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A Survey on Use, Hazards and Potential Risks of Rice Farming Pesticides in Permatang Keriang, Pulau Pinang (Malaysia)

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Abstract

In agriculture, the use of pesticide has been the dominant form of pest management since the 1950s to kill pest organisms including insects, weeds, fungi and nematodes. In recent times, use of pesticides in rice farming has increased rapidly and this scenario contributes significantly towards adverse effects on human health and environment. This study investigated types of pesticide and identified their hazards and potential risks used by rice farmers in the village of Permatang Keriang, Pulau Pinang, Malaysia. Pesticide use, pesticide formulation, groups, classes, major pests as well as pesticide risks and toxicity were examined. Forty selected rice farmers which represent 33% of the total rice farmer population were interviewed based on 40 questions. From the survey, eight pesticide formulations including Actara (85%), Karate (93%), Nurelle 505 (73%), Nominee 100 SC (83%), Tapisan (65%) and Yasodion (62%) were found commonly used by the farmers in rice farming activities to control several major pests including plant diseases, fungi, insects and rodents. Major active ingredients of the pesticides found in this study were cypermethrin, chlorpyrifos, lambda-cyhalothrin, difenoconazole, bispyribac-sodium, isoprothiolane and cartap hydrochloride. From the study, it was observed that both high and low toxicity pesticides were used. Hazard identification and evaluation of potential risks which takes into account pesticide use and toxicity conducted in this study can help prioritise pesticides of greatest health risk to rice farming communities. In addition, this study could provide a fundamental baseline of a further study on a detailed risk assessment of pesticides amongst rice farmers and on the environment in order to establish control measures.

***Index Terms**- Pesticides; Risks; Toxicity; Hazard Identification; Pests; Rice Farming*

I. INTRODUCTION

Pesticides are chemicals designed to kill or control unwanted organisms including insects, weeds, fungi and nematodes. They are widely used in agricultural production since the 1950s in an effort to reduce or eliminate yield losses and maintain high quality production. These pesticides can be classified in various and different types of chemicals with over eight hundred active ingredients in over tens of thousands of formulations [1]. They can be roughly divided based on the organisms they are intended to kill such as fungicides, insecticides, herbicides, molluscicides, nematocides, rodenticides and others [2]. In agriculture including rice farming, pesticide application has been promoted among farmers in developing countries to increase their productivity and enhance economic potential for farm households [3]. In particular, the rapid increase in the application of pesticides has posed threats to the environment and adverse health effects on farmers [4]. A proportion of the pesticide that is not absorbed by the plants will be moved and transferred to the environment through wind, water and soil. Depending on the physico-chemical properties, it can be transported thousands of miles away and can infiltrate into meat, milk, human blood, animal and plants [5] which may result in serious health implications to humans and the environment. In relation to this, various reports of ill health associated with those applying pesticides has been reported by Food and Agricultural Organisation (FAO) [6].

With the growth of agricultural pesticide usage, many studies pinpointed a number of accidents; cases of poisoning and occurrence of environmental hazards [7]. The World Health Organisation (WHO) had estimated that a million people were being poisoned every year with 20,000 cases resulting in death in its 1986 annual report [8]. Much of this problem was due to the toxicity of the pesticides used by many small-scale farmers in the agriculture sector, without adequate knowledge of safe pesticide management practices and failure to wear appropriate personal protective equipment [9]. In addition, continuous pesticide application may put farmers' health at risk, with pesticides being dispersed, spilled or leaked and entering the human body either directly or indirectly. In the literature, there is vast evidence that pesticides do pose a potential risk to humans [5],[10], [11], [12] and other life forms as well as unwanted side effects to the environment [13], [14], [15]. Based on these scientific evidence, several studies provided data on pesticide assessment in paddy areas [16], [17], [18], [19], [20], [21].

