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THE USE OF PESTICIDES IN TRIPLE-RICE CROP IN THE COASTAL DISTRICT, TRA VINH, VIETNAM

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Abstract:

This study aimed to assess the use of pesticides and their impact on the triple-rice crops in Phu Can commune, Tieu Can district, Tra Vinh province by directly interviewed 60 farmers in the study area. The results showed that during cultivation, the farmers used pesticides with a very high dose and spray frequency. The farmers often applied various types of pesticides belonging to toxicity categories II, III, and IV according to the World Health Organization (WHO) classification. The treatments of bottles and packages of the pesticides after use by burying, disposing of in the rice field, selling to the vendors, and burning were improper practices. Consequently, these practices could pollute the environment with pesticides. The findings of the present study revealed that rice farming in the study area potentially poses a high risk to the surrounding environments and human health. Local authorities and environmental managers should pay more attention to solving this problem.

Keywords:

Human Health, Risk, Ecosystem, Pollution, Triple-Rice Crop, Pesticides, Tra Vinh

Introduction

The Vietnamese Mekong River Delta is a key rice production region of the country, contributing more than 90% of food export output (Nhan et al., 2015). Data from the Statistical Yearbook (2019) showed that the Mekong Delta has a rice cultivation area of 4,069.7 thousand hectares (accounting for 54% of the country's rice cultivation area) with an output of 24,282 thousand tons (accounting for 55% of production amount of rice in the country). To ensure food security in the country and meet export demand, intensive crop intensification in the whole region has been being promoted. Along with the impact of climate change and the complicated

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development of pests and diseases, people have increased use of pesticides in rice cultivation. Of the total number of pesticides imported annually, over 53% of the pesticides were used in the Vietnamese Mekong Delta (Toan, 2013). Farmers in the Vietnamese Mekong Delta are more likely to use pesticides than other regions, with an estimated 3.1-7.0 kg of active ingredient/ha/year (Nhan et al., 2015) and the average number of sprays was 5.3 times/crop while in the Red River Delta only 1.0 times/crop (Toan, 2013). Although pesticides are useful in controlling and preventing pests and diseases, they are also factoring that cause impacts on the environment and public health (Toan, 2013; Chuyen and Tam, 2020). Improper use of pesticides causes environmental pollution and degradation in agricultural land and prevents the growth of aquatic ecosystems (Margni, 2002; Yen, 2019; Phong and Thong, 2020). In addition, pesticides also affect the health of people in direct contact with and consuming products containing pesticide residues (Toan, 2013; Phong and Thong, 2020). As a coastal province of the Vietnamese Mekong Delta, Tra Vinh has an area of about 91 thousand hectares of rice cultivation (accounting for 62% of the province's agricultural production area). In 2019, the province's rice cultivation area is 224,348 hectares and yields 5.59 tons/hectare, the total output is 1,254 million tons. In particular, the people of Tieu Can district have a tradition of cultivating rice for many years, rice cultivation is also the main source of income for most households in the district. However, there are no studies on the current status of use and management of pesticides in rice cultivation. Therefore, this study was conducted to investigate the current status of pesticide use and casings management in triple-rice crop cultivation in Phu Can commune, Tieu Can district, Tra Vinh province. Potential risks of pesticides in rice cultivation on the environment and public health were also mentioned.

Materials and Methods

The study collected primary data by randomly interviewing 60 rice farmers in Phu Can commune, Tieu Can district, Tra Vinh province. To determine the current status of production, the research was conducted to collect information on rice production area, number of cultivated crops, experience in production. Besides, information about pesticides, dosage use, frequency and timing of spraying were collected to assess the current status of pesticide use during triple rice-crop farming. Finally, information on people's perceptions of pesticides, collection and treatment of pesticides packages and bottles after use were also collected.

