IPM on organic estate crops: opportunities and challenges

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Abstract. An obstacle in Indonesian crop estate products marketing abroad is the contamination of chemical pesticide residues and heavy metals. Implementing integrated pest management (IPM) and organic certification on estate crops are applied to meet consumer demands for healthier, quality, and safer products. Seventy-four of the 2351 certified organic products registered at Competence Authority of Organic Food, MOA, are primary and processed products from 12 estate crops commodities, i.e. cashew, cinnamon, citronella, coffee, cocoa, coconut, kapok, palm sugar, nutmeg, pepper, tea, and vanilla. In the organic certification process, pest control is carried out integrated by combining various environmentally-friendly control components, available in the garden environment, and/or organic certified commercial biopesticides, no synthetic chemical pesticides. Farmers' experience has shown that plant pests are relatively easy to control, while plant diseases with high damage intensity and fast spreading were difficult to control and plants must be eradicated. Therefore, a more innovative integrated pest control technology is needed to carry out organic certification in estate crops.

Keywords: organic farming, integrated control, organic certification, pest control, safety

1. Introduction

Sustainable and environmentally friendly agriculture is increasingly trending and is widely practiced today as an effort to meet the demands of the community for good quality, healthier, and safer products for consumption. Various regulations, which were set to apply globally, regionally, and locally, have been made and applied in the production and international trade of agricultural commodities, including plantations, and serve as prerequisites for product acceptance by consumer countries. One aspect of concern in establishing the regulation is the effort to minimize chemical pesticides and heavy metals residues that have the potential to endanger consumer health if they are present or carried in food raw materials when exported to destination countries. The content of pesticide residues and heavy metals that are above the threshold set by the importing country often becomes an obstacle in the cross-border trade of agricultural products.

Indonesia as one of the main producers of several estate commodities needed by people in various parts of the world has also responded to this issue. There are 16 national superior estate commodities developed in Indonesia, 11 of which are raw materials for food, medicine, and cosmetics that are exported to foreign countries, including palm oil, coconut, coffee, cocoa, cashew, cloves, pepper, tea, nutmeg, sago, and patchouli. These eleven commodities were cultivated in various regions in the Indonesian archipelago. Their products were sent to foreign countries with export values in 2019 reaching USD 18.64 billion [1]. Production of estate commodities generally fluctuates, influenced by several factors including the condition of old plants, the throbbing of environmental factors, both biotic and abiotic, and less optimal implementation of Good Agricultural Practices (GAP).
On the other hand, export destination countries for Indonesian estate commodities also apply strict regulations related to product safety, which limits the minimum residue content (MRL) of chemical pesticides, heavy metals, toxins, and polluting fungi, which are set to protect consumers in these countries. Within the scope of global trade, several environmentally friendly and sustainable agricultural certifications for estate crops products, including coffee commodities that have been compiled and applied include Organic, Fair Trade, Rainforest Alliance Certified, SA 8000, and UTZ [2]. This paper presents an overview of the role of IPM (Integrated Pest Control) in organic estate crops as an integrated effort to meet consumer demands for healthy and safe nutritious food.

2. Organic farming on estate crops

Organic farming is an alternative solution to obtain healthily and safe food by implementing a holistic production management system that improves the health of the agroecosystems, including biodiversity, biological cycles, and soil biological activity [3]. One of the regulations applied regarding the application of organic farming is organic certification, which is a quality assurance and internationally initiated by FAO. Each country, that ratifies the standard, also establishes its national organic regulations, such as the USA (NOP), Canada (COR), Australia (NASA), Japan (JAS), Indonesia (SNI 6729:2016), as well as for certain regions, such as European Union (EUREPGAP) and ASEAN (ASOA). In Indonesia, organic certification is coordinated by BSN, and specifically for agricultural commodities is regulated and managed by the Organic Food Competent Authority (OKPO), which is under the Food Security Agency, the Indonesian Ministry of Agriculture.

Organic farming regulations in Indonesia have been regulated via SNI 6729:2016, Decree Minister of Agriculture 64/2013, and Decree Director of Indonesian Drug and Food Agency (Perka BPOM) HK.00.06.52.0100/2008. Estate crop cultivation operators have responded, in an effort to meet the demands of consumers at home and abroad for certified organic estate commodity products. Currently, 13 local and foreign Organic Certification Bodies (CBs) have been registered and recognized that also operate in Indonesia, and 2351 organic certificates for agricultural commodities registered at the Ministry of Agriculture’s OKPO, of which 74 pieces (3.15%) are for estate commodities, and 53 certificates for imported organic commodities. Some of the main estate commodities that have received Indonesian Organic certificates include coffee, tea, cocoa, cashew, coconut, palm sugar, nutmeg, cinnamon, pepper, vanilla, citronella, coconut wood vinegar, and kapok [4].

