UNIVERSITI PUTRA MALAYSIA

PESTICIDES CONTAMINATION IN PERSONAL AIR AND ASSOCIATED HEALTH RISK AMONG PADDY FARMERS IN TANJUNG KARANG, KUALA SELANGOR

NUR SYADZA NORIZAN

PESTICIDES CONTAMINATION IN PERSONAL AIR AND ASSOCIATED HEALTH RISK AMONG PADDY FARMERS IN TANJUNG KARANG, KUALA SELANGOR

BY

NUR SYADZA BINTI NORIZAN

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ABSTRACT

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Introduction: Tanjung Karang, Selangor is widely known for its paddy cultivation activity and the third largest paddy field in Malaysia. The contamination of pesticides in agriculture field is very common as the pesticides is used to increase the paddy productivity and to reduce plant diseases. Environmental exposure of humans to agrichemicals is common and results in both acute and chronic health effects such as acute and chronic neurotoxicity. **Objective:** To determine the concentration of pesticides (propiconazole, difenoconazole, chlorantraniliprole) in the personal air samples collected at Tanjung Karang, Kuala Selangor paddy field and assess the potential health risk to the farmers. **Methodology:** A cross sectional study was conducted in Kampung Sawah Sempadan at Tanjung Karang. 83 respondents were interviewed to get the pesticide's information, personal information of respondents and their exposure information. A glass fibre filter and an XAD-2 resin tube were attached in the breathing zone with a clip, and an air pump was fastened on the belt to collect personal air samples. Pesticides trapped on the XAD-2 resin and filter were extracted with 10 mL of acetone, centrifuged, concentrated via a nitrogen blowdown and reconstituted with 1 mL of 3:1; ultrapure water: methanol. Aliquot (2 µL) of the extract was analysed using ultra-high perfomance liquid chromatography tandem mass spectrometry (UHPLC-MS/MS). **Result and Discussion:** The highest mean concentration was chlorantraniliprole 0.0308 ng/m^3 followed by difenoconazole (0.0086 ng/m^3) and propiconazole (0.0099 ng/m^3). The mean Daily Inhalation Expousure (DIE) for chlorantraniliprole, difenoconazole, propiconazole were 0.49 ng/kg/day, 0.11ng/kg/day and 0.25ng/kg/day respectively. All compound did not exceed the recommended Reference Dose (RfD) by United State Environmental Protection Agency (USEPA). The Hazard Quotient (HQ) for all pesticides did not exceed 1 and Hazard Index is also less than 1. **Conclusion:** There were no significant non-carcinogenic health risk for farmers during pesticides spraying due to the inhalation as the HQ and HI is less than 1.

Keywords: pesticides, paddy field, air, agriculture, health risk assessment

ABSTRAK

PENCEMARAN RACUN PEROSAK DALAM SAMPEL UDARA PERIBADI DAN RISIKO KESIHATAN YANG BERKAITAN DI KALANGAN PESAWAH PADI DI TANJUNG KARANG, KUALA SELANGOR

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Pengenalan: Tanjung Karang, Selangor terkenal dengan aktiviti penanaman padi dan sawah padi yang ketiga terbesar di Malaysia. Pencemaran racun perosak dalam bidang pertanian adalah sangat biasa sebagai racun perosak digunakan untuk meningkatkan produktiviti padi dan mengurangkan penyakit tumbuhan. Pendedahan persekitaran manusia untuk kimia pertanian adalah perkara biasa dan menyebabkan kedua-dua kesan kesihatan akut dan kronik seperti ketoksikan saraf akut dan kronik. **Objektif:** Untuk menentukan kepekatan racun perosak (propiconazole, difenoconazole, chlorantraniliprole) dalam sampel udara peribadi yang dikumpulkan di Tanjung Karang, sawah Kuala Selangor dan menilai risiko kesihatan yang berpotensi untuk petani. **Metodologi**: Kajian irisan lintang telah dijalankan di Kampung Sawah Sempadan di Tanjung Karang. 83 responden telah ditemubual untuk mendapatkan maklumat berkaitan racun perosak, maklumat peribadi responden dan maklumat pendedahan mereka. Penapis gentian kaca dan XAD -2 tiub resin ditempatkan di zon pernafasan dengan klip, dan pam udara diikat pada tali pinggang untuk mengumpul sampel udara peribadi. Racun perosak terperangkap di resin XAD -2 dan penapis telah diekstrak dengan 10 mL aseton, disentrifugasi, dikeringkan menggunakan nitrogen dan disusun semula dengan 1 mL daripada 3: 1; air ultrapure: metanol. Aliquot (2 ul) ekstrak dianalisis menggunakan ultra- tinggi perfomance kromatografi cecair seiring spektrometri jisim (UHPLC-MS / MS). **Keputusan dan Perbincangan:** Kepekatan min tertinggi ialah chlorantraniliprole 0, 0.308 ng/m3 diikuti oleh difenoconazole (0.0086 ng/m3) dan propiconazole (0.0099 ng/m3). Min pendedahan penyedutan setiap hari (DIE) untuk chlorantraniliprole, difenoconazole, propiconazole adalah 0.49 ng/kg/hari, 0.11 ng/kg/hari dan 0.25 ng/kg /hari. Semua kompaun tidak melebihi Rujukan Dos disyorkan (RFD) oleh United State Environmental Protection Agency (USEPA). Bahaya hasil bahagi (HQ) untuk semua racun perosak tidak melebihi 1 Indeks Bahaya juga kurang dari 1. **Kesimpulan:** Tidak ada risiko kesihatan bukan karsinogen ketara bagi petani semasa menyembur racun perosak disebabkan oleh penyedutan sebagaimana HQ dan HI adalah kurang daripada 1.

Kata kunci: racun perosak, sawah padi, udara, pertanian, penilaian risiko kesihatan

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LIST OF ABBREVIATIONS

ACP	The UK Advisory committee on Pesticides
BW	Body Weight
C	Concentration
DIE	Daily Inhalation Exposure
ED	Exposure Duration
EUP`	End User Product
FIFRA	Federal Insecticides, Fungicides and Rodenticides Act
GDP	Gross Domestic Product
HBRV	Health Based Risk Value
HI	Hazard Index
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome
UHPLC MS/MS	Ultra High- Performance Liquid Chromatography Mass Spectrometry/ Mass Spectrometry
HQ	Hazard Quotient
IRinh	Inhalation Rate per Hour
LC_{50}	Lethal Concentration- Concentration required to kill half a population of laboratory animal
LD_{50}	Lethal Dose- Dose required to kill half a population of laboratory animal
MOA	Ministry Of Agriculture
PAN	Pesticide Action Network
PRIA	pesticides Registration Improvement Extension Act
TCDD	Tetrachlorodibenzodioxin
USDA	United State Department of Agriculture
USEPA	United State Environmental Pesticides Act

CHAPTER 1

INTRODUCTION

1.1 Background

According to the European Commission (2015), a 'pesticide' is to prevent, destroys, or controls a harmful organism ('pest') or disease, or protects plants or plant products during production, storage and transport. The term includes herbicides, fungicides, insecticides, ascaricides, nematicides, molluscicides, rodenticides, growth regulators, repellents, rodenticides and biocides. The practice of agriculture first began about 10,000 years ago in the Fertile Crescent of Mesopotamia (part of present day Iraq, Turkey, Syria and Jordan) where edible seeds were initially gathered by a population of hunter/gatherers (Kislev et al., 2004).

Most of the pesticides used today are chemicals which have been developed in a laboratory by scientists and produced in factories. One of the examples of chemically-related pesticides is organophosphate pesticides, where these pesticides affect the nervous system by disrupting the enzyme that regulates acetylcholine, a neurotransmitter. Some pesticides are last longer in the environment which they can affect the land, the water and the air badly. Plus, they are very poisonous too (Lah, 2011).

Currently, approximately 600 active pesticide ingredients are used, but adequate toxicological data are only available for approximately 100 of these pesticices. Environmental exposure of humans to agrichemicals is common and results in both acute and chronic health effects such as acute and chronic neurotoxicity (insecticides, fungicides, fumigants), lung damage (paraquat), chemical burns (anhydrous ammonia), and infant methemoglobinemia (nitrate in groundwater). According to Dennis & Weisenburger (1993), the negative effects of pesticides have been reported such as Immunologic abnormalities, adverse reproductive as well as developmental effects.

Consequently, the pesticides will start to immerse in human body. This is because, people have the least control over the inhalation pathway although they can choose what food to eat or what types of products to be used in the house, it is impossible to selectively breathe air. More information about air quality can serve as a springboard to make changes and prevent future health problems related to contamination.

Traditionally, immune analysis methods and instrumental analysis methods have been used for the determination of pesticides residues. However, the method suffers from several drawbacks. Nowadays, UHPLC-MS/MS (high performance liquid chromatoghraphy-mass spectrometry/mass spectrometry) is becoming one of the most powerful techniques for the residual analysis of polar, ionic or low volatility pesticides in complicated matrices. Hence, this study is proposed to simultaneously quantify commonly used pesticides in Malaysian paddy field air by using UHPLC-MS/MS method.

1.2 Problem Statement

In Malaysia, agriculture sector is growing efficiently with the help of pesticides to increase production of the plantation. Large group of pesticides have been introduced in Malaysia to support the growth. There are different types of pesticides used in a single plantation such as fungicides, herbicides and insecticide. These pesticides have different functions towards the plantations. Farmers in paddy field applied pesticides to their plantation by using spray drift and post- application volatilization (Yusà, Coscollà, & Millet, 2014). By using these two methods, the pesticides can travels in the air. There are studies reported that wide range of pesticides have been found in ambient air (Yusà et al., 2009). Unfortunately, there is limited study reported on personal air sample at paddy field in Malaysia.

Therefore, there is a need to study the residues of pesticides in personal sample such as air samples. Hence, this study is being conducted to identify the concentration of pesticides in personal air and the associated health risk among paddy farmers in Tanjung Karang.

1.3 Research Justification

In Malaysia, the agricultural area covers approximately 20% of the total land area, and the agricultural sector contribution to GDP in 2003 is 8.45% (MOA, 2014). In order to maintain the quality and appearance of the crops, pesticides are widely used in agriculture sector. The overly used amount of pesticides for crop protection will disrupt the environmental quality and human health negatively (Jaipieam, Visuthismajarn, Siriwong, Borjan, & Robson, 2009).

