NIPES

Journal of Science and Technology Research

Journal homepage: www.nipesjournals.org.ng

The Use and Management of Pesticides in Paddy Rice and Durian Cultivation in Phong Dien District, Can Tho city, Vietnam

Nguyen Thanh Giao[1*], Dao Chi Cong[1], Phan Thi Lan Tuong[1], Truong Hoang Dan[1], Lam Thi Kieu Trinh[1]

[1]College of Environment and Natural Resources, Can Tho University, Vietnam
[*]Corresponding Author Email: ntgiao@ctu.edu.vn

Article Info

Received 03 May 2021
Revised 17 May 2021
Accepted 28 May 2021
Available online 31 August 2021

***Keywords*:**
active ingredients, durian Ri6, environment, health, paddy rice, pesticides, Phong Dien district.

https://doi.org/10.37933/nipes/3.3.2021.1

https://nipesjournals.org.ng

Abstract

This study investigates the current status of pesticides use and management in paddy rice and durian Ri6 farming in Phong Dien district, Can Tho city, Vietnam by interviewing 60 farmers directly in this area. The results showed that the farmers often applied various types of pesticides belonging to toxicity categories II, III and IV according to World Health Organization (WHO) classification with 95 active ingredients. The paddy rice and durian Ri6 farming used 54 and 41 active ingredients, respectively. Among the active ingredients used, the Carbosulfan, Trichlorfon, Glyphosate, Paraquat, 2.4D, Acephate were banned from use. The frequency of spraying pesticides in durian farming model was 8.8 times higher than that of the paddy rice. Pesticide bottles and packages were often improperly handled by burning, burying, throwing in the fields, mixing with domestic waste or selling to vendors. Although the knowledge of the farmers is relatively good, the environmental and their health impacts were often neglected or considered unimportant. This leads to urgent need to raise awareness of the farmers in using and managing pesticides and its wastes to ensure sustainable agriculture development.

1. Introduction

The Mekong River Delta is the largest agricultural production region of Vietnam with the strength of rice and orchard production. According to the General Statistics Office of Vietnam (2019) [1] the region contributed 56% of the country's total rice output and more than 90% of the total annual rice export volume of Vietnam. At the same time, contributed from 65.6-70.3% of the total fruit production of the whole country [2]. In particular, durian is a popular fruit in the market due to its characteristic aroma and high nutritional value. Provinces with large durian areas in the region include Tien Giang, Vinh Long, Can Tho, Ben Tre [3]. Similar to other provinces in the region, agricultural farming of Can Tho city is growing day by day. However, along with the achieved agricultural output are the environmental and human health challenges caused by the abuse of pesticides in farming [5-9]. The fact that farmers use too many pesticides in agricultural production has polluted the surrounding environment, degraded the soil environment and reduced the quality of agricultural products due to residues of toxic substances [10]. At the same time, they also cause serious acute health problems from direct contact with pesticides as well as long-term effects from the use of products with residues of pesticides [11]. To achieve large yields of rice and durian,

farmers in Phong Dien district, Can Tho city also use a variety of pesticides during their cultivation. Therefore, it is essential to assess the current status of pesticide use and management in that farming models, thereby proposing appropriate pesticide management solutions to minimize risks potential human and environmental risks.

2. Materials and methods

Data were collected from 60 farmers in Truong Long commune (tripple-rice crop cultivation) and Nhon Ai commune (durian Ri6 cultivation) in Phong Dien district, Can Tho city by field survey and direct interview of farmers. The map of the study area is shown in Figure 1. Informations were collected including current farming status, current status of pesticide use (type and dosage), status of storage and handling of pesticides after application use. At the same time, the study also evaluated knowledge, attitudes and practices of farmers through pre-designed questions. In which, knowledge and attitude of pesticide use was assessed through a rating scale including eighted questions. Concerning the knowledge of farmers, the correct answers are given 1 point and incorrect answers are given 0 points, the result is classified into 3 levels: low (under 4 points), medium (from 4 to under 6 points) and high level (6-8 points). Farmers attitude is also divided into 3 levels: positive attitude (22-32 points, equivalent to 75% -100%), neutral attitude (16-under 22 points, equivalent to 50% - under 75%) and negative attitude (0-16 points, equivalent to <50%). For each the strongly agree answer is given 4 points, agree = 3, confused = 2, disagree = 1 and strongly disagree = 0.

