

# Pesticide Risk Reduction of Vegetable Farmers: A Case Study in Vietnam

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## Abstract

A survey was carried out on farmers cultivating vegetables in Gia Lam district, Hanoi city, Vietnam to investigate their practice in reducing pesticide risks in their farming. Pesticides were an important input in the production there, but the risks of pesticides in recent years had been insignificant. Research results showed that the majority of farmers had relatively well implemented various solutions to reduce pesticides risks in their production, including actively using alternative pest management (IPM) solutions, using biological pesticides, using pesticides properly according to the 4-right pesticide use principle, using labour protection while spraying, and applying treatment measures after spraying. The study suggested solutions to reduce and avoid pesticide risks.

## Keywords

Pesticides, Risk Reduction, Vegetable Farming

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## 1. Introduction

Pesticides are the substances or mixtures of substances that are used intentionally in order to control or destroy unwanted forms of life or organisms with the aim of protecting crops and plants [1]. Using pesticides in agricultural production is one of the most important measures to help limit the reduction of agricultural output due to pests and diseases, helping to create a large amount of agricultural products at reasonable prices year round, meeting the growing needs of people around the world [2]. In other words, pesticides are an economical, effective and labour-saving pest management method that are widely applied in

most fields of agricultural production [3]. Various types of pesticides have been used to protect crops for centuries [1]. However, an excess use and misuse of pesticides in agricultural production often lead to severe impacts on human health and the environment [4]. Farmers, the direct users, are easily exposed to pesticides [5]. Exposure to pesticides is generally through contact with the skin, ingestion, or inhalation [6].

Pesticide risks are considered as the potential for a pesticide to cause harm as determined by environmental conditions and preventive actions [7]. Pesticide risks to farmers are the risks that often occur during the time they are spraying pesticides and working on the fields [3]. [8] defines pesticide risk as the result of a toxic hazard and exposure to that hazard (including intensity and duration of exposure). Therefore, pesticide risk reduction will be achieved by reducing toxic hazard and/or reducing exposure [3]. Reduction of toxic hazard is attained by choosing less hazardous products, and reduction of exposure is obtained by using less pesticides, better spraying methods, and more complete protective equipment.

Gia Lam district, Hanoi city is a delta district with fertile soil, favourable natural conditions with a humid monsoon climate suitable for intensive cultivation of wet rice, vegetables, fruit trees and short-term cash crops; in which, the vegetable production area (1572 ha) accounts for about 28.57% of the total agricultural land area of the district [9]. Vegetable production in the district not only meets the needs of the people in the area but also is an important supply for the needs of the people of Hanoi city.

The use of pesticide products to increase efficiency in vegetable production in Gia Lam district is, therefore, an inevitable need, however, the risks of pesticides in recent years for vegetable farmers have been almost negligible here. Hence, this study focused on investigating the current farmers' reduction practice of pesticide risks in vegetable production in Gia Lam district, Hanoi city, thereby proposing more solutions to further enhance pesticide risk reduction in the near future.

