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Current Status of the Management of Plant Protection Product Containers in Cho Moi District, An Giang Province, Vietnam

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ABSTRACT

Every year, thousands of tons of plant protection product (PPP) containers are indiscriminately discharged into the environment as toxic waste that has a negative impact on the land, water, and air environment as well as public health. This study surveyed the use of PPPs in rice cultivation, and the generation of hazardous waste (HW) when using pesticides, specifically pesticide packaging and containers in Long Kien and Long Dien B communes, Cho Moi district, An Giang province, Vietnam. Data collection was conducted through direct interviews, mainly collecting personal information of farmers in the surveyed area, the current situation with regard to pesticide use, container management, environmental awareness, and proposals for hazardous waste management from the farmers' perspectives. The results show that local farmers are aware of the harmful effects of pesticide containers, but they are not able to make use of effective methods of collecting and treating the waste containers properly. Based on the survey results, several solutions are proposed for managing HW in order to reduce environmental pollution from the use of pesticides, minimize the impacts of HW on people's health, and contribute to local sustainable development.

Keywords: plant protection products, pesticide container management, pesticide use, pesticide container collection system

INTRODUCTION

Over the years, Vietnam has traditionally been one of the world's top five biggest exporters of rice. The hot and humid tropical climate in the agricultural country of Vietnam is conducive to the growth of crops, but also very favorable to pest and weed infestations that damages crops. Along with intensive farming processes, the use of fertilizers and pesticides is gradually increasing in dosage and variety. Particularly in the Mekong Delta, a wide variety of pesticides are used, mainly organic phosphorus, carbamate, pyrethroid insecticides, conazole fungicides, and biological pesticide groups.

From 2012 to 2014, Vietnam imported and used 90,000 - 100,000 tons of plant protection products (PPPs) per year, of which packaging accounted for about 10% (equivalent to more than ten thousand tons per year). According to the report of National State of Environment in 2011-2015 by the Ministry of Natural Resources and Environment (MONRE), it is estimated that, each year, Vietnam generates more than 14,000 tons of PPPs and fertilizer containers. According to the environmental assessment report from the Vietnam Environment Administration (VEA, 2015), there are about 200 sites polluted by pesticides. The main cause of this is the uncontrolled use of PPPs that have led to a significantly increased quantity of the various types of PPP containers, bottles, and packages. According to the report of National State of Environment in 2017 (Ministry of Natural Resource and Environment [MONRE], 2017), thousands of tons of pesticide containers have been discharged into crop fields. Improper disposal of plastic, glass, or metal pesticide containers affects the health of the nearby communities and causes negative impacts to the soil, water, and air environment.

In An Giang, agricultural production accounts for a large proportion of local economic activity and growth. According to the Statistical Office of An Giang Province (SOAGP, 2018) , 254,320.08 ha of rice are under cultivation, accounting for 71.91% of the total natural area of the province (equivalent to 6.17% of the whole country). With the large rice-producing area, without appropriate awareness of PPP use by authorities, manufacturers, and farmers, then packaging will not be disposed of properly, and resulting negative impacts will severely affect human health and the environment in the area.

According to Decision No. 491/QD-TTg Article 1 on the adjustment of the National Strategy of Integrated Solid Waste Management up to 2025 with a vision toward 2050, signed in 2018 by the Vietnamese Prime Minister, all of the chemical and pesticide packaging containers used in the agricultural industry must be collected, stored, and handled in accordance with the law by 2025, all of the chemical and pesticide packaging containers used in the agricultural industry must be collected, stored, and handled in accordance with the law. However, at present, most localities are not handling the PPP containers safely and hygienically due to a lack of equipment and infrastructure. According to VEA (2015), the pesticide containers, after being gathered together with empty fertilizer bags, are often burned or buried far from residential areas. In many localities, farmers also put waste PPPs together with household waste. Even in the areas with waste collection services, large waste containers are required for farmers to store this hazardous waste before it is collected and transported to the destruction site. With the small number of qualified incinerators in Vietnam, the cost of transporting the waste to the treatment facilities is relatively high (Chi, 2011).

The primary objectives of this study are to assess the current status of PPP use, and the generation of hazardous waste related use of PPPs. Based on the results revealed by those assessments, short-term and long-term solutions/measures for Hazard Waste (HW) management are proposed in an effort to contribute to timely pollution control in rice cultivation areas in Cho Moi district. A key outcome is improvement in solving the inadequacies in HW management in Cho Moi district, in particular, and An Giang province in general. To achieve the above two objectives, this study conducted investigations into (1) the current situation of PPPs use in rice cultivation, as well as (2) waste container management, and (3) farmers' opinions on the program to collect PPP packaging.