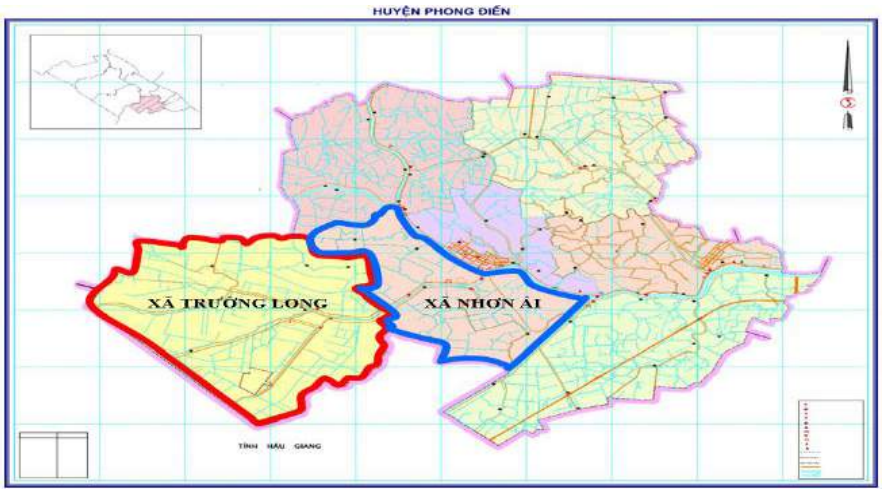

Figure 1. Location of the study site

3. Results and discussion

3.1. Current status of use and management of pesticides

3.1.1 General information of the interviewees

The results showed that the farmers were dominated by male (accounting for 90%) who were directly involved in the use of pesticides. These farmers were mainly under 50 years old (accounting for 48.8%). Respondents' education level have mainly from primary to secondary school (78.3%) and 15% of respondents have attained a high school to university education. The main income of farmers was from cultivation (95%), in which farmers were 10-30 years of experience in rice cultivation and 5-7 years of experience in farming durian. The cultivated areas of triple rice crops and durian in the study area were 1.5±1.1 ha and 0.8±0.5 ha, respectively.

3.1.2 Current status of using pesticides

Most farmers tended to increase the pesticides (Figure 2) in both three-crop rice model (43.33%) and durian Ri6 (76.67%) due to the effects of severe weather, epidemic diseases and increased crop intensification [12].