According to Jaipieam et al., (2009), farmers are directly and indirectly exposed to the pesticides residues either by inhalation during mixing, loading, or application of pesticides. The inhalation exposure results in the individual breathing in dilute pesticides, that is, absorbed through the surface of the lung. Therefore, the question arise as to whether the massive use of pesticides have caused any health impact on the health of farmers in Tanjung Karang. In view of this, the level of pesticides pollution at Tanjung Karang paddy field for air samples need to be determined and quantified.

The method will be a simultaneous quantification of the commonly used pesticides in Malaysian paddy field by using UHPLC-MS/MS method. Upon completion of the quantification of the level of pesticides pollution in the air sample at paddy field, further study on the health risk assessment will be done to answer the research question on whether the overly used pesticides in Malaysian paddy and rice industry bring any potential health risk to the farmers.

1.4 Conceptual Framework

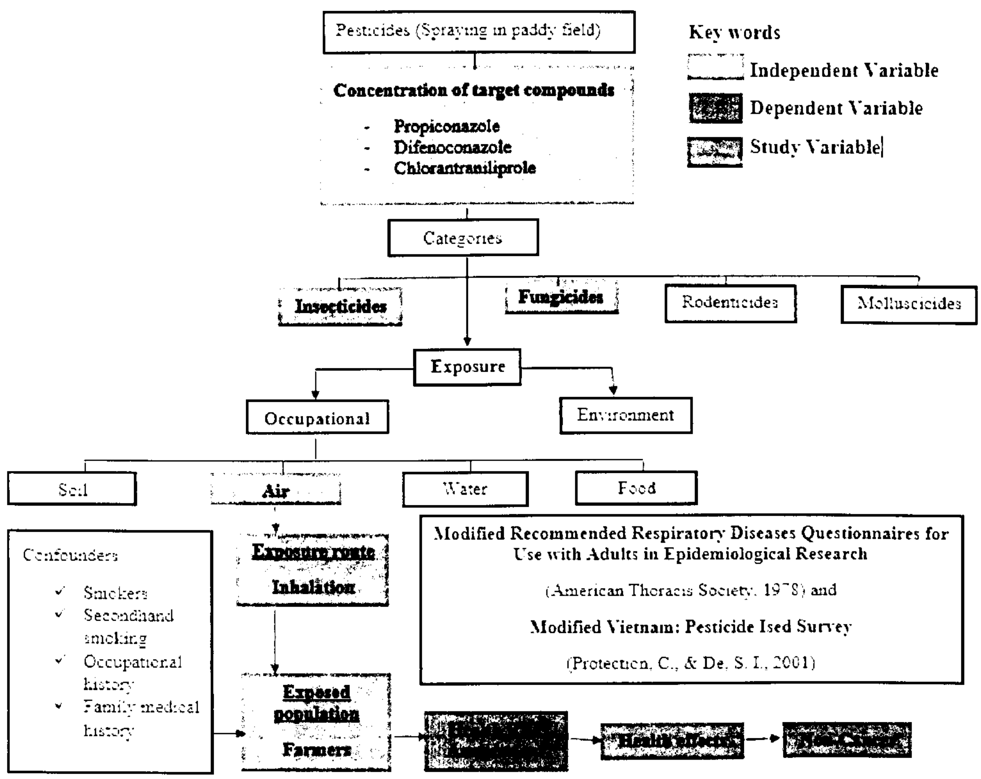

Figure 1.1: Research Conceptual Framework

Paddy farmers spray many types of pesticides to their crops every seasons. The top three most commonly used pesticides sprayed by farmers are chlorantraniliprole, difenoconazole and propiconazole. Chlorantraniliprole is a fungicides while difenoconazole and propiconazole are insecticides. Farmers is one job scope where they plant paddy to get money. Thus, exposure of pesticides to paddy farmers is an occupational exposure. The chosen occupational exposure is through air where the exposure route is by inhalation. The exposed population is obviously the paddy farmers who spray pesticides to their crops. As the concentration of pesticides obtained, the health risk assessment were calculated to determine the health effect to all paddy farmers.

1.5 Research Question

By completion of this study, present study will be able to answer the following questions:

i) Do the personal air samples collected at Tanjung Karang, Kuala Selangor contaminated with pesticides (propiconazole, difenoconazole, chlorantraniloprole)?

ii) Does spraying off pesticides cause any potential non-carcinogenic health risk through inhalation pathway by the farmers?

1.6 Objectives

1.6.1 General Objective

To determine the concentration of pesticides (propiconazole, difenoconazole, chlorantraniloprole) in the personal air samples collected at Tanjung Karang, Kuala Selangor paddy field and assess the potential health risk to the farmers.

1.6.2 Specific Objectives

i. To determine the concentration of (propiconazole, difenoconazole, chlorantraniloprole) in the personal air samples collected from paddy farmers at Tanjung Karang, Kuala Selangor paddy field.

ii. To assess the potential non-carcinogenic health risk from pesticides contaminants in the air through inhalation pathway during the spraying activity among paddy farmers at Tanjung Karang, Kuala Selangor.

iii. To determine the association between the three selected pesticides in personal air samples and the wind speed reading during the spraying activity.

iv. To determine the association between the three selected pesticides in personal air samples and the temperature reading during the spraying activity.

1.7 Hypothesis

i. There is significant association between concentration of the three selected pesticides in air samples and the wind speed reading during the spraying activity.

ii. There is significant association between concentration of the three selected pesticides in air samples and the temperature reading during the spraying activity.

CHAPTER 2

LITERATURE REVIEW

2.1 Pesticides Usage in Agriculture

Pesticides are used around us every single day and everywhere we go, at homes, gardens, schools, parks and agricultural fields. The mostly used pesticides are obviously in agriculture fields in order to increase their production and to ensure that their product is in good conditions. Pesticide is a term used to generalise insecticides, herbicides, fungicides, rodenticide, molluscicides, nematicides, plant growth regulator and others. Each type of pesticide is very useful to ensure that the plant is in a good condition. Insecticides are used to kill bugs or any insect that eat the plants and the crops. Fungicides are used to kill fungus which will destroy the crops.

Over 1 billion pounds of pesticides are used in the United State (US) each year and approximately 5.6 billion pounds are used worldwide (Donaldson et al., 1999). In many developing countries programs to control exposures are limited or non-existent. As a consequence; it has been estimated that as many as 25 million agricultural workers worldwide experience unintentional pesticide poisonings each year (Jeyaratnam, 1990). The application of pesticides is often not very precise, and unintended exposures occur to other organisms in the general area where pesticides are applied. Children, and indeed any young and developing organisms, are particularly vulnerable to the harmful effects of pesticides (Sarwar, 2015). For example, the herbicide atrazine is found in 94% of U.S. drinking water tested by the United State Department of Agriculture (USDA, 2004).

2.2 Type of pesticides

2.2.1 Propiconazole

Propiconazole (CAS No 60207-90-1) is a fungicide and antimicrobial that was first registered in 1981, used to protect grass grown for seed. The Environmental Protection Agency expanded its tolerances to include several food crops in 1987, and again in 1993 and 1994. Propiconazole is in the triazole class of fungicides. Commercially, propiconazole is available as an emulsifiable concentrate, flowable concentrate, ready-to-use liquid, liquid soluble concentrate, wettable powder, and dust (USEPA, 2006)

Propiconazole has a moderately low acute toxicity. The acute oral LD50 for rats is 1517 mg/kg. When exposed to the eyes, popiconazole caused corneal opacity which reversed within 72 hours (USEPA, 2006). Chronic toxicity tests on rats and mice found benign and malignant liver tumours to occur in males at doses as low as 3.6 mg/kg daily (EC, 2003). The EPA has categorized propiconazole as a possible human carcinogen (USEPA, 2006).

In a reproductive toxicity test with rats, doses as low as 30 mg/kg caused skeletal deformations in newborn pups. Reduced litter size and pup weight were observed at the 8mg/kg dose level (EC, 2003). Propiconazole is a developmental toxin on the Toxics Release Inventory (PANNA). The body absorbs 86% of a propiconazole dose in 48 hours. Excretion occurs at 95% in 48 hours (EC 2003).

2.2.2 Difenoconazole

Difenoconazole (CAS No. 119446-68-3) is an active ingredients of various commercial fungicides, belong to the 14 α-demethylation inhibitors (DMIs) (Bai and Liu, 1987, Chen et al., 2008 and Gopinath et al., 2006). The triazole fungicides are agrochemicals used worldwide in the agricultural industry due to their wide spectrum of actions (Kim, Beaudette, Shim, Trevors, & Suh, 2002). These fungicides are typically applied directly on plants (Colson et al., 2003, Kim et al., 2003 and Li et al., 2013). They have both protective and curative activities and are extensively used for control of diseases of cereals, grapevines, banana and peanut (Munkvold, Dixon, Shriver, & Martinson, 2001), and also for the control of anthracnose of strawberry (Smith & Black, 1991).

The mode of action of difenoconazole is that it is a sterol demethylation inhibitor which prevents the development of the fungus by inhibiting cell membrane ergosterol biosynthesis.

2.2.3 Chlorantraniliprole

Chlorantraniliprole is the ISO approved common name for 3-bromo-N-[4-chloro-2-methyl-6-(methylcarbamoyl)phenyl]-1-(3-chloropyridin-2-yl)-1H-pyrazole-5-carboxamide). Chlorantraniliprole (CAS No. 500008-45-7) is an insecticide that operates by a highly specific biochemical mode of action. It binds and activates ryanodine receptors, resulting in depletion of intracellular calcium stores and leading to muscle paralysis and death.

It is used as an active ingredient in many different formulations. This compound has novel mode of action for synthetic insecticides called ryanodine receptor activators (Cordova et al., 2007) which are critical for muscle contraction. As the insect and mammalian ryanodine receptors are structurally different, chlorantraniliprole exhibits remarkable selectivity and safety for mammals (Lahm et al., 2007).

The toxicity category for chlorantraniliprole is category IV for all routes of exposure and is a non-sensitizer (USEPA, 2008).

