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THE RELATIONSHIP BETWEEN SPRAYING FREQUENCY AND INCIDENCE OF ANEMIA IN FARMERS

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ABSTRACT
Various types of pesticides commonly used by farmers and the public include insecticides, fungicides, and herbicides. Excessive pesticide use in agricultural settings can lead to adverse health effects, one of which is anemia. This study aimed to analyze the relationship between pesticide spraying frequency and the incidence of anemia among horticultural farmers in Gisting District, Tanggamus Regency, in 2025. A quantitative, case-control design was employed. The study was conducted in Gisting District, Tanggamus Regency, Lampung Province, from August 2024 to January 2025. The study population consisted of 41 anemic farmers with hemoglobin levels below 13 g/dL, and 41 non-anemic farmers as the control group. Purposive sampling was used, with the case group comprising anemic farmers and the control group including non-anemic respondents. The independent variable was spraying frequency, and the dependent variable was anemia. Data on spraying frequency were collected via questionnaire, while anemia was assessed through laboratory analysis. Data analysis included univariate and bivariate methods, with the Chi-Square test applied for inferential statistics. Results showed that the majority of farmers in the case group (73.2%) sprayed pesticides more than twice per week, whereas 53.7% of the control group sprayed less than twice per week. The analysis yielded a p-value of 0.024, indicating a significant association between spraying frequency and anemia incidence. The odds ratio (OR) of 3.158 (95% CI: 1.253–7.957).

Keywords: anemia; farmers; spraying frequency

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INTRODUCTION

Indonesia is known as an agricultural country, with its economy strongly supported by the agricultural sector. According to labor force data from the Central Statistics Agency, at least 40.69 million people are employed in agriculture (Central Statistics Agency, 2023). To address agricultural challenges such as pest infestations—including insects, fungi, and weeds—most farmers use pesticides to control these threats (Agustina & Norfai, 2018). Pesticides are toxic chemicals designed to manage pests that negatively impact human interests. They are also utilized in the health sector to protect humans from direct harm caused by certain organisms or indirectly from various infectious disease vectors. In agriculture, pesticides are applied to increase crop production (Khairunnisa & Rahmi, 2023).

Pesticide use by farmers has increased year after year. Fertilizer demand rose from 12.2 million tons in 2021 to 12.3 million tons in 2022, and further increased to 13.9 million tons in 2023. Indonesia, a developing agricultural nation with a harvested area of 10,606,513 hectares in 2022, is a major user of pesticides. According to data from 2021 to 2023, pesticide use in Indonesia includes 2,784 brands registered with the Directorate of Fertilizers and Pesticides, Directorate General of Agricultural Infrastructure and Facilities (Kementrian Pertanian, 2019).

Pesticide use must be managed wisely. Common types of pesticides used by farmers and the public include insecticides, fungicides, and herbicides, all marketed under various brand names. The habitual use of pesticides has detrimental effects on both the agricultural environment and human health. Negative consequences of excessive pesticide use in agricultural settings include the emergence of resistant pests and diseases, loss of germplasm, extinction of natural predators within the ecosystem, and increased resistance among plant-damaging organisms (Munawarah & Sulasmi, 2023).

The improper use of pesticides in agriculture can have detrimental health effects. Pesticide exposure is a significant issue, particularly in farming communities within poor and developing countries. According to the World Health Organization, up to one million people suffer health problems related to pesticides each year, with incidence rates continuing to rise in countries such as Indonesia, Nicaragua, Brazil, Vietnam, China, Cambodia, Bangladesh, and India. Overall, farmers are the most vulnerable group to pesticide poisoning (Indrianti et al., 2021).

The primary risk to user safety and health is direct contact with pesticides, which can result in acute or chronic poisoning. Acute poisoning may cause symptoms such as headache, nausea, vomiting, and other related effects. Pesticide exposure can lead to abnormalities in blood profiles because pesticides interfere with blood cell-forming organs and the immune system (Prajawahyudo et al., 2022). Specifically, pesticides can disrupt the blood cell formation process and affect hemoglobin levels by decreasing production or increasing the destruction of red blood cells. This disruption can result in the formation of methemoglobin within red blood cells, ultimately causing a reduction in hemoglobin levels (Murniati, 2023).