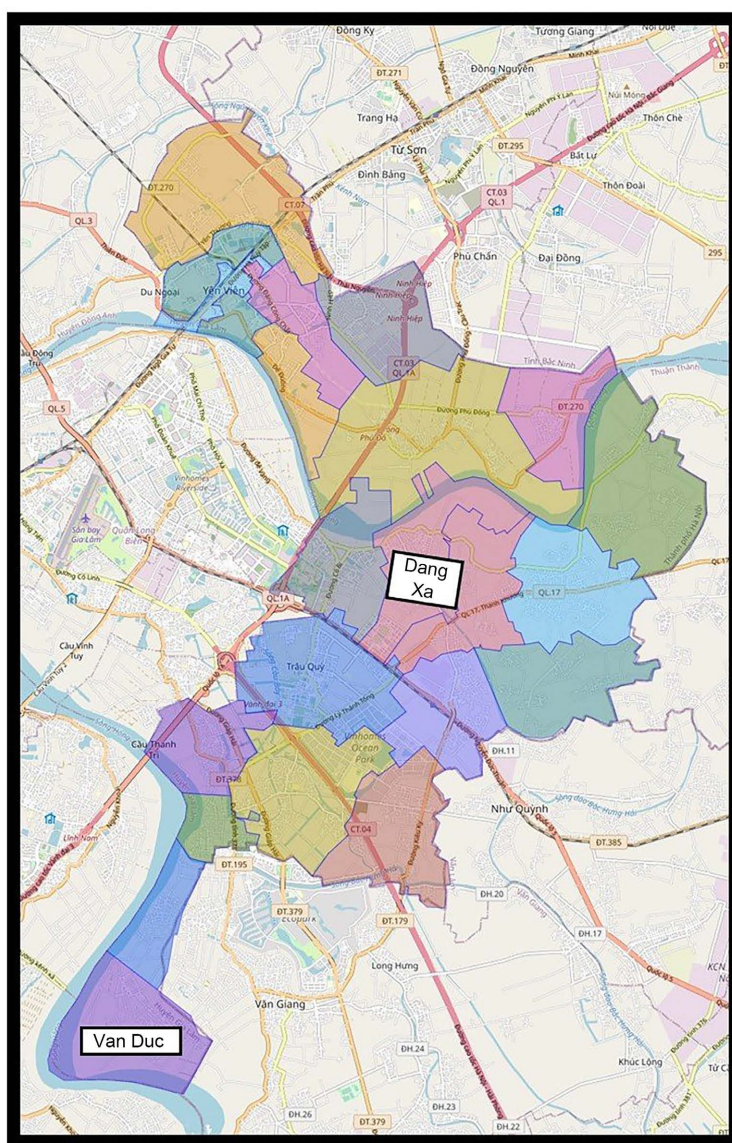
## 2. Materials and Methods

### 2.1. Study Site

The study was carried out in Gia Lam district, Hanoi city, Vietnam. The district is located on the East of the city in the Red River Delta, one of the two important deltas which produce the majority of agricultural products of the country. Gia Lam district had a total of 5503.22 ha of agricultural land, accounting for 47.15% of the natural area of the whole district; of which land for annual crops was 4294.1 ha (accounting for a high proportion of 78.03%), whilst the land for perennial crops made up only 12.06%, equivalent to 663.7 hectares and aquaculture land was only 301 ha (11.92%) [9]. These figures suggest that agriculture plays an important role in the production of the district and the farmers' income is mainly from annual crop production.

Among 20 communes and 2 towns of Gia Lam district, Van Duc and Dang Xa

communes (as shown in **Figure 1**) were chosen for this study because they were the two communes with the largest areas of vegetable production in the district, with 221 ha and 130 ha over a total of 740 ha of the district vegetable growing area in the 2020 winter crop. These locations were also representative for areas with highly intensified farming where pesticides application were considerably significant and safe production were dominant (Van Duc commune had 200 ha of safe vegetable production area and Dang Xa commune had 120 ha of safe vegetable production area, together taking account for the largest proportion of the total safe vegetable production area of the district of 380 ha) [10]. Farmers in Van Duc and Dang Xa communes were growing different vegetables, such as cabbages, Chinese cabbage, broccoli, bitter gourd, cove beans, bok choy, and mustard greens, etc. Among which, many were granted the 3 or 4 star OCOP (one commune, one product) certificates of Hanoi city.



**Figure 1.** Map of the study area (Gia Lam district, Hanoi city, Vietnam).

## 2.2. Data Collection

For the purpose of this study, secondary data were collected from books, newspapers, magazines, scientific works, theses, scientific articles related to risks and solutions to reduce pesticide risks around the world as well as in Vietnam; and periodic reports and annual summary reports of relevant governmental agencies, especially Gia Lam District People's Committee, Plantation and Plant Protection Station, Economic Departments, and Statistics Department.

Primary data used in the study was collected through direct surveys of 60 vegetable farmers in Van Duc and Dang Xa communes, Gia Lam district using structured questionnaires and direct interviews with state managers related to plant protection in the district using semi-structured questionnaires. The surveys were conducted from March to May 2021.

## 2.3. Data Analysis

The collected data were processed using Excel software. Descriptive statistics and comparative statistics were the main analysis methods used in this study to analyse data after data collection and processing processes.

## 3. Results and Discussion

### 3.1. General Information about the Interviewed Farming Households

Basic information of the interviewed households is presented in **Table 1**. Farmers in the two studied communes were similar in terms of age, ranging from 41 to 53 years old. All of them were experienced in vegetable farming.