Despite the serious implications of pesticides to humans and the environment, only a few studies have published on pesticide in rice farming in Malaysia. They typically focus on the effect of pesticides on rice [22] and ecotoxicology of pesticides in the tropical paddy field ecosystem [23]. In contrast little information is available about the pesticide, hazards and potential risks used by rice farmers in Malaysia. With further expansion and intensification in rice production, extended research on pesticide use among farmers is then essential. This in turn may help in adapting safe pesticide management practices in rice farming. Thus, to close this gap this paper presents a study on pesticides, hazards and potential risks of rice farming pesticides used by rice farmers in Penang, Malaysia.

II. METHODOLOGY

A. Study Area

The village of Permatang Keriang is situated in the district of Seberang Perai Utara, Pulau Pinang, in the northern part of Peninsular Malaysia (Latitude: 5°34'0.01"Longitude: 100°22'0.01"). It lies in the hot and humid zone of Malaysia with an area of 1.5km^2 out of 753 km^2 (Seberang Perai) with average temperature ranges from 30 to 34 °C throughout the year, 60 to 87 % of relative humidity and 2670 mm of average rainfall annually. The village is an important rice-producing area with 0.7 km^2 of rice farming areas (47 % of total area) in Seberang Perai Utara. This district is known as the largest contributor of rice production in Pulau Pinang with three t farming seasons in a year. About 15 % of the village population (about 119 farmers out of a total population of 800) is engaged in rice farming activities.

B. Survey on Farmers' Background and Pesticide Use

A study was conducted in April 2013 involving a sample population of 38 active rice farmers out of a total of 119 total rice farmers (about 32%) in a village of Permatang Keriang, situated in Northern Peninsular Malaysia. Ethical approval was given to this study by Human Research Ethics Committee USM [Ref: USM/JEPeM/279.3.(6)]. Farmers were selected randomly according to active rice farmers in the village as well as based on residence area near or adjacent to the rice farm and indirectly have high rates of exposure to the effects of pesticide use. Survey and formal interview which were guided by 40 questions were carried out to obtain information on pesticide use in rice farming activities of the farmers. The interview was carried out in an appropriate local language (Bahasa Melayu) for 30-45 minutes for each session. Farmers were asked about their socio-demographic data such as age, work experience, sex, education level and size of rice farm. They were also asked about pesticide use including types of pesticide to control pests, formulation or commercial name, major pests in rice farming, pesticide practices and frequency of spraying in one rice farming season.

C. Identification of Hazards and Potential Risks of Pesticide

Hazards and potential risks of each pesticide were identified and assessed based on the guidelines for potential health risk and occupational exposure drawn up by the Department of Occupational Safety and Health, Malaysia. Material Safety Data Sheet (MSDS) of each pesticide was collected from the manufacturer. Hazard identification was conducted in order to assess its potential risks and toxicity level. In addition, labels on pesticide containers were analysed to obtain information about hazards and potential risks of the pesticide.

III. RESULTS AND DISCUSSION

A. Farmers' Background

The rice farming system sampled in Permatang Keriang commonly consists of smallholder rice farmers planting paddy plants in areas with average farm size ranging from 0.4 to 10 hectares as shown in Table 1. Overall from the table, the size of rice farm showed that most farmers had less than 6.0 ha. From the interviews, it was found that most of the farmers were Malay (97%) while only (3%) was Chinese. The average ages of farmers ranged from 31 to 50 years. Therefore it appears that there are relatively few new entrants to rice farming in the area for the past 10 years. Most of the farmers interviewed were males (97%) and only 3% were females. The highest education level was secondary school (upper) (42%), followed by 26% for both secondary school (lower) and primary school. About 5% of farmers have higher education level at college or university. From the interview it was revealed that most of the farmers received training from the Department of Agriculture and obtained rice farming knowledge from experience with their parents, work on other farms or by asking other farmers. As reported by Mazlan and Mumford [24], farming experience is not much different between generations because they gained from their friends and parents through working experience. Most of the farmers were full-time pesticide applicators (66%) and about 34% were working as part-time applicators. The majority of the farmers involved in the interviews were smokers (84%) and only 16% were non-smokers. Most of the farmers were not suffering any illness (87%).

