Research article

Guidelines for Pesticide Risk Management at the Community Level in Northeast Thailand

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Abstract This study aimed to assess the risk of pesticide use and study guidelines for pesticide risk management at the community level in Northeast Thailand. From 2022 to 2023, data was collected by using semi-structured interviews and group discussions. Representatives of a group of farmers who use pesticides were purposively selected 10 per group with a total of 19 villages. Data collected from farmer interviews about pesticide use included substance type, application rates, spraying frequency, and plot size of plantations. This data was used in the EIQ Field Use equation to assess environmental risks. Group discussions included farmer representatives, community leaders, agricultural extension officers, public health officials, and researchers. It was found that the average Field Use EIQ of vegetable plots had a high-risk level, particularly in the case of villages growing chilies, tomatoes, and cabbage. From group discussions on guidelines for reducing the risk from pesticide use in each village, common guidelines identified included the following: 1) personal safety, requiring regulations on the use of appropriate spraying equipment, protective clothing and other personal protective equipment to prevent exposure to pesticides; 2) safety of people in the community, not spraying pesticides in villages or communities, schools, temples, and hospitals, and notifying the village headman with a spraying plan when spraying chemicals in areas close to the community or village; additionally, areas where pesticides are sprayed must have warning signs indicating the date and time; 3) safety for the ecosystem and public areas of the community; refraining from spraying chemicals, and leaving chemical bottles in public areas, water sources, and community forests; 4) food safety, ensured through compliance with the requirements outlined in the GAP standard; and 5) setting up a community committee to coordinate safe use of pesticides by the community's. These guidelines will be used as policy recommendations for reducing pesticide risk in commercial agricultural communities.

Keywords agriculture, environmental risk, community, pesticide, risk management

INTRODUCTION

Over the past few decades, agricultural activities have rapidly grown and diversified in Thailand. This creates new challenges in a variety of fields, especially the health and safety of agricultural workers and their families, as well as consumers. To meet global demand, the country relies heavily on pesticides to control pests in order to maintain high crop yields (Panuwet et al., 2012). In 2021, Thailand has pesticide use per area of cropland at 0.84 kg/ha, China 1.83 kg/ha, Philippines 3.37 kg/ha, Vietnam 4.28 kg/ha, Indonesia 5.29 kg/ha, Malaysia 5.51 kg/ha, and Japan 11.24 kg/ha (FAO, 2023). Although the rate of pesticide use is lower than in other countries in the region, they are also concerned about the behavior of using pesticides that are not yet correct. There are still problems such as applying higher concentrations than recommended and using adequate personal protective equipment (PPE) (Rivera et al., 2016). Their decisions regarding pesticide use are often based on information given by retailers, other farmers, agricultural extension service agents, and even the pesticide companies themselves (Tawatsin, 2015). Due to a lack of knowledge of availability and the affordability or inconvenience of wearing protective equipment, it was found that only a few farmers used PPE that was suitable for using pesticides (Kongtip et al., 2018). FAO's Code of Conduct article regarding pesticide selection as a risk management tool recommends that: ‘Pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small-scale users in tropical climates. Preference should be given to pesticides that require inexpensive personal protective and application equipment and to procedures appropriate to the conditions under which the pesticides are to be handled and used’ (FAO and WHO, 2020). The challenges to pesticide risk reduction have been identified by the Food and Agriculture Organization (FAO) of the United Nations: (a) the rapid expansion of pesticide trade in terms of total volume, number of products, and number of selling points, combined with a weak regulatory and enforcement capacity; (b) a high level of satisfaction among farmers with pesticides combined with low levels of risk awareness, lack of technical know-how about integrated pest management (IPM), and general unavailability of bio-control agents; and (c) no regular monitoring of pesticide risk, which makes it difficult for legislators, regulators, farmers and consumers to make rational decisions (Schreinemachers et al., 2015).

The Thai government has encouraged farmers to adhere to crop production standards, including GAP (Good Agricultural Practice) and organic farming. GAP's main principle in managing risks from the use of pesticides is IPM. IPM is the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations. It combines biological, chemical, physical, and crop-specific (cultural) management strategies and practices to grow healthy crops and minimize the use of pesticides, reducing or minimizing risks posed by pesticides to human health and the environment for sustainable pest management (FAO, 2024). Risk is a function of the probability of adverse health or environmental effect, and the severity of that effect, following exposure to pesticide. Risk assessment is an important tool to predict pesticide effects on human health or the environment. It is therefore widely used to justify registration decisions for reducing pesticide risks (FAO, 2017).