Results and Discussion

General Information of The Households

The survey results showed that the force directly involved in the rice cultivation process was mainly male (accounting for 93.33%). The remaining 6.77% of households were cultivated by women. However, they often hire local labour to spray pesticides for the fields so they did not know the procedures as the males did. In the study area, the production participants were middle-aged with 38.33% in the 47-57 aged group and 36.67% in the 36–46-year-old group. These are farmers with many years of experience in farming. Educational attainment was one of the factors affecting access to effective farming techniques and market information. Through interviews, it can be seen that the respondents had low educational attainment and there was a significant difference between levels. There were 53.33% of the interviewed people reached secondary education; followed by high school with 33.33%; Primary school accounted for 11.67% and only 01 person achieved university degree. In Phu Can commune, rice cultivation is a traditional profession and the main source of income for 63.33% of the interviewed households, all of whom cultivate 3 crops of rice per year. The next source of income comes

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from livestock (16.67%); Fruit cultivation and trading have equal proportions of 3.33% and finally income from vegetables (1.67%).

Area of Land and Rice Cultivation Experience

The survey results showed that the average cultivated area per household was 1.4 ha. In which, the number of households with arable land area of 1-2 ha accounted for the highest percentage with 56.67%. Next was the area of less than 1 ha (23.33%) and from 2-3 ha, accounting for 16.67%. The number of households with arable land over 3 ha was only 3.33%. The cultivated area was not uniform, so the number of pesticides used among farmers was also different. In addition, the number of pesticides between crops was also different. In the rainy season, farmers used more pesticides than in the dry season due to the leaching of pesticides by rainwater. Since the households have settled in the locality for more than 20 years, they have a lot of experience in agricultural cultivation, especially in rice cultivation, with a minimum farming experience of 5 years. There were 8.33% of farmers had 5-10 years of experience and 25% had 10-20 years of experience. Accounting for the highest proportion were those with production experience over 20 years (66.67%). This could help people predict the emergence of pests and diseases so that there are measures to prevent and treat promptly. However, these people with many years of experience often cultivate according to traditional methods and rely on their own experience, so it is difficult to access advanced techniques (Kiet, 2017)

Current Status of Pesticide Use

Forms of pesticides use in rice cultivation: According to the report of the Vietnam Environment Administration (2015), pesticides are produced in the form of milk pesticides, soluble powder, powder spray, granular pesticides, liquid form. However, farmers in the study area often divided pesticides into two forms, namely powder and liquid, for easy distinction. According to farmers, the liquid pesticides are easier to use and safer than the powder because it can be used immediately and is less dispersed into the air. However, people still use both types of pesticides to increase the ability to kill pests and reduce the number of sprays to save travel and labour costs.

Types of pesticides use in rice farming: During the rice cultivation process, farmers in Phu Can commune used many kinds of pesticides such as pesticides, herbicides, diseases, snails, mice and growth stimulants. The rate of use of these chemicals was shown in in Figure 1. The study results showed that pesticides and herbicides were the two most commonly used by the farmers with the rates of 66.67% and 61.67%, respectively. Followed by disease treatment chemicals (accounting for 48.33%) and chemicals to kill snails (40%). Growth stimulants were used by 13.33% of the households. And the least used pesticides were rodenticides with a rate of 3.33%. In particular, 30% of the farmers used all of the above chemicals. Active ingredients in the pesticides used by the people of Phu Can commune have the toxicity (according to the World Health Organization's classification) as follows:

Pesticides: There were 18 types of pesticides used during rice farming. In which, 50% of pesticides used were in group II, 22% of pesticides of category IV, 17% of pesticides of type III, and 11% of pesticides have not yet updated the toxicity level. Farmers mainly used pesticides with group II toxicity because these pesticides kill pests and diseases quickly and achieved high efficiency for each spray.

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Herbicides: Pesticides used in the study area consisted of 17 types. In which, pesticides with toxicity of group IV accounted for 41%, group III accounted for 35%, group II accounted for 18% and 6% had not updated toxicity.