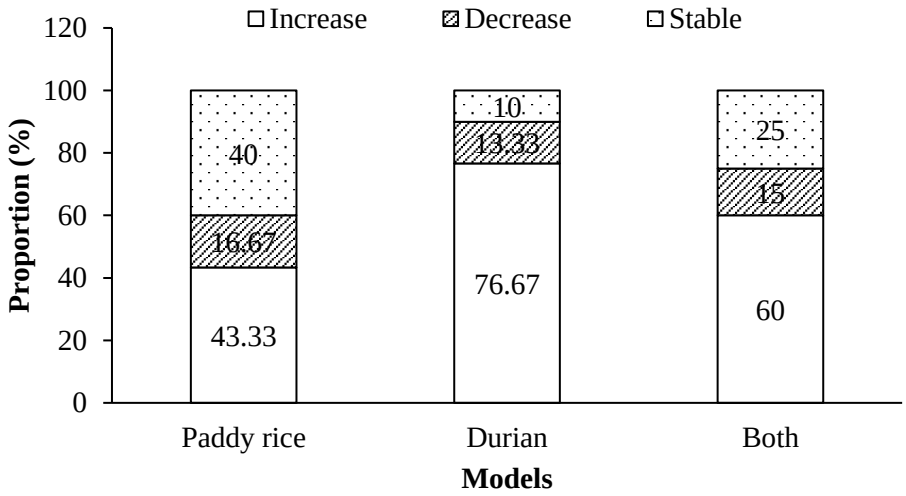

Figure 2. Pesticide use in paddy rice and durian cultivation

Durian farming model has very high frequency of pesticide spraying with 61.8±9.1 times/crop, 8.8 times higher than that of three rice crops cultivation. The frequency of pesticide used in winter-spring, summer-autumn and autumn-winter rice crops was 6.48±1.72, 7.27±1.96 and 7.33±1.82 times/crop, respectively. The results of this study were similar to the frequency of 7-8 times/crop in the study in Hau Giang province [13]. However, this frequency is 1.32 times higher than the average frequency in the Mekong Delta and 7.0 times higher than the Red River Delta [14].

3.1.3 Current status of pesticides management

The interview results showed that the management of pesticides was not paid attention when 38.3% of farmers kept it indoors, 55% kept it in warehouses (about 10m away from home) and 21.7% left outdoors (Figure 3). The unsafe preservation of pesticides has many risks to the environment and public health [6]. Especially, compounds with high toxicity, difficult to decompose in the environment such as chlorine, DDT, and Aldrin, which remain too long in the soil, will produce new compounds that are more toxic than the original ones [15].

Figure 3. Farmers' forms of pesticide storage: (a) indoor storage, (b) store a private warehouse, (c) left outdoor

A number of pesticide management programs have been implemented locally. For example, the program of "Environmental protection program with farmers" have been performed in the triple-

rice farming model by placing 16 tanks for containing pesticides bottles and packages. The collected wastes were then collected every six month for the treatment. In the model of durian farming, packages of pesticides were collected at the end of each month. However, the results of these programs were not effective because those were not widely available.

The licensed pesticide business establishments in Truong Long commune and Nhon Ai commune were 10 and 5 establishments, respectively. Inspection of pesticide business establishments is carried out regularly in Truong Long commune and periodically in Nhon Ai commune.

3.2 Knowledge, attitude, and practice of the farmers in the use of pesticides

3.2.1 Knowledge of the farmers

The interview results showed that, pesticides play an important role (41.67%) and very important (55%) in the cultivation process. However, only 78.3% of farmers care about the origin of pesticides, the remaining farmers only care about the effectiveness of pesticides. Especially, 42% of farmers do not want to switch to using pesticides of biological origin due to concerns about efficiency and cost. Pesticides were used mainly through recommendation from sellers (58%) or by people around them (6.8%) and through TV advertisements (5.7%). Besides, there were 29.5% of farmers using pesticides according to their experiences and habits. The average score for assessing farmers' knowledge was 6.8±0.8 (accounting for 85%), which shows that farmers in the study area have relatively good knowledge of pesticide use.

The dosage of pesticides used according to the instructions on the packages and the sellers was 48.4% and 36.8%, respectively. The few remaining farmers use it based on the amounts of pests and diseases, the guidance of local officials and personal experience. To save time and effort, most farmers spraying with many pesticides at the same time (91.7%). They usually spray in the early morning (35.4%) or the afternoon (35.4%). The combination of pesticides has the potential to increase toxicity or decrease the effect of pesticides [7]. The toxic substances in the pesticides have a serious impact on the quality of the soil, air and water environments, and those also affect humans and aquatic life [16].