The Environmental Impact Quotient (EIQ) is a formula created to provide growers with data regarding the environmental and health impacts of their pesticide options, so they can make better informed decisions regarding their pesticide selection (Cornell University, 2024). The formula helps to calculate the environmental impact of the most common fruit and vegetable pesticides used in commercial agriculture. The values obtained from these calculations can be used to compare different pesticides and pest management programs to ultimately determine which program or pesticide is likely to have a lower environmental impact. The method addresses a majority of the environmental concerns that are encountered in agricultural systems including farm workers, consumers, wildlife, health, and safety (Kovach et al., 1992). Since 2000, the EIQ has been used in several IPM projects in Asia for different purposes ranging from impact assessment to pesticide selection (FAO, 2008). Assessing the risks from the use of pesticides is important for deciding how to manage pests. When farmers receive risk information, they will become aware of the dangers and reduce the use of highly toxic pesticides. Risk assessment is useful in warning of impacts to health, environment, and food safety and is used to set guidelines for risk management by government agencies in collaboration with farmers or people in the community who are stakeholders in the area.

OBJECTIVE

To assess the risk of pesticide, use by farmers and find ways to reduce the risk from the use of pesticides in commercial fruit and vegetable grower villages in Northeast Thailand.

METHODOLOGY

Data Collection

Data was collected by using semi-structured interviews and group discussions. Representatives of a group of farmers who use pesticides were purposively selected 10 per group with a total of 19 villages. Data from farmer interviews about pesticide use, including type of substances, application rates, spraying frequency, and plot size of plantations. Data from the interviews were used to assess risk using the EIQ equation (Eq. (1)). Once risk information was obtained, it was brought to a meeting with farmer representatives, community leaders, and government officials to clarify information on risks from the use of pesticides in each community. After that, it is a matter of finding ways to reduce the risk from the use of pesticides and reduce the impact on the community and the environment together. The commercial agriculture village in Northeast Thailand was purposively selected as a study site in this research. This village has a large vegetable and fruit production in the area where farmers have continued to grow vegetables or fruit for more than 10 years as it is the main source of their income. Pesticide application data were collected by using a semi-structured interview and making observations, from January 2022 to October 2023. Data were compiled for each pesticide compound, common name, active ingredient, % active ingredient, rate of application, frequency of application, and plot size were collected from sample plots. A guideline for pesticide risk management in community agriculture was obtained from group discussions including farmer representatives, community leaders, agricultural extension officers, public health officials, and researchers.

Risk Assessment of Pesticide Used by EIQ

The EIQ value for a particular active ingredient is calculated according to a formula that includes parameters of toxicity (dermal, chronic, bird, bee, fish, and beneficial arthropod), soil half-life, systemicity, leaching potential, and plant surface half-life are considered. The formula for determining the EIQ value of individual pesticides is listed below and is the average of the farm Worker, consumer, and ecological components. EIQ Eq. (1) is provided below (Kovach et al., 1992):

$$EIQ=\{C[(DT*5)+(DT*P)]+[(C*((S+P)/2)*SY)+(L)]+[(F*R)+(D*((S+P)/2)*3)+(Z*P*3)+(B*P*5)]\}/3 \quad (1)$$

Where DT= dermal toxicity, C= chronic toxicity, SY= systemicity, F= fish toxicity, L= leaching potential, R= surface loss potential, D= bird toxicity, S= soil half-life, Z= bee toxicity, B= beneficial arthropod toxicity, P= plant surface half-life.

Field Use EIQ is calculated by multiplying the table EIQ value for a specific chemical by the Percentage of the active ingredient in the formulation and its dosage rate per hectare, as in Eq. (2).

$$\text{Field Use EIQ} = \text{EIQ value} \times \%\ \text{active ingredient} \times \text{Dosage rate} \quad (2)$$

The risk level according to the EIQ Field Use Rating Levels; when EIQ Field Use less than 25= very low risk, less than 50= low risk, 50-99= moderate risk, 100-199= high risk, over 200= very high risk (Cornell University, 2024).

RESULTS AND DISCUSSION

Types of Pesticides that Farmers Use in Northeast Thailand

In cabbage vegetable plots, the most used herbicides are alachlor, atrazine, clethodim, haloxyfop-P-methyl, glyphosate, oxadiazon, and triclopyr, the most common fungicides used are mancozeb and metalaxyl, whereas the most used insecticide used are abamectin, carbaryl, cyantraniliprole, cypermethrin, dinotefuran, dichlorvos, emamectin benzoate, profenofos spinetoram, and tolfenpyrad.

In chilli plots, the most used herbicides are alachlor, atrazine, mesotrione, and quizalofop-P-ethyl. The most common fungicides used are azoxystrobin, cymoxanil, carbendazim, difenoconazole, etridiazole, mancozeb, metalaxyl, prochloraz, and pyraclostobin, whereas the most common insecticide used are abamectin, amitraz, beta-cyfluthrin, carbosulfan, clothianidin, chlorantraniliprole, cypermethrin, dinotefuran, emamectin benzoate, imidacloprid, spinetoram, and tebufenpyrad.