Previous research has identified a significant relationship between work duration, spraying frequency, and pesticide dosage with hemoglobin levels in farmers. Specifically, the duration of pesticide spraying is significantly associated with the incidence of anemia. Studies indicate that spraying pesticides for more than five hours per day increases the risk of anemia. Prolonged exposure to pesticides can disrupt red blood cell production due to their chemical composition. Additionally, pesticide dosage should be considered a factor influencing hemoglobin levels in farmers. Therefore, caution and protective measures are essential for farmers exposed to pesticides for extended periods (Ropen & Sugiarto, 2021).

The mechanism by which pesticides cause anemia typically involves several biological processes that disrupt the production, function, and survival of red blood cells. Certain pesticides are toxic to the bone marrow, the site of red blood cell production (erythropoiesis) (Utami et al., 2019). This damage reduces the number of red blood cells produced, leading to anemia. Some pesticides contain chemicals that directly destroy red blood cells through hemolysis. Excessive hemolysis decreases the number of circulating red blood cells, resulting in anemia. Additionally, certain pesticides interfere with the synthesis of hemoglobin, the primary protein in red blood cells responsible for oxygen transport. This disruption leads to abnormal red blood cell production and a reduced oxygen-carrying capacity (Agustina & Norfai, 2018).

A preliminary study conducted in the Gisting District involving 10 horticultural farmers found that the average frequency of pesticide spraying was three times per week, with each spraying session lasting between 1 and 2 hours. Blood tests revealed that three farmers had hemoglobin levels ranging from 9.1 to 10 grams per deciliter. Interviews with the farmers indicated that six of them frequently experienced dizziness, weakness, pale skin, and blurred vision upon standing during the planting process—symptoms consistent with anemia.

The purpose of this study was to analyze the relationship between spraying frequency and the incidence of anemia among horticultural farmers in Gisting District, Tanggamus Regency, in 2025.

METHOD

This research employed a quantitative, case-control design. The study was conducted in Gisting District, Tanggamus Regency, Lampung Province, from August 2024 to January 2025. The study population consisted of 41 anemic farmers with hemoglobin (Hb) levels below 13 g/dL, while the control group included 41 non-anemic farmers. Purposive sampling was used, with the case group comprising anemic farmers and the control group including respondents without anemia. The independent variable was the frequency of pesticide spraying, and the dependent variable was anemia. Data on spraying frequency were collected using a questionnaire, while anemia status was determined through laboratory analysis. The questionnaire is valid and reliable, with an r-value ranging from 0.387 to 0.881 and a Cronbach's alpha of 0.93. Data analysis involved univariate and bivariate methods, with the Chi-square test used for statistical significance.

RESULT

Tabel 1.
Characteristics of Respondents

Characteristics of Respondents	Case		Control	
	f	%	f	%
Age				
>40 years old	34	82,9	29	70,7
≤40 years old	7	17,1	12	29,3
Education				
Low	32	78,0	21	51,2
High	9	22,0	20	48,8

The results of the study found that in the case group, most farmers were aged >40 years (82.9%) and in the control group, most farmers were aged >40 years (70.7%).

Table 2.
Relationship between Spraying Frequency and the Incidence of Anemia in Farmers

Spraying Frequency	Case		Control		p-value	OR (95% CI)
	f	%	f	%		
>2x/weeks	30	73,2	19	46,3	0,024	3,158 (1,253-7,957)
<2x/ weeks	11	26,8	22	53,7		

The results of the analysis found that most of the case group, namely farmers with anemia, mostly had a spraying frequency of >2x/week (73.2%), in the control group, namely farmers who were not anemic, mostly had a spraying frequency of <2x/week (53.7%). The analysis obtained a p-value = 0.024 which means there is a relationship between the frequency of spraying and the incidence of anemia in farmers. The OR value = 3.158 (1.253-7.957) means that farmers who have a spraying frequency of >2x/week are at 3.158 times risk for anemia compared to farmers who have a spraying frequency of <2x/week.