Table 1. Socio-demographic data from the survey and interview of rice farmers in Permatang Keriang

Characteristics	**Frequency (Σn = 38)**
Age	
20 and below	2
21-30	5
31-40	8
41-50	8
51-60	8
61-70	7
Race	
Malay	37
Chinese	1
Gender	
Male	37
Female	1
Education Level	
Primary school	10
Secondary school (lower)	10
Secondary school (upper)	16
College / University	2
Work	
Full time applicator	25
Part Time applicator	13
Farming Experiences (years)	
1 - 5 years	6
6 - 10 years	7
11 - 15 years	8
16 – 20 years	9
21 – 25 years	2
26 – 30 years	5
More than 30 years	1
Farming Area (ha)	
0.4 – 2.0	21
2.4 – 4.0	6
4.4 – 6.0	7
6.4 –8.0	1
8.4 – 10.0	1
More than 10	2
Smoking habit	
Smoker	32
Non- smoker	6
Suffering from any illlness	
Yes	5
No	33

B. Pesticide Use

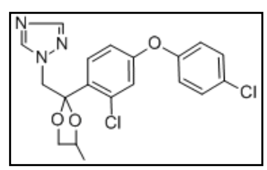
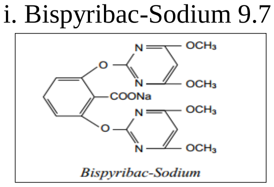
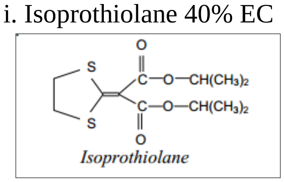
From the survey, a total of eight different pesticides were identified as the most commonly used by the rice farmers in Permatang Keriang to control the infestation of various pests. Table 2 characterises the eight pesticides according to formulation, group and class. The use of these pesticides was recommended by the Department of Agriculture. Due to major pests, farmers usually applied several types of pesticide during a rice farming season including insecticides, herbicides, fungicides and rodenticides. It was found that pesticides from insecticide group are the most common pesticide utilised by the farmers with formulation or commercial names of Actara (85%), Karate (93%), Nurelle 505 (73%), Nominee 100 SC (83%), Tapisan (65%) and Yasodion (62%).

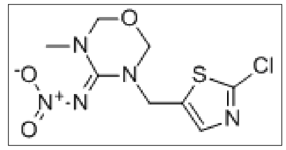
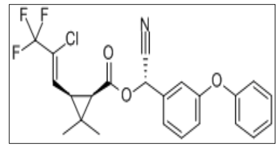
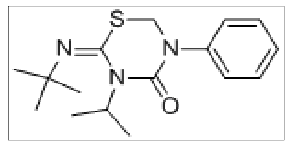
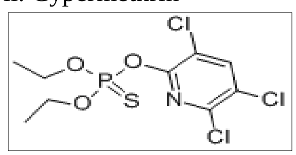
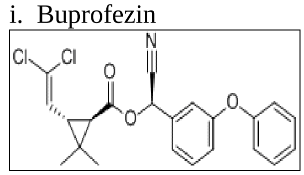
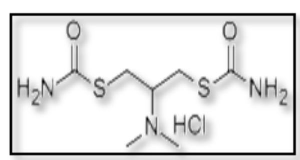
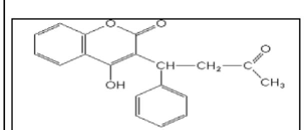
Table 2. Common pesticides used by rice farmers in Permatang Keriang

Pesticide Formulation	Pesticide Group	Pesticide Class
Actara	Insecticide	Class IV
Karate	Insecticide	Class II
Nurelle 505	Insecticide	Class Ib
Nominee 100 SC	Herbicide	Class III
Score	Fungicide	Class III
Tapisan	Insecticide	Class III
Yasodion	Rodenticide	Class IV