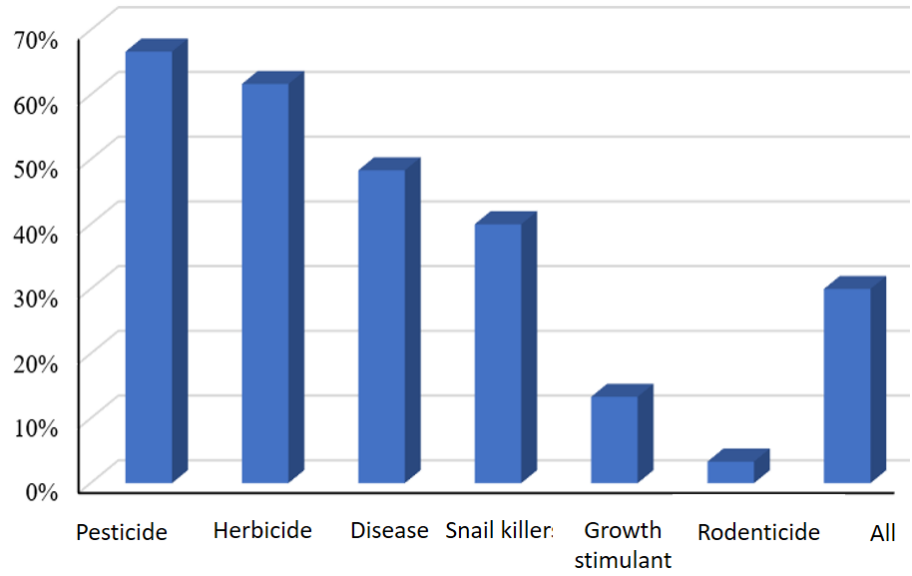

Figure 1. Types of pesticides use in rice farming

Diseases treatment pesticides: most commonly used by the farmers in the flowering stage. Of the 23 pesticides used, 61% were in group III, 26% were in group IV, 9% were in group II, and 4% had not yet determined the toxicity.

Snail killer: Active ingredients in snail killers were mainly metaldehyde and niclosamide, these two active ingredients were toxic in groups III and IV. In which, the active ingredient metaldehyde accounted for 60%, this was an active ingredient with low toxicity, slow death and relatively safe for fish and the environment. Meanwhile, active ingredient niclosamide (33.33%) had the ability to rapidly inhibit snail respiration and caused death after 15-20 min of exposure. Active niclosamide was highly toxic, could kill fish and other organisms. The rest was RADAZ 750WP, this snail killing chemical contained both of the above two active ingredients.

Rodenticides: There were two types of rodenticides (mainly to kill rat) that was used with toxicity in groups I and II, so the effectiveness of rat removal was very high. Farmers used rodenticides mainly in the seeding stage.

Growth stimulants: The growth stimulants used in the study area were mainly of group IV toxicity. These chemicals would stimulate rice growing healthy, increase pollination, have more seeds and reduce the rate of flatness

Frequency of pesticides spray in rice farming: The farmers in the study area often used pesticides for such stages as killing pathogens when sowing; killing grass when pumping water into the field; spray pesticides, fungicides, growth stimulants for the growth stage. In average, each farmer sprays pesticides 5.9 times per season. Of which, 63.33% of the households sprayed from 6-7 times/crop; 21.27% of the households sprayed from 4-5 times/crop and 13.33% sprayed from 8-9 times/crop. There were 1.67% of the households sprayed pesticides

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depending on weather conditions in which the time of spray may increase in the rainy season. The frequency of spraying pesticides by the farmers in Phu Can commune was was higher than the average of spraying time in the Vietnamese Mekong Delta (5.3 times/crop) and in the Red River Delta (1 time/crop) (Toan, 2013).