RESEARCH METHODOLOGY

Study Area: Cho Moi district, An Giang province

Cho Moi is an islet district of An Giang, one of 17 southern provinces of Vietnam, 29 km on Provincial Road 944 from Long Xuyen City. Cho Moi is bordered by Phu Tan district, An Giang province to the North (separated by the Vam Nao river); Lap Vo, Dong Thap province to the South (separated by the Cai Tau Thuong canal); Chau Thanh, Chau Phu, and Long Xuyen City, An Giang province to the West (separated by the Hau River); Thanh Binh, Cao Lanh City, and Dong Thap province to the East (separated by the Tien River). Cho Moi has two townships, Cho Moi and My Luong, which are divided into 16 communes (Kien An, Kien Thanh, Long Giang, My Hoi Dong, Nhon My, Long Dien A, Long Dien B, Long Kien, An Thanh Trung, Hoa Binh, Hoa An, My An, Hoi An, Tan My, My Hiep, and Binh Phuoc Xuan).

Cho Moi has a tropical monsoon climate with two different seasons. Every year, the Southwest monsoon carries a lot of water vapor, bringing rain, while the Northeast monsoon is dry, lasting from December to April and causing drought.

Because Cho Moi is located deep inland, it is less affected by storms, but strongly affected by hydrological processes such as floods and riverbank landslides.

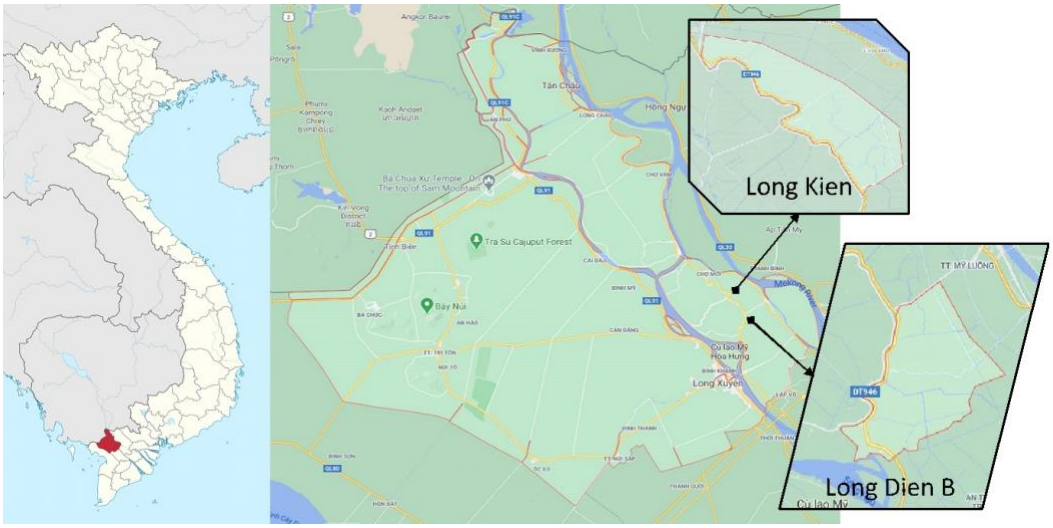
Cho Moi is not only surrounded by the Tien and Hau rivers, but also interlaced with canals. The systems of rivers and canals provide Cho Moi with fresh water for people's daily lives and agricultural production, and act as waterways for tourism and transportation. In addition, the inland canals and surrounding rivers help the local agricultural production by providing water for irrigation of 27,349.24 ha of agricultural land, accounting for 74.1% of the district's natural area and about 9% of the province's land area, according to SOAGP (2018).

For many years, the development goal of Cho Moi district focused on agriculture as the foundation in the local economy. Therefore, the use of pesticides has become more and more important for production. Pesticides can control the occurrence and development of epidemics, prevent large-scale disease outbreaks, ensure productivity, and reduce crop damage.

This study investigated rice-growing areas in the Long Dien B and Long Kien communes, 2 out of the 16 communes of Cho Moi district in An Giang province (Figure 1).

Figure 1

Location of Long Kien and Long Dien B communes in An Giang province



Note. Adapted from *An Giang in Vietnam*, by Wikimedia Common, 2021 (https://commons.wikimedia.org/wiki/File:An_Giang_in_Vietnam.svg#/media/File:An_Giang_in_Vietnam.svg). CC BY-SA 3.0; *Long Dien B and Long Kien communes*, by Google Map, 2021. Copyright 2021 by Google Map.

Figure 2

Pictures of PPP use and waste containers taken at the surveyed area

Methods and Approaches

This study employs a social practice approach (Herndl & Nahrwold, 2000; Luiza & Smolka, 2001), which relies on fieldwork to identify the linkages between practice and contexts in social situations. In this study, the farmer/farm household is considered a social agent, and the use of PPPs and the handling of waste containers after use are considered social practices.

A face-to-face survey was conducted from January to April 2017. The information collection technique was designed based on the guidelines in the Handbook of Survey Methodology for the Social Sciences (Gideon, 2012). The survey was structured as a formal interview (also known as formal survey-based interview), in which the target respondents were approached in order to inquire about their basic information and learn about their experiences and thoughts by asking 26 predetermined questions. General information about the respondents includes the full name of each interviewee, his or her experience and main role in rice cultivation, and details about the interviewee's cultivated area. Regarding the current situation of PPP use, the collected information mostly focused on the most used PPPs, the list of target pests, the dosage, and the number of sprays per year. The management of PPP containers by farmers in the area was assessed through information on commonly used packaging types, the number of waste containers generated after each spraying time, and how they manage packaging types after spraying. Finally, environmental awareness and opinions on the tank model for waste container collection were collected and analyzed for the purpose of proposing HW management measures.

