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Environmental Risk Analysis and Control For the Development of Sustainable Urban Agriculture

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Abstract

Realizing sustainable urban agriculture is one of the sustainable development goals (SDGs) targets that must be achieved. This research was conducted to analyze and explain environmental risk control for the development of sustainable urban agriculture. The research location was in East Jakarta, one of the cities in Indonesia that has implemented urban farming practices. Identification of urban agricultural environmental risks caused by biotic and abiotic factors determined of 17 categories of questions that can be represented in this research. Three risk assessment scales were used, low, medium and high risk. The environmental risk of urban agriculture caused by biotic and abiotic factors was found to have the highest risk in the air dust category. Based on the research results, it was concluded that, in general, respondents had quite effective knowledge of environmental risks but needed to increase their knowledge and deeper understanding of creating sustainable urban agriculture. Urban agriculture, due to its social, economic, and environmental benefits, should be considered part of a dynamic urban system during planning and implementation.

Keywords: sustainability, urban ecology, urban agriculture, urban landscape

Introduction

Realizing sustainable urban agriculture is an obligation that must be carried out in accordance with the Instruction of the Governor of the Special Capital Region of Jakarta Province Number 14 of 2018 regarding the implementation of urban agriculture in Jakarta and the SDGs targets (Bappenas, 2024) in creating sustainable development. The SDGs are a universal call for global action aimed at protecting the planet and ensuring that all people enjoy prosperity; they are all interconnected and integrated, balancing the environmental, social, and economic dimensions of sustainable development (Grigorieva et al., 2023). Urban agriculture is evolving with new areas of academic exploration, including the concept of zero-acreage farming (ZFarming) (Sousa et al., 2024). Urban agriculture can be defined as the growing of crops and rearing of livestock within a city (intra-urban) or in the areas surrounding the cities (peri-urban agriculture), involving input provision and processing of raw materials into edible forms followed by marketing activities (Chatterjee et al., 2020). Urban agriculture in East Jakarta is one of the areas in the city of Jakarta that has the highest number of agricultural activities. According to the DKI Jakarta Provincial Central Statistics Agency (2022), the harvest area for vegetable crops in East Jakarta is 896.3 ha, the number of fruit trees is 293,414 trees, the harvest area for biopharmaceutical crops is 2,435 m^2.

Urban farming in East Jakarta, involves cultivating plants in open spaces, narrow and limited areas, and public spaces. Limited land is not an obstacle to agricultural activities in urban areas (Martellozzo et al., 2014) including in Jakarta. Many ways can be attempted to start urban agriculture, including various crop cultivation methods (Hodgson et al., 2011) and many types of plants that can be cultivated in Jakarta.

The development of urban agriculture in East Jakarta by urban agricultural actors has its challenges, one of which is environmental factors. According to Adiyoga et al. (2004) the role and potential for developing urban agriculture in Jakarta are quite high, but this is driven by concerns or doubts as planners and city policymakers regarding the risks of urban agriculture, namely possible environmental risks and health risks.

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Such biophysical environmental conditions are not a barrier to developing agriculture in Jakarta but are an input for agricultural actors in Jakarta to cultivate plants sustainably under Jakarta's environmental conditions. Sewage water has the potential for use in crop production, irrigating urban and recreational landscapes to conserve fresh water (Khan et al., 2022).

This research was conducted to analyze and control environmental risks for the development of sustainable urban agriculture, with the research location being in East Jakarta. The environmental risks that arise from urban agriculture can be illustrated by the research results. So far, urban farming actors in East Jakarta have not fully realized that if risks occur due to these activities, they will have a serious impact that can hinder the development of sustainable urban agriculture if not controlled as early as possible.

The type of urban agriculture considerable a role in cutting or increasing some risks. Indoor urban agriculture, for example, will naturally tend to minimize the risk of air or soil pollution. But this model of farming raises other issues that relate to the amount of energy consumed, the profitability of the crops in the light of the financial investment needed, or the artificial nature of such growing systems, which sometimes struggle to be accepted by consumers who are wary of wholly artificial local production systems (Aubry, 2019).