Dose of pesticides use in rice farming: The surveys showed that most of the respondents were interested in the number of pesticides used (91.67% of the households). However, the dose used in Phu Can commune was still higher than the average in the Mekong Delta. For liquid pesticides, while on average the Mekong Delta only used 2.6 litters/ha, the farmers in Phu Can commune used 3-5 litters/ha (65% of the households) and 5-10 litters/ha (26,67% of the households). More seriously, there were 5% of the farmers used 10-20 litters/ha. In addition, 3.33% of the households could not estimate the dosage of pesticides used. In addition to liquid pesticides, the farmers also combined powdered pesticides to increase effectiveness of insect control. It was estimated that on an area of 1 ha, 68.33% of the farmers used 3-5 kg of powdered pesticides. Next 3.33% of the households used 5-10 kg and 1.67% used 10-20 kg. The remaining 26.67% of the households could not estimate. Through the survey results, it can be seen that the number of pesticides used for rice cultivation in the study area was very large. Estimated amount of the pesticides used for 1,539 ha of rice cultivated area of Phu Can commune (2020) with assumption of average used of 4 litters/ha. The results showed that people used 6,156 litters of pesticides for triple-rice crop in the commune. Over-spraying not only increases production costs but also causes resistance in some pests and diseases. At the same time, the use of pesticides at high doses also increases the risk of poisoning for the sprayers and potential risks of causing pollution to the surrounding environment. According to Linh and Hoa (2018), the number of sprays and dosage would increase the risk index of the pesticides. Therefore, farmers need to use pesticides in the right dosage and the right way to minimize risks to humans and the environment

Time of pesticides use: Most farmers in the study area sprayed with pesticides when they found signs of the pest (96.67% of the households). According to the villagers, spraying at this time could help prevent the attack of pests and help to save costs. In addition, 3.33% of the households sprayed pesticides according to the schedule of spraying by the neighbouring households to avoid the spread of disease. Farmers often sprayed on sunny days, mainly in the early morning (70%) or late afternoon (21.67%) to bring higher efficiency of the prays. Because when the sun is hot, the high temperature causes the pesticides to evaporate quickly, and the pests also hide in the leaves, which could limit the contact between the pesticides and the pests. In addition, farmers also chose to spray at times with little wind and no rain to limit the dispersion and leaching of the pesticides into the environments.

Experience in pesticides use: Although they have many years of experience in rice cultivation, only 5% of the respondents used pesticides according to personal experience. The farmers often mixed pesticides according to their feelings. Consequently, the effectiveness of pest destruction was low and the investment costs for pesticides were often very high. Most of the farmers used pesticides according to the instructions on the product packaging (83.33%). The remainders (11.67%) believed to use the advice of local pesticides distributors.

Current Management of Pesticides After Use in Rice Farming

Out of a total of 60 farmers interviewed, only 30% had the places for collection of pesticide packages and bottles after use. According to collected information, the whole commune had

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32 fixed collection places, located along the roads near the rice cultivated area. However, these collection pits did not have the covers and other types of wastes were thrown away by people such as broken glass, light bulbs, domestic waste and these could result in difficulty in handling the wastes. Besides, the distance between these collection holes is relatively far, so certain farmers cannot place the pesticides after use in the collection points.

Among the households that did not use the collection pits, 28.33% of the households treated the pesticides bottles and packaging by burning. According to the farmers, this method is easy to implement and does not take much time and effort. However, burning pesticide packaging and bottle could cause air pollution and greatly affect the ecosystem because it is a hazardous waste that requires special treatment. In addition, 26.67% of the households disposed of the pesticides after use in the field or surrounding canals. This indiscriminate disposal could cause pollution of the surrounding soil and water sources, polluting the environment and affecting the ecosystem. In addition, some farmers stored (20%) the pesticides bottles and packages after use for sale. Finally, there were 1.67% of the household buried the wastes in the fields and gardens. This practice could affect the soil and surrounding water environment. Through the way of handling pesticide after being applied by local people and opinions on future treatment measures, it shows that the awareness of environmental protection of rice farmers in the study area is not high. However, there are 100% of the household agree to build more proper collection places for the collection of casings of pesticides after use. This is a very important consensus for future better management of pesticides after use in the study area.