**Table 1.** Basic information of the interviewed farming households.

Criteria	Unit	Van Duc commune	Dang Xa commune	Total
1. Total number of respondents	Households	30	30	60
2. Gender	Persons	30	30	60
Male	Persons	20	17	37
Female	Persons	10	13	23
3. Average age	Years old	43.56	47.13	45.35
4. Educational levels				
Primary school	%	23.33	26.67	28.33
Secondary school	%	23.33	20	21.67
High school	%	33.33	30	28.34
Complementary education	%	6.67	3.33	5
Technician school	%	0	10	5
College	%	6.67	3.33	5
University	%	6.67	6.67	6.67
5. Average number of members/household	Persons/household	3.96	3.76	3.86
6. Average number of labourers/household	Persons/household	2.23	2.36	2.3

Source: Survey result (2021).

Regarding the gender of the household heads, most of the household heads of the interviewed farming households were male. Out of a total of 60 interviewed households, 37 heads of households were male (61.67%), 23 heads of households were female (38.33%). In Van Duc commune, the households with a male head of household accounted for 66.67%, while the ones with a female head of household accounted for only 33.33%. In Dang Xa commune, the households with a male head made up 56.67%, while those with a female head made up 43.33%. It can be seen that the majority of household heads were male maybe because men tended to be decision makers in the family, deciding their production activities and being more active in applying scientific and technological advances (**Table 1**).

Regarding the educational level of the household head, the survey data shows that out of a total of 30 surveyed households in each commune, 100% of the household heads of the surveyed farming households had an educational level of at least primary school. High school degree holders accounted for the highest percentages, with 33.33% and 30.00% of the interviewees in Van Duc and Dang Xa communes, respectively. Household heads with secondary education accounted for 23.33% and 20% of the surveyed households in Van Duc and Dang Xa communes, respectively. The percentage of household heads with college or university education was low (less than 13%). The educational level of the household head is important because it reflects the level of awareness, understanding and ability to absorb and apply science and technology to production activities of the farmer household. From the survey results, it can be seen that the heads of households in the two communes had a relatively high level of education. This is an advantage for production activities, applying science and technology to production, absorbing new knowledge into production activities, and implementing effective measures to reduce risks of pesticides by plants of the surveyed households.

On average, the number of household members was 3.86 people/household. The average population of Van Duc commune was 3.96 people/household, higher than Dang Xa commune with 3.76 people/household. The number of laborers per household in Dang Xa commune was higher with 2.36 laborers/household; while in Van Duc commune, this figure was 2.34 laborers/household.

### **3.2. The Current Pesticide Use by Vegetable Farmers in Gia Lam District, Hanoi City**

Pesticides were an important input material in vegetable cultivation in Gia Lam district, especially in the two survey communes, Van Duc and Dang Xa. The results of the investigation and field survey show that people in 2 communes Van Duc and Dang Xa currently used 18 main active ingredients with 30 different trade names in vegetable production (**Table 2**). The most commonly used active ingredients were Permethrin, Abamectin, Spirotetramat, Chlorothalonil, Bacillus Thuringiensis, Emamectin benzoate, Diafenthiuron, Matrine, Azadirachtin,