According to Kahan (2013), farming is risky; farmers live with risks and make daily decisions that affect their agricultural operations. In agricultural development, there will be risks, which, if handled as early as possible, can minimize the impact on the environment, society, and economy. Following the definition of sustainable agriculture according to Pasandaran et al. (2017), sustainable agriculture will be emphasized on the environmental, social, and economic side, which has high resilience or resilience that can be achieved if resource-saving technological innovations are developed and implemented by agricultural sector development partners sustainably. It is hoped that the results of this research will become one of the efforts that urban agriculture actors can consider by applying the precautionary principle in developing sustainable urban agriculture, especially in East Jakarta.

Material and Methods

This research analyzes environmental risks by applying ERA (Environmental Risk Assessment) steps (Table 1), through the stages of preparation, assessment, and obtaining research results (Parks, 2000). The ERA process is widely used for prospective and predictive evaluations to support decisions on chemical use and retrospective evaluations focusing on hazards and remediation of chemical spills or contaminated sites to protect natural resources and the environment (Rattner et al., 2023).

Next, the urban agriculture risk assessment indicators are categorized, and the risks are explained and connected. This study's three risk assessment scales used were based on Parks (2000), i.e., low, medium, and high risk (Table 1). The risk scale is determined using the ERA technique through (1) problem formulation: determining the scope, context, and criteria that will be used to assess the risk to be studied; (2) risk identification: identifying all the risks that may occur; (3) exposure assessment: carrying out an analysis and evaluation of the possibilities that may occur: (4) risk characterization, combining the value of the probability and impact of the risk, and (5) risk mitigation: the treatment plan that needs to be implemented to deal with the risk.

The risks were determined after pre-research observations looking at urban agricultural activities that were prone to risks, such as water use for crop irrigation. A lot of dust was stuck to horticultural plants, which were often planted on the side of main roads or highways, and there was minimal visible activity of land animals or insects around the urban agricultural plant cultivation location.

Primary and secondary data from the field were analyzed with descriptive analysis, which could describe the activities carried out by urban agricultural actors in East Jakarta as the object under study. The research data is presented as narratives, tables, and matrices.

Research sampling was carried out in 10 sub-districts in East Jakarta, namely Cakung District, Pulogadung District, Matraman District, Jatinegara District, Duren Sawit District, Makassar District, Kramat Jati District, Cipayung District, Ciracas District and Pasarebo

Table 1. Risk scale color symbol

Score	Risk scale	Color symbol
1	Low	Green
2	Medium	Yellow
3	High	Red

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District. Primary data was obtained through interviews and filling out research questionnaires.

Interviews and questionnaires were conducted with urban agricultural actors in East Jakarta, using a predetermined sample of 50 respondents per sub-district. Urban agriculture actors in East Jakarta are diverse: farmers, women's farming groups, schools, universities, offices, other agencies, individual communities, youth organizations, community groups, traders/entrepreneurs involved in urban agriculture, and others.

Each respondent was given two identical research questionnaires on knowledge of environmental risks. Before interviews and group discussions were conducted, each respondent was asked to complete the questionnaire. In addition, after a group discussion on the need for research data, each respondent was asked to complete the same questionnaire again. In this way, the respondent's level of knowledge can be calculated according to this formula.

In this research, respondents' knowledge was also measured, namely, as urban agricultural actors, and their understanding and knowledge regarding the environmental risks of urban agriculture. The level of respondents' knowledge regarding environmental risks is calculated by referring to the formula in Risna (2017) as follows:

$$\text{Effectiveness of increasing knowledge} = \frac{Increased\ Knowledge}{Gap}\ x\ 100\%$$

Increased knowledge	= Average final test score – average initial test score
Gap	= Target – average initial test score
Target	= Maximum value x number of questions

Effectiveness criteria score:
1. Effective = > 66.66%
2. Quite effective = 33.33-66.66%
3. Less effective = < 33.33%

This formula is used to find out how respondents from 10 subdistricts in East Jakarta understand the environmental risks of urban agriculture. The research discussion below and Figure 4 show how this is done.

Results and Discussion

According to BPS (2024), East Jakarta is located at $6^0$10'37" S and $106^0$49'35" E, with a height of 16 meters above sea level. In general, the city of Jakarta generally has a hot climate with an average air temperature of 28.5^{o}C, air humidity reaching 73-78%, and an average wind speed reaching 2.2-2.5 m per sec (DKI Jakarta Provincial Government Information and Communications Office, 2024).