2.3 Sources, Transport Pathway and Fate of Pesticides in the Environment

Pesticides vary in the way that they are structured. This is what allows them to "target" certain organisms such as a particular weed or insect. Variance in chemical structure also helps to define on how a pesticide will move in the environment. Some pesticides are soluble in water, which means that they can move wherever water moves. Some pesticides "volatilize" easily, which means that they can change from a liquid to a gas and move more easily with the air. Sometimes, not entire applied chemical is reachable to the target site, therefore, it can be harmful to release the pesticides into the environment (Woodwell, 1967)

Environmentalists, scientists and agriculturalists are all too aware of the long-term effects of pesticides as they seep away to pollute streams and watercourses. Air in field margins may be contaminated with pesticides because of application drift, post-application vapour loss and wind erosion of treated soil. Soil, vegetation and water bodies within field margins may become contaminated through wet and dry atmospheric deposition of pesticides and through surface runoff from pesticide-treated agricultural land (Cessna et al., 2005). According to Cessna et al., contamination within field margins that include soil, vegetation and water bodies have disseminated through wet and dry atmospheric deposition of pesticides as well as through surface runoff from pesticide-treated agricultural land.

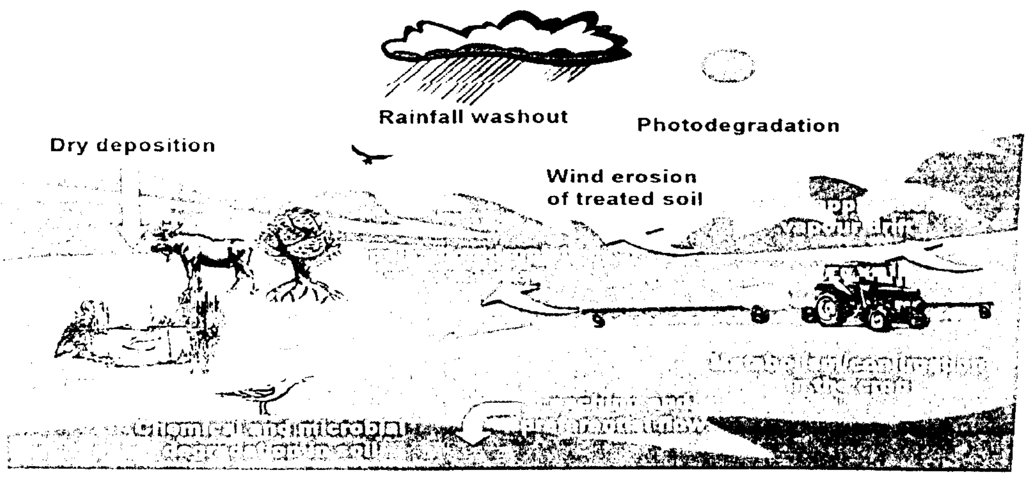

Figure 2.1 Routes of entry of pesticides into the atmosphere and into surface and ground waters and mechanisms of pesticide transformation in air, soil and plants (J.L.T Pestana, A.C Alexander, J.M. Culp, D.J. Baird, A.J. Cessna, 2009).

Pesticides are applied in many different ways that depend upon the medium (liquid, solid, gas) of the pesticide, the area over which the pesticide will be applied, and what device is used to apply it. How a pesticide is applied will affect how free it will be to move in the environment.

Pesticides, regardless of the medium that they are applied in, all have the potential to be transported by air. Airborne pesticides can move very long distances and can occur in several ways. One of the ways are they can be carried in the wind during application. They can be carried on small particulates such as soil or on larger objects like leaves that are caught up by wind, and they can volatilize off of any surface that they are applied to. Deposition is what occurs when the wind carrying a pesticide slows down enough that its velocity can no longer hold it in the air, and it falls on whatever is beneath it. This is called "dry deposition." Very small particulates or molecules of pesticide may remain in the atmosphere even when the air is relatively still. These pesticides may be removed from the atmosphere when it rains and the droplets catch them on their way down. This process is called "wet deposition."

Movement of pesticides in the atmosphere occurs due to simultaneous combination of diffusion and transport processes through dispersion (Schroeder & Lane, 1988). Diffusion, which promotes the dispersion of gases and atmospheric particles (aerosols), is caused by turbulent motions that develop in air that is unstable. Transport, on the other hand, results from air-mass circulation driven by local or global forces. Certain meteorological conditions such as thunderstorms can move these airborne pesticide vapours and particles into the upper troposphere. Once there, they can be distributed regionally and even globally (Majewski & Capel, 1995). The actual distance travelled by pollutants strongly depends on the amount of time a specific pollutant resides in the atmosphere and is available for dispersion.

2.4 Effects of Pesticides

2.4.1 Environment

Pesticides are toxic chemicals designed to be deliberately released into the environment. Although each pesticide is meant to kill a certain pest, a very large percentage of pesticides reach a destination other than their target. Instead, they enter the air, water, sediments and even end up in our food. Pesticides easily contaminate the air, ground and water when they run off from fields, escape storage tanks, not discarded properly and especially when they are sprayed aerially.

According to the USGS, as cited by Savonen, 1977, pesticides have been detected in the atmosphere in all sampled areas of the USA. Nearly every pesticide investigated has been detected in rain, air, fog, or snow across the nation at different times of the year (U.S. Geological Survey, 1999). Many pesticides have been detected in air at more than half the sites sampled nationwide. Herbicides are designed to kill plants, so it is not surprising that they can injure or kill desirable species if they are applied directly to such plants, or if they drift or volatilise onto them. The U.S. Fish and Wildlife Service have recognized 74 endangered plants that may be threatened by glyphosate alone (U.S. EPA Office of Pesticides and Toxic Substances, 1986).

2.4.2 Human health

Pesticides are the only toxic substances released intentionally into our environment to kill living things. This includes substances that kill weeds (herbicides), insects (insecticides), fungus (fungicides), rodents (rodenticides), and others. The use of toxic pesticides to manage pest problems has become a common practice around the world. Pesticides are used almost everywhere that not only in agricultural fields, but also in homes, parks, schools, buildings, forests, and roads.

According to the World Health Organization (WHO, 2001), there are estimated that 3 million cases of pesticide poisoning each year and up to 220,000 deaths, primarily in developing countries. The application of pesticides is often not very precise, and unintended exposures occur to other organisms in the general area where pesticides are applied. Children, and indeed any young and developing organisms, are particularly vulnerable to the harmful effects of pesticides. Even very low levels of exposure during development may have adverse health effects.

The health effects of pesticides depend on the types of them such as affecting the nervous system, irritate the skins or eyes and affecting hormone or endocrine system in the body (U.S. EPA, 2014).

Pesticide exposure can cause a range of neurological health effects such as memory loss, loss of coordination, reduced speed of response to stimuli, reduced visual ability, altered or uncontrollable mood and general behaviour, and reduced motor skills. These symptoms are often very subtle and may not be recognized by the medical community as a clinical effect. Other possible health effects include asthma, allergies, and hypersensitivity. Besides, pesticide exposure is also linked with cancer, hormone disruption and problems with reproduction and fetal development (Lah, 2011).

Most herbicides interfere with plant hormones or enzymes do not have any direct counterpart in animals. The most serious human health concerns have been related to chemical contaminants in the active ingredient. Military personnel and others exposed to Agent Orange, a mixture of the herbicides 2,4-Dand 2,4,5-T that was contaminated with dioxin (TCDD), reported birth defects, cancers, liver disease, and other illness (Lah. 2011).

Insecticides are known to have the most acute and immediate toxic which most of them are designed to invade an insect's brain, nervous system and have neurotoxic effects in humans as well. Herbicides are more widely used and present chronic exposure risks, such as cancer and reproductive harm (PAN North America, 2014).

2.5 Law and Regulation of Pesticides

2.5.1 International

The law and regulation on pesticide already exist decades ago. It started on 1910 where the United States federal law set up the basic U.S system of pesticides regulation to protect the applicators, consumers and the environment which is the Federal Insecticides Act 1910. This act was implemented to prevent the manufacture, sale or transportation of pesticides. This implementation of this act was also to regulate traffic there in and any other related purposes as well.

This act is then enacted major revision to Federal Insecticides, Fungicides and Rodenticides Act in 1972 which regulates the sale and use of pesticides. Then it was amended to Federal Drugs, Food and Cosmetic Act which controls the amount of pesticides residues allowed to be present in food. Recently, the act was amended in 2012 by the Pesticide Registration Improvement Extension Act of 2012 where the purpose of PRIA is to ensure a smooth implementation of pesticides rules and regulations to its user.

Pesticides are also subjected to other regulation such as, the Clean Water Act, the Safe Drinking Water Act, the Endangered Species Act, the Resource Conservation and Recovery Act, the Transportation Safety Act, and the Food, Agriculture, Conservation, and Trade Act.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) give the EPA authority to determine which pesticides can be used in the United States, and how they can be used. The Environmental Protection Agency (EPA) is primarily responsible for regulating pesticides in the United States. Their mission is to protect human health and the environment. The EPA Office of Pesticide Programs handles most of the regulatory issues pertaining to pesticides. EPA, federal and states agencies will evaluate new pesticides, proposed the used of the pesticides and other preventive measures regarding the pesticides.

2.5.2 Malaysia

There are several laws and regulations applied in Malaysia which related to the usage of pesticides such as Food Regulation 1985, Pesticides Act 1974, Environmental Quality Act 1974 and Occupational Safety and Health Act 1994. The act that is very close to the matters regarding pesticides is the Pesticides Act 1974. This act regulated for pesticide import permits for research and educational purposes, issue licenses for premises to sell pesticides and to store pesticides for sale, carry out the registration of imported and manufactured pesticides for sale, grant approval for aerial spraying of pesticides and grant approval of pesticide advertisements.

CHAPTER 3

METHODOLOGY

3.1 Study Design

The study design is a cross-sectional study which conducted from 9th January 2016 to 28th February 2016. The relationship between health risk to farmers and exposure or inhalation of pesticides contaminated air in study area is established and understood.

3.2 Study Area

The study area is Tanjung Karang, Kuala Selangor a paddy growing area. The area was chosen based on the following criteria

i. Most of the farmers lived very closely to the paddy field. Based on close observation and interview with the farmers, almost 80% of them does not wear proper personal protective equipment, commonly referred to as "PPE" while spraying pesticides to the paddy growing area.

ii. Farmers are prone to exposure of pesticide through inhalation of pesticide contaminated air during the pesticides spraying activity.

The sampling location is depicted in **Figure 3.1**.