**Table 2.** Commonly used pesticides on vegetables in Van Duc and Dang Xa communes, Gia Lam district.

No.	Trade names	Active ingredients	Subject to pests/diseases	Classification by hazard
1	Pounce 50EC	Permethrin 50% w/w	Leaf-eating caterpillars	
2	Vitashield gold 600EC	Alpha Cypermethrin 50 g/L + Chlorpyrifos Ethyl 545 g/L + Indoxacarb 5 g/L	Leaf folders and stem borers	Group II (Moderately hazardous)
3	Abamine 3.6EC	Abamectin 3.6%	Silkworm, borer, green worm, and thrips	
4	Movento 150OD	Spirotetramat 150 g/L	Jumping beetles, suckers (aphids and thrips, etc), and yellow flies	
5	Mig 18 207WG	Azadirachtin 1.5 g/kg + Chlorfluazuron 200 g/kg + Emamectin benzoate 5.5 g/kg	Leaf rollers, stem borers, fruit borers, silkworms, and green caterpillars	
6	Delfin WG	Bacillus Thuringiensis (Var. Kurstaki): 32BUI/KG	Silkworm, green worm, and armyworm	Group III (Slightly hazardous)
7	Elcarin 0.5SL	Fugous Proteoglycans 0.5% (w/w)	Wilting and rotting	
8	Kuraba WP	Abamectin 0.1% (3.5%) + Bacillus thuringiensis var.kurstaki 1.9% (0.1%)	Silkworm, green worm, leaf borer, armyworm, and thrips	
9	Daconil 75WP	Chlorothalonil (min 98%)	Powdery mildew, leaf spot, anthracnose, and downy mildew	
10	Promectin 5.0EC	Emamectin benzoat	Leaf-eating caterpillars	
11	Pegasus 500SC	Diafenthiuron 500 g/L	Jumping beetles, suckers (aphids and thrips, etc.), and yellow flies	
12	Radiant 60SC	Spinetoram 60 g/L	Smooth-skinned caterpillars, leaf borers, fruit borers, thrips, silkworms, green caterpillars, and white butterflies	Group IV (Unlikely to present acute hazard)
13	Cajet-M10 72WP	Cymoxanil 8% + Mancozeb 64%	<i>Pseudoperonospora cubensis</i> , leaf spot, rust and late blight diseases	
14	Etobon 0.56SL	Cytokinin (Zeatin) 5.6 g/L	Nematodes, damping-off disease, and pythium root rot	

Note: EC, OD, WG, SL, WP, and SC denote the formulation of the pesticides, namely Emulsifiable Concentrate, Oil Dispersion, Water Dispersible Granule, Soluble Liquid, Wetable Powder, and Suspension Concentrate, respectively. Source: Survey result (2021).

Cytokinin (Zeatin), and Bacillus subtilis, etc. The most widely used pesticides in production could be listed as Pounce 50ec, Vitashield gold 600EC, Movento 150OD, Delfin WG, Kuraba WP, Promectin 5.0EC, and Radiant 60SC, etc.

Research results showed that, according to the WHO recommended classification of pesticides by hazard categorizes [10], in vegetable cultivation in Van Duc and Dang Xa communes, farmers mainly used pesticides in Group II (Moderately hazardous), Group III (Slightly hazardous), and Group IV (Unlikely to present acute hazard), whereas pesticides in Group I (Extremely and Highly hazardous) were totally not in use (Table 3). Among these, pesticides belonging to group III accounted for the highest proportion of 51.63%. All of the widely used pesticides were on the list of pesticides issued by Vietnam's Ministry of Agriculture

**Table 3.** Structure of commonly used pesticides by farmers in vegetable production in Gia Lam district.

Category	Van Duc commune (%)	Dang Xa commune (%)	Whole
1. Origins	Chemical pesticides	32.37	34.41
	Biological pesticides	67.63	65.60
2. Hazard levels	Group I	0.00	0
	Group II	26.75	29.48
	Group III	54.58	51.63
	Group IV	18.67	18.90
3. Included in the list allowed to use for rice and cash crops	Yes	100.00	100.00
	No	0.00	0.00

Source: Survey result (2021).

and Rural Development. It can be seen that farmers in the study area had the tendency to use less toxic pesticides for their cultivation. It is also essential to further encourage the use of Group IV pesticides to minimize pesticide risks in the future.

### 3.3. The Current Application of Pesticide Risk Reduction Measures by Vegetable Farmers in Gia Lam District, Hanoi City

Conventional pesticides are an integral part of the protection systems in agricultural production [11]. Its use is, hence, inevitable. Farmers in Gia Lam districts strived to reduce their reliance on conventional pesticides and reduce their exposure to pesticides by employing a number of measures as follows:

#### 3.3.1. Application of Integrated Pest Management (IPM)

Integrated pest management (IPM) is the ideal method to reduce pesticide use and protect the environment from pollution, helping to ensure food safety and human health [12]. Pest management is achieved directly using a variety of tools, including pesticides, and indirectly through a number of other farming practices; this integrated approach has a positive effect on plant health in general as well as helps to reduce the pesticides needed for the plants [13]. In Gia Lam district, alternative pest and crop protection methods focusing on agroecosystems and integrated pest management had been prioritized for application in vegetable production by farmers in the two surveyed communes (Table 4).

1) *Field sanitation*: That is an important tactics in IPM which mean cleaning up crop residues and eliminating weeds thoroughly. This helps to reduce the appearance of pests and diseases, thus minimizing early-season spraying. The survey results showed that more than 90% of the farmers in the two surveyed communes thoroughly cleaned the fields at the beginning of each cropping season.