The target population is the farmers who use PPPs in rice cultivation in Choi Moi, An Giang province, Vietnam. Due to operational constraints such as accessibility and budget, the survey population of farm households was selected from two out of 16 communes of Cho Moi district. The set of farmers was selected based on convenience or accessibility; that is, households were chosen based on which ones the fieldwork staff were more likely to meet in person. Respondents comprised farmers with direct experience and skills in rice cultivation who were able to provide sufficient information.

The sampling method is non-probability; it assumes that chosen farmers are representative of all farm households of the survey population. The sample size was subjectively chosen based on convenience sampling, with consideration of the size of the study areas and survey fieldwork operators' capabilities. The proposal was to interview 50 random farm households in each of

the two surveyed communes (total number of samples = 100). Collected information was analyzed using MS Excel 2016. Information obtained from interviews was input directly into the worksheet and all hard copies were kept.

RESULTS AND DISCUSSION

Current situation of PPP used in rice cultivation in Long Dien B and Long Kien communes

Respondents were rice farmers with many years of experience, which was, on average, over 21 years in the Long Kien commune, and over 18 years in the Long Dien B commune (SeeTable 1). In addition, the set of farmers in the study area with cultivation experience of less than 10 years or more than 40 years comprises a very small portion. Further, it can be said that most of the respondents are over 30 years old.

Also, the amount of area used for rice cultivation differed greatly among the surveyed farmers, and between the two surveyed areas. The proportion of farmers cultivating small rice areas (less than 1 ha) comprised over 50% of the survey area in the Long Kien commune. However, in the Long Dien B commune, the proportion of cultivation area among farm households was divided fairly equally between the five size of area classifications. This may indicate different trends that could affect the results of the psychological analysis of PPP use for smallholder rice farmers (e.g., disease outbreak could cause smallholder rice farmers to lose everything, yet represent a lower risk for farmers who mainly rely on planting rice in larger areas).

Table 1

Statistics comparing basic information of farmers in the survey area

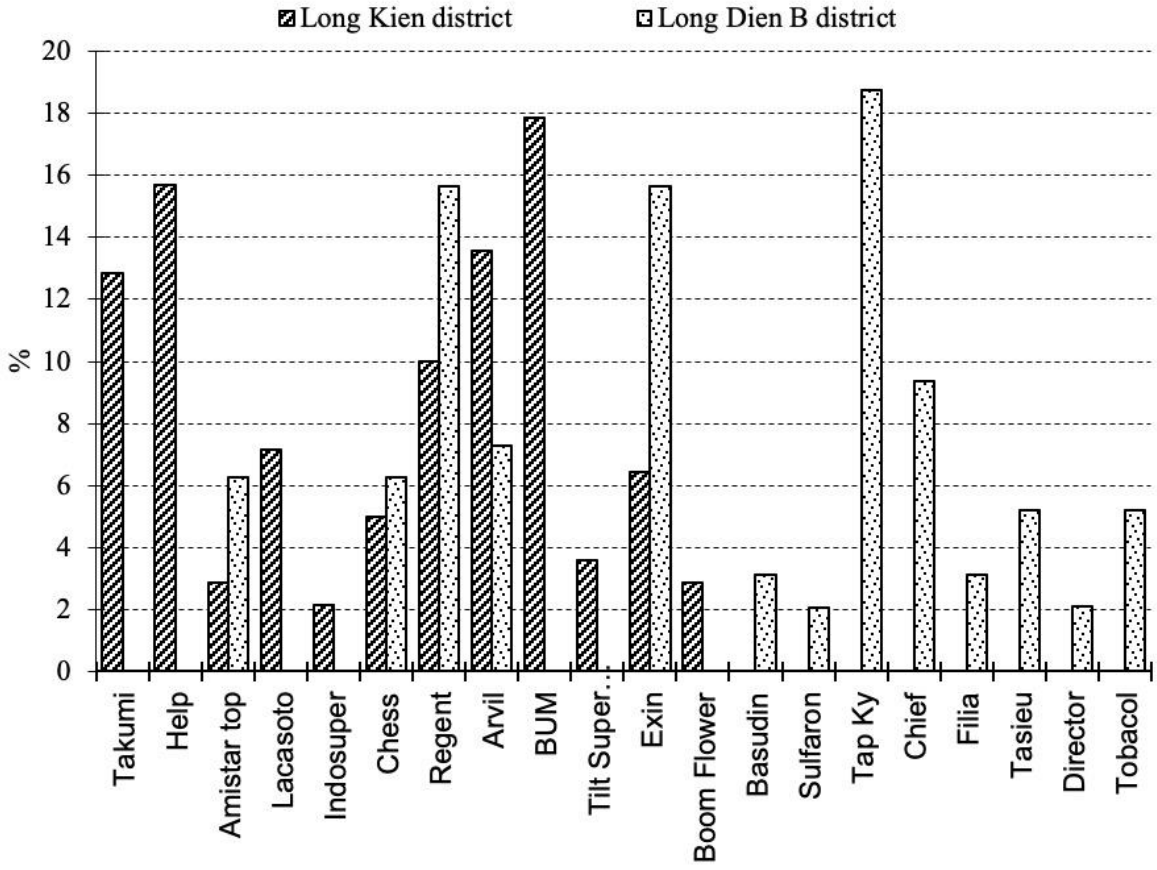
	Long Kien	**Long Dien B**
Crop per year	**3**	
Cultivation area (%)		
≤ 1 ha	52	32
1-2 ha	22	22
2-3 ha	20	14
3-4 ha	0	20
> 4 ha	6	12
Average cultivation area (ha)	2.5±1.8	1.8±2.0
Rice cultivation experience (%)		
<10 years	8	0
10-20 years	66	62
21-30 years	20	28
31-40 years	6	6
> 40 years	0	4
Average	21.1±7.7	18.2±8.2
PPPs spraying per crop	9.84	7.18