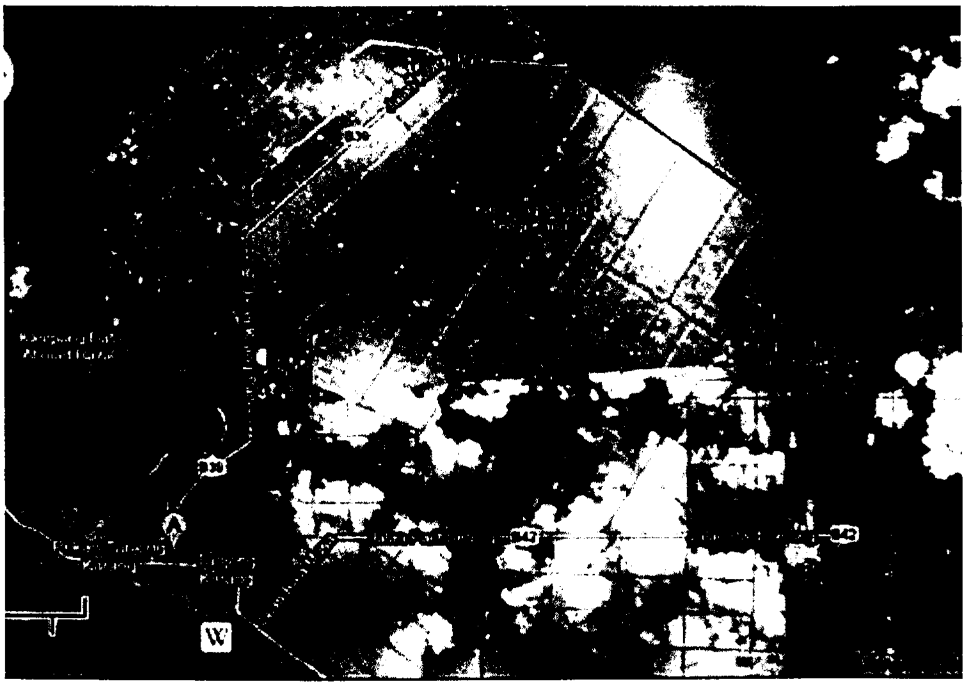

Figure 3.1: Location of the sampling sites at Kampung Sawah Sempadan, Tanjung Karang, Selangor

3.3 Sampling

3.3.1 Study Population

The study population consists of adults' male farmers of Kampung Sawah Sempadan, Kuala Selangor.

Inclusion criteria

The inclusion criterias are:

i. Farmers who work in the paddy field area for more than one year as pesticide sprayer.
ii. The age of respondents is 18 years old to 60 years old.
iii. Farmers who lives in the paddy field.

Exclusion criteria

The exclusion criteria is:

i. Individuals who have chronic disease and HIV/AIDS.

3.3.2 Study Sample

The study sample were chosen based on the inclusion criteria which is farmers who work in the paddy field area for more than one year where they will have chronic exposure to inhalation of pesticides. The age of respondents is 18 to 60. Individual who have chronic disease and HIV/AIDS will be excluded in this study.

3.3.3 Questionnaire

The respondents in this study were given a set of questionnaire to answer. The questionnaire was modified according to two standard questionnaire: (i) Recommended Respiratory Disease Questionnaires for Use with Adults in Epidemiological Research (American Thoracic Society, 1978) and (ii) Vietnam: Pesticide Use Survey (Protection, C., & De, S.I., 2001). This questionnaire comprises of six sections: section A: personal information, Section B: lifestyle, Section C: working background, Section D: information on usage of pesticides, Section E: information on usage of PPE, and Section F: information on health (Refer Appendix: Questionnaire).

3.3.4 Sample Size

In epidemiological studies, recruitment of enough samples for the study is very crucial. The sample size must be adequate so that the results will be precise. The sample size for this study was calculated based on the formula adapted from Social Research Methods (Lemeshaw, 1990). The sample size was determined by using calculation formula as depicted in equation 3.1:

$$N = \frac{\left[Z_{1-\alpha}\sqrt{2\acute{P}(1-\acute{P})} + Z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\right]^2}{(P_1 - P_2)^2} \qquad \text{E.q 3.1}$$

Where,

P_1=0.22

P_2=0.09

$\acute{P} = (P_1 - P_2)/2 = 0.155$

$Z_{1-\alpha}$=1.282

$Z_{1-\beta}$=0.842

The valuc for P_1 is 0.22 based on the study (Müller, Faria, Augusto, & Gastal, 2005). While the value for P_2 is 0.09 based on the study by (McCurdy et al., 1996).

$$N = \frac{\left[1.282\sqrt{2(0.155)(0.845)} + 0.842\sqrt{0.22(0.78) + 0.09(0.91)}\right]^2}{(0.22 - 0.09)^2}$$

= 69

= ± 69 (+ 20%)

Based on the calculation above, the sample size of this study was 69 respondents but increase by 20% for considering non-response and missing data, so the sample size was 83 respondents.

3.4 Selection of Target Pesticides

The target compounds in this study were selected based on the interview of the respondents. The top 3 pesticides were selected as the target compound in this study (**Table 3.1**).

Table 3.1: Common active ingredient used in pesticides for paddy farming, frequency and percentage of usage among farmers (n=83).

Active ingredient of pesticides	Frequency	Percentage (%)
Chlorantraniliprole	44	53.0
Difenoconazole	44	53.0
Propiconazole	38	45.9
Azoxystrobin	34	40.9
Propineb	34	40.9
Pretilachlor	31	37.3
Lamda cyhalothrin	31	37.3
Tebuconazole	29	34.9
Thiamethoxam	23	27.7
fenthion	23	27.7
Fipronil	22	26.5

Active ingredient of pesticides	Frequency	Percentage (%)
Tricyclazole	21	25.3
Thiobencarb	19	22.9
Imidacloprid	17	20.5
Buprofezin	13	15.7
Metamifop	11	13.3
Bispyribac-sodium	11	13.3
2,4-D butyl ester	10	12.0
Delta methrin	8	9.6
Eyhalotop-butyl	7	8.4
Flubendiamide	7	8.4
Propanil	6	7.2
Bensulfuron-methyl	6	7.2
Cartap hydrochloride	6	7.2
Copper (II) sulphate pentahydrate	6	7.2
Fenobucarb	5	6.0
Isoprocarb	5	6.0
Infenuron	3	3.6
Fenoxaprop-ethyl	2	2.4
Bentazone sodium	2	2.4
Paraquat dichloride	2	2.4

3.5 Sampling and Extraction

In this study, the exposure of pesticides contaminated air during spraying activity of farmer were measured by using a personal air monitor equipped with an air pump (GilAir-3, Sensidyne, Clearwater, FL), a solid sorbent tube (SKC Sorbent Tube, XAD-2, 8x110mm size, 2-section, 200/400 mg sorbent, SKC, USA). The solid sorbent tube is dual-layered and contains one larger bed of absorbent (400 mg) followed by a smaller back-up bed (200 mg) to capture any sample breakthrough. The beds contain separators of glass wool to secure the beds in place. XAD-2 resin was used for trapping pesticides in the air. During the personal air sampling, an XAD-2 resin tube were attached in the breathing zone with a clip, and an air pump was fastened on the belt. The air flow rate was 2 L/min. After mixing/loading or spraying, the XAD-2 resin and filter were removed and analysed for pesticides content.

Pesticides trapped on the XAD-2 resin and filter were extracted with 10 mL of acetone, centrifuged with 40x100 rpm for five minutes and the supernatant was decanted in the centrifuge tube After that, the extract had been concentrated via a nitrogen blowdown and reconstituted with 1mL of 3:1, ultrapure water: HPLC methanol. Aliquot (2 μL) of the extract was analysed by using UHPLC MS/MS.

3.6 Instrumental Analysis

The UHPLC-MS/MS method conditions were as follows: Chromatographic separation were performed on a Luna C18 column (2.1mm×50mm I.D., 1.8μ particle size). The mobile phase were a gradient of H_2O with 0.1% formic acid and 5mM ammonium formate and methanol 0.1% formic acid and 5mM ammonium formate with the gradient conditions as in **Table 3.2**. The flow rate will be 0.5 ml min $^{-1}$. The auto sampler and column temperatures will be set at 40°C and a 2.0μl volume injection were used. All pesticides were detected by using electrospray ionization (ESI) in positive mode. The optimised operating conditions were: capillary voltage, 3500 V; gas temperature, 220°C; gas flow, 11L/min and nebulizer was 30 psi. Multiple reaction monitoring mode (MRM) as in **Table 3.3** were used for all analytes.

Table 3.2: Gradient Condition

	Time (minutes)	A%	B%	Flow rate (mL/min)
1	0	94.00	6.00	0.5
2	15.00	2.00	98.00	0.5
3	18.00	2.00	98.00	0.5
4	18.01	94.00	6.00	0.5
5	20.00	94.00	6.00	0.5

Mobile phase A (aqueous): 0.1% formic acid and 5mM ammonium formate in ultrapure water

Mobile phase B (solvent): 0.1% formic acid and 5mM ammonium formate in methanol

Table 3.3: MRM Condition

	Chlorantraniliprole	Difenoconazole	Propiconazole
Parent to product ion (m/z) - Collision energy	- 483.9>285-8V - 483.9>452.9-16V	- 406.1>251-20V - 406.1>337-10V	- 342.1>69.1-16V - 342.1>159.0-32V
Retention time (min)	7.359	9.475	9.032
Fragmentation	380.0V	380.0V	380.0V

3.7 Health Risk Assessment

The health risk assessment is aimed to describe the relationship between effects of inhalation of pesticides and health risk that may exist in a specified population at a particular time.

3.7.1 Hazard Identification And Characterization

For potential non cancer effects, dose response information for each compound will be reviewed. The data for Reference Concentration (RfC) for all the three listed target compounds is currently not available from any sources such as EU (European Union) or USEPA. So, the Health Based Reference Values (HBRV) that were chosen for all the three listed target compounds is Reference Dose (RfD), that was based on chronic inhalation exposure.

3.7.2 Chronic Exposure And Risk Assessment

Inhalation of atmospheric pesticides is an important route for pesticide exposure. Chronic (>1 year) inhalation exposures were assessed for adults. To estimate the inhalation exposure from the atmospheric pesticides, the following equation were used (Coscollà et al., 2014)

DIE (μg/kg/day) = (C x IR inh x ED) / BW Eq.(3.2)

Where DIE is the daily inhalation exposure, C is the total concentration of each pesticide find in the air (ngm^{-3}), IR inh is the inhalation rate per hour (m^3h^{-1}), ED is the exposure duration (h) to air based on questionnaire and BW is body weight of the subject (kg).