2) *Taking advantage of natural enemies and parasites*. Farmers use *Eocanthecona*

**Table 4.** The current application of alternative pest control methods (IPM) of the vegetable farmers in Gia Lam district.

Methods	Van Duc commune		Dang Xa commune	
	Number of households	Percentage (%)	Number of households	Percentage (%)
1. Field sanitation	28	93.33	27	90
2. Taking advantage of natural enemies and parasites	11	36.67	9	30
3. Crop rotation	14	46.67	13	43.33
4. Choosing the proper plant varieties	11	36.67	12	40
5. Applying technical advances into production	18	60	16	53.33
-Methyl Eugentol bait traps to eliminate fruit flies	12	40	15	50
-Yellow sticky traps to trap silkworms	14	46.67	16	53.33
-Green sticky traps to trap thrips	7	23.33	6	20
-Using the Passlite coating	4	13.33	5	16.67

Source: Survey result (2021).

furcellata bugs, parasitic wasps, and beetles, etc. (these species are natural enemies of pests such as green planthoppers, leafhoppers, butterflies and young caterpillars of stem borers, and greenworms, etc.) to eliminate pests, thereby helping to reduce the amount of pesticides used in farming and limiting the risks of pesticides. More than 30% of the interviewees used natural enemies and parasites in their production to reduce the use of pesticides.

3) *Crop rotation*: Farmers have formed the habit of diversifying vegetable varieties, alternating crop varieties throughout the years, thereby limiting the proliferation of pests, thus limiting the use of pesticides. This is a relatively important measure in preventing pests and diseases of the farmers in the study area, with about 43.33% to 46.67% of the interviewed households in each commune applying this method as a solution. reduce the use of pesticides.

4) *Choosing proper plant varieties*: People have paid attention to choose the varieties that are disease-free, resistant to pests and diseases, and certified by the seed quality testing agency. This helps to reduce the amount of pesticides used on crops in the area quite effectively. The rate of applying plant variety orientation in the two surveyed communes was about 40% of the interviewed households (mainly and with cabbage and cucumber).

5) *Applying technical advances into production*: There were 60% of households in Van Duc commune and 53.33% of households in Dang Xa commune that implemented models of technical advances including Methyl Eugentol bait traps to eliminate fruit flies, yellow sticky traps to trap silkworms, green sticky traps to trap thrips, and sweet and sour bait traps to kill insects, etc. to prevent and control pests and diseases, especially putting the Passlite coating model into testing to minimize the use of pesticides.

### 3.3.2. Application of Biological Pesticides

Biological pesticides, in general, have many advantages over conventional pesticides [14] [15]. Biological pesticides are becoming more and more popular around



the world by being a safer tactic in the management of pests and diseases for the crops whilst having significantly lower risks to not only humans but also the environment [16]. Using biological pesticides and pesticide products with low toxicity and high efficiency in pest control but safer for humans and the environment is one of the important risk reduction measures.

The survey results show that the proportion of biological pesticides in the pesticide structure used in Van Duc commune was 67.63%, this rate in Dang Xa commune was 63.56% (higher than the rate of chemical pesticides) (Table 2). In which, the most popular were pesticides of Group III (accounting for more than 50% of the structure of pesticides). This is the result of the careful guidance from technical staff specialized in plant protection, cooperative staff and thanks to active participation in the farmer groups.

Most common biological pesticides applied in vegetable cultivation in the two communes were those containing active ingredients such as *Bacillus Thuringiensis*, Emamectin benzoate, Diafenthiuron, Matrine, Azadirachtin, Cytokinin (Zeatin), and *Bacillus subtilis*, etc. All of these pesticides were included in the list allowed to be used by the Vietnam's Ministry of Agriculture and Rural Development as well as the list of pesticides recommended for use prepared by the Plantation and Plant Protection Station of Gia Lam district and sold in pesticide stores in the study area.

### 3.3.3. Application of Pesticides According to the 4-Right Pesticide Use Principles

The application of pesticides, especially of the improper pesticides and improper doses applied, poses a dominant threat to the farmers who apply the pesticides on the fields [17]. Pesticide use principle is important since pesticide risks can be avoided or reduced if farmers understand and practice the principle well. The 4-right principles in the use of pesticides was officially legalized in Vietnam in 2015. It is one of the most important principles in plant protection and quarantine activities in Vietnam [18].