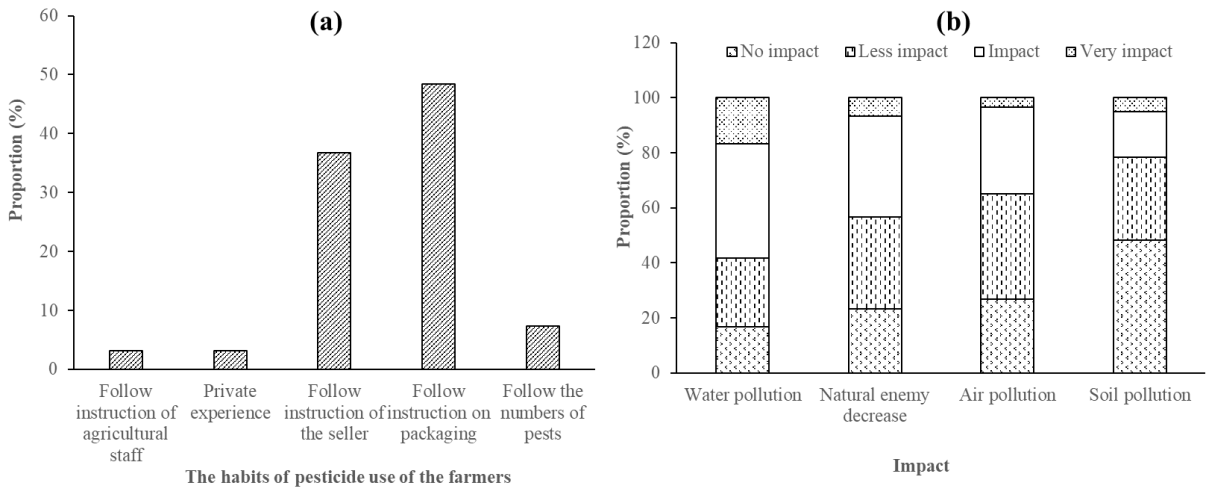

Figure 4. (a) Bases of pesticides use and (b) farmers' perception of the impact of pesticides on the environment

The results showed that 21.7 - 58.3% of farmers realized that excessive use of pesticides had an impact on the environment and destroyed natural enemies (Figure 4b). In which the water environment is the most seriously impacted [17]. In addition, the soil environment should also be

considered as up to 50% of the pesticide when sprayed is dropped on the ground [6]. Information on the effects of pesticides was accessed by the farmers mainly via radio plus television (69.3%), internet (17.3%), loudspeaker (4%), newspapers (1.3%) and other sources (8.1%). Some of the eco-friendly farming programs adopted by the farmers are Integrated Pest Management - IPM (23.2%), "One Must and Five Reductions" (19.2%) and "3 Reductions, 3 Gains" (28.3 %).

3.2.2 Attitude of the farmers

The interview results showed that the attitude of farmers is positive about the harms of pesticides. The number of respondents in agreement with the need to wear protective gear and the hygiene after spraying pesticides was 55% and 100%, respectively. In addition, 63.3% of farmers said that it is safer to use a mixer than to mix pesticides by hand. Furthermore, they disagree with the non-recommended use of pesticides (60%). However, 46.7% of farmers said that wearing protective clothing would interfere with the movement process and 55% of the respondents considered burning as a safe method of handling pesticide packages and bottles. Their attitudes showed indifference to occupational safety and environmental health.

Table 1. Farmers' attitudes towards pesticide use

Farmers' attitude in using pesticides	Proportion (%)				
	Strongly agree	Agree	Confusing	Disagree	Strongly disagree
Protective clothes during spraying pesticides cause difficulty in movement	6.7	46.7	10.0	26.7	10.0
Protective clothes are unnecessary and costly	1.7	20.0	26.7	43.3	8.3
Wearing clothes carefully when spraying pesticides is not necessary	3.3	20.0	0	55.0	21.7
Having bath after spraying pesticides is a preventive measure	56.7	43.3	0	0	0
Compliance with instructions on the label recommendations is not necessary.	3.3	20.0	5.0	60.0	11.7
It is safer to use a pesticides mixer than with the hands.	25.0	63.3	10.0	1.7	0
Increasing dose of pesticides is the only way to get rid of pests	16.7	33.3	21.7	21.7	6.7
Burning is a safe way to discard the packages and bottles of pesticides after use.	23.3	55.0	13.3	6.7	1.7

Farmers' attitude towards pesticide use was assessed through 8 questions. The assessment results showed that the attitude of farmers in the study area was average with 19.0 ± 3.7 points (equivalent to 59.4%).