IR inh applied was 20 m^3day^{-1} for adults. BW will be 70 kg for adults (USEPA, 1989; USEPA, 2004; USEPA, 1991). The risk assessment will be estimated using the Hazard Quotients (HQ) as a risk descriptor, which were calculated as follows:

HQ = DIEi/HBRVi Eq.(3.3)

Where HBRVi is Health Based reference Values

The HQ level of concern was set as 1.0, thus an HQ > 1 indicated that a potential risk may be present. The cumulative exposure were estimated using a Hazard Index (HI)

$$HI = HQ_1 \text{ (pesticide 1)} + HQ_2 \text{ (pesticide 2)} + HQ_3 \text{ (pesticide 3)} + \text{(and so forth)} \quad \text{Eq. (3.4)}$$

3.8 Data Analysis

The samples were injected into UHPLC MS/MS for determination of pesticides concentration (chlorantraniliprole, definoconazole and propiconazole). The concentrations of pesticides in air samples were used to calculate Daily Inhalation Exposure (DIE). Values DIE were compared to the recommended Reference Dose (Rfd) of pesticides by United State Environmental protection Agency (USEPA, 2008). The recommended RfD of pesticides (chlorantraniliprole, definoconazole and propiconazole) by USEPA (2008) are as in **Table 3.4.**

Table 3.4: Recommended Reference Dose (Rfd) of Pesticides from USEPA

Parameter	RfD (ng/kg/day)
Chlorantraniliprole	$1.58x10^6$
Definoconazole	$1.0x\ 10^4$
Propiconazole	$1.25x10^4$

A normality test was done to determine the type of correlation that will be used. Based on the normality test, Spearman correlation was used to determine the association between the concentration of pesticides in the air samples at Tanjung Karang paddy field and the wind speed. Statistical Package for the Social Sciences (SPSS) version 22 was used to perform the statistical analysis.

3.9 Quality Control

All glassware were went through acid wash before used to ensure they were free of any contaminants based on US EPA method 1694 (2007). All glassware were soaked with 5-10% hydrochloric acid (HCL) overnight followed by washed with Decon 90. Then, the glassware was rinsed immediately, first with methanol, then with hot tap water. After that, it was rinsed with methanol again, followed by acetone, and then dichloromethane. After washing, all glassware were dried at 60°C and capped with solvet rinsed aluminium foil to prevent any accumulation of dust or other contaminants.

Calibration curve was obtained by injecting the external standards of chlorantraniliprole, difenoconazole and propiconazole. For chlorantraniliprole, the point calibration curve lies between 0.5 to 125 ng/ml where the correlation coefficient was 0.995 as shown in **Figure 3.2**. For difenoconazole, the point calibration curve were o.5, 1.0, 5.0 and 125.0 ng/ml and the correlation coefficient was 0.998 as shown in **Figure 3.3**. As for propiconazole, the point calibration curved were 0.5, 1.0, 3.0, 5.0 and 125.0 ng/ml; the correlation coefficient was 0.997, as shown in **Figure 3.4**.

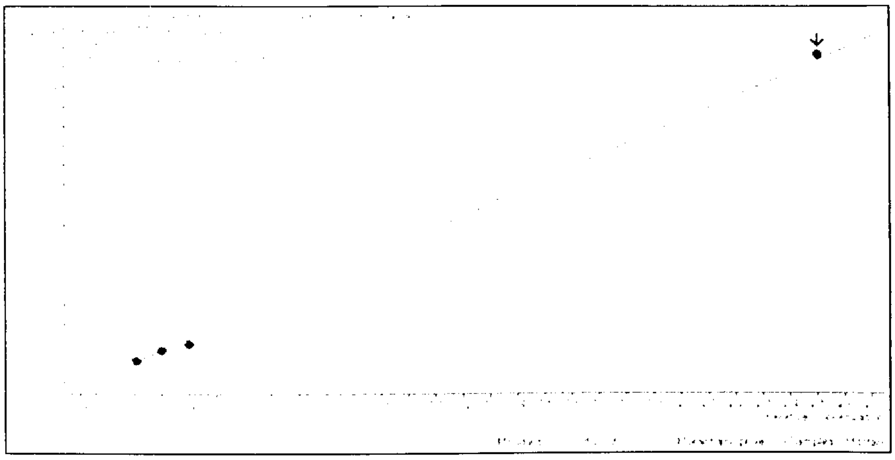

Figure 3.2: Calibration curve of chlorantraniliprole

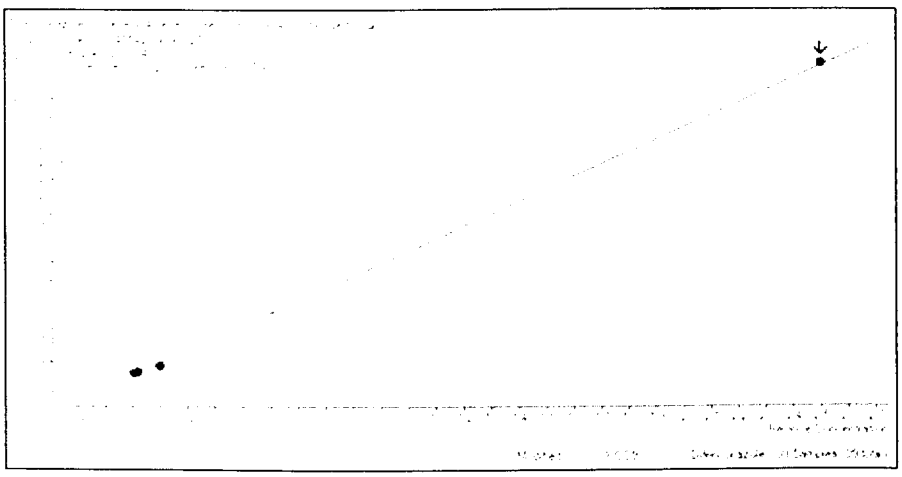

Figure 3.3: Calibration curve of difenoconazole

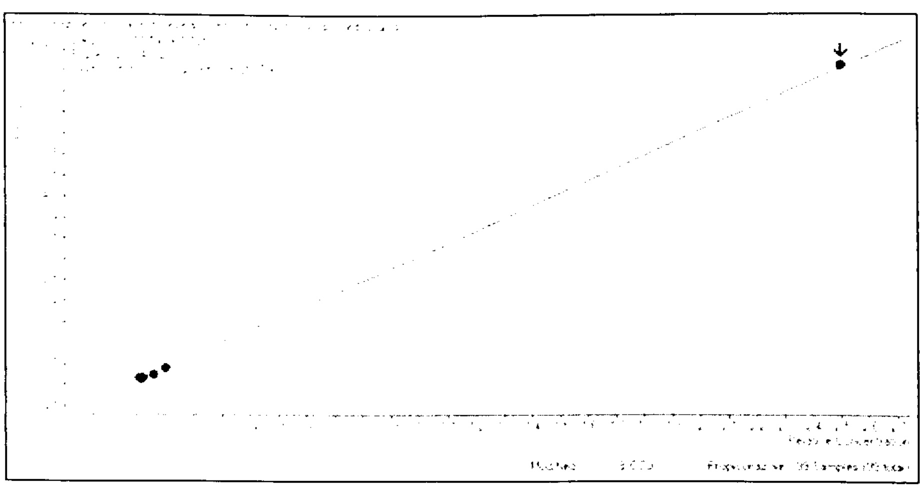

Figure 3.4: Calibration curve of propiconazole

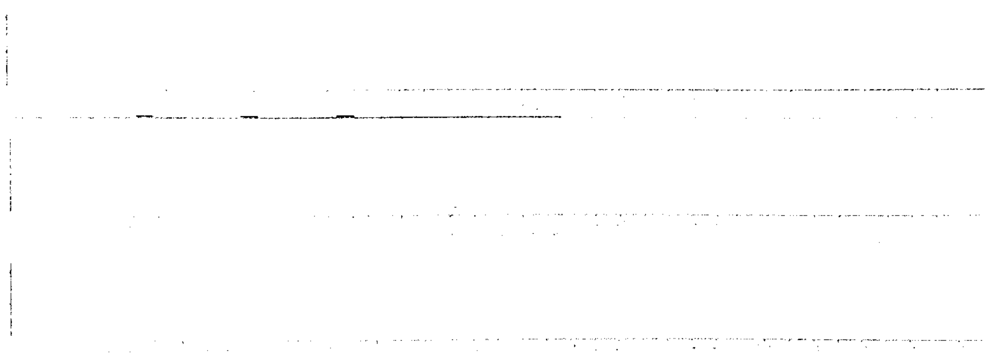

Figure 3.5: Example of MRM chromatogram for chlorantraniliprole, difenoconazole and propiconazole standard at 125 ng/mL

In order to avoid any interference or contamination, a procedural blank (except no sample added, the other experimental procedures were exactly the same as the samples from the extraction until the instrumental analysis) was analysed for every batch of samples. **Figure 3.6** shows the example of chromatogram for procedural blank.

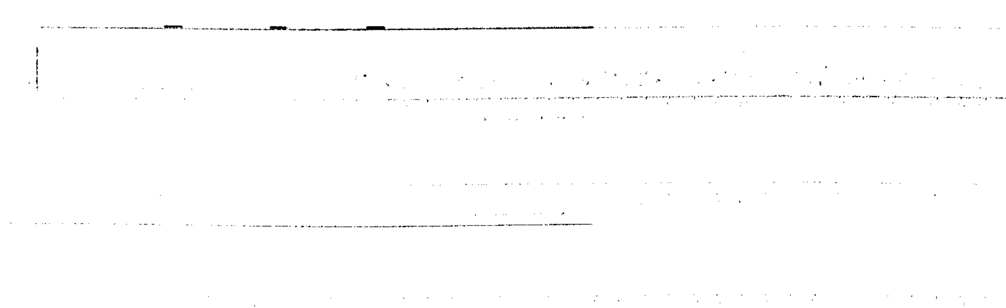

Figure 3.6: Example of MRM chromatogram for procedural blank

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Socio Demographic Background

4.1.1 Socio-Demographic Information of Respondents

The socio-demographic information of respondents was summarized in **Table 4.1**.