Table 3 shows pesticide formulation, active ingredients, chemical formula and chemical structure of pesticides regularly used by the rice farmers in Permatang Keriang found from the survey. Only frequently used active ingredients are listed, and the remaining group as unclassified. From the table, it can be seen that the number of formulations for an individual active ingredient varied. Some pesticide formulations contain more than one active ingredient. For instance, Score in fungicide group consists difenoconazole and bispyribac-sodium 9.7% SC as its active ingredient. In addition, Tapisan in insecticide group also contains two active ingredients which are buprofezin and cartap hydrochloride. The largest group (93%) of farmers used 3 to 4 types of these pesticides within one rice farming season. Of those interviewed 71.34% did use herbicides, while 97% relied on pesticides for insect and disease control. Fungal diseases were treated mainly with difenoconazole and bispyribac-sodium. The application of a very large range of insecticides was reported, but lambda-cyhalothrin, cypermethrin and chlorpyrifos were the most widely used. This survey also revealed that farmers under unusual circumstances tended to mix different types of pesticide with different active ingredients that would expose them to highly hazardous pesticides. This finding seems to support results reported by Panuwet et al. [25] that farmers usually mix the pesticides themselves, making a "cocktail" with some of them having different active ingredients without thinking of their synergistic effects [25].

Table 3. Pesticide formulations and their active ingredients

Pesticide Formulation	Active Ingredients	Chemical Formula	Chemical Structure
Score	i. Difenoconazole	Difenoconazole $C_{19}H_{17}Cl_2N_3O_3$	i. Difenoconazole 
	ii. Bispyribac-Sodium 9.7 % SC	i. Bispyribac-Sodium 9.7 % SC $C_{18}H_{17}N_4NaO_8$	i. Bispyribac-Sodium 9.7 % SC 
Fujione 40 EC	i. Isoprothiolane 40% EC	i. Isoprothiolane 40% EC $C_{12}H_{18}O_4S_2$	i. Isoprothiolane 40% EC 

Actara 25WG	Thiamethoxam	Thiamethoxam $C_8H_{10}ClN_5O_3S$	 i. Thiamethoxam
Karate	Lambda-Cyhalothrin	Lambda-Cyhalothrin $C_{23}H_{19}ClF_3NO_3$	i. Lambda-Cyhalothrin 
Nurelle 505	i. Chlorpyrifos ii. Cypermethrin	i. Chlorpyrifos $C_9H_{11}Cl_3NO_3PS$ ii. Cypermethrin $C_{22}H_{19}Cl_2NO_3$	i. Chlorpyrifos  ii. Cypermethrin 
Tapisan	i.Buprofezin ii.Cartap Hydrochloride	i. Buprofezin $C_{16}H_{23}N_3OS$ ii. Cartap Hydrochloride $C_7H_{16}ClN_3S_2O_2$	i. Buprofezin   ii. Cartap Hydrochlorid e
Yasodion	Warfarin 1% Heavy Dust	Warfarin 1% Heavy Dust $C_{19}H_{16}O_4$	i. Warfarin 1% Heavy Dust 

The chemical class for each active ingredient is characterised in Table 4. Each pesticide formulation has different active ingredient and chemical class depending on its group. From Table 4, it can be seen that most of the pesticides were classed under Class II, III, IV, Ib and IV with different chemical class of difenoconazole, organo-sulphur, pyrimidinyl carboxy, neonicotinoid, pyrethroids, organophosphate and thiadiazin. Of these products, one contains active ingredients classified as 'highly hazardous', another one contains active ingredients classified as ‘moderately hazardous’, and six other contain active ingredients classified as ‘slightly hazardous’ by the WHO. According to the classification of the US EPA [26] one product is classified as “warning”, three are classified as “caution” and four are classified as non-required.