3.2.3 Practice of the farmers

In the study area, 76.2% of the farmers used the pesticide at the correct dosage stated on the package and 23.8% of the farmers used it higher than the recommended dose. Farmers sprayed pesticides mainly according to the expression of pests and diseases (55.3%) or periodically (44.7%). Previous studies have shown that farmers in the Mekong River Delta often use pesticides at higher doses than recommended on the label to increase efficiency [6, 9]. This leads to residues of pesticides in products, leading to dangerous diseases for consumers such as cancer [18]. Moreover, despite being aware of the importance of using protective gear in the spraying process, still 30% of farmers did not use labor protection when spraying. The remaining 70% of farmers used it, but it was still sketchy, they only used masks, glasses, and gloves.

The pesticide mixture left over from the application is usually sprayed to the end (70%) or stored and sprayed for the next time or poured into canals near the field (Figure 5). Spraying tools were washed in canals (70%) or at home (1.7%), especially 28.3% of farmers did not wash these tools.

The handling of tools after spraying by farmers is potentially risk and requires safety measures to replace it [19]. At present, the locality has not had measures to collect and centrally treat pesticide packages and bottles. Therefore, most of this waste is treated by burning (54.7%) or burying (10.7%), thrown in the field (17.9%), and thrown away with domestic waste (2.4%) or collect and sell to sellers (13.1%) (Figure 5).

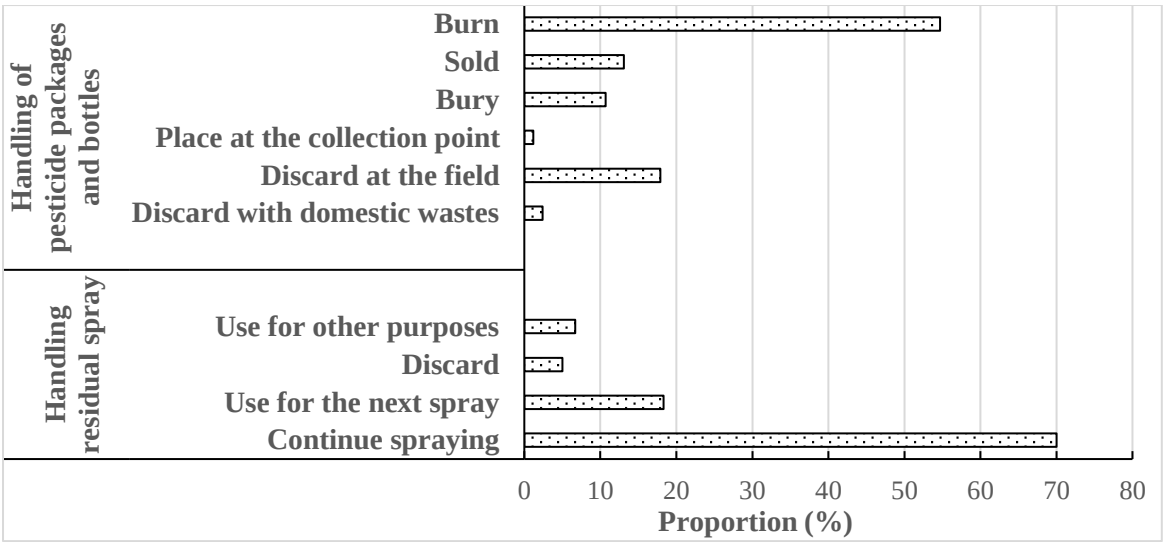

Figure 5. Forms of waste treatment after spraying pesticides

3.3 Toxicity of pesticides used

The results of the investigation on the three-crop rice farming discovered 65 pesticides (mainly insecticides, herbicides, mice and plant growth stimulators) with 54 active ingredients. This farming used pesticides higher than the Ri6 durian farming with 59 pesticides (41 active ingredients). In which, the number of pesticides on the list of pesticides permitted for use in Vietnam (Circular 10/2020/TT-BNNPTNT) in the three-crop rice cultivation (54 types) is lower compared with the model of durian Ri6 (59 types). The active ingredients which were banned in use include Carbosulfan, Trichlorfon, Glyphosate, Paraquat, 2,4D (three-crop rice model) and Acephate, Carbofuran (Durian Ri6 farming model). By February 2021, some active ingredients banned from use were Chlorpyrifos Ethyl, Fipronil according to Decision 501/QD-BNN-BVTV.

