



**UNIVERSITI PUTRA MALAYSIA**

***COMPARISON OF THE EFFECTS OF SYNTHETIC PESTICIDE USE  
ON LIVER AND KIDNEY FUNCTION AMONG VEGETABLE FARMERS  
FROM CAMERON HIGHLAND***

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**UNIVERSITI PUTRA MALAYSIA**

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FROM CAMERON HIGHLAND**



**BY  
FARAH IZZATI BINTI FAKRULLAH**

**This thesis submitted in fulfilment of the requirement for the degree of Bachelor of  
Science in Environmental and Occupational Health with Honours from the  
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## ABSTRACT

### COMPARISON OF THE EFFECTS OF SYNTHETIC PESTICIDE USE ON LIVER AND KIDNEY FUNCTION AMONG VEGETABLE FARMERS FROM CAMERON HIGHLAND

FARAH IZZATI BINTI FAKRUULLAH

**Introduction:** Cameron Highlands, located in Pahang, Malaysia, has a tropical climate which is ideal for cultivating a wide variety of vegetables and fruits. However, concerns arise when pesticides are widely used by farmers to ensure high agricultural yields in response to market demand. Pesticides can pose a threat to human health through either acute and chronic health effects such as liver and kidney damage. Some pesticides are highly toxic, even in small amounts. **Objectives:** To compare the effects of synthetic pesticide use on liver and kidney function among vegetable farmers from Cameron Highland. **Methodology:** A comparative cross-sectional study was conducted among 47 conventional vegetable farmers and 15 organic vegetable farmers from Bertam, Tringkap, Tanah Rata and Brinchang of Cameron Highland. The respondents were chosen based on the inclusion and exclusion criteria, such as being a farmer in Cameron Highland with at least 12 months of experience and being between the ages of 18 and 60. A face-to-face interview using a validated questionnaire was conducted to examine respondents' socio-demographical and occupational backgrounds, followed by venipuncture blood collection to perform liver and kidney function tests. The Statistical Package for Social Sciences Software (SPSS) Version 29 was used to analyze all of the data collected. **Results and Discussion:** Spearman correlation was done to associate pesticide-induced changes in cholinesterase activity, kidney function and liver function among organic and conventional vegetable farmers. The correlation between cholinesterase level and liver function indicator (AST and ALT) from organic farmers was negative and poor,  $r(45) = -0.161$ ,  $p > 0.05$  for AST and negative and poor,  $r(45) = -0.218$ ,  $p > 0.05$  for ALT. The correlation between cholinesterase level and kidney function indicator (creatinine and urea) from organic farmers was negative and poor,  $r(45) = -0.046$ ,  $p > 0.05$  for creatinine and negative and poor,  $r(45) = -0.243$ ,  $p > 0.05$  for urea. There were negative associations between cholinesterase activity, kidney function, and liver function among all vegetable farmers. **Conclusion:** There were adverse correlations observed among all vegetable farmers between cholinesterase activity, kidney function, and liver function. given the potential health risks, regular health check-ups for farmers could be recommended. Early detection of any adverse health effects related to pesticide exposure can facilitate timely intervention and treatment.

**Keywords:** Pesticide, Cholinesterase, Farmers, kidney function, Liver function

## ABSTRAK

### PENYELIDIKAN PERBANDINGAN KESAN PENGGUNAAN PESETISID SINTETIK KE ATAS FUNGSI HATI DAN BUAH PINGGANG DALAM KALANGAN PENANAM SAYUR-SAYURAN DI CAMERON HIGHLAND

FARAH IZZATI BINTI FAKRUULLAH

**Pendahuluan:** Cameron Highlands, terletak di Pahang, Malaysia, mempunyai iklim tropika yang sesuai untuk penanaman pelbagai jenis sayur-sayuran dan buah-buahan. Walau bagaimanapun, kebimbangan timbul apabila racun serangga digunakan secara meluas oleh petani untuk memastikan hasil pertanian yang tinggi sebagai respons kepada permintaan pasaran. Pesetisid boleh mengancam kesihatan manusia melalui kesan kesihatan yang biasa dan kronik seperti kerosakan hati dan buah pinggang. **Objektif:** Untuk membandingkan kesan penggunaan racun serangga sintetik terhadap fungsi hati dan buah pinggang di kalangan petani sayur-sayuran dari Cameron Highlands. **Metodologi:** Satu kajian keratan rentas perbandingan telah dijalankan di kalangan 47 petani sayur konvensional dan 15 petani sayur organik dari Bertam, Tringkap, Tanah Rata, dan Brinchang di Cameron Highlands. Responden dipilih berdasarkan kriteria inklusi dan eksklusi, seperti menjadi petani di Cameron Highlands dengan pengalaman sekurang-kurangnya 12 bulan dan berusia antara 18 dan 60 tahun. Temu bual muka menggunakan soal selidik yang telah disahkan dilakukan untuk mengkaji latar belakang sosiodemografi dan pekerjaan responden, diikuti dengan pengumpulan darah melalui venipunktur untuk menjalankan ujian fungsi hati dan buah pinggang. Perisian Statistical Package for Social Sciences (SPSS) Versi 29 digunakan untuk menganalisis semua data yang dikumpul. **Hasil dan Perbincangan:** Korelasi Spearman telah dilakukan untuk mengaitkan perubahan yang disebabkan oleh racun serangga dalam aktiviti kolinesterase, fungsi buah pinggang, dan fungsi hati di kalangan petani sayur organik dan konvensional. Korelasi antara tahap kolinesterase dan penunjuk fungsi hati (AST dan ALT) dari petani organik adalah negatif dan lemah,  $r(45) = -0.161$ ,  $p > 0.05$  untuk AST dan negatif dan lemah,  $r(45) = -0.218$ ,  $p > 0.05$  untuk ALT. Korelasi antara tahap kolinesterase dan penunjuk fungsi buah pinggang (kreatinin dan urea) dari petani organik adalah negatif dan lemah,  $r(45) = -0.046$ ,  $p > 0.05$  untuk kreatinin dan negatif dan lemah,  $r(45) = -0.243$ ,  $p > 0.05$  untuk urea. Terdapat hubungan negatif antara aktiviti kolinesterase, fungsi buah pinggang, dan fungsi hati di kalangan semua petani sayur. **Kesimpulan:** Terdapat korelasi yang tidak baik diperhatikan dalam kalangan semua petani sayur antara aktiviti kolinesterase, fungsi buah pinggang, dan fungsi hati. Mengingat risiko kesihatan yang mungkin, pemeriksaan kesihatan berkala bagi petani boleh dicadangkan. Pengesanan awal terhadap sebarang kesan kesihatan yang tidak baik berkaitan dengan pendedahan racun serangga dapat memudahkan intervensi dan rawatan tepat pada waktunya.

**Kata Kunci:** Racun Perosak, Kolinesterase, Petani, Fungsi Buah Pinggang, Fungsi Hati

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## LIST OF ABBREVIATIONS

<	Less than
>	More than
=	Equal to
%	Percent
P	Significant value
r	Correlation
SD	Standard deviation
et. al.	And others
ChE	Cholinesterase
AST	Aspartate transaminase
ALT	Alanine transaminase
WHO	World Health Organization
PPE	Personal protective equipment
AChE	Acetylcholinesterase

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

Cameron Highlands located in Pahang, Malaysia has a tropical climate with an average temperature of 19.4 °C. This makes it an optimal location for cultivating a wide variety of vegetables and fruits. Despite being one of the smallest districts (in terms of size), Cameron Highlands' main agricultural activities have accounted for 50% of the agricultural revenue in Pahang state (Pang and Tan, 2022).

Over the decades, there has been a growing demand for vegetables among Malaysians, as well as an increase in vegetable and fruits exports to other countries for a period of 25 years prior to 1996 (Midmore et al., 1996). This is attributed to an increasing recognition of the significance of upholding a nutritious diet in our everyday existence. As a result, consumers have since to integrate a greater quantity of vegetables and fruits into their dietary intake. To date, western countries have a growing demand for healthy food and this trend has also been observed in Malaysia over the year (Willer et al, 2014).

The Malaysian government is implementing measures to encourage the adoption of nutritious eating patterns and enhance the accessibility of fresh vegetables based on the Dietary Guidelines and Malaysian Food Pyramid (Tee, 2011). These efforts are expected to enhance the demand for fruits and vegetables, which has already been increasing as a result of population growth. Consequently, the agricultural sector is focusing on increasing production and diversification of cultivated fruits and vegetables. In 2015, Malaysia produced 1.03 million tons of vegetables, representing a significant 58% growth compared to the output in 2010. With farmer participation, not only the agricultural industry grew, but 1,700 hectares of farmland have been dedicated to vegetable cultivation since then (Ibrahim, 2020).

To meet these vegetable demands, farmers need to put extra effort to enhance production in Malaysia. However, they face numerous challenges in protecting their crops from pests and disease (Tudi et al., 2021). Farmers have a crucial role in cultivating and maximizing vegetable production through the implementation of effective farming techniques, optimizing land utilization, and adopting sustainable practices. They must also stay informed on what customers want to buy, what varieties of fruits and vegetables are popular, and any new types of vegetables that become available. This allows them to provide a diverse range of vegetables that people enjoy eating, thereby increasing industry demand.

## 1.2 Problem Statement

A challenge arises when farmers in Cameron Highland begin utilizing synthetic pesticides to manage pests in their agricultural practices. Annually, approximately 2 million tonnes of pesticides are applied globally to safeguard crops from pests. Malaysia is not the sole country utilizing it; however, China stands as the primary user, with the USA and Argentina following suit, both experiencing rapid growth in their synthetic pesticide consumption. Given this, projections indicate that global pesticide consumption will rise to 3.5 million tonnes by 2020 (Sharma et al., 2019). The increasing utilization of pesticides can be attributed to the rise in population, urban expansion, and the increased interconnectedness of markets, resulting in intensified farming practices. The phenomenon of global warming has resulted in gradual and extreme temperature increases, leading to heat waves that hinder agricultural activities. Certain countries have observed an increasing occurrence of pests and diseases, necessitating the increased use of pesticides by farmers (Sarkar et al., 2021). The potential health risks associated with prolonged usage of pesticides have been a subject of concern for both consumers and farmers engaged in agricultural activities (Sinha et al., 2012). The foreseeable future may witness the emergence of an epidemic of health effects attributed to the utilization of synthetic pesticides.

Pesticides can pose a threat to human health through either acute and chronic health effects. Some pesticides are highly toxic, even in small amounts. Others are less toxic, but prolonged exposure can still be harmful (Damalas & Koutroubas, 2016).

Synthetic pesticides, especially carbamate and organophosphate pesticides have the ability to inhibit the enzyme acetylcholinesterase, which is responsible for the breakdown of a substance called acetylcholine in our bodies. Therefore, cholinesterase monitoring has been extensively employed to monitor the pesticide exposure in farmers (Shentema et al., 2020). A decrease in acetylcholinesterase levels results in an increase in the acetylcholine levels in the bloodstream, which gradually affects the neural communication. As a result, the symptoms of pesticide exposure such