Table 4. Chemical class for each pesticide formulation

Pesticide Group	Pesticide Formulation	Pesticide Class	Chemical Class
Fungiside	Score	Class III	Difenoconazole
	Fujione 40 EC	Class III	Organo-sulphur
Herbiside	Nominee 100 SC	Class IV	Pyrimidinyl carboxy
Insecticide	Actara	Class IV	Neonicotinoid
	Karate	Class II	Pyrethroids
	Nurelle 505	Class Ib	Organophosphate
	Tapisan	Class III	Thiadiazin
Rodenticide	Yasodion	Class IV	Aromatic hydrocarbon

[a]WHO classification of chemical classes : Ia = extremely hazardous, Ib = highly hazardous, II = moderately hazardous, III = slightly hazardous, U = unlikely to present acute hazard in normal use.
[b]EPA United Stated of chemical class: I = danger, II = warning, III = caution, IV = none required.

C. Major Pests in Rice Farming

Most of the farmers interviewed in this study were very knowledgeable in identifying pests and damage made by them in rice farming. All farmers stated that their primary method to control pest infestation is by the use of chemical pesticides. Only a few aged farmers (11%) still maintain pheromone and biological pest control methods for certain pests. Unfortunately, these pest control methods in rice farming are almost forgotten especially for the new generation [27]. Table 5 summarises the major pests in rice farming, which cause yield losses in rice farms in Permatang Keriang. The major pests in Permatang Keriang rice farms were *Rhizoctonia solani, Helminthosporium oryzae, Pyricularia oryzae, Pyricularia oryzae, Ishaemum rugosum, Echinochloa crus-galli, Empuasca fabae, Leptocorisa acuta, Nephotettix virescenes, Nilaparvata lugens, Sogatella furcifera, Cnaphalocrosis medinalis, Nymphula depuntalis, Helopeltis spp and Rattus argentiventer.* These findings are in agreement with the outcome reported by Savary et al. [28]. From the survey, most of the famers frequently used insecticide to control insects. These insecticides contain active ingredients of thiamethoxam, lambda-cyhalothrin, chlorpyrifos, cypermethrin, buprofezin and cartap hydrochloride and were applied more than twice in the early stages of rice farming. With respect to this, Ecobichon [3] stated that at global level, the higher usage of pesticide become a trend in the majority of developing countries, where insects are the biggest problem in agriculture. Buprofezin and cartap hydrochloride are the active ingredients contained in Tapisan pesticide formulation that are usually utilised in rice farming to control green leafhopper, brown plant hopper and leaf roller. Meanwhile, difenoconazole and isoprothiolane are the active ingredients contained in Score and Fujione, respectively used to control fungus pests (*Rhizoctonia solani* and *Pyricularia oryzae)*. As reported by Skamnioti and Gurr [29], about 10% until 30% of rice harvest were lost annually due to fungus infestation.

Table 5. Major pests in Permatang Keriang rice farms

Pesticide group	Pest	Pesticide formulation	Types of damage
Fungicide	Hawar seludang (*Rhizoctonia solani*)	Score	Produce empty rice especially at the bottom of stalk, cause rice collapse
	Bintik perang (*Helminthosporium oryzae*)		Caused by a fungus borne seeds that produce gray or white spots on the leaves or seeds.
	Karah Daun (Pyricularia oryzae)	Fujione 40 EC	Rice leaves will dry up and die.
	Reput Tangkai (Pyricularia oryzae)		Rice stalk rot and no substance in grains and rice plant will fall.
Herbicide	Rumput colok cina (*Ishaemum rugosum*)	Nominee 100 SC	Live in paddy field and compete with paddy to get nutrients needed by plants
	Rumput padi burung (*Echinochloa crus-galli*)		