Farmers often applied various types of pesticides belonging to toxicity categories II, III and IV according to World Health Organization (WHO) classification. In which, the three-crop rice farming mainly used pesticides of group IV (42.6%), followed by group II (29.5%) and group III (27.9%). Meanwhile, the Ri6 durian cultivation used pesticides with higher toxicity with 37.5% of farmers used those of toxicity categories II, followed by categories IV and categories III with 32.1% and 30.4%, respectively. Previous research showed that 50% of pesticides used in the Mekong Delta had toxicity in groups II and III [6].

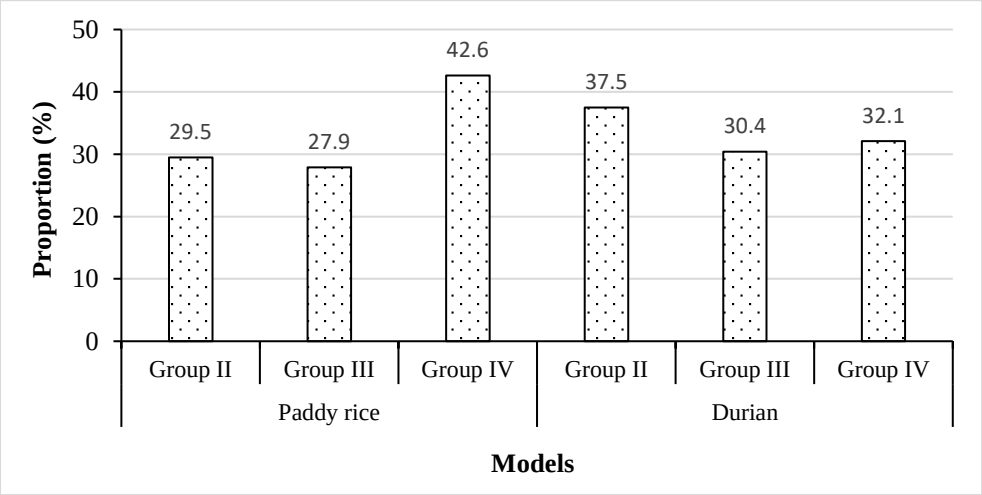

Figure 6. Proportion of toxicity group of pesticides used in the models

Although the pesticides have many effects on human health, only 25% of the farmers clearly understand the harms of the pesticides. Most farmers only generally know about the harms of pesticides (55%). A few farmers do not know or do not care about the harms of pesticides (Figure 7a) because most of them (44.6%) do not feel any abnormal symptoms after spraying. However, the study also recorded that some symptoms appeared during and after farmers using pesticides such as eye and nose pain (24.3%), pruritus (13.5%), and difficulty breathing (9.5%), headache, dizziness and nausea (8.1%) (Figure 7b). The results of this study are consistent with the study of Phong (2020) when farmers often showed symptoms of fatigue (82.1%), heat and itching (57%) and pain (56.6%) when exposed with pesticides.