Urban agricultural commodities developed in East Jakarta are diverse, and urban agricultural cultivation techniques are also diverse. Urban agricultural commodities developed in East Jakarta include food crops, plantation crops, vegetable crops, fruit crops, ornamental plants, and biopharmaceutical plants. Urban agriculture activists in East Jakarta not only focus on cultivating plants but also cultivating land waters and animal husbandry (Table 2), the majority of which are developed, including cultivating catfish, tilapia, gourami, milkfish, ornamental fish, breeding ducks and ducklings, chickens, quails, rabbits, and goats. Urban agriculture includes a range of activities, such as growing vegetables, fruit, herbs, and grains and raising fish (aquaculture), bees, and animals (chickens, goats, pigs, rabbits) (Horst et al., 2024). Plant cultivation is carried out using various cultivation techniques, namely conventional cultivation on land, through '*tabulampot'* (fruit plants in pots), polybags, using soilless culture techniques such as hydroponics, vermiculture, aquaponics, aeroponics, and permaculture (Figure 1). Soilless cultivation systems do not only offer the opportunity to save water and cultivate without soil, but also the chance to open up urban areas such as residential rooftops for food production close to consumers and soilless culture almost completely controlled environment is a relatively modern cultivation technology (Fussy et al., 2022).

Table 2. Stages of environmental risk analysis

Preparation	Step 1	Setting the context of ERA (Environment Risk Assessment)
	Step 2	Identify and categorize the main environmental pressures
	Step 3	Determine environmental values and indicators
Assessment	Step 4	Characterize environmental trends, and indicator relationships and assign risk classes
	Step 5	Evaluate changes and risk indicators
Results	Step 6	Report results and develop risk reduction strategies

Source: (Parks, 2000).

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Innovations in urban farming such as aquaponics, hydroponics, recirculating aquaculture systems (RAS), sack farming, drip irrigation, animal husbandry, and water upcycling could play a major role in urban food systems in the long term as the rate of urbanization continues to soar (Benjamin et al., 2024). The innovative urban farming system, specifically hydroponic farming, aquaponic farming, and aeroponic farming system does not impact resource efficiency because these innovative methods do not depend on soils for plant growth, different combinations of other materials are required to support the roots of the plant and grow crops directly through the supply of nutrient-enriched water (Sharma et al., 2023).

According to Suryaningprang et al. (2021), the hydroponic farming system allows farmers to increase production. Hydroponic farming can produce yields in 15-21 days and more than conventional systems. Aquaponics has a good prospect of achieving sovereignty in healthy food characterized by organic properties that foster a healthy lifestyle (Sundari et al., 2021).

Vertical farming can reduce urban heat islands and conserve natural resources (Harada et al., 2021). It also provides aesthetic and economic advantages, including increased food production, secure organic and healthy crops, and energy savings. The aesthetic dimension of vertical farming is related to the positive visual image of the garden and improving its relation to buildings (Fauzia et al., 2024).

According to Dewi et al. (2023), permaculture is the design of productive agricultural ecosystems that are diverse, stable, and resilient. Permaculture can provide food resources and allow a mutually beneficial interaction between humans and the environment, benefiting a big city like Jakarta. Permaculture systems might be valuable for the sustainable development of agriculture because permaculture principles guide the design, implementation, and maintenance of resilient agroecological systems (Krebs et al., 2018).

According to BPS DKI Jakarta (2023), there are 20 types of important horticultural crops in Jakarta, and five of them are fruit crops with extensive production with an average of more than 1000 tons as a contributor to urban agricultural products: mangoes, fruit guava, banana, rambutan, and star fruit. Other fruit plants that are starting to be cultivated by the community and urban agriculture activists in Jakarta are dragon fruit and pineapples, which have been cultivated since 2022. Pineapples have the potential to be developed because of the high market demand for fresh fruit and processed foods such as jam, sweet glutinous rice (*dodol*), candy, sweets, fruit juice, jelly, chips, syrup, canned pineapple, and pies (Trianita et al., 2020).