Usually, rice growing areas in the Mekong River Delta use one of two main types of cultivation: 2 crops per year, or 3 crops per year. However, 100% of the interviewed farmers directly cultivate rice 3 crops/year. The survey results provide data on the frequency of pesticide spraying between the two surveyed areas as being representative of the Cho Moi district. As seen from the survey results (Table 1), the average number of sprays in the Long Kien commune were different from that of the Long Dien B commune, ranging from 1-36 times/crop, compared to 1-40 times/crop respectively. From the study by Escalada et al. (2009), the frequency of spraying herbicides and pesticides in Long An and Can Tho between 2002-2007 was 3.5 times/crop (Long An), and from 1.8-2.5 times/crop (Can Tho). Another study by Nhan et al. (2015) found that the number of sprays of pesticides in Hau Giang province was higher, with 7-8 sprays/crop. Meanwhile, recent studies have suggested reducing the frequency of spraying to 4 times/crop (according to research by Xuan et al. (2020)). Recently, in several agricultural areas in the north of Vietnam, farmers were found to be spraying 1-7 times/crop, or 4 times/crop on average, according to Sattler et al. (2018).

In addition, the varieties of PPPs have also changed significantly over the years. Specifically, in the Long Kien commune, 11 commercial pesticides with 12 active ingredients are in use; Long Dien B commune has 12 commercial products with 13 active ingredients in use. In general, PPP use in rice cultivation is widely applied in the 2 communes of Long Kien and Long Dien B (Figure 3). This simple measure is designed to make the pests less resistant to the pesticides.

Figure 3

The proportion of PPPs use by category of commercial name in the surveyed areas



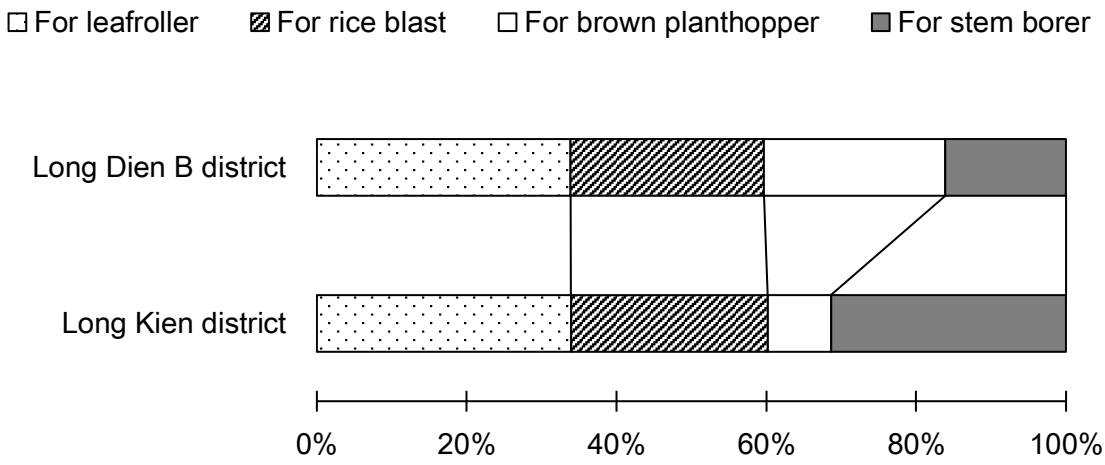
According to Figure 3, the pesticides and active ingredients such as Abamectin (Tap Ky 1.8EC, 3.6EC), Fipronil (Chief 9.9GR, 260EC, 520WP; Regent 0.2GR, 0.3GR, 5SC, 800WG), salicylic acid (Exin 4.5SC, 2.0SC), hexaconazole (Anvil 5SC), and propineb (Tobacol 70WP) are commonly used in the Long Dien B commune, while less commonly used PPPs include Director and Filia. By comparison, in the Long Kien commune, the most popular pesticides and active ingredients include isoprothiolane, tricyclazole (BUM 600WP, 650WP, 800WP), azoxystrobin, difenoconazole (Help 400SC; Amistar top 325SC), flubendiamide (Takumi 20WG, 20SC), hexaconazole (Anvil 5SC); Sophora japonica (Lacasoto 4SP), salicylic acid (Exin 4.5SC, 2.0SC); pymetrozine (Chess 50WG) and rarely use Amistar Top, Indosuper. However, after comparing with the list of pesticides permitted for use in Vietnam according to Circular No. 03/2016/TT-BNNPTNT by the Ministry of Agriculture and Rural Development (MARD, 2016), it was found that two drugs are permitted: Boom Flower (stimulating growth) and Basudin (special treatment of controlling a wide range of soil pests, and foliar chewing and sucking pests).