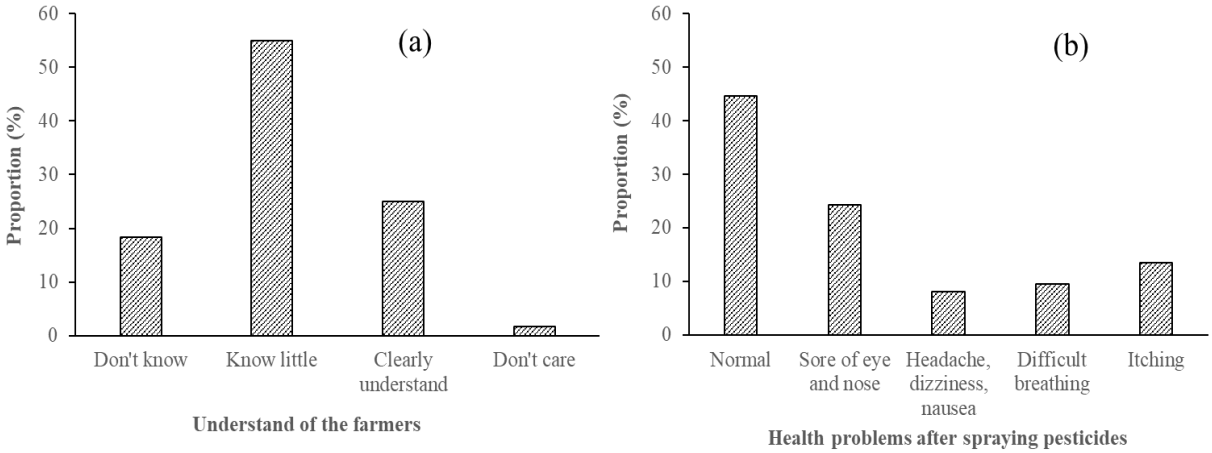

Figure 7. (a) Farmers' understanding of the harmful effects of pesticides on health and (b) manifestations of health after spraying pesticides

3.4 Measures to ensure occupational safety in the process of using plant protection drugs

The research results showed that most farmers do not pay attention to labor safety in the process of using pesticides. Therefore, the study proposes a number of measures to help ensure the safety of users' health and limit the impact on the environment. These measures are shown in Table 2

Table 2. Measures to ensure occupational safety in the process of using pesticides

Time	Methods
Before spraying pesticides	- Workwear (long clothing, nylon apron or impervious cloth, hat, mask, glasses). - Eat well before spraying; bring clean drinking water, soap, towels, and clean clothes for immediate use.
While spraying pesticides	- Do not spray against the wind direction, when the wind is too strong, avoid skin contact. - Do not eat or drink when spraying, spraying tools to ensure safety.
After spraying pesticides	- Clean spraying tools, collect packaging, bottles and wastes and place them in the designed collecting points. - Bathing and washing protective tools with soap, store excess spray in a separate, locked storage and place away from home.

Pesticide poisoning is one of the most common health risks associated with pesticide use. Depending on the dose and duration of exposure to the pesticide, the degree of poisoning can be acute poisoning, chronic toxicity or chronic toxicity due to long-term low dose absorption. The main chemical poisons are poisoning of organic phosphates, carbamates or organic chlorine.

3.5 Proposing a model for collection and treatment of pesticides bottles and packages

To improve the management efficiency of pesticide packages and bottles, the locality needs to deploy the collection model with a reasonable number of collection tanks, located at convenient and satisfactory locations as prescribed in the Circular Joint Venture 05/2016/TTLT-BNNPTNT-BTNMT [20]. Authorities need to regularly check tanks for timely collection and transfer to treatment facilities. At the same time, it is necessary to promote propaganda on the use of pesticides in accordance with regulations and guide farmers to collect pesticide packages into tanks.