Insecticide	Lelompat daun (*Empuasca Fabae*)	Actara	Insect adults and nymphs suck the liquid from the surface of the leaves while inserting toxic substances into the leaves.
	Kesing or Pianggang (*Leptocorisa acuta*)	Karate, Tapisan	Adult leafhopper and young leafhopper suck the liquid (milk) of rice being formed which will result in smaller fruit rice and half-filled.
	Bena Hijau or Green leafhopper (*Nephotettix virescenes*)	Karate, Tapisan	Green leafhopper damage the rice plants either by sucking liquid from rice plants or carrying the virus that causes red (PMV).
	Bena Perang (*Nilaparvata lugens*)	Tapisan	Rice plant becomes yellow and dry
	Bena belakang putih (*Sogatella furcifera*)	Tapisan	Adult and young white leafhopper will suck fluids from rice plants and cause leaves to wither and slowly turn red.
	Ulat lipat daun /ulat guglung daun (*Cnaphalocrosis medinalis*)	Karate, Tapisan	Larvae will attack during rice growth by winding up the leaves and combine them at the end of growing process. They also will chew the green leaf.
	Ulat ratus (*Nymphula depuntalis*)	Nurelle 505	Caterpillars feed on green tissues of the leaves and leaves become whitish and papery
	Kepinding nyamuk or Nyamuk hijau (*Helopeltis spp.*)	Nurelle 505	Sucking on mouth parts, they pierce plant tissues and cause damage ranging from leaf destruction and fruit blemishes
Rodenti-cide	Rat *(Rattus argentiventer)*	Yasodion 1	Rodent infestation will cause effects such as cut rice stalks. Rice fields appear yellow and dry.

D. Hazard Identification and Potential Risks

The concentrations of active ingredients in field applications in rice farming activities may pose a threat to humans and animals. Thus, hazard identification which takes into account pesticide use, toxicity, and exposure potential can help prioritise pesticides of greatest health risk to rice farming communities. In general, it was found that there were three main ways pesticides could enter the farmers' bodies: i) inhalation; ii) skin contact and; iii) ingestion. The characteristics of each pesticide formulation in the study area in terms of active ingredients, health effects on human and animals, persistence and degradability, mobility and environmental fate are listed in Table 6.

From the table, it can be seen that Yasodion under rodenticide group contains active ingredients of diphacinone which has oral toxicity of (LD_{50}): 20 to 50 mg/kg and dermal toxicity of (LD_{50}) (female):637 mg/kg and (LD_{50}) (male): 807 mg/kg. This implies that exposure to only small amounts of this pesticide will cause toxic effects to the skin and eyes of rodents. According to US EPA, all formulations containing 3% of diphacinone are classified as Restricted Use Pesticides (RUP) and under Category 1 "danger". While based on WHO, it is categorised as "extremely hazardous". In general, exposure to this pesticide causes adverse toxic effects [26]. In addition, based on the Hodge and Sterner Scale which was invented in 1943 [7], pesticide that contains diphacinone is categorised as highly toxic (1 to 50 mg/kg) with toxicity rating of 2. On the other hand, Tapisan from insecticide group with active ingredients of buprofezin has a value of 209 mg/kg (male) and 289 mg/kg (female) in terms of LD_{50} (oral toxicity) and is categorised as moderately toxic (50-500 mg/kg) based on the Hodge and Sterner Scale (toxicity rating = 3). As stated by US EPA, buprofezin has low acute toxicity via the oral, dermal and inhalation routes of exposure and has classified buprofezin as having no greater than suggestive evidence of carcinogenicity. Nurelle 505 with active ingredient of chlorpyrifos has acute oral toxicity LD_{50} of 776 mg/kg (male) and 300 mg/kg (female). Also, it has acute dermal toxicity LD_{50} of >5000mg/kg. This indicated that Nurelle 505 is extremely toxic [26], as compared to other pesticide formulations commonly used by the rice farmers in this study.

