abstract. Malang Regency is one of the cocoa producers in East Java, Indonesia with an area of more than 3,000 hectares. Some cocoa plantation in Malang have implemented organic farming systems. The purpose of this study was to reveal the organic farming process and system of cocoa plantations in South Malang. This research was conducted in Sumbermanjing Wetan Sub-district from May to July 2020 with a survey method of 40 respondents, selected by snowball sampling. The results showed that 97.5% of farmers understood about organic farming systems. Most of their knowledge comes from field instructors and fellow members of farmer groups. The practice of organic farming that they do is by using organic fertilizer derived from manure, compost, and liquid organic fertilizers. Furthermore, farmers also use 16 plant species as botanical pesticides. In pest control, 65% of farmers also understand the importance of natural enemies. One of the most popular natural enemies is the weaver ants (Oecophylla smaragdina) or as a pest control Tea mosquito bug (Helopeltis antonii). Type of effort to preserve: preparing special trees, making nests, leaving them alive and breeding, and avoiding sprayed with pesticides. However, farmers still undergo obstacles such as field maintenance and processing, less effective pest control, expensive of market bio-pesticides price products, declining crop yields, and marketing difficulties.

Key words: biological control, cocoa, organic farming practice, organic fertilizer

1. Introduction
Indonesia is the fifth largest cocoa producer in the world, after Ivory Coast, Ghana, Ecuador, and Nigeria. In Asia and Pacific, Indonesia is the 1st ranked producer of cocoa, with an annual production of approximately 240,000 tones and contribute 73% of cocoa from this area [1]. In the past 10 years the performance of cocoa production has tended to decline. This is indicated by the decrease in the area of cocoa plantations, followed by the decrease in production and export volumes. However, this situation has not altered the cocoa position as the one of the important plantation commodities because its substantial role for the national economy [2]. This is mainly as a provider of employment and as the third largest source of foreign exchange from the plantation sub-sector after rubber and palm oil [3].

Since it was first introduced in Indonesia, the green revolution developed into a conventional farming system including cocoa plantations which have high production characteristics but have a
significant impact on health and the environment [4]. Ecological impacts are faced by communities at local, regional and global levels, because of the application of chemical pesticides and fertilizers. In the last five years efforts to change the agricultural system from a conventional system to a more environmentally friendly system have been initiated. Organic systems are considered environmentally friendly agriculture systems for producing foods and have received environmental-payments for conserving biodiversity [5,6]. However, this system is considered by farmers and practitioners to be deficient due to lower yields and product quality. This results in lower incomes than conventional farmers. However, this situation was not always supported by several studies. Long-term research results in the Alto Beni region of Bolivia show organic cocoa farming reaching higher trees and plant diversity, yields, and income, as well as more social connectivity [7]. Therefore, organic farming has been acceptable as fundamental alternative system [8].

Efforts to conserve conventional towards organic systems in Indonesia are often not optimal. One of the obstacles is the inefficient management of agricultural land and the low incentives that cause this business to have a great dependence on the farmers' own business. In addition, the agricultural research agenda is often organized and implemented without systematic participation and consultation with farmers. The majority of research on cocoa development strategies is related to industry and business [9,10,11]. While the study of cultivation and pest control, is generally still done at a laboratory and demonstration scale. Until now there has been no study of strategies related to cultivation, pest control and fertilization. Malang Regency is one of the cocoa producers and received guidance from Research Institute of Plant Germination and Plantation Protection. There are a lot of effort from this research institute and local government to foster the cocoa production with special attention to organic system. The purpose of this study was to analyze the organic farming process and system of cocoa plantations in South Malang.

2. Method of implementation
This research was conducted in Sumbermanjing Wetan Sub-regency, Malang Regency, east Java, Indonesia from May to July 2020. This area was selected because most farmers had participated in the training and implemented their knowledge in their fields. The survey research was carried out by distributing questionnaires to farmers. Respondents were chosen by snowball sampling starting with the head of the farmer group. A total of 40 respondents were contributed to the questionnaire. The questions on the questionnaire consist of 10 closed questions and 10 open questions which revolve around four things, namely the practice of fertilizing, pest control, the role of government and marketing. After the data has been collected, the validity test of the data was done by the triangulation of sources and triangulation methods, based on interviews with 2 field instructors. Data was analyzed descriptively.

3. Result and discussion
Of the 40 respondents who responded, 5% were female, 95% male. The education level of the respondents is relatively low, i.e. 80% have the education level of elite school or junior high school. The average age of farmers is 48% years and has an experience of 17 years. The majority (97.25%) of farmers understand about organic farming systems. Their knowledge generally comes from field counselor (30%) or from members of farmer groups (Figure 1). Their knowledge of organic fertilizers and pesticides on the market is low (16%). The majority of farmers are not aware of organic fertilizers and pesticides on the market (52%) (Figure 2).