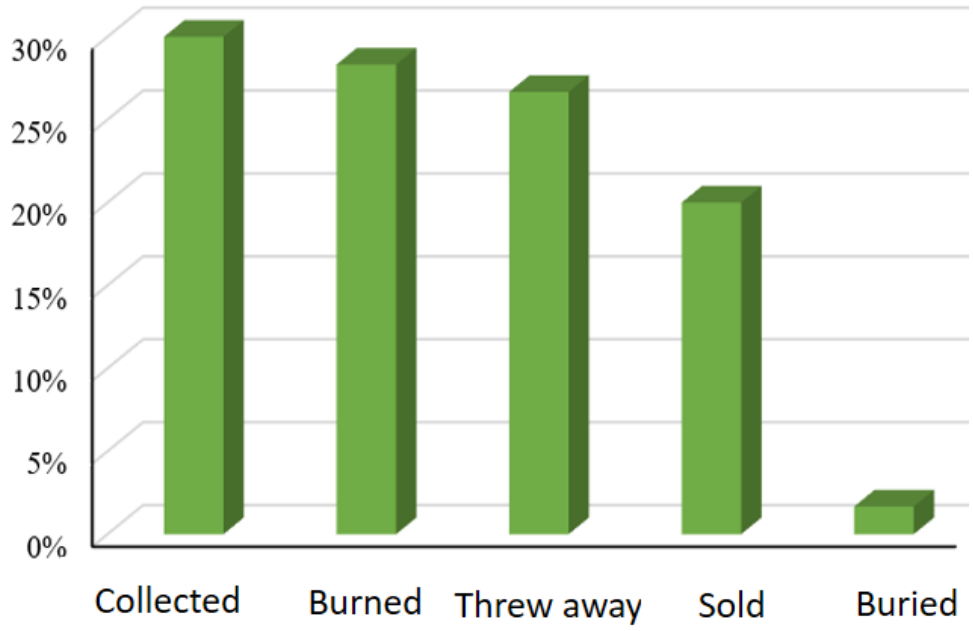

Figure 1. Ways of Treatment of Pesticides After Use in the Study Area

Effect of Pesticides Use in Rice Farming

Although pesticides help protecting plants, destroying pathogens, killing pests, stimulating growth and help plants achieving high yields, they also have the ability to cause dangerous impacts on the environment and human health by direct and indirect contact. In general, the use of pesticides and the treatment of related wastes in Phu Can commune was not reasonable and may cause risks due to the persistence of pesticides in the environment. According to Viet

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et al. (2016), preliminary risks from pesticide residues include exposure to chemicals in burial pits and exposure to contaminated surface water, groundwater, soil, and sediment. The exposure to pesticides could cause adverse impact on human health and ecosystems. After spraying, pesticides would be partly absorbed by animals and plants, the rest would be evaporated into the air or be washed away by rainwater into soil, water. The factors affecting the environmental and health impact of pesticides included the number of sprays, dosage of pesticides use and participation of the farmers in pesticide use training (Phi and Chung, 2012). According to the water cycle, pesticides are released into the aquatic environment through leakage from the soil environment or by leaching and erosion processes. In particular, users spilling excess chemicals, discarding pesticide packaging and bottles or rinsing aerosols in canals along fields also contribute to water pollution. Pesticides, after being released into the water environment, will possibly bioaccumulate into aquatic species. Pesticides residues prevent the growth of aquatic ecosystems and accumulate pesticides on aquatic species, causing serious harm to the aquatic environment and human health (Margni, 2002; Phong and Thong, 2020). Cultivated land was a concentrated place for pesticide residues. Improper use of fertilizers and pesticides was the main cause of environmental pollution and degradation in agricultural land (Yen, 2019). According to the research results of the Vietnam Environment Administration (2015), up to 50% of pesticides sprayed to plants fell to the soil. Some of this was absorbed by the plant and the rest was retained by the soil matrix. Pesticides' persistence time in soil was usually relatively long and it could produce new compounds that may be more toxic. For example, DDE, a residue product of DDT in the soil, is 2-3 times more toxic to the development of avian oocytes than DDT. Under the impact of light, temperature, wind, chemical properties of pesticides, the pesticides can be released into the air and cause pollution in the form of dust and vapours. When released into the air, pesticides can travel far away and settle into surface water, affecting people and aquatic ecosystems.