Mangosteens were cultivated again in 2023 after not being grown for two years. According to Aji et al. (2013) mangosteen production area in Indonesia is quite large, but the fruit quality is still very low. Mangosteen

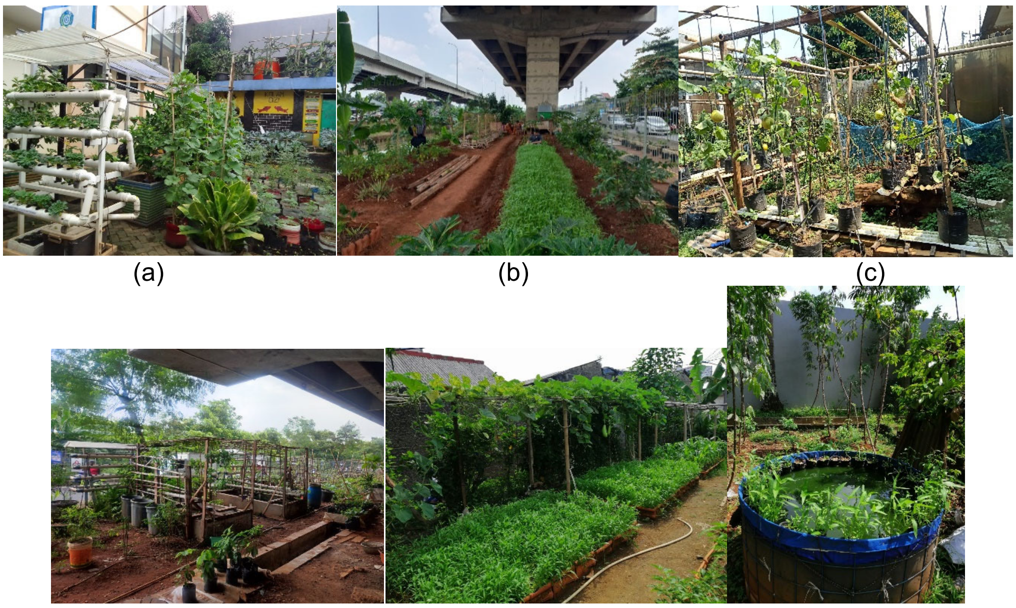
(a) (b) (c) (d) (e) (f)

Figure 1. Urban agricultural methods in East Jakarta (a) hydroponics (b) conventional (c) crop production in pots (d) aquaponics and pots (e) vertical and conventional farming (f) crop production in buckets.

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Table 3. Types of crops and agricultural cultivation methods in East Jakarta, Indonesia

Types of crops	Crops	Cultivation method
Food crops	Lowland rice, upland rice, beans, corn, sweet potatoes, cassava, taro	Conventional, pot, or polybag
Plantation crops	Coconut, coffee, chocolate, sugarcane, kapok	Conventional
Plants fruits	Mango, guava, banana, rambutan fruit, starfruit, breadfruit, watermelon, grapes, dragon fruit, durians, langsat, papaya, snake fruits, soursop, honeydew, strawberry, pomelo, orange, longan, mangosteen, jackfruit	Conventional, polybag, fruit trees in pots (tabulampot), verticulture
Vegetables	Kale, spinach, red spinach, large chili, cayenne pepper, curly chili, eggplant, long beans, cauliflower, cabbage, chayote, stink beans, mustard greens, tomatoes, sweet pepper, stink beans, scallions, shallots, garlic, oyster mushrooms, straw mushroom	Conventional, polybag, pot, hydroponic, verticulture, aquaponic, aeroponic
Flowers and ornamental plants	*Philodendron*, *Aglaonema*, *Orchids*, Palms, Ixora, *Chrysanthemums*, Roses, Tuberose, Ferns, Sansevieria, Jasmines, *Anthurium*, *Bromelia*, *Bougainvillea spectabilis*, *Cordyline fruticosa*, *Dracaena spp*., *Codiaeum variegatum*, *Gerbera jamesonii*	Conventional, polybag, pot, hydroponic, verticulture, aquaponic
Biopharmaceutical plants	*Phaleria macrocarpa*, *Aloe vera*, Noni/Pace, turmeric, galangal, lemongrass, *Curcuma aeruginosa*, *Boesenbergia rotunda*, ginger, *Andrographis paniculata*, Lime, *Elettaria cardamomum*	Conventional, polybag, tabulampot, Verticulture
Livestock	Chickens, ducks, geese, quail, rabbits, goats, cows	Conventional, permaculture
Fish	Catfish, tilapia, patin fish, milkfish, gourami fish, goldfish, shrimp, ornamental fish	conventional, plants growing in buckets, aquaponic

is one of the tropical fruits with lots of market potential as almost all parts of the fruit, from the flesh, skin, and seeds, can be processed. According to Santosa et al. (2021), city fruit trees are multifunctional greeneries that provide nutrition, ecosystem services, social cohesion, and genetic conservation. The total fruit production in East Jakarta in the last three years is described in Figure 2.