In the two surveyed communes, the majority of farmers understood and practiced quite well in accordance with the 4-right principle: When pests and diseases have reached the threshold, farmers use pesticides in compliance with the instructions of specialized agencies, using pesticides according to the 4-right principles: "RIGHT pesticides for the right crop, RIGHT dose and concentration, RIGHT time of application and RIGHT methods of application".

Specifically, according to the survey results with the Plantation and Plant Protection Station of Gia Lam district on the practice of using pesticides on vegetables of farmers in 2 Van Duc commune and Dang Xa, there were about 86.67% of the farming households in Van Duc commune and 83.33% of households in Dang Xa commune practiced spraying according to the 4-right principle. People chose the right pesticides according to the type of pests and diseases, did not use pesticides of unknown origin, choose pesticides on the list of pesticides allowed to use, mainly on the list of recommended pesticides prepared by the District Plantation and Plant Protection Station and the cooperatives in the locality.

Thanks to the guidance and timely advice of technical staff, most farmers in the study area sprayed at the time when the pest was easily destroyed, reached the threshold, sprayed when it was cool and windless. The spraying process of households followed the instructions on the labels, within the recommended dosage and concentration range. Pesticides were also mixed according to the instructions of the technicians, it was very rare for farmers to arbitrarily mix them.

Besides that, about 60% of households have paid attention to alternating pesticides in use, thereby limiting the phenomenon of pesticide resistance and resistance of pests and diseases. This was possible thanks to the timely advice of technical staff as well as the owners of local drug stores. Every year, at the beginning of each cropping season, the staff of the District Cultivation and Plant Protection Station make a list of pesticides recommended for use in production for each crop for the farmers, which is shown by visual images and distributed to each commune, each cooperative to promptly advise and provide recommendations to people.

#### **3.3.4. Application of Labour Protection While Spraying Pesticides**

Protective equipment is again an important solution to pesticide risk reduction [19]. Using labour protection when spraying contributed to the minimization of the exposure to pesticides during use, thereby minimizing the risks of pesticides for direct users, the farmers.

The survey results at Van Duc commune and Dang Xa showed that most the majority of farmers were aware of and habitually using protective equipment during spraying (Table 5). Specifically, over 83% of people regularly used labor protection while spraying. Over 96% used masks, over 60% used gloves, over 73% wore boots, over 96% of people wear hats/caps, over 46% wore eyeglasses, only about 10% - 16.67% of people used a raincoat while spraying (Table 5).

#### **3.3.5. Application of Treatment Techniques after Spraying**

Survey results show that the majority of farmers in Van Duc and Dang Xa communes in Gia Lam district consciously collected bottles and packages of pesticides after using them to the right places as regulated. Rarely the farmers threw away pesticide bottles and packages at the yards at the banks of the fields, or rivers, streams and ponds, causing water pollution, soil and air pollution. Table 6 shows that about 80% of households in Van Duc and Dang Xa communes collected drug bottles and packages to the storage tanks in accordance with regulations (summarizing results of interviews with the officials of the Cultivation and Plant Protection Station of Gia Lam district, 2021). Most farmers understood and formed the habit of not burning pesticide containers, but collecting them to the dumping tanks according to regulations.

Two communes, Van Duc and Dang Xa, important safe vegetable granaries of Hanoi city, have also invested in building a system of cement tanks containing pesticide packaging in 5 safe vegetable production areas to create favorable conditions for the farmer households to fulfill the commitment of keeping the field clean implemented by the District People's Committee and the cooperatives.

**Table 5.** Application of labor protection while spraying of the vegetable farmers in Gia Lam district.

Criteria		Van Duc commune		Dang Xa commune		Whole	
		Number of households	Percentage (%)	Number of households	Percentage (%)	Number of households	Percentage (%)
1. The frequency of using labor protection when spraying	-Often	26	86.67	25	83.33	51	85
	-Sometimes	4	13.33	5	16.67	9	15
2. Types of labor protection	-Face masks	30	100	29	96.67	59	98.33
	-Gloves	18	60	19	63.33	37	61.67
	-Boots	22	73.33	25	83.33	47	78.33
	-Hats/Caps	30	100	29	96.67	59	98.33
	-Glasses	14	46.67	15	50	29	48.33
	-Raincoat	5	16.67	3	10	8	13.33

Source: Survey data (2021).