According to research by Chau et al. (2019), in Thua Thien Hue, the average number of pesticides used per vegetable crop ranged from three to five different drugs, depending on the plant growth stage and pest situation. However, for rice cultivation, this number usually varied, e.g., about 9 different pesticides were found to be widely applied in Dai Thanh commune, Quoc Oai, Hanoi (Tuan et al., 2015), or in Hai Duong and Hai Phong provinces with an average of 19.2 pesticides (Sattler et al., 2018). On the other hand, the situation of PPP use was more widely diverse in many provinces in the Mekong Delta, e.g., in Hau Giang 97 pesticide products were commonly used in the years 2011-2014, according to Nhan et al. (2015)

As seen in Figure 4, the most commonly used pesticides were for leafroller, comprising 33.9% (at Long Kien) and 33.87% (at Long Dien B). However, in the Long Dien B commune, the frequency of pesticide use for stem borers was less than that of the Long Kien commune.

Figure 4

Proportion (%) of pests and diseases for which farmers often apply pesticides



With adjacent boundaries, the difference in the proportion of pests and diseases indicates that there is a difference in the prevention of pests and diseases in crop protection. That may come from the different programs promoted by the agricultural extension officers in each region, or may be based on each farmer's farming experience and crop conditions in the two surveyed areas. These results show that the influence on the frequency of spraying for each pathogen in rice cultivation is also a factor affecting the generation of PPP containers; the more frequently spraying happens, the larger the number of bottles generated.

Information on PPP containers usually provides some instructions for the use and preparation of the mixture. Through the interview results, 88% and 86% of farmers reported referring to the

container label for primary guidelines to effective spray mixtures in the Long Kien and Long Dien B communes, respectively. A small percentage of farmers reported using higher doses than the guidelines recommend because they think that spraying with high doses will increase the effectiveness of an insecticide. This is one reason that pests and diseases become more resistant to pesticides, and indirectly indicates the consequences of abuse and misuse of pesticides in farming. However, the mixing procedure, personal habits, and dosage adjustment were not clearly stated in the survey.

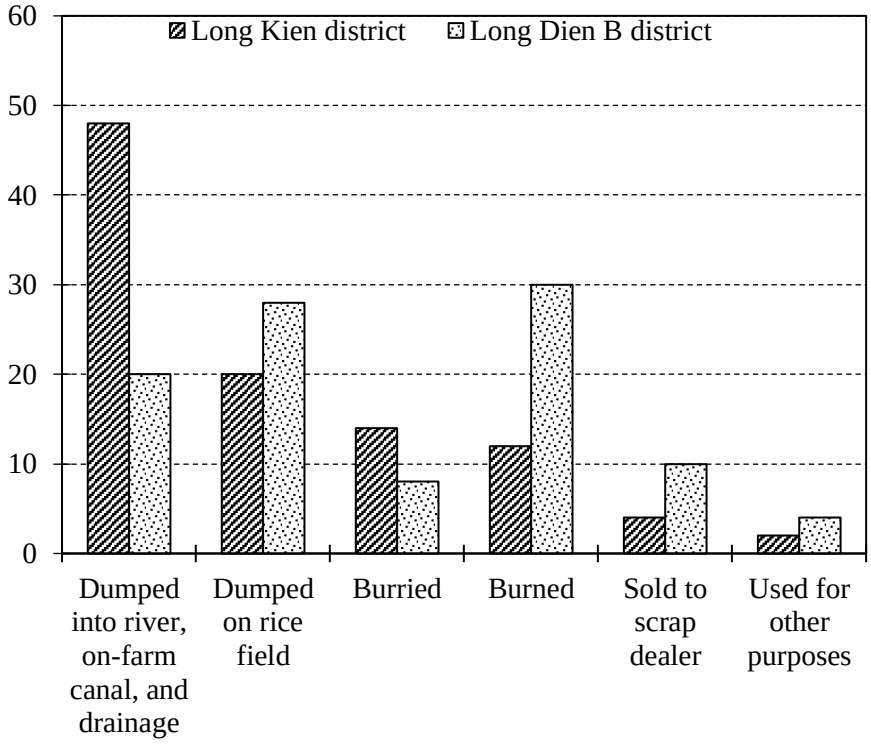
Current situation of PPP container management in the Long Kien and Long Dien B communes

Currently, most PPP containers are plastic bottles and aluminum-coated packages because of low production costs, high physical durability, ability to contain different types of pesticides, and flexible packaging design. As the less common types, glass bottles are often large and fragile, while paper and plastic bags have low physical strength and are often not suitable for liquid PPPs. According to the results of actual weight during the survey fieldwork, the packaging of pesticides generated 97.42 kg PPPs bags/crop on the total area of 213.55 hectares of rice cultivation by 100 farmers in 2 communes (Long Kien commune = 56.07 kg/crop, and Long Dien B = 41.35 kg/crop). The composition of the PPP container waste generated comprised 50% plastic bottles, 47.5% aluminum-coated packages, and 2.5% glass bottles.