Table 4.1: socio-demographic background

Variables	Mean±SD	Minimum	Maximum
Age (years)	44.40±12.53	18	60
Weight (kg)	67.69±12.43	45	120
Height (m)	1.67±0.07	1.53	1.80
BMI (kg/m^2)	25.07±4.04	16.81	39.18
Variables	**Category**	**Frequency**	**Percentage (%)**
Gender	Male	83	100
Race	Malay	83	100
Smoking		56	67.5

Eighty-three paddy farmers participated in this study. All the paddy farmers that participated in this study were male and Malay with mean age of 44.4 and ranged from 18 to 60 years old. The minimum weight of respondent is 45kg, the maximum weight is 120kg and the mean weight of paddy farmers is 67.9kg. The mean height of respondents is 1.67m which ranged from 1.53m to 1.89m. The average Body Mass Index is 25.07 and ranged from 16.81 to 31.18. Based on the questionnaire, 67.5% of the paddy farmers reported that they are smokers.

4.1.2 Exposure of Respondent to Pesticides

The information needed to assess the health risk was obtained by interviewing farmers by using the questionnaire. The information of farmer's exposure to heavy metals was recorded in **Table 4.2**.

Table 4.2: Information of farmer's Exposure to Pesticides

Parameters	Average
Exposure frequency (hours/day)	4
Exposure duration (years)	20.7
Exposure frequency (days/week)	6

The exposure frequency refers to how long paddy farmers was exposed to pesticides in a day while spraying the pesticides to their crops. Exposure duration refers to the number of years the paddy farmer has exposed to the pesticides. Exposure frequency is the number that paddy farmers exposed to pesticides in a week.

4.1.3 Personal Hygiene and Use of Personal Protective Equipment (PPE)

The use of personal protective equipment can reduce the risk of getting expose to the pesticide especially during spraying activity. The information on personal hygiene and use of personal protective equipment among respondents was recorded in **Table 4.3**.

Table 4.3: Personal Hygiene and Use of Personal Protective Equipment (PPE) among Respondents (n=83)

Variables	Frequency	Percentage (%)
Wash up/Shower after spraying	83	100
Change clothes after farming	83	100
Use full PPE (Air Purifying Respirator)	7	8.4

100% of respondent took shower after spraying pesticides to maintain their personal hygiene. 100% respondent change their clothes after spraying pesticides. 76 respondent out of 83 does not wear a proper PPE while spraying pesticides to their crops. Only 8.4% used a proper PPE while spraying pesticides.

4.2 Pesticides Concentration in Personal Air Samples

Among the selected pesticides, chlorantraniliprole has the maximum mean concentration (0.0308 ng/m^3) followed by difenoconazole (0.0086 ng/m^3) and propiconazole (0.0099 ng/m^3). The maximum concentration detected among the selected pesticides is chlorantraniliprole (10.9 ng/m^3). **Figure 4.1** shows an example of MRM chromatogram obtained from one of the personal air samples of the respondent.

The average concentrations of the pesticides assessed in this study were lower as compared to the other studies. (Jaipieam et al., 2009) reported the concentrations of organophosphate pesticides in farm area were in range of 0.022-0.056 mg/m^3. Other study done by (Lozier et al., 2013) shows that 1.41μg/m^3 concentration of altrazine detected from respondent that did not do the spraying activity but approximately 1-30m away from the atrazine applicators at all time.

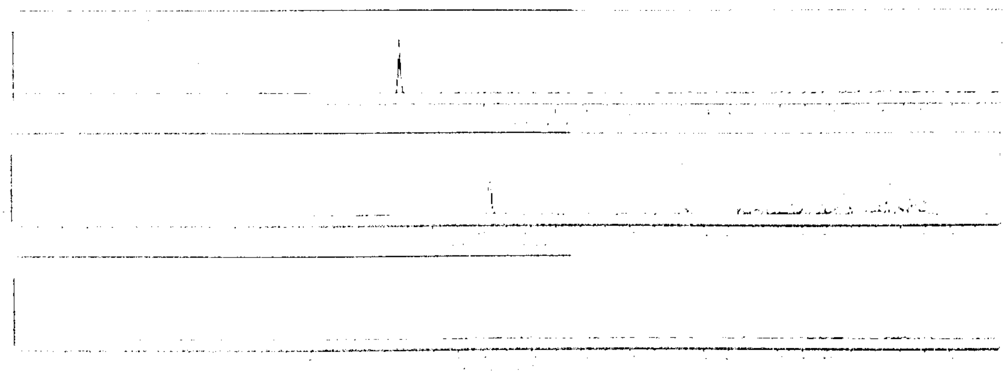

Figure 4.1: Example of MRM chromatogram obtained from one of the personal air samples of the respondent

4.3 Health Risk Assessment

Based on **Table 4.4,** the mean DIE for chlorantraniliprole is 0.49 ng/kg/day which it is the highest mean compare to the other two pesticides where difenoconazole (0.11 ng/kg/day) and propiconazole (0.25 ng/kg/day). The maximum value for chlorantraniliprole is 11.28 ng/kg/day, difenoconazole (4.86 ng/kg/day) and propiconazole (5.15 ng/kg/day). The DIE value for all samples were less that the recommended value by USEPA which is chlorantraniliprole ($1.58x10^{6}$.), difenoconazole ($1.0x10^{4}$) and propiconazole ($1.25x10^{4}$) (US EPA, 2008)

Among all the three selected pesticides, none of the hazard quotient (HQ) more than 1. The mean HQ reported for chlorantraniliprole was $3.20x10^{-7}$, for difenoconazole was $1.12x10^{-5}$ and for propiconazole was $3.16x10^{-5}$. The maximum HQ values for chlorantraniliprole, difenoconazole and propiconazole were $7.00x10^{-6}$, $4.86x10^{-4}$, and $4.13x10^{-4}$ respectively. From **Table 4.4**, it was clearly shown that the HQ is less than 1 which indicate that there was no significant health risk due to inhalation in pesticides spraying activity.

The hazard index for all the three compound is 3.16×10^{-5} which indicate that there is low risk of getting chronic health effect related to pesticides through inhalation. The maximum hazard index reported in **Table 4.4** was 6.26×10^{-4} which was still less than 1.

Table 4.4: Summary of Concentration of Pesticides, Daily Inhalation Exposure, Hazard Quotient and Hazard Index.

	Concentration (ng/m^3)			Daily Inhalation Exposure (DIE) (ng/kg/day)			Hazard Quotient (HQ)			Hazard Index (HI)
	C	D	P	C	D	P	C	D	P	
Mean	3.08×10^{-2}	8.60×10^{-3}	9.90×10^{-3}	0.49	0.11	0.25	3.20×10^{-7}	1.12×10^{-5}	2.01×10^{-5}	3.16×10^{-5}
Minimum	ND	ND	ND	NA	NA	NA	NA	NA	NA	NA
Maximum	1.09×10^{1}	4.86×10^{-1}	1.73×10^{-1}	11.28	4.86	5.15	7.00×10^{-6}	4.86×10^{-4}	4.13×10^{-4}	6.26×10^{-4}

C- Chlorantraniliprole

D- Difenoconazole

P- Propiconazole

NA- Not Applicable

ND-Not Detected

4.4 Statistical Analysis

The normality test was done on the data with the value of less than 0.05. thus, the spearman correlation was run to study the relationship between the three selected pesticides in air samples and the wind speed reading during sampling. Result recorded in **Table 4.5** shows the relationship between wind speed and Chlrorantraniliprole is 0.132 with r =-0.167; difenoconazole is 0.322 with r -0.110; propiconazole is 0.83 with r =-0.192. The relationship between the three selected pesticides in air samples and the temperature reading during sampling is not significant where the p value for all compound is more than 0.05. There is very weak relationship between the concentration of pesticide and wind speed where value r ranged from 00.110 to -0.192. Up until now, there is no study reported in the relationship between pesticides in personal air samples and the wind speed reading during sampling.

Table 4.5: The relationship between the three selected pesticides in personal air samples and the wind speed (ms^{-1}) reading during sampling

	r	p-value
Chlorantraniliprole	-0.167	<0.05
Difenoconazole	-0.110	<0.05
Propiconazole	-0.192	<0.05

The Spearman Correlation was also run to study the relationship between the three selected pesticides in air samples and the temperature reading during sampling. Result recorded in **Table 4.6** shows the relationship between temperature and Chlrorantraniliprole is 0.240 with r 0.130; difenoconazole is 0.901 with r -0.014; propiconazole is 0.486 with r -0.078. The relationship between the three selected pesticides in air samples and the temperature reading during sampling is not significant where the p value for all compound is more than 0.05. There is very weak relationship between the concentration of pesticide and wind speed where value r ranged from -0.078 to 0.130. Up to date, there is no study reported on the relationship between pesticides in personal air samples and the temperature during sampling.

Table 4.6: The relationship between the three selected pesticides in personal air samples and the temperature (°C) reading during sampling

	r	**p-value**
Chlorantraniliprole	0.130	<0.05
Difenoconazole	-0.014	<0.05
Propiconazole	-0.078	<0.05

4.5 Conclusion

The present study showed the selected pesticides used by paddy farmers at Kampung Sawah Sempadan present is in lower concentration and did not exceed the recommended concentration by USEPA.

The mean concentration of chlorantraniliprole is 0.0308 ng/m^3 with the maximum concentration of 1.09x10^1. Mean Concentration of difenoconazole is 0.0086 ng/m^3 with the maximum concentration of 4.86x10^{-1}. The mean concentration of propiconazole 0.0099ng/m^3 with the maximum concentration of 1.73x10^{-1}.

The HQ calculated for all selected pesticides were below than 1 thus indicate that risk of non-carcinogenic through inhalation exposure to pesticides in paddy field among farmers were negligible. The HI calculated were below than 1 hence indicate that the cumulative hazard quotient is still negligible.

4.6 Recommendation

In order to improve for the future research, there is a need to develop HBRV for inhalation especially for pesticides which currently lacking in EPA and other databases.

Future researcher need to consider the overall inhalation hours because, almost all farmers stay in the paddy field. Thus, they might have risk of inhaling pesticides even when they are not spraying.

Future researcher should also include all types of pesticides that farmers used to know the exact exposure of pesticides to the farmers.