In the context of eco-toxicity characteristics, Yasodion has LC_{50} 96 h of 2.1 mg/l (channel catfish), 7.6 mg/l (bluegill), 2.8 mg/l (rainbow trout) and LC50 48 h of 1.8 mg/l (daphnia). Tapisan presents higher toxicity as compared to other pesticide formulations. It showed 2.7 mg/L or 2.703 ppm of fish toxicity (carp) for 48 hours. Score 250 EC with active ingredient of difenoconazole from fungicide group indicated higher toxicity of 3.7 mg/L or 3.704 ppm of fish toxicity (rainbow throat) for 96 hours followed by Fujione 40 EC with active ingredient of Isoprothio-lane from the same pesticide group which has 6.7 mg/L or 6.707 ppm of fish toxicity (carp) for 48 hours. According to US EPA [26], Fujione 40 EC is categorised as "moderately toxic" in terms of eco-toxicity (fish) and Score is classified as "moderately toxic" in terms of algae eco-toxicity.

Table 6. Health effects, eco-toxicity, physical and ecological properties of pesticides in Permatang Keriang rice farms

Property		Fungicide		Herbicide	Insecticide				Rodenticide
Pesticide formulation		Score 250 EC	Fujione 40 EC	Nominee 100 SC	Actara	Karate	Nurelle 505	Tapisan	Yasodion
Active Ingredients		Difenoconazole	Isoprothio-lane 40% EC	Bispyribac-Sodium 9.7 % SC	Thiametho-xam	Lambda-cyhalothrin	Chlorpyrifos	Buprofezin	Diphacinone 0.005% G
Health Effects	Oral Toxicity	Acute : (female rat) LD_{50} = 3129 mg/kg	Acute LD_{50} Rat (mg/kg) : Male: 2429 Female: 2698	Acute LD_{50} Rat (mg/kg) Male:>5000 Female:>5000	Low acute (Rat) LD50 = >5000mg/kg	-	Acute LD_{50} Rat (mg/kg) Male:776 Female:300	Acute LD_{50} Rat (mg/kg) Male:209 Female:289	LD_{50} (Rat): 20 - 50 mg/kg
	Dermal Toxicity	Acute: (male and female rat) LD_{50} = >5000mg/kg	Acute LD_{50} Rat (mg/kg) Male:> 2000 Female: > 2000	Acute LD_{50} Rat (mg/kg) Male:>4000 Female:>4000	Low acute (Rabbit) LD50 = >2000mg/kg	Slightly toxic: (rat) LD_{50}=>2000mg/kg	Acute (Rat) LD_{50} = >5000mg/kg	Acute LD_{50} Rat (mg/kg) Male:1326 Female:1083	LD_{50} Rat (mg/kg) Male: 637 Female: 807
	Inhalation	Acute: (male and female rats) (4h) = >5.17 mg/L	LD_{50} Rat: Male: > 2.77 mg/l (isoprothiolane)-4h	Acute (Rat) LC_{50} = >3.99mg/l - 4h	Low acute (Rat) LC50 = >2.79mg/l air-4h	LC_{50} (Animal not available= 3.12mg/L air- 4h available)	Acute (Rat) LC_{50} = >2.7mg/l - 4h	Acute LD_{50} Rat: Male, female = >4.57mg/L-4hr	LC_{50} Rat : No data available
	Skin irritation	Slightly	Slightly	Mildly (rabbit)	Mildly (rabbit)	Mildly (rabbit)	Moderate (rabbit)	Slightly (rabbit)	No data available
	Eye irritation	Moderate	Slightly	Not irritant (rabbit)	Mildly (rabbit)	Mildly (rabbit)	Moderate (rabbit)	Slightly (rabbit)	No data available
	Sensitisation	Skin- not sensitizer (guinea pig)	Positive	Not sensitizing (Guinea pig)	Skin- not sensitizer (guinea pig)	Mildly (animal tests)	Skin- not sensitizer (guinea pig)	Negative (guinea pig)	No data available
Eco-toxicity	Fish	LC_{50} (rainbow trout)=3.7 mg/L, 96h	LC_{50} (Carp) = 6.7 mg/l (48hr)	Bluegill sunfish: >100 ppm Common carp: >100 ppm	Slightly : LC_{50}(Rainbow Trout) = >100 ppm (96h)	Eco-acute: 96h, LC_{50}: 0.19-0.21ppb Eco-chronic: 300-days LOEC 0.062ppb	Toxic	LC_{50} 48h: 2.7mg/L (Carp)	LC_{50} 96 h: 1. 2.1 mg/l (Channel catfish) 2. 7.6 mg/l (Bluegill) 3. 2.8 mg/l (Rainbow trout)
	Aquatic Invertebrates	E_C50 (water flea)=4.3 mg/L, 48h	LC_{50} (Daphnia) = 40 mg/l (3hr)	Daphnla-magna: >100 ppm	E_C50= >106 ppm (Water flea)	Very toxic	Toxic and hazardous to aquatic organisms (L_C50/E_C50 <0.1mg/L	LC_{50} 30h: 50.6mg/L (Daphnia)	LC_{50} 48 h= 1.8 mg/l (Daphnia)