From the survey results shown in Figure 5 on pesticide packaging management, it can be seen that the discard rate directly into the environment is very high (accounting for over 50%). Most farmers are aware of the impact of PPP waste containers on the environment and human health, but cannot collect them due to a lack of knowledge on standard collection methods, and lack of support from local authorities. Therefore, it is necessary to have solutions/measures to manage PPP waste containers in time to avoid local pollution of hazardous wastes from pesticide bottles and packages in the field.

Figure 5

The current situation of PPP container management



Respondents in the Long Kien commune, after using pesticides, chose to dump empty containers into rivers, on-farm canals, and in the field at a high rate (68%). With the location of the Long Kien commune adjacent to the Hau River, indiscriminate disposal in the river and canal not only has a harmful impact on the local area but also affects the large river basin supplying water to the Mekong River Delta. Meanwhile, in the other commune, Long Dien B, the direct disposal rate is also quite high (48%), and this area is only about 1km from the basin of the Mekong River. However, people in the Long Dien B commune, mostly farmers, report often selling to scrap dealers for profit; however, they reported burying, burning, or used for other purposes any containers that could not be sold. Aluminum-coated packages are not worth selling to scrap dealers if they are collected, so people choose to bury or burn them. Plastic bottles that can be used for other purposes are later usually discarded and disposed of together with household waste.

According to research by Nhan, Nga, and Toan (2015), during the period 2011-2014, the management of PPPs discarded in Hau Giang changed over time, with selling and burning increasing from 47.8% to 75.9%, and direct disposal in fields and on-farm canals gradually decreasing from 40.9% to 13.3%. For vegetable farmers in Thua Thien Hue, the percentage of empty containers dumped in the field, buried, and burned (totaling 27.9%) was lower than the percentage disposed of together with other types of waste (72.1%), according to research results of Chau et al. (2019).

In the surveyed area, the pesticide bottles and packaging left by farmers in fields, rivers, canals, and on-farm canals are very difficult to collect, transport, and treat. They pollute the surrounding soil, water, and air environment. Furthermore, due to the economic conditions in the locality, the collection service for PPP containers is almost not available. Most of the collection events in the past had been supported by NGOs or under national projects, so when the project ended or was no longer supported, the collection effort was no longer effective.

As shown in Figure 5, farmers often treat PPP waste containers by unsafely burying or burning them together with household waste, without treatment of emissions. Meanwhile, some other farmer households use them for other purposes, and eventually dispose of them together with domestic waste. In addition, the storage of a large number of empty PPPs containers in anticipation of selling them in bulk to scrap dealers is also harmful to the health, not only of farmers, but also for collectors or scrap dealers who may not be using appropriate personal protective equipment when in contact with this HW.

From the situation of PPP container management existing in the two surveyed areas, it can be seen that the farmers' ways of handling waste containers is improper and creates a huge risk of environmental pollution. The emissions of harmful substances in the combustion process may adversely affect the health of the people, while indiscriminate disposal and unsafe landfills create the risk of soil and water pollution. This may be due to a lack of awareness, or even knowledge, of the problems associated with improper disposal of PPP containers.

Results of farmers' awareness of PPPs and opinions on PPP container collection programs

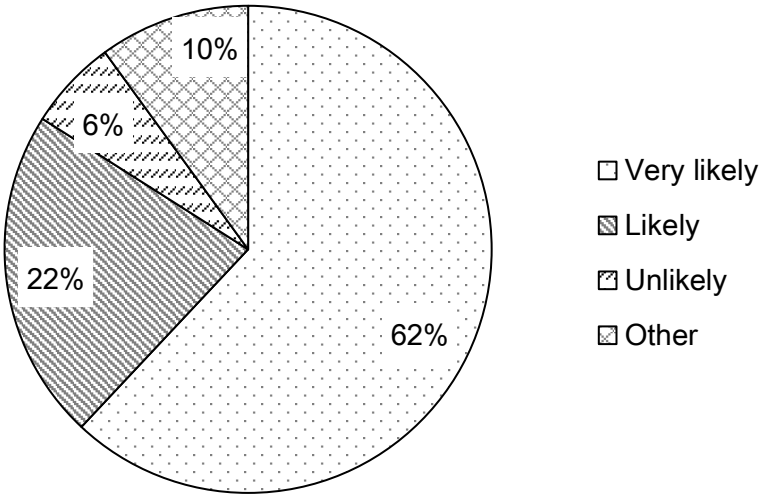
In responding to the survey, most farmers answered that they do not like using PPPs (accounting for 76%), but that this is the only way for them to protect their crops. In particular, the farmers who do not like to use pesticides gave several reasons, such as the fact that pesticides can affect the environment and human health, and that pesticides are dangerous because they are toxic when inhaled, or that the use of pesticides is very costly. Meanwhile, other farmers said that they preferred to use pesticides because pesticides can easily control pests and diseases, and limit damage to crops, ensuring a high yield at harvest, and because they can kill pests quickly, are less time consuming, and because they offer the only way to get rid of pests and diseases for rice cultivation.