Table 4 shows the environmental risks related to the presence of biotic and abiotic factors that result from urban agricultural activities in East Jakarta. Seventeen categories of questions can be represented to identify urban agricultural environmental risks caused by biotic and abiotic factors. This was determined after conducting pre-research observations, which focused on environmental risk factors often experienced by urban agricultural practitioners in East Jakarta and originate from biotic and abiotic factors.

The highest environmental risk in East Jakarta is air dust. Based on the results of interviews, respondents often experience scattered dust when carrying out agricultural activities in the afternoon and evening. Although pollutants are not new to the environment, their exposure still poses the greatest threat to humanity and is a significant cause of environmental illness and mortality (Shetty et al., 2023). According to Sobczak et al. (2019) dust is one of the main detrimental factors in farmers' work environments. Dust suspended in the air is a mixture with varying chemical composition and physical properties. According to Perdinan et al. (2023), the nearest pollution sources in DKI Jakarta are industrial emissions, motor vehicles, and local sources from community activities such as open burning. The effects of dust can cause pneumoconiosis and potentially, cancer.

According to WHO (2006) and Pietrodangelo et al. (2024), particulates are air pollutants consisting of solid and liquid particles dissolved in the air. Based on their size, particles are classified into TSP (Total Suspended Particulate), PM10 (particles with a diameter of less than 10 μm), and PM2.5 (particles with a diameter of less than 2.5 μm). Particulate matter with a diameter of less than 2.5 μm is a dangerous pollutant because it is very fine and can

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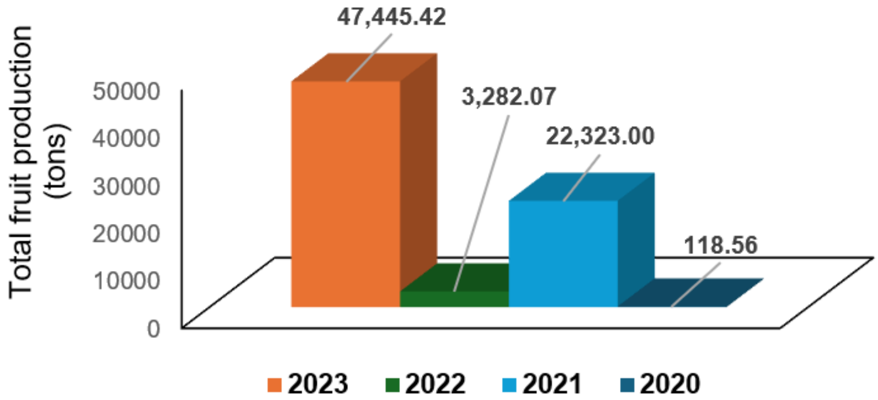

Figure 2. Total fruit production in East Jakarta 2020-2023 (BPS DKI Jakarta, 2023).

Table 4. Results of biotic and abiotic environmental risk identification for urban agriculture

No.	Indicator	Average respondent answer			Risk potential category		
		High	Medium	Low	High	Medium	Low
1	Mosquitoes were found in the yard of the house/school/workplace		•			•	
2	Often exposed to mosquito bites during agricultural activities		•			•	
3	Caterpillars were found in the yard of the house/school/workplace		•			•	
4	Often exposed to caterpillar bites during agricultural activities		•			•	
5	Weaver ants were found in the yard of the house/school/ workplace			•			•
6	Weaver ants bite during agricultural activities			•			•
7	Butterflies were found in the yard of the house/ school/workplace that has plants		•			•	
8	There were other unknown insects in the yard of the house/school/workplace that has plants	•			•		
9	Often bitten by other insects during agricultural activities		•			•	
10	The air feels cool with plants in the yard of the house/school/ workplace		•			•	
11	There is dust scattered by the wind around the yard of the house/ school/workplace that has plants	•			•		
12	There are bird droppings			•			•
13	Presence of animal faeces			•			•
14	Feel comfortable with plants around the house/ school/office	•					•
15	Insects around plants at home/school/ workplace are dangerous			•			•
16	Often smell unpleasant odors coming from plants at home/school/workplace			•			•
17	Often see splashes of soil on walls/fences around plants at home/school/workplace when it rains		•			•	