Contamination prevention is also important in organic farming cultivation. Contamination may come from agricultural equipment used, contiguous adjacent conventional land, water sources, and post-harvest processes. Agricultural equipment must be separated between equipment used for conventional farming using chemical inputs with organic farming. Water pollution occurs if the source of water that enters the organic area passes through or comes from non-organic land, households, industrial water waste disposal, and irrigation canal. To prevent that condition, it is necessary to make a filter pond with an area of 0.1% of the cultivated area with a minimum depth of 60 cm. The aquatic plants should be planted in the ponds to reduce water contaminants, such as Eichhornia crassipes, Pistia stratiotes, Ipomoea aquatic, and others. On the other hand, if possible, look for water sources that can come from springs that are channeled directly to organic gardens, or it can be if the water source comes from rainfall. The spraying pesticide effect from adjoining non-organic areas can be reduced by making natural or artificial barriers or buffer zones. Barrier height must be dense and relatively high. While the ‘buffer zone’ was planted with a similar organic cultivation plant or other plants with a width of at least 2 m. Buffers zones include trenches, drainages, rivers, or roads that are at least 3 m wide[5].

The following is a summary of the procedure for registering and certifying organic agriculture by the Organic Certification Bodies (CBs) [6]. In the organic certification process, organic farming operators need to prepare various required documents, including: a) Identity of organic operator (individuals, companies, farmer groups), office addresses and farm locations, legal status, scope of certification (fresh plants, plant products, or their processed products), number of farmers involved, certified area, annual production estimates; b) The list of farmers who are approved to enter the
organic certification process, could be all members of the farmer group or selected farmers who agreed to participate in the certification process, the list contains the name of the farmer, the location of the garden, the area of the garden, the number of plants (which have produced, and have not yet produced), the number of livestock owned; c) location map, showing the position of each estate crops or factory in an area as well as transportation routes to that location, d) garden map, showing the layout of the estate crops proposed to be certified, equipped with land boundaries, irrigation facilities, places of manufacture of production facilities (seeds, organic fertilizers, botanical pesticides, biological agents), location of post-harvest processing and storage, e) land history for the last 3 years legalized by local authorities, including block names, cultivation activities, last time using synthetic chemical production facilities, f) organizational structure and job descriptions from administrators, internal organic standards, internal control system (ICS) organization, if the number of group members entering the certification scheme is relatively large (≥10 farmers); g) Standard Operating Procedures (SOP) for cultivation, manufacture of production facilities, processing, packaging, storage, product transportation, h) Farmer's records-keeping (cultivation schedule, number of harvests, number of sales, list of consumers), i) other supporting documents. In the organic certification activity, documents related to the implementation of IPM were included in the Cultivation SOP[6].

By following per under, the provisions of SNI 6729: 2016, the validity period of organic certificates is 3 years, with the obligation to carry out annual surveillance by the CB that issues organic certificates, and after 3 years recertification is carried out. To pass and be recognized for its organicity, in the certification process it must be demonstrated and documented the production process using permitted materials and methods in organic farming. Broadly speaking, the process of plant cultivation and post-harvest is prohibited from using genetically engineered materials, and synthetic chemicals that are prohibited in SNI 6729-2016, especially synthetic chemical fertilizers and pesticides.

The development of organic agriculture in the estate crops environment is one of the efforts in realizing safe and healthy products, as well as to realize an increase in added value, competitiveness and market share of Indonesian estate products. The Organic Plantation Village development program is one of the main activities of the Directorate General of Plantations for the 2020-2024 period [7]. However, in the current OKPO database of the Ministry of Agriculture (2021), of the 14 main estate commodities, coffee is the most product that received organic certificates (34 products), followed by tea (13 products) and nutmeg (8 products), while other commodities only received a little number of organic certificates, some even have only 1 organic operator, and the only organic estate products imported to Indonesia were only cocoa [4]. In the OKPO database, for the time being, there are no cocoa businesses listed with organic certificates. Several years ago, 4 organic cocoa organic operators received organic certificates from one of the LSOs [8], but the validity period of their organic certificates was not extended, for some reason or other, they did not carry out surveillance.

On the other hand, perhaps because the business opportunity is good, organic coffee is currently the only major beverage category present in Indonesia, which registered a value growth of 9.0% in 2019. The potential for organic products seems positive in the long term, leading to a forecast value CAGR of 3.5% with a growing number of consumers interested in organic products and an emerging economy in Indonesia for the period 2019-2024 [9].

At the international level, organic products get a premium price, priced more expensively, because apart from being considered healthy products, consumers are also willing to give more prices as a form of appreciation for organic producers who have cultivated environmentally friendly cultures, so they are considered environmental heroes [10]. It is hoped that with organic certificates, the competitiveness of Indonesian estate products can be increased to provide added economic value for farmers and other business actors involved in the production and trade of these organic products.