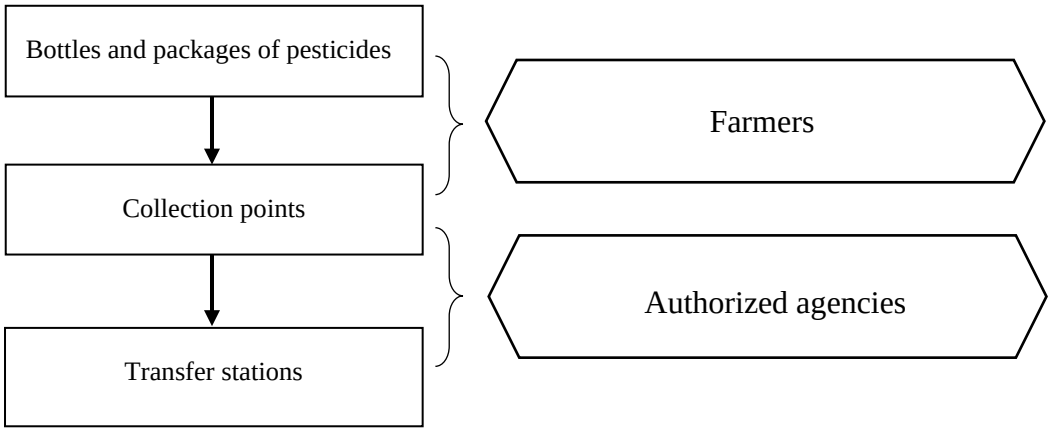

Figure 8. Simple diagram of a pesticide wastes management model

Specifically, pesticide packages and bottles can be temporarily stored by farmers in warehouses or placed directly in collection holes constructed by local authorities. Authorities will regularly monitor, inspect and collect and transport to the treatment site. The process will start with the pretreatment and classification step. This waste is often classified into two main groups, including glass and plastic bottles or polyethylene covers. Treatment methods can be applied such as recycling, reuse, incineration or chemical treatment.

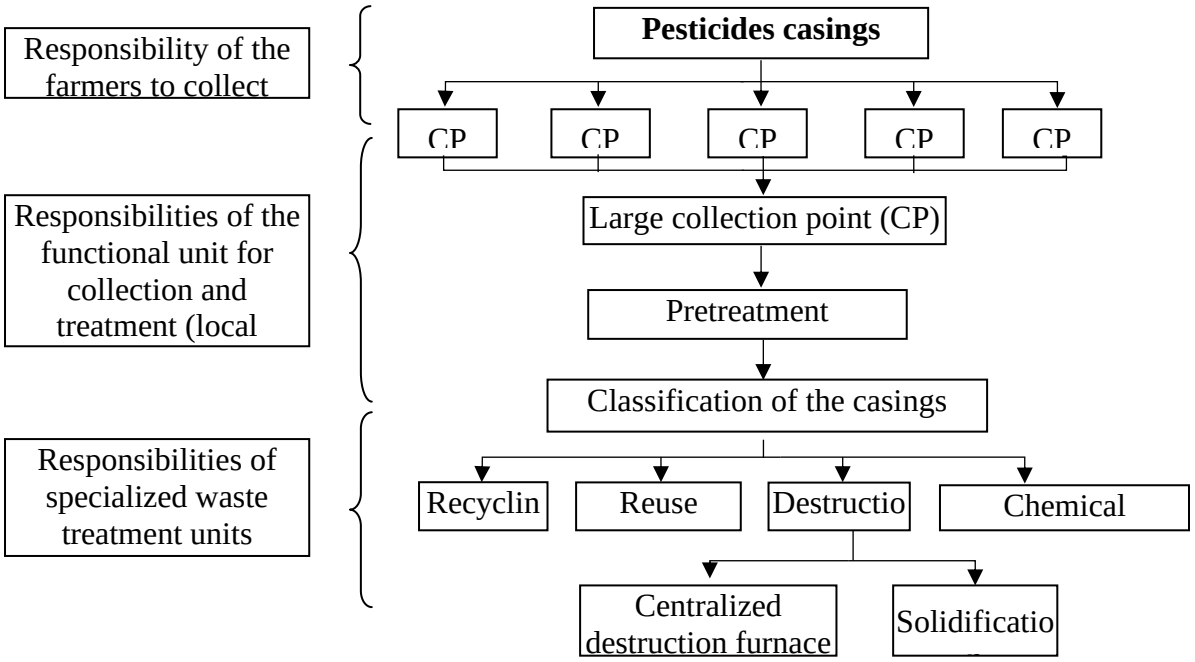

Figure 9. Schematic diagram of pesticide waste management model

4. Conclusion

The demand for pesticides in rice and durian cultivation tends to increase with high frequency of spraying. Farmers often applied various types of pesticides belonging to toxicity categories II, III and IV according to World Health Organization (WHO) classification. In particular, durian cultivation using pesticides has higher toxicity and spraying frequency 8.8 times higher than the triple-rice crop cultivation. Moreover, burning, buring, throwing in the fields, mixing with domestic waste or selling pesticide packages and bottles were improper practices. Although farmers have good knowledge about the harmful effects of pesticides, they were still indifferent to health and environmental issues. It is therefore essential to raise awareness among farmers about the effects of exposure to pesticides and the improper handling of packages and bottles.

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