**Table 6.** Application of different treatment techniques after spraying of the vegetable farmers in Gia Lam district.

Treatment techniques after spraying		Van Duc commune		Dang Xa commune		Total	
		Number of households	Percentage (%)	Number of households	Percentage (%)	Number of households	Percentage (%)
1. Place of dumping the pesticide bottles and packages	Regulated places	24	80	27	90	51	85
	Dumping site on the fields	5	16.67	2	6.67	7	11.67
	Any place convenient	1	3.33	1	3.33	2	3.33
2. Handling of excess pesticides	Spraying it all	7	23.33	10	33.33	17	28.33
	Pouring into the ditch	3	10	0	0	3	5
	Dumping to the ponds and lakes	2	6.67	1	3.33	3	5
	Spraying other plants/crops	3	10	2	6.67	5	8.33
	Dumping at the regulated places	15	50	17	56.67	32	53.33
3. Place of cleaning the spraying tools	Any place convenient	6	20	7	23.33	13	21.67
	Regulated places	24	80	23	76.67	47	78.33
	Do not clean the spraying tools	0	0	1	3.33	1	1.67
4. Keeping spraying tanks	Far away from houses and barns	22	73.33	24	80	46	76.67
	Close to houses and barns	8	26.67	6	20	14	23.33
5. Rinsing the mouth after spraying	Yes	26	86.67	25	83.33	51	85
	No	4	13.33	5	16.67	9	15
6. Using eye drops after spraying	Yes	19	63.33	16	53.33	35	58.33
	No	11	36.67	14	46.67	25	41.67
7. Keeping spraying clothes separately	Yes	26	86.67	28	93.33	54	90
	No	4	13.33	6	20	10	16.67

Source: Survey result (2021).

In addition, the farmers of the two surveyed communes also formed a habit of cleaning spraying tools after spraying—washing the pesticide spray tanks both inside and outside with soap, disassembling each set part separately, opening the nozzle, draining the water and letting the tanks dry off, and storing them in a warehouse separate from houses and barns. The proportion of farmers cleaning the pesticide spray tanks after spraying at Van Duc and Dang Xa communes reached 100% of the surveyed households. The percentages of households that kept spray tools away from houses and barns in Van Duc and Dang Xa communes were 73.33% and 80%, respectively (**Table 6**).

For the excess pesticides after spraying, most farmers poured them into the containers in accordance with regulations. This percentage of surveyed households pouring excess pesticides to the regulated places reached 50% and 56.67% in Van Duc and Dang Xa communes, respectively. There was no case that farmers dumped the excess pesticides in the ditches or near water sources.

After spraying pesticides, most of the surveyed farmers practiced personal hygiene measures such as rinsing the mouth (85% of the interviewed households), using eye drops (58% of the interviewed households) and keeping the spraying clothes separate from other clothes (90% of the interviewed households).

It can be seen that, in general, farmers in the two surveyed communes performed the treatment measures after spraying relatively well as a solution to reduce the risks of pesticides in their production.

#### **4. Conclusions**

Vegetable farmers in Gia Lam district, Hanoi city, made significant efforts to reduce the risks of pesticides by applying a number of risk reduction measures in their agricultural production, including using alternative pest management solutions (IPM) such as field sanitation, crop rotation, exploitation of natural enemies and parasites, crop selection orientation, and application of technical advances; using biological pesticides (over 63%); using pesticides properly according to the 4-right pesticide use principles (over 80% of the households); using labor protection while spraying pesticides; and applying treatment techniques after spraying.

In the coming years, to further reduce the risks of pesticides in vegetable production of farmers in Gia Lam district, Hanoi city, it is of importance to focus on implementing a number of solutions as follows: 1) Strengthening governmental management for pesticides (increasing human resources for the plant protection departments to manage pesticides at the commune level, strengthening management of the collection and treatment of pesticide packaging after use and after collection at the storage tanks, and establishing a commune-level pesticide management board); 2) Strengthening training and communication on pesticide risks and pesticide risk reduction; 3) Strengthening support and supply of biological pesticides to farmers; 4) Strengthening activities of PGS groups in pesticide risk reduction; 5) Strengthening the application of technical measures to

reduce exposure to pesticides for farmers; and 6) Encouraging more farmers to participate in health insurance.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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