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enter the inner respiratory tract, thus harming long-term human health. PM10 particulate matter in urban areas can be in the form of dust generated from roads passing by motorized vehicles, as well as from the residue from burning industrial and transportation fuels and PM10 can affect health. According to data from Mahajan (2006), humans inhale around 12.3 m^3 of air daily, namely a mixture of gases, liquid particles, and solids. Therefore, cities need plants to minimize air pollution, as plants are key in removing nutrient-based, partially non-biodegradable, and heavy metals in stormwater runoff (Francini et al., 2022).

The highest risk category is in the category of other insects found around plantings. Unfortunately, the names of the insects are not known. Ecologically, this is the influence of the presence of plants, thereby enabling an increase in the variety and number of flora and fauna, which is a parameter for the sustainability of biological resources around the cultivation area. The public does not quite understand the names and types of insects that often approach plant cultivation areas, and many respondents also consider the insects that approach them as pests that can disrupt plant productivity and harm them. According to Arnold et al. (2019) pests in urban agriculture are everywhere, and the characteristics of urban areas can make pests very dangerous and difficult to control. The use of pesticides in urban agricultural activities at the research location will also impact organisms and humans. According to Samways et al. (2020), many pesticides pose risks to human health and biodiversity, while pests can also become genetically resistant, rendering pesticides ineffective. According to Oliva et al. (2024), vegetables and soils can be contaminated by different potentially toxic elements. The widespread use of insecticidal neonicotinoid seed dressings is of concern, as they severely affect bee behavior and even terrestrial and aquatic food webs.

In general, the results of identifying urban agricultural environmental risks found in this study have a medium risk; there are interactions with biotic and abiotic factors, namely mosquitoes, caterpillars, butterflies, and soil splashes (Figure 3). This important finding can illustrate urban agricultural activities in Jakarta, which ecologically interact with biotic and abiotic components. According to the DKI Jakarta Environmental Service (2018), DKI Jakarta Province is an urban environment that is dominated by artificial ecosystems and only has a narrow natural ecosystem but has a high amount of biodiversity and a diversity of butterfly fauna in Jakarta, there are 29 types of butterflies (order *Lepidoptera).* The existence of plants cultivated for urban agriculture opens up opportunities for interactions between biotic and abiotic components (Hodgson et al., 2011). According to Fineschi and Loreto (2020), plants in urban environments are useful for climate mitigation. Still, in urban environments, they are vulnerable to climate change, which causes negative anthropogenic factors (e.g., pollution, heat island effect, land scarcity, and the impact of rare roots and interception and poor water availability) to threaten plant life. Therefore, plants in urban environments must be carefully selected to adapt to the combination of stresses they will face currently and in future conditions. According to Santosa et al. (2020), to minimize potential risks and adapt to city characteristics, tree selection is important, which is also linked to local species, food security, and biodiversity conservation to ensure the products' safety.

Urban agricultural activities are evidence that shows that there is hope for biological resources in urban

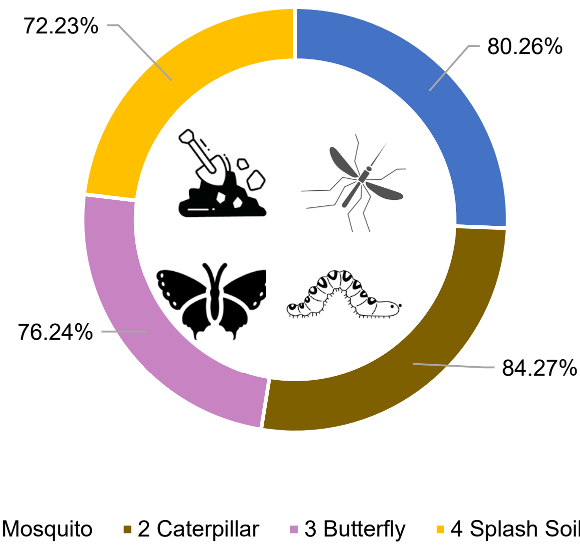

Figure 3. Percentage of medium environmental risk categories answered by respondents.