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APPENDIX

Concentration of Pesticides

RESPONDENT ID	CONCENTRATION (ng/m^3)		
	Chlorantraniliprole	Difenoconazole	Propiconazole
01	ND	ND	ND
02	ND	ND	ND
03	ND	ND	ND
04	1.09602	ND	ND
05	ND	ND	ND
06	ND	ND	ND
07	.00413	.00419	.02894
08	ND	ND	.01285
09	ND	ND	.04631
10	ND	ND	.02333
11	ND	ND	.00991
12	ND	ND	.01231
13	ND	.48666	.17382
14	ND	.05474	.13454
15	ND	ND	ND
16	.00510	ND	.01341
17	ND	ND	.01689
18	ND	ND	ND
19	ND	.00064	.00819
20	ND	ND	.01046
21	ND	ND	ND
22	ND	ND	ND
23	ND	ND	ND
24	ND	ND	ND
25	ND	ND	ND
26	ND	.00266	ND
27	ND	ND	.00556
28	ND	.00189	.02735
29	ND	ND	.13973
30	ND	ND	ND
31	ND	ND	ND
32	ND	ND	ND
33	ND	.01015	.01610
34	ND	ND	ND
35	ND	.00142	ND
36	ND	ND	.06430
37	ND	ND	ND
38	ND	ND	ND
39	ND	ND	ND
40	ND	ND	ND
41	ND	ND	ND

ND- Not Detected

Respondent ID	Concentration (ng/m^3)		
	Chlorantraniliprole	Difenoconazole	Propiconazole
42	ND	ND	ND
43	ND	ND	ND
44	ND	ND	ND
45	ND	ND	ND
46	ND	ND	ND
47	ND	ND	ND
48	ND	ND	ND
49	ND	ND	ND
50	ND	ND	ND
51	ND	ND	ND
52	.23179	ND	ND
53	ND	ND	ND
54	ND	.05692	ND
55	ND	ND	ND
56	ND	ND	ND
57	ND	ND	ND
58	ND	ND	ND
59	ND	.00592	ND
60	ND	ND	ND
61	.04608	.00483	ND
62	.15383	.06146	ND
63	ND	ND	ND
64	ND	.00056	.02490
65	ND	ND	ND
66	ND	ND	ND
67	.01250	ND	ND
68	ND	ND	ND
69	ND	ND	ND
70	ND	ND	ND
71	ND	ND	ND
72	ND	ND	ND
73	ND	ND	ND
74	ND	ND	ND
75	.43376	ND	ND
76	.23519	.02161	ND
77	.09177	.00402	.05364
78	ND	ND	ND
79	ND	ND	ND
80	ND	ND	ND
81	ND	ND	ND
82	.24258	ND	ND
83	ND	ND	ND

ND- Not detected

Information on Daily Inhalation Exposure (DIE), Hazard Quotient (HQ) and Hazard Index (HI)

Respondent	Daily Inhalation Exposure (DIE)			Hazard Quotient (HQ)			Hazard Index
ID	Chlorantraniliprole	Difenoconazole	Propiconazole	Chlorantraniliprole	Difenoconazole	Propiconazole	(HI)
01	NA	NA	NA	NA	NA	NA	NA
02	NA	NA	NA	NA	NA	NA	NA
03	NA	NA	NA	NA	NA	NA	NA
04	11.2825	NA	NA	.000007	NA	NA	.000007
05	NA	NA	NA	NA	NA	NA	NA
06	NA	NA	NA	NA	NA	NA	NA
07	.1238	.1258	.8681	NA	.000013	.000069	.000082
08	NA	NA	.6765	NA	NA	.000054	.000054
09	NA	NA	1.5157	NA	NA	.000121	.000121
10	NA	NA	.9332	NA	NA	.000075	.000075
11	NA	NA	.3660	NA	NA	.000029	.000029
12	NA	NA	.3741	NA	NA	.000030	.000030
13	NA	4.8666	1.7382	NA	.000487	.000139	.000626
14	NA	.8212	2.0180	NA	.000082	.000161	.000244
15	NA	NA	NA	NA	NA	NA	NA
16	.1801	NA	.4734	NA	NA	.000038	.000038
17	NA	NA	.7797	NA	NA	.000062	.000062
18	NA	NA	NA	NA	NA	NA	NA
19	NA	.0266	.3389	NA	.000003	.000027	.000030
20	NA	NA	.1569	NA	NA	.000013	.000013
21	NA	NA	NA	NA	NA	NA	NA
22	NA	NA	NA	NA	NA	NA	NA
23	NA	NA	NA	NA	NA	NA	NA

NA- Not Applicable

Respondent ID	Daily Inhalation Exposure (DIE)			Hazard Quotient (HQ)			Hazard Index (HI)
	Chlorantraniliprole	Difenoconazole	Propiconazole	Chlorantraniliprole	Difenoconazole	Propiconazole	
24	NA	NA	NA	NA	NA	NA	NA
25	NA	NA	NA	NA	NA	NA	NA
26	NA	.1598	NA	NA	.000016	NA	.000016
27	NA	NA	.4170	NA	NA	.000033	.000033
28	NA	.0755	1.0939	NA	.000008	.000088	.000095
29	NA	NA	5.1592	NA	NA	.000413	.000413
30	NA	NA	NA	NA	NA	NA	NA
31	NA	NA	NA	NA	NA	NA	NA
32	NA	NA	NA	NA	NA	NA	NA
33	NA	.5454	.8649	NA	.000055	.000069	.000124
34	NA	NA	NA	NA	NA	NA	NA
35	NA	.0675	NA	NA	.000007	NA	.000007
36	NA	NA	.5144	NA	NA	.000041	.000041
37	NA	NA	NA	NA	NA	NA	NA
38	NA	NA	NA	NA	NA	NA	NA
39	NA	NA	NA	NA	NA	NA	NA
40	NA	NA	NA	NA	NA	NA	NA
41	NA	NA	NA	NA	NA	NA	NA
42	NA	NA	NA	NA	NA	NA	NA
43	NA	NA	NA	NA	NA	NA	NA
44	NA	NA	NA	NA	NA	NA	NA
45	NA	NA	NA	NA	NA	NA	NA
46	NA	NA	NA	NA	NA	NA	NA
47	NA	NA	NA	NA	NA	NA	NA

NA- Not Applicable

Respondent ID	Daily Inhalation Exposure (DIE) Chlorantraniliprole	Difenoconazole	Propiconazole	Hazard Quotient (HQ) Chlorantraniliprole	Difenoconazole	Propiconazole	Hazard Index (HI)
48	NA	NA	NA	NA	NA	NA	NA
49	NA	NA	NA	NA	NA	NA	NA
50	NA	NA	NA	NA	NA	NA	NA
51	NA	NA	NA	NA	NA	NA	NA
52	7.9471	NA	NA	.000005	NA	NA	.000005
53	NA	NA	NA	NA	NA	NA	NA
54	NA	.7319	NA	NA	.000073	NA	.000073
55	NA	NA	NA	NA	NA	NA	NA
56	NA	NA	NA	NA	NA	NA	NA
57	NA	NA	NA	NA	NA	NA	NA
58	NA	NA	NA	NA	NA	NA	NA
59	NA	.0911	NA	NA	.000009	NA	.000009
60	NA	NA	NA	NA	NA	NA	NA
61	2.0478	.2147	NA	.000001	.000021	NA	.000023
62	1.9228	.7683	NA	.000001	.000077	NA	.000078
63	NA	NA	NA	NA	NA	NA	NA
64	NA	.0100	.4459	NA	.000001	.000036	.000037
65	NA	NA	NA	NA	NA	NA	NA
66	NA	NA	NA	NA	NA	NA	NA
67	.3948	NA	NA	NA	NA	NA	NA
68	NA	NA	NA	NA	NA	NA	NA
69	NA	NA	NA	NA	NA	NA	NA
70	NA	NA	NA	NA	NA	NA	NA
71	NA	NA	NA	NA	NA	NA	NA
72	NA	NA	NA	NA	NA	NA	NA

NA- Not Applicable

Respondent	Daily Inhalation Exposure			Hazard Quotient (HQ)			Hazard Index
ID	Chlorantraniliprole	Difenoconazole	Propiconazole	Chlorantraniliprole	Difenoconazole	propiconazole	(HI)
73	NA	NA	NA	NA	NA	NA	NA
74	NA	NA	NA	NA	NA	NA	NA
75	3.4701	NA	NA	.000002	NA	NA	.000002
76	6.8837	.6325	NA	.000004	.000063	NA	.000068
77	3.6706	.1608	2.1456	.000002	.000016	.000172	.000190
78	NA	NA	NA	NA	NA	NA	NA
79	NA	NA	NA	NA	NA	NA	NA
80	NA	NA	NA	NA	NA	NA	NA
81	NA	NA	NA	NA	NA	NA	NA
82	3.4247	NA	NA	.000002	NA	NA	.000002
83	NA	NA	NA	NA	NA	NA	NA

NA- Not Applicable

ID Responden:

Tarikh :

UNIVERSITI PUTRA MALAYSIA

JABATAN KESIHATAN PERSEKITARAN DAN PEKERJAAN

FAKULTI PERUBATAN DAN SAINS KESIHATAN

UNIVERSITI PUTRA MALAYSIA

KAJI SELIDIK KESAN PENDEDAHAN KEPADA UDARA YANG DICEMARI DENGAN RACUN PEROSAK KEPADA KESIHATAN DI KALANGAN PESAWAH PADI DI KAWASAN SAWAH PADI TANJUNG KARANG, KUALA SELANGOR, SELANGOR

Borang soal selidik ini mengandungi **Enam (6)** bahagian iaitu:

Bahagian A : Maklumat Diri
Bahagian B : Gaya Hidup
Bahagian C : Latar Belakang Pekerjaan
Bahagian D : Maklumat Penggunaan Racun Serangga di Tempat Kerja
Bahagian E : Maklumat Penggunaan Kelengkapan Pelindung Diri
Bahagian F : Maklumat Kesihatan

KAJI SELIDIK KESAN PENDEDAHAN KEPADA UDARA YANG DICEMARI DENGAN RACUN PEROSAK KEPADA KESIHATAN DI KALANGAN PESAWAH PADI DI KAWASAN SAWAH PADI TANJUNG KARANG, KUALA SELANGOR, SELANGOR

KEGUNAAN PENYELIDIK

BAHAGIAN A : MAKLUMAT DIRI

1. Umur : .... tahun
2. Jantina : ☐ Lelaki ☐ Perempuan
3. Bangsa : ☐ Melayu ☐ Cina ☐ India
   ☐ Lain-lain (Sila nyatakan) : ....
4. Status : ☐ Bujang ☐ Berkahwin ☐ Duda/Janda
5. Bilangan anak : .... orang anak
6. Berat : .... kg
7. Tinggi : .... cm
8. Jisim Berat Badan : .... kg/m^2

SULIT

KAJI SELIDIK KESAN PENDEDAHAN KEPADA UDARA YANG DICEMARI DENGAN RACUN PEROSAK KEPADA KESIHATAN DI KALANGAN PESAWAH PADI DI KAWASAN SAWAH PADI TANJUNG KARANG, KUALA SELANGOR, SELANGOR

KEGUNAAN PENYELIDIK

BAHAGIAN B : GAYA HIDUP

9. Adakah anda merokok?

☐ Ya ☐ Tidak

10. Pada umur berapakah anda mula merokok? Jika anda telah berhenti merokok, isi pada umur berapakah anda berhenti merokok di tempat yang disediakan.