When asked about the degree of cooperation and participation in the collection and transportation of PPP containers, 84% said they were ‘Very likely’ or ‘Likely’ to participate, with those not interested in participating accounted for

just 6% ('Unlikely'), while other opinions comprised 10% (Figure 6). Of particular concern was that the collection program require that farmers participating in the collection of PPP containers to pay the cost after each crop/season, and at an acceptable price.

Figure 6

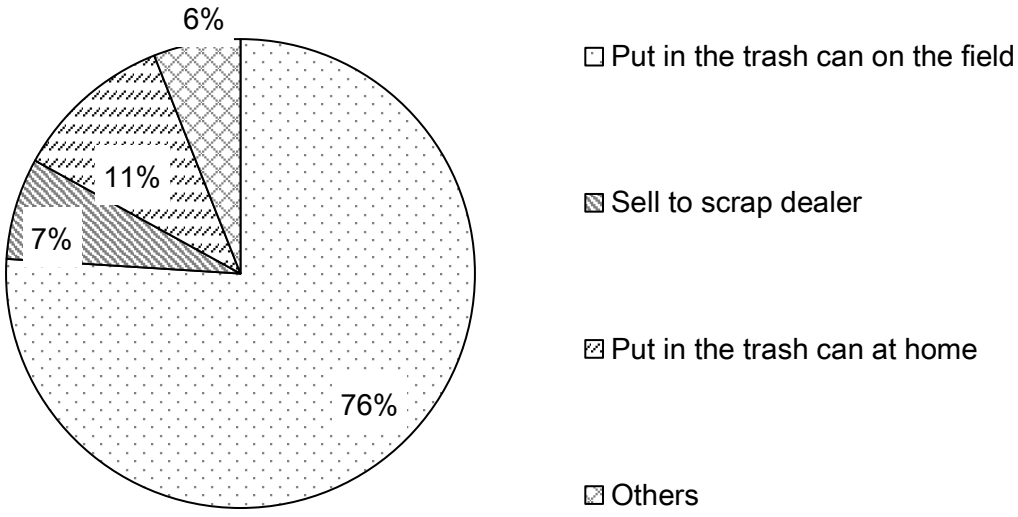
Opinions on participation in waste PPP container collection programs



The number of farmers who did not wish to participate in the collection program said that they were unwilling because the payment for the collection and transportation may reduce or exceed the profit earned after crop/season. Meanwhile, other farmers have different opinions. Such opinions included the idea that local authorities be required to directly participate in the management, and that the collection and transportation program must be highly effective.

Figure 7

Opinion on which collection methods are considered to be effective by the farmers



Survey results on the most effective collection method (Figure 7) in Long Kien and Long Dien B communes showed that most farmers prefer to put waste in trash cans in the field; a few prefer to sell to scrap dealers, while others prefer to put the waste in trash cans at home, or had other opinions. The opinions on collection measures considered to be effective by farmers showed somewhat of a preference for 'convenient method' in accessing the disposal places, while still complying with the law and local regulations. Therefore, the study proposes storage and collection of discarded PPP containers in a small collection tank next to the cultivation field to meet the 'convenient' requirements for farmers in disposal of containers after spraying. According to the opinion of the survey respondents, any such container needs so be designed to be put in the field under variant weather conditions, and it must be suitable to the local economy.

The survey results on the level of support from farmers showed that 96% of respondents will support the arrangement of having a collection tank in the cultivated areas. This is also consistent with the 'convenient method' for disposal as discussed in Figure 7. In addition, when asked to suggest the tank locations, farmers responded with several suggested locations, such as the entrance to the field, the on-farm canal banks next to the field, or next to main roads for easy access to the collection truck. The most common suggestion (83%) was placing the collection tank on the on-farm canal banks near the field. In addition, farmers proposed to set up collection sites in the area of local cooperative organizations, and suggested that the transportation unit that collects directly from the tank to the collection site belong to the local cooperative organization. At the collection sites, all PPP containers will be handled according to Circular 36/2015 / TT-BTNMT, and then transported by An Giang Urban Environment Company Limited.

However, some potential shortcomings in the implementation of a collection program can be found in ensuring farmers' awareness of disposing of waste containers at designated sites, the balance between convenience for farmers to access the collection sites, and the designed distance between each site with the local economic conditions.

For farmers who were aware of the dangers of using pesticides to human health, most of them showed interest and understanding after being asked about collection program and effectiveness of collection methods. However, in comparing sustainable values, the current situation of PPPs uses and perceptions of farmers in particular, and the management of PPPs containers in general, it was found that many respondents did not ensure environmental safety and human health, and may be indirectly affecting crop productivity and pesticides application.

Proposed solutions to the PPP container management issues

This study proposes several solutions to improve the effectiveness of PPP container management in the surveyed area. This study divides all proposed solutions into short-term and long-term groups.

a. Short-term solutions

i. Solution for awareness-raising

After learning basic information and knowledge about the environment, farmers will be more active in environmental protection activities. Through communication and propaganda about the impact of agricultural HW, activities of collecting abandoned pesticide bottles and packaging from the fields and surrounding areas, canals, and rivers will be launched to overcome the habit of direct disposal of PPP containers, and to reduce the amount of waste in the environment.

In addition, communication activities can be enhanced through the number of articles, news articles, banners, posters, leaflets, community notice boards, local radio, and television channels on the impact of PPP containers. In addition, holding training sessions every 3 months will help raise the awareness of farmers concerning the impact of agricultural HWs. These training sessions should be mandatory, and held in the intercommunal meetings, and each household should be required to send at least one member to attend. Also, the commune

unions and cooperative organizations should regularly organize public labor sessions, in conjunction with Farmer's Union, Women's Union, Youth Union, School, and Commune Radio to spread key messages and information about regular activities.

ii. Establishment of a collection, transportation, and treatment system for HWs in agriculture

The aim is to reduce the number of PPP containers dumped into the environment through consistent recycling or reuse of pesticide packaging, and effective HW management. PPP manufacturers, authorities, and farmers should jointly build a system for the collection, transportation, and treatment of agricultural HWs. With the aim of overcoming farmers' habits of directly disposing of PPP containers, campaigns should be launched to increase farmers' awareness and ability to classify pesticide packages; namely, after being collected, they must be classified into 3 categories (glass bottles, plastic bottles, and polyethylene bags).

In the collection system, PPP manufacturers need to initiate and promote programs to return the containers after use. Along with that, the local authorities at the district/commune level should manage and build collection tanks and transfer sites. Waste containers, after being collected, need to be periodically transferred to the licensed operators according to national standard regulations together with the registration book for waste source owners. The handling unit (An Giang Urban Environment Company Limited) need to carry out the role of periodically collecting and disposing of these HW containers under a signed contract.

b. Long-term solutions

A communication channel needs to be built that will distribute to farmers the guideline for PPP use together with publishing and distributing a handbook on the list of PPPs permitted and recommended by the the Plant Protection Department.

Provincial and district-level People's Committees should encourage PPP manufacturers that use persistent chemical origins to replace them with others which are biodegradable. Along with that, it also is necessary to encourage these manufacturers to institute collection programs for recycling and reuse. The construction of an HW treatment plant in An Giang province may be undertaken after assessing the current situation and investigating the economic conditions, after which PPP containers will be treated by proper incineration processes.

In addition, for the collection tank model, the tank should be designed in a rectangular shape with a lid, with separate compartments for the different types of packaging. The exterior should contain a notice saying, ‘contains pesticides after use’, and a HW warning icon. The location of the collection tanks must be far from residential areas and away from water sources. According to joint Circular 05/2016/TTLT from MARD-MONRE dated May 16, 2016, regulating the guidance on the collection, transportation, and treatment of PPPs container after use, 01 tanks containing pesticide packaging must be spaced at least 03 hectares apart. The appropriate time to collect agricultural HWs is after the harvest. When the collection tank becomes full, the local unit will collect and bring it to the designated site, and then the Urban Environment Company will come and collect the waste containers.

CONCLUSION AND RECOMMENDATION

This study investigated the current situation of waste PPP container management in rice cultivation areas of the Long Kien and Long Dien B communes, Cho Moi district, An Giang province, Vietnam. The surveyed farmers in this area have the following characteristics: small cultivated area (<2 ha), long-term farming experience, and most of them do not like to use PPPs. Most of the farmers who were aware of the dangers of using pesticides to human health showed interest in collection programs and understanding of the effectiveness of collection methods.

The main types of packaging for PPPs are plastic bottles and aluminum-coated packages. Farmers in the surveyed area often treat discarded packaging arbitrarily, namely by burying it in the ground, burning it, selling it to scrap dealers, or taking it home to use for other purposes. The study also found that many PPPs with trade names and related active ingredients are used by

farmers in the study area. In the study area, there is no collection system for PPP containers, so agricultural HWs are dispersed and difficult to control.

The situation of PPP container management in the two surveyed areas showed that the current methods of handling PPP containers are improper and create many risks to the environment. The emissions from burning waste containers and unsanitary landfills will affect the local community's health and environment. Therefore, this study proposes some solutions to limit the spread of agricultural HWs into the environment, namely, propaganda to raise public awareness about pesticide packaging and related environmental issues, collection tank design, and solutions for pesticide packaging treatment after use. In addition, there is a need for coordination between farmers and local authorities.

However, the correlation between factors influencing the choice of disposal methods and factors affecting knowledge and practice of PPP use were not carefully evaluated in this study. Further studies are needed to identify the main factors influencing PPP use and waste container disposal after use in this study area, and there is also a need to expand to a larger scale of case studies. While the communication method is familiar to the farmers, the implementation of more advanced practices such as Integrated Pest Management (IPM) and Good Agricultural Practices (GAP) programs, which aim for the reduction of chemicals used in agriculture and proper irrigation, can also provide solutions that can indirectly limit the amount of PPP containers generated, while contributing to the sustainable development of agricultural production.

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