In tomato plots, the most used herbicides are alachlor, atrazine, clethodim, mesotrione, and glyphosate. The most used fungicide is metalaxyl, mancozeb, propineb, whereas the most common insecticide used are abamectin, carbaryl, emamectin benzoate, chlorantraniliprole, cypermethrin, lambda-cyhalothrin, deltamethrin, fipronil, imidacloprid, and thiamethoxam.

In mango plots, the most used herbicides are glyphosate, the most used fungicides are azoxystrobin, captan, carbendazim mancozeb, prochloraz, and propineb, whereas the most common insecticides used are abamectin, acetamiprid, carbaryl, carbosulfan, cypermethrin, dinotefuran, emamectin benzoate, fipronil, imidacloprid, lambda-cyhalothrin, spinetoram, and thiamethoxam. In jujube plots, the most used herbicides are glyphosate, the most used fungicide are azoxystrobin, carbendazim, captan, difenoconazole, mancozeb, and propiconazole, whereas the most common insecticide used are abamectin, buprofezin, cypermethrin, dinotefuran, fipronil, lambda-cyhalothrin, imidacloprid, propargite, and pyridaben.

Risk of Pesticide Use in Terms of the EIQ Equation

The information on the type of pesticides, the amount of active ingredient spraying rate, plot area, and spraying frequency from interviews with representatives from 19 communities is used to assess risk from the EIQ equation (EIQ Field Use Rating Levels). The EIQ Field Use was as follows (Fig. 1): cabbage grower average 67.64 (moderate risk); tomatoes grower average 116.01 (High risk); chilli grower average 86.65 (moderate risk); mango grower average 55.76 (moderate risk); and jujube grower average 59.20 (moderate risk).

Guidelines for Pesticide Risk Management in Community Agriculture

From the group discussion on guidelines for reducing the risk from pesticide use in each village, there were common guidelines: 1) Personal safety, requiring regulation of the use of appropriate spraying equipment. To prevent exposure to pesticides, applicators should wear protective clothing and personal protective equipment; 2) Safety of people in the community. Do not spray pesticides in villages or communities, schools, temples, and hospitals. Spraying chemicals in areas close to the community or village must notify the village headman with a spraying plan. Areas where pesticides are sprayed must have warning signs indicating the date and time; 3) Safety for the ecosystem and public areas of the community. Do not spray chemicals, and do not leave chemical bottles in public areas, water sources, and community forests; 4) Food safety. Farmers must comply with the requirements according to GAP standards; Also, 5) Set up a community committee to control the community's use of pesticides. The committee is responsible for coordinating the correct and safe pesticide use in the community. The guidelines will be used as policy recommendations for reducing the pesticide risk in commercial agricultural communities.

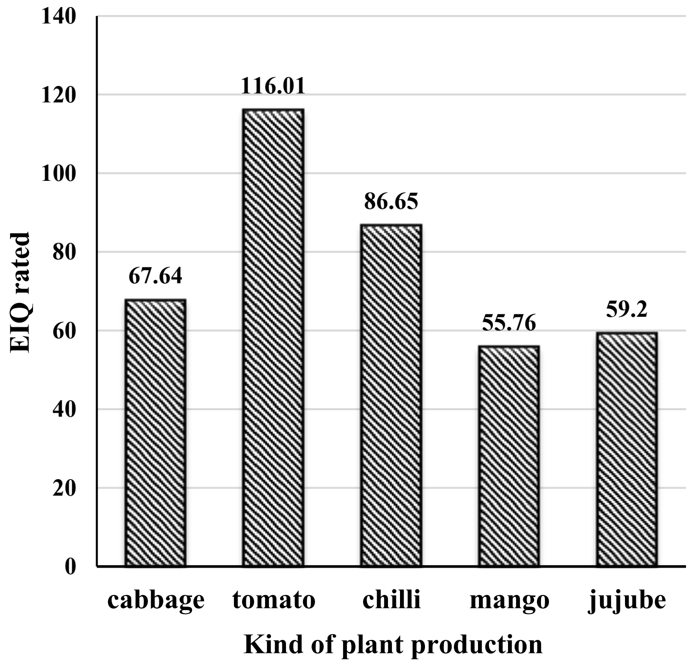

Fig. 1 EIQ Field uses rating of pesticide use in vegetable and fruit growers in the Northeast Thailand

CONCLUSION

For risk assessment from the use of pesticides using the EIQ equation, most of the information was obtained from interviews. Farmers may not yet be aware of risk reduction, so they should study other information, such as the results of testing for pesticide residues in the farmers' blood. Collection of plants, soil, and water samples for analysis. In this study, high-risk values will also be found in pesticide residues in the plants and soil of the planting plots. Analysis results are another factor that helps encourage farmers to improve their pest management methods to be more careful. Smallholders in the Northeast of Thailand, usually live within or near agricultural plots. For the guidelines for preventing the effects of pesticides used on communities and the environment, farmers must plan chemical spraying and inform those involved in the community and those living in nearby areas.

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