Mula : ☐☐ tahun ; Berhenti : ☐☐ tahun

11. Berapa batang rokok anda hisap dalam sehari?

☐☐ batang

12. Adakah terdapat perokok lain di dalam rumah anda?

☐ Ya ☐ Tidak

13. Apakah hobi anda pada waktu lapang?

☐ Berkebun ☐ Bertukang ☐ Bersukan

☐ Lain-lain (Sila nyatakan) : ....

14. Adakah anda mandi sebelum ke tempat kerja?

☐ Ya ☐ Tidak

15. Adakah anda mandi selepas pulang dari tempat kerja?

☐ Ya ☐ Tidak

16. Adakah anda menukar pakaian kerja anda setiap hari?

☐ Ya ☐ Tidak

KEGUNAAN PENYELIDIK

BAHAGIAN C : LATAR BELAKANG PEKERJAAN

17. Pernahkah anda bekerja selain daripada pesawah padi sebelum ini?

☐ Ya ☐ Tidak

Jika "Ya", sila jawab soalan no. 18; Jika "Tidak", sila terus menjawab soalan no. 21

18. Pernahkah anda bekerja selama sepenuh masa (30 jam/seminggu atau lebih) untuk jangka masa 6 bulan atau lebih?

☐ Ya ☐ Tidak

Jika "Ya", sila jawab soalan no. 19-20; Jika "Tidak", sila terus menjawab soalan no. 21

19. Pernahkah anda bekerja dalam kawasan yang berdebu? Jika ya, sila nyatakan spesifikasi kerja dan berapa tahun.

☐ Ya (Sila nyatakan) : ....

☐ Tidak

20. Pernahkah anda bekerja dalam persekitaran yang terdedah kepada gas berbahaya atau asap bahan kimia? Jika ya, sila nyatakan spesifikasi kerja dan tahun.

☐ Ya (Sila nyatakan) : ....

☐ Tidak

21. Jawatan pekerjaan sekarang : ....

22. Bilangan tahun anda bekerja di tempat sekarang : .... tahun

23. Jumlah hari bekerja dalam seminggu : .... hari seminggu

24. Jumlah masa bekerja dalam sehari : .... jam sehari

25. Adakah anda merokok di kawasan sawah padi?

☐ Ya ☐ Tidak

BAHAGIAN D : MAKLUMAT PENGGUNAAN RACUN SERANGGA DI TEMPAT KERJA

26. Apakah jenis racun makhluk perosak tanaman yang digunakan di tempat kerja anda sekarang?

☐ a. Racun Serangga
☐ b. Racun Kulat
☐ c. Racun Siput
☐ d. Racun Cacing
☐ e. Racun Rumpai
☐ f. Racun Tikus
☐ g. Racun Anai-anai
☐ h. Lain-lain (nyatakan) ....

27. Apakah jenis aktiviti yang anda lakukan di tempat kerja?

☐ a. Membancuh racun
☐ b. Meracun
☐ c. Membaja
☐ d. Membajak
☐ e. Menuai

28. Nyatakan tempoh masa anda menggunakan racun makhluk perosak tanaman tersebut:

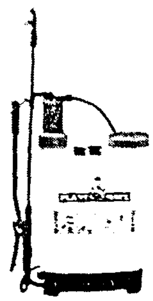
☐☐ minit

29. Pada bulan berapakah aktiviti penyemburan racun perosak dilakukan?

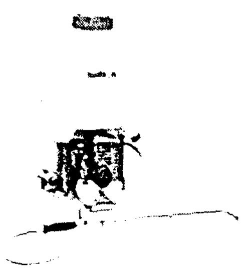
Jan	Feb	Mar	Apr	Mei	Jun	Jul	Ogos	Sep	Oct	Nov	Dec

☐ Tidak berkaitan

30. Apakah jenis penyembur racun yang anda gunakan?



☐ a. Penyembur racun manual



☐ b. Penyembur racun bermotor

☐ c. Penyembur racun bertekanan

31. Nyatakan kekerapan anda menggunakan racun makhluk perosak tanaman dalam sehari:

Pagi	0 – 1 jam	
	2 – 3 jam	
	3 – 4 jam	
	4 jam ke atas	
Petang	0 – 1 jam	
	2 – 3 jam	
	3 – 4 jam	
	4 jam ke atas	
Sepanjang masa bekerja		

32. Apakah formulasi racun serangga yang kerap anda gunakan?

- [ ] a. Cecair
- [ ] b. Pepejal
- [ ] c. Butiran
- [ ] d. Serbuk
- [ ] e. Aerosol, asap atau kabus

33. Adakah anda mandi di tempat kerja selepas menggunakan racun serangga?

- [ ] Ya
- [ ] Tidak

BAHAGIAN E : MAKLUMAT PENGGUNAAN KELENGKAPAN PELINDUNG DIRI

34. Adakah majikan anda membekalkan kelengkapan pelindung diri kepada anda?

- [ ] Ya
- [ ] Tidak

35. Adakah penggunaan kelengkapan pelindung diri wajib digunakan semasa anda bekerja?

- [ ] Ya
- [ ] Tidak

36. Adakah anda menggunakan sebarang kelengkapan pelindung diri semasa bekerja?

- [ ] Ya
- [ ] Tidak

Jika "Ya", sila jawab soalan no. 37; Jika "Tidak", sila terus menjawab soalan no. 38

37. Apakah jenis kelengkapan pelindung diri yang anda gunakan semasa bekerja?

- [ ] a. But/Kasut keselamatan
- [ ] b. Apron
- [ ] c. Baju kalis air
- [ ] d. Alat pernafasan
- [ ] e. Lain-lain (nyatakan) : ....
- [ ] f. Sarung tangan
- [ ] g. Cermin mata
- [ ] h. Topeng
- [ ] i. Penutup kepala

38. Apakah alasan anda jika tidak menggunakan kelengkapan pelindung diri semasa bekerja?

☐ a. Tidak selesa
☐ b. Tidak dibekalkan
☐ c. Tidak pasti cara penggunaannya
☐ d. Tidak pasti kebaikan penggunaannya

39. Kekerapan anda menukar kelengkapan pelindung diri kepada yang baru :

a. Setiap hari	
b. Seminggu sekali	
c. Dua minggu sekali	
d. Sebulan sekali	
e. Lain-lain (sila nyatakan)	

BAHAGIAN F : MAKLUMAT KESIHATAN

40. Pernahkah anda mengalami masalah kesihatan berikut (sila tanda \ di tempat yang berkaitan).

Simptom	Setiap hari	Beberapa kali seminggu	Seminggu sekali	Jarang (sebulan sekali atau kurang)	Tidak berkaitan
Kesukaran bernafas					
Sakit/sesak dada					
Batuk					
Kahak					
Berdehit					

KEGUNAAN PENYELIDIK

41. Pada bulan berapakah anda lebih kerap mengalami simptom-simptom di atas?

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Jan	Feb	Mar	Apr	Mei	Jun	Jul	Ogos	Sep	Oct	Nov	Dec

☐ Tidak berkaitan

42. Pernahkah anda berjumpa doktor perubatan disebabkan oleh simptom yang disenaraikan di atas?

☐ Ya ☐ Tidak

Sejarah penyakit / masalah pernafasan

43. Adakah anda pernah menghidapi penyakit asma?

☐ Ya ☐ Tidak

Jika "Ya", sila jawab soalan no. 44 dan 45; Jika "Tidak", sila terus menjawab soalan no. 46

44. Pada umur berapakah anda mula menghidapi penyakit asma?

☐☐ tahun

45. Adakah anda masih menghidapi penyakit asma? Jika tidak, sila nyatakan pada umur berapakah anda tidak lagi menghidapi penyakit asma.

☐ Ya ☐ Tidak (sila nyatakan) : …… tahun

46. Adakah anda menghadapi penyakit / masalah pernafasan yang serius dan telah di sahkan oleh doktor perubatan? (contoh : radang paru-paru; kanser paru-paru/hati)

☐ Ya (Sila nyatakan) : ....

☐ Tidak

KEGUNAAN PENYELIDIK

47. Jika "Ya" pada soalan 46, pada umur berapakah anda mula menghadapi penyakit / masalah pernafasan tersebut?

☐☐ tahun

48. Adakah anda pernah mengalami kecederaan paru-paru atau menjalani pembedahan paru-paru sebelum ini?

☐ Ya (Sila nyatakan) : ....

☐ Tidak

49. Jika "Ya" pada soalan 48, pada umur berapakah anda mengalami kecederaan paru-paru atau menjalani pembedahan paru-paru ini?

☐☐ tahun

Sejarah keluarga

50. Adakah kedua ibu bapa kandung atau sama ada ibu kandung atau bapa kandung anda menghidapi penyakit / masalah kesihatan yang serius dan telah di sahkan oleh doktor perubatan? (contoh : asma; radang paru-paru; kanser paru-paru/hati) ?

Bapa Kandung

☐ Ya (Sila nyatakan) : ....

☐ Tidak

Ibu Kandung

☐ Ya (Sila nyatakan) : ....

☐ Tidak

51. Jika kedua ibu bapa kandung atau sama ada ibu kandung atau bapa kandung anda telah meninggal dunia, apakah punca kematian mereka?

Bapa Kandung; (Sila nyatakan) : ....

Ibu Kandung; (Sila nyatakan) : ....

~ Borang soal selidik tamat ~

Terima kasih atas kerjasama yang telah anda berikan.
Sekian.