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agriculture. This shows that urban agriculture activities will connect the food chain directly and indirectly, affecting the stability and sustainability of biological resources. According to Hendrickson and Porth (2012), urban agriculture increases awareness of our relationship to the food cycle. Cities and towns are characterized by high human density and significantly changing ecosystems by replacing green landscapes (green spaces) with hard surfaces (hardscape). Green spaces vary greatly in insect conservation value according to size, functional connectivity, heterogeneity, vegetation type, structure, and volume (Samways et al., 2020).

The presence of bird and other animal waste around the cultivation area showed the low-risk category. The diversity of bird species can be used as an indicator of environmental quality because their lives are highly affected by physical, chemical, and biological factors (DKI Jakarta Environmental Service, 2018). It is rare to find bird droppings and other debris around cultivation areas because urban farming is often carried out in more controlled environments such as greenhouses and vertical gardens (Lanarc et al., 2013), which can limit access to wild animals. According to the DKI Jakarta Environmental Service (2018), many bird species in DKI Jakarta live in wild/ open habitats. Urban areas usually have fewer wild animal populations than rural areas, so the risk of contamination by animal waste is lower. However, animal waste can function for plants that can be processed naturally biochemically. According to Murphy et al. (2009), biochemical processes occur when water is purified primarily through the actions of living organisms. Energy from sunlight drives photosynthesis in aquatic plants, which releases oxygen, whereas decomposition by bacterial activities produces carbon dioxide, nutrients, and other substances aquatic plants and animals could use. The purification cycle continues as these plants and animals die, and bacteria decompose their remains, providing food for new generations of organisms.

Urban farming actors in East Jakarta have varied knowledge about the environmental risks of urban farming. Based on the research results, it was concluded that, in general, respondents had an effective understanding of environmental risks; this was because of the 10 sub-districts, respondents had <66% knowledge of environmental risks in urban agriculture. As stated in the previous chapter, in the research methods chapter, according to Risna (2017) the effectiveness of respondents' knowledge can be categorized as effective if it has a value of > 66.66%, quite effective with a value of 33.33 - 66.66% and less effective if the value is < 33.33%. Based on the research results, respondents' knowledge regarding environmental risks in urban agriculture is classified as quite effective, ranging from 33-66%. This is found in seven subdistricts, Ciracas (62%), Pasarebo (55%), Kramat Jati (49%), Jatinegara (48%), Pulo Gadung (47%), Makassar (47%), Duren Sawit (43%) and Matraman (37%) (Figure 4). According to Ilieva et al. (2022), the knowledge of urban agricultural actors is needed so that urban agricultural food growth can produce maximum commodities because farmer knowledge will also be related to improving individuals' mental health and emotional well-being.

Environmental Risk Control Efforts of Urban Farming Activity

It is essential to control risks in urban agricultural activities to minimize the negative impacts that result in low productivity and its long-term implications for human health (Duong et al., 2019). According to Ali et al. (2019), risks of agricultural activities in urban areas include contamination of vegetables and soil, water pollution, problems with fruit loss, water consumption, volatile organic compounds, and invasive species, excessive use of chemicals, and high installation costs. In addition, there are specific environmental risks, such as soil contamination by heavy metals and pollutants for edible urban forests and edible urban greening, community gardens, and risks for water pollution from fertilizers and chemical inputs.

Environmental risk control according to Surjaningsih et al. (2021) includes educating the public about environmental and health risks and how to avoid them, decentralized waste management and processing, regular monitoring of urban agricultural activities, determining the threshold for permitted use of agricultural chemicals, and providing recommendations for urban agricultural commodities according to regional conditions. Ali et al. (2019) recommend specific actions to mitigate the potential health risks associated with contaminants (Table 5).