3. IPM on organic estate crops

From biotic factors, pest attacks (plant-disturbing organisms) are often an obstacle in the cultivation of estate commodities. The government c.q. the Ministry of Agriculture has established various policies and facilitated the facilities and infrastructure needed for the successful cultivation of estate crop
commodities, such as procurement of superior seeds, assistance for production and processing facilities, preparation of various guidelines, including GAP which includes IPM. The government, c.q. the Ministry of Agriculture has organized socialization, training, and technology transfer for the application of IPM by farmers through the IPM Field School (SLPHT) on six estate crops commodities (pepper, coffee, tea, cocoa, cashew nut, and cotton) through the IPM for Smallholder Estate Crops Project (IPMSECP), with the facilitation of ADB (Asian Development Bank) funds which was carried out in the period 1996–2008 [11]. It is hoped that through learning as well as practice, farmers can understand and implement it more easily so that they become IPM experts in their gardens. It was reported [12] that the implementation of IPM on coffee plants in East Java could increase the profitability and quality of coffee beans, while the price of coffee at the farm level significantly influenced farmers to implement IPM and increase farm income.

In general, the concept of IPM on estate commodities is directed for using environmentally friendly technology assemblies to produce quality estate products that are safe for consumption while preserving the environment. The government has facilitated the preparation and determination of the GAP for several estate commodities through the Decree of the Minister of Agriculture of the Republic of Indonesia, including the GAP for coffee, cocoa, tea, and patchouli. These GAP documents, if necessary, will be revised following the development of policies and issues related to the commodity in question, as well as to adopt developments in cultivation technology to support increased production and quality problems, some of which are relatively difficult to control in environmentally friendly ways, thus depending on the use of chemical pesticides. This is of course at risk of finding chemical pesticide residues in the resulting product. Another impact due to the continuous use of chemical pesticides for a long time is the resistance of the target pest to the chemical pesticides used. The use of chemical fertilizers to increase productivity and quality also has the potential to leave traces of heavy metals. In the organic certification, of course, the use of these synthetic chemicals will prevent obtaining an organic certificate for the proposed commodity.

Some pests that are present and live in plant parts such as roots, stems, and fruits, their control requires extra effort. On the other hand, although some effective synthetic chemical pesticides are available and registered, their use is prohibited in organic farming. However, the experience of organic farming operators shows that certain estate crop’s pests can be controlled with IPM, while for specific pests that have been already attacked on a large scale and with high intensity, they must use chemical pesticides or destroy plants mechanically. Environmentally friendly technological innovations are still needed to control diseases of the main estate commodities such as stem rot in pepper plants, wood vascular bacteria in clove plants, vanilla stem root, and root fungus in nutmeg. Several existing IPM technology innovations such as resistant varieties, the use of biostimulants and probiotics for resistance induction, and direct pest control were needed to be developed and improved.

In the organic estate crops product certification, the application of IPM with natural control components is a necessity and a must. If for fertilization there are many options for using natural ingredients, both from the environment around the garden and from commercial products, which must be certified and labeled organic, then for pest control sometimes certain difficulties occur. If this last condition occurs, the garden or estate crops that use synthetic chemical agro-input cannot pass the organic certification process. Likewise, varieties that are resistant to certain pests but whose seeds are Genetically Modified Organisms (GMO) are not permitted to be used in organic farming systems according to SNI 6729:2016.

Pest control is one of the crucial aspects of organic farming in realizing environmental security and sustainability. Therefore, a holistic approach to the entire agricultural system is needed in determining the control tactics that will be selected. The control components are (1) cultivation control, (2) physical control, (3) botanical pesticides, (4) biological control, (5) trapping plants, and (6) supporting regulations [13].

Why there are only a few Indonesian estate crops products certified organic? In terms of agricultural regulations, certain commodities may still use methods and materials that are prohibited from being used in organic farming, such as GMO seeds, synthetic chemical fertilizers, and pesticides.
Especially for pest control, this is also inseparable from cropping conditions and pest disturbances experienced during the organic certification process. If the pest can be controlled with the materials and technology recommended in the IPM assembly of the commodity. As an illustration, in the coffee commodity with the largest number of organic certified operators, the type and intensity of pest attacks may differ between regions with different types of coffee plants and different land and climatic conditions. In the GAP document for coffee plants [14], 3 types of pests that interfere with coffee plants are described, namely dwarf leaf disease, yellowing and leaf fall caused by nematodes (Pratylenchus coffeae and Radopholus similis), leaf rust caused by the fungus Hemeleia vastatrix, and coffee berry borer (CBB) Hypothenomus hampei.