Farmers in Indonesia generally have low levels of education and technology adoption. This situation has an impact on the low efficiency of resource use [12,13]. However, with an increase in efficiency, Indonesia can increase its comparative advantage in marketing cocoa production and exports. Therefore, some effort to improve the cultivation system must be incorporated with the development of the whole system from field production to industry.
The majority of farmers (97.5%) understand the raw material resources from the environment for making organic pesticide or fertilizer by their self. Types of surrounding materials are commonly used as fertilizer include manure, leaves or litter, liquid fertilizer (with local microorganism as decomposers), biological fertilizer. The farmers also use those of 16 plant species as botanical pesticides. Types of surrounding materials as botanic pesticides: lemongrass, beard-tree, betel, cloves, husks, wild yam, sour sop, derris, neem, banana leaves, water hyacinth, mahogany seeds. Most of the farmers know about natural enemies (65%) (Figure 3a) and 70% have an effort to conserve these (Figure 3b). A research conducted in India shows that the Majority of cocoa farmers have a medium level of knowledge about organic farming practices. Knowledge of farmers on biocontrol agents (35%), botanical pesticides (33.3%) and biofertilizers (31.7%) were recorded. Their knowledge was influenced by variables like, education, social participation, extension orientation, mass media exposure and training attended were found to have positive and significant relationships with knowledge on organic farming practices [14].

Farmers in southern Malang only know one type of natural enemy, namely weaver ant (Oecophylla smaragdina). This ant was known as a natural enemy for controlling Tea mosquito bug (Helopeltis antonii). A study in Australia support this finding. The ants are common natural enemy for controlling of Helopeltis spp. and Amblypelta spp. The ants also reduced the densities of R. nitides in the absence of cacao fruit husks. In contrast, ants are generally increased the densities of mealybugs [15]. There are many other natural enemies in controlling mealybugs. The major predators belong to the families Cecidomyiidae and Coccinellidae. Two primary parasitoids, Leptomastix dactylopii, Coccidoxenoides perminutus [16]. Though only a simple effort, the farmer in South Malang has
known and practiced the natural enemies preserve: preparing special trees, making nests, mulching, leaving them alive and breeding, not sprayed with pesticides. Mulching and use of green leaf manure were the main agronomic practices. Main organic inputs which were produced or prepared at the farm were, farm yard manure, crop residues, cow dung slurry, ash and vermicompost. Farm yard manure, neem cake, biofertilizers, goat manure etc. were the major inputs which were purchased from the market.

Perception on the organic farming benefits were quite diverse. Less than one third of the farmer feel that there was no benefit of organic farming (30%), other responded that the benefit was improving the experience and awareness (25%), provide safe and healthy food, productivity and fertility (12%) and others (Figure 4). Government effort was considered as very good (57.5%) and good (25%) (Figure 5). Type of role: providing counseling, training, tool assistance, organic fertilizer/pesticide assistance. Farmers in India showed that one fifth of farmers had undergone training on organic farming, soil testing was done by nearly 31 per cent farmers and very few farmers (5%) had done organic certification [14].

![Figure 4. Farmer perception on organic farming benefits](image4)

![Figure 5. Farmer perception on government supports](image5)

As a new five-year system, the cultivation system often encounters several problems. Among the farming obstacles in South Malang included: difficulty of field maintenance and processing, less effective pest control, expensive of market bio-pesticides price products, declining crop yields, and marketing difficulties. Marketing is a common problem faced by organic agricultural products, such as rice. The knowledge of farmers about the organic cultivation system was actually enough. several studies have examined strategies to increase production and marketing including sustainable development of farmers and the improvement of cooperation with other farmer groups that have implemented organic farming systems as well as with other stakeholders [17]. The availability of technology is also important to utilize infrastructure and market demand and minimize pest attacks to utilize climate in accordance with cocoa [18]. Other study recommends to increase the independence of farmers through coaching and counseling, development partnerships in agro-industry activities in an effort to add value to commodity production cocoa and strengthen farmer groups and optimize the role of associations [9,10].

4. Conclusion
The results showed that 97.5% of farmers understood about organic farming systems. Most of their knowledge comes from field instructors and fellow members of farmer groups. The practice of organic farming included the use organic fertilizer derived from manure, compost, and liquid organic fertilizers. Furthermore, farmers also use 16 plant species as botanical pesticides. In pest control, 65% of farmers also understand the importance of natural enemies. One of the most popular natural enemies is the weaver ants (Oecophylla smaragdina) or as a pest control Tea mosquito bug (Helopeltis antoniii). Type of effort to preserve: preparing special trees, making nests, leaving them alive and breeding, and avoiding sprayed with pesticides. However, farmers still undergo obstacles such as field
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