Assessing the sustainability of agriculture systems and predicting the future state of food security requires a prior understanding of the functioning of agricultural systems and the intricate relationships that exist between below and above-ground biodiversity (Cock et al., 2012). Due to its social, economic, and environmental benefits, urban agriculture should be considered part of a dynamic urban system. A comprehensive urban agriculture plan must be considered during planning and its implementation (Hodgson et al., 2011).

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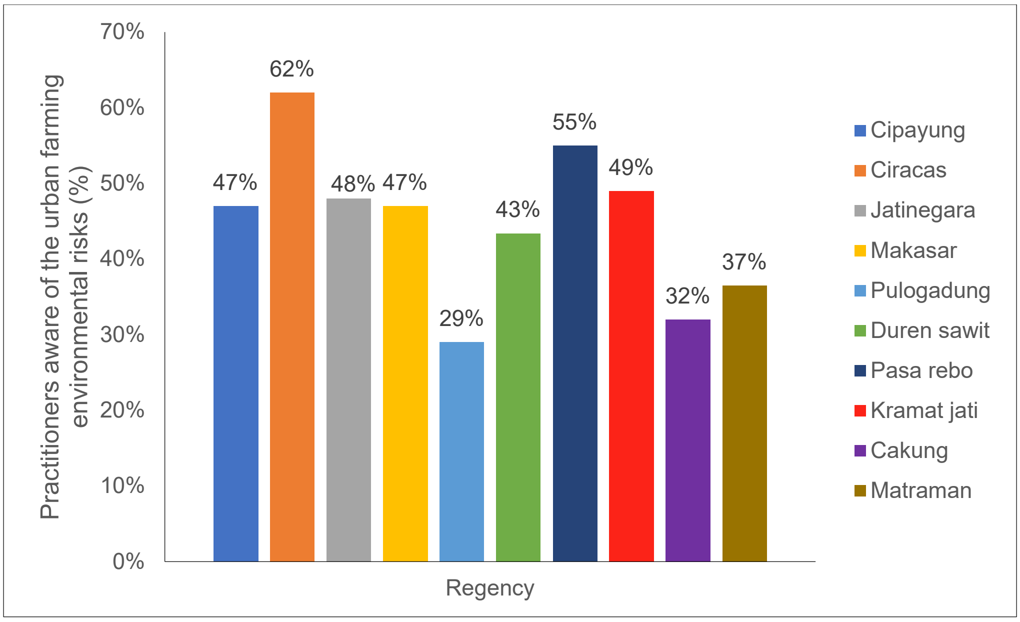

Figure 4. Percentage of practitioners aware of the environmental risks of urban agriculture.

Table 5. Recommendations for action based on level of concern and risks (Ali et al., 2019)

Level of concern	Site examples	Recommended actions
Low	The site was previously residential, parkland, farmland, or a school.	Wash hands after gardening and always before eating, wash produce with soap and water
Medium	The site was previously an orchard or hydro corridor 30m from a rail line or arterial road.	- Lower the concentration of contaminants by adding clean soil and organic matter - Reduce dust by covering bare soil with ground cover/mulch. - Peel root vegetables before consuming - Avoid growing the types of produce that accumulate soil contaminants (see list in the complete guide).
High	The site was once a gas station, dry cleaner, autobody shop, print shop, or industrial land.	- Build raised bed gardens in which a minimum of 40 cm of clean soil is added on top of garden fabric or grow food in containers. - Reduce dust by covering the soil with a ground cover or mulch. - Add clean soil and organic matter such as compost and manure to the raised bed or containers annually, or grow nuts and fruit trees

Conclusion

Biotic and abiotic factors cause the environmental risks of urban agriculture in East Jakarta. The highest risk was found in air dust and insect infestations. The ecological risks of urban agriculture in this study can be categorized as medium. In general, respondents in East Jakarta had effective knowledge of environmental risks, but the knowledge and understanding to create sustainable urban agriculture should be expanded. Recommendations to control ecological risks in urban agriculture include educating urban agriculture practitioners to plant crops according to the geographical conditions of the site, creating a planting calendar according to the season, using environmentally friendly tools and materials, and reducing the use of chemicals that can pollute the environment. Uses of pesticides should carefully check the dosages while monitoring the crop health. Recycling of agricultural tools and materials should be encouraged. Urban agriculture provides social, economic, and environmental benefits, so it should be considered part of a dynamic urban system during planning and its implementation.

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