Integrated control components against the three pests: a) Nematodes: using BP 308 clon material for new plantings, application of manure 10 kg tree⁻¹ per six months, and application of pathogenic fungus Paecilomyces lilacinus strain 252, as much as 20 g tree⁻¹ per six months; b) rust disease: use of resistant or tolerant varieties of Arabica coffee (Line S 795, USDA 762, Andungsari 2K), technical culture control by strengthening plant fitness through balanced fertilization, pruning, and providing adequate shade; c) CBB: using plant materials that are the cherry ripens simultaneously (USDA 762, BP 42, BP 358, BP 409), culturally technical to break the CBB life cycle by sanitation, picking lelesan, spoils, followed by soaking the results in hot water at 60°C for ± 5 minutes, setting the shade, application of the entomopathogenic fungus Beauveria bassiana, as well as the use of traps and attractants. With the relatively large number of coffee business actors certified organic, it is estimated that pest attacks in locations processed for organic certification are not too high.

The same thing also happens to other estate commodities, if the intensity of the pest disturbance is not too high and the distribution is not widespread, then the control is easier to implement by doing sanitation and using botanical pesticides whose ingredients are easily found around the garden, both those that grow wild or intentionally planted. Organic coconut farmers tend to just leave their plantings as long as there are no real disturbances that cause the production of coconut sap to decrease and can still be processed into brown sugar. Usually, farmers or farmer groups already have information on IPM technology for their crops.

On the other hand, in estate commodities that have many pests and diseases must be controlled, special attention must be addressed. Case on pepper, experiencing a severe attack of pest and disease for a relatively long period has caused the farmers to change their plant into palm oil and rubber [15]. The main pests that attack pepper plants are stem borers (Lophobaris piperis), flower suckers (Diconocoris hewetti), and fruit sucker (Dasynus piperis). While for the disease is stem rot disease caused by fungi Phytophthora capsici, Yellowing caused by complex of nematodes Radopholus similis and Meloidogyne incognita, combined with fungi Fusarium oxysporum, and low fertility and low soil moisture; and curling or dwarf diseases caused by pepper yellow mottle virus (PYMV) and cucumber mosaic virus (CMV), velvet blight caused by fungi Septobasidium spp and scale insect [16]. GAP for pepper has been set up and environmentally friendly control measures were preferred.

In the application of IPM, the control of stem rot disease, yellow disease, and velvet blight disease will be controlled by eradication and burning dead plants, then treating the former soil with bokashi fertilizer and Biological Control Agent (BCA) fungi Trichoderma sp. or apply lime to suppress the pathogen. Meanwhile, plants with mild damage and healthy plants in the vicinity were given fertilizing treatment with bokashi and Trichoderma sp. The control of stem/branch borer is carried out by means of garden sanitation, botanical pesticides like neem extract, and the application of BCA (Biological Control Agent) entomopathogenic fungi B. bassiana. In the end, pepper farmers are expected to be able to apply IPM technology in their own gardens independently and sustainably.

For stem rot disease in pepper plants, even though the intensity of the attack is low, it must be controlled because the disease caused by the fungus Phytophthora capsici can spread quickly and cause death on plants. Infected plants must be eradicated because other control methods have not been able to overcome the attack of the pathogen. Because chemical control is sometimes unavoidable in pepper plantations, it is relatively difficult to meet the requirements required in the organic certification process. Another illustration is on the cashew plant. This plant is generally cultivated in

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dry climate areas in Eastern Indonesia. The pests that attack cashew nuts are relatively few and vary between developing areas, and the damage they cause is relatively small so that the use of synthetic chemical pesticides in IPM can be avoided. Organic sprays for control of Cashew pests have been described [17]. Thus, it is relatively easy for this commodity to obtain an organic certificate.

The results of observations on several farmer groups whose farms were organically certified showed that the main way of pest control is the use of botanical pesticides by mixing some material of plants known to have pesticide properties obtained from surrounding areas. There were 27 kinds of plants commonly used, sometimes combined with dead fish, snails, and cow urine. Biological agents used were fungi B. bassiana and Trichoderma harzianum. Technical culture is also performed by applying of multiple cropping systems and crop rotation, planting trap crops and repellents, insect pheromones, gauze lid, and mulching, especially for vegetable crops. In general, the control measures applied by farmers could reduce the pest population, but in case of severe pest attacks then the farmers are forced to destroy their crops [18].

Therefore, although the market prospects are good, the opportunities and challenges of implementing IPM in the context of the organic certification process for estate commodities are varied between commodities and between developed areas. This is a challenge for researchers and academia to help find components of IPM for estate crops that are effective against pests but are also environmentally friendly.

4. Conclusions
The application of IPM in organic cultivation of estate crops commodities needs to be supported to obtain quality and safe products to be accepted by consumers. Several existing IPM technology innovations such as resistant varieties, natural enemies and botanical pesticides, and other control components to be carried out by following per under applicable organic farming regulations, still need to be developed and improved their performance.

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