DISCUSSION

The analysis found that the majority of farmers in the case group—those with anemia—sprayed more than twice per week (73.2%), whereas in the control group—farmers without anemia—sprayed less than twice per week (53.7%). The analysis yielded a p-value of 0.024, indicating a significant association between spraying frequency and the incidence of anemia among farmers. The odds ratio (OR) of 3.158 (95% confidence interval: 1.253–7.957) suggests that farmers who sprayed more than twice per week had a 3.158 times higher risk of developing anemia compared to those who sprayed less than twice per week.

Anemia among farmers is a significant health concern that demands attention. Exposure to pesticides is a major cause of anemia in this population, often resulting from poisoning. Pesticides can reduce hemoglobin levels and damage red blood cells. Farmers who experience chronic pesticide exposure are at an increased risk of developing anemia. Studies have demonstrated a clear association between pesticide exposure and anemia, especially among horticultural farmers. Pesticide exposure in farmers can increase the risk of anemia. Pesticide poisoning may disrupt the production or accelerate the destruction of red blood cells, resulting in decreased hemoglobin levels and anemia. Several studies have demonstrated a link between pesticide exposure and anemia in farmers, particularly those working in horticulture (Ropen & Sugiarto, 2021).

Farmers typically apply sprays based on crop conditions and the season. This study was conducted during the harvest season, a period marked by farmers' intensive harvesting activities. To safeguard crops from pests and diseases that threaten yields, farmers commonly use pesticides as a protective measure. Pesticide application during the harvest season is especially important because crops ready for harvest are particularly vulnerable to pests and diseases that can diminish both yield and quality. The crop grown by the respondents in this study was rice (Mualim et al., 2002).

Based on statements from farmers during interviews, their spraying practices depended on necessity. Farmers reported that when their crops were attacked by pests and diseases, they would spray as often as possible, regardless of the interval, to minimize damage and increase yields. They also indicated that the frequency of spraying depended on the weather. Farmers sprayed more frequently during the rainy season because various diseases typically affect crops during this period (Ramli et al., 2016). This study aligns with previous research showing a correlation between decreased hemoglobin levels and spraying frequency. Spraying more than twice a week increases the risk of pesticide poisoning by 4,727 times. Other studies have also demonstrated a significant correlation between spraying frequency and hemoglobin levels. The number of spraying sessions performed by farmers is referred to as spraying frequency (Pratama et al., 2021). The potential bioaccumulation of pesticide residues in farmers' bodies may influence the relationship between spraying frequency and hemoglobin levels. Frequent exposure to pesticides can cause both acute and chronic poisoning in farmers who spray pesticides (Fitriana et al., 2020).

Pesticide exposure in farmers can cause anemia through several mechanisms. Pesticides, particularly neurotoxic types, can disrupt the function of the bone marrow, where red blood cells are produced. Additionally, some pesticides can directly damage red blood cells or accelerate their destruction. Pesticide exposure in farmers can cause anemia because pesticide poisoning affects hemoglobin levels, leading to decreased production or increased destruction of red blood cells. Studies have demonstrated a link between pesticide exposure and anemia, particularly among horticultural farmers. Pesticide poisoning disrupts the formation of healthy red blood cells, resulting in anemia. Therefore, it is crucial for farmers to take preventive measures and protect themselves (Agustina & Norfai, 2018).

CONCLUSION

The analysis results showed that most individuals in the case group—farmers with anemia—had a spraying frequency of more than twice per week (73.2%). In contrast, the control group—farmers without anemia—mostly had a spraying frequency of less than twice per week (53.7%). The analysis yielded a p-value of 0.024, indicating a significant association between spraying frequency and the incidence of anemia among farmers. The odds ratio (OR) was 3.158 (95% confidence interval: 1.253–7.957), meaning that farmers who spray more

than twice per week have a 3.158 times higher risk of developing anemia compared to those who spray less than twice per week.

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