Table 1. Common Poisoning Symptoms From Pesticides

No.	Symptoms	Common effects
1	Neurological syndrome	Central nervous system disorders, headache, insomnia, memory loss. Severe levels can cause peripheral nerve damage leading to paralysis, brain damage.
2	Cardiovascular syndrome	Peripheral constriction, myocardial toxicity, arrhythmia, and severe heart failure.
3	Respiratory syndrome	Respiratory tract inflammation, wheezing, pneumonia and possible acute respiratory failure, apnoea when severe intoxication.
4	Gastrointestinal syndrome - hepatobiliary	Gastritis, hepatitis, bile, biliary tract spasm.
5	Blood syndrome	Anaemia, leukopenia, haemorrhage, changes in blood sugar and increased concentration of pyruvic acid in the blood.
6	Other syndromes	Damage to the urinary system, endocrine and thyroid

(Source: Vietnam Environment Administration, 2015)

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Although pesticides help to control and prevent pests and diseases, they are also toxic to natural enemies and other beneficial organisms (Toan, 2013). Natural enemies such as parasitic bees and insects are often very sensitive to pesticides. After spraying, the number of natural enemies decreased significantly, affecting the effectiveness of pest control in rice fields. In addition, the aquatic ecosystem is also severely affected by the persistence of pesticides, which prevents the growth and accumulation of pesticides in aquatic species (Margni, 2002; Phong and Thong, 2020). Pesticides are usually stable at room temperature, are not biodegradable, accumulate in adipose tissue and bio-amplify in the food chain. They can cause acute and chronic toxicity. Regular work and exposure to pesticides can cause chronic poisoning with manifestations such as blue skin, insomnia, headache, muscle fatigue, liver failure, circulatory disorders. The pathway to cause poisoning of the pesticides is through eating accounts for 97.3%; through skin and respiratory tract, accounting for 1.9% and 1.8% respectively (Vietnam Environment Administration, 2015). In addition, pesticide residues were detected in the blood of 35% of the farmers tested in the Vietnamese Mekong Delta, which could be the cause of dangerous diseases such as cancer and other tumours (Toan, 2013). More seriously, poisoning from pesticides can lead to death. A study in Thailand showed that more than half of all poisoning cases in Thailand were caused by pesticides and a quarter of deaths from poisoning were from pesticides (Lan et al., 2016). The findings showed that improper use of pesticides can cause negative impacts on ambient quality environment and public health. Therefore, localities need to implement strategy to reduce the potential harmful impact from pesticides.

Conclusions

The present study found that some farmer still uses pesticides with the dose higher than the recommended and the frequency of pesticides use was also high in triple rice-crop in Tieu Can district, Tra Vinh province. The pesticides used mainly belongs to the group of toxicity II, III and IV according to the classification of the World Health Organization (WHO). In addition to the improper use, farmers also use inappropriate measures (burning, selling to vendors, and burying) to treat pesticides' wastes. Burning, disposing or burying in the field is the cause of the release of pesticides residues resulting in pollution of soil, water and air environments. At the same time, these practices could cause potential risks to human health. The use and management of pesticides in rice cultivation in the study area is an issue that needs to be addressed and adjusted appropriately to limit potential risks to the environment and public health.

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