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	Algae	Highly toxic E_bC_{50}/E_rC_{50} (green algae) =1.7-4.4 mg/L, 72 h	-	-	E_cC_{50} = >100 ppm (5day)	Eco-acute (Water flea): 48h EC50 0.04ppb	-	-	-
	Soil dwelling organisms	-	-	Acute LC_{50}: >1,000 ppm (14 days)	-	-	-	-	-
	Bees	-	-	LD_{50} : >200 µg/ bee	-	Eco-acute: LD_{50} 0.038 ʋg/bee	Highly toxic	-	-
Persistence and degradability		Degradation half life in water : 1 d (not persistent in water) Degradation half time in soil : 149-187d (not persistent in soil)	-	No data available	Moderate persistence in water and soil	-	Half-life: i)Photolysis in water :3-4week ii)Tropospheric: 1.4 hours iii)Aerobic soil: 30-60 days Degradation: in soil within days to weeks	No data available	Decompose by microorganisms
Mobility		Low mobility in soil	-	No data available	Low mobility	-	-	No data available	Does not accumulate in the environment.
Environmental fate		High potential to bioaccumulation.	-	-	Moderate bioaccumulation potential	-	Bio-concentration potential is moderate.	-	-

IV. CONCLUSION

From this study it was found that, eight pesticide formulations including Actara (85%), Karate (93%), Nurelle 505 (73%), Nominee 100 SC (83%), Tapisan (65%) and Yasodion (62%) were commonly used by the farmers in rice farming activities to control several major pests including plant diseases, fungi, insects and rodents. Both high and low toxicity pesticides were used. These contain the active ingredients of cypermethrin, chlorpyrifos, lambda-cyhalothrin, difenoconazole, bispyribac-sodium, isoprothiolane and cartap hydrochloride. Hazard identification and evaluation of potential risks which takes into account pesticide use, toxicity, and exposure potential conducted in this study can help prioritise pesticides of greatest health risk to rice farming communities. By looking at the toxicity data of the pesticides, rice farmers who applied pesticides without adequate personal protection equipment and neglecting safety were exposed to hazards. It is also predicted that pesticide use and the associated risks to human health and the environment will increase rather than decrease in the near future [4]. From this study, it can be seen that the list of pesticides used in rice farming in the village of Permatang Keriang is in need of review in terms of potential risks, hazards and safety measures. In order to tackle these problems, monitoring programme and safety training are essential to ensure the permissible exposure limits of the pesticide are complied. Besides, farmers' awareness of the specific risks of pesticides and the necessity of using personal protection equipment and proper clothing should be emphasised. In this case, personal protection equipment should be used and maintained according to instructions on the container label. Besides, this study could provide fundamental data for further studies on knowledge, attitude and practices as well as a detailed risk assessment of pesticides amongst rice farmers and on the environment in Permatang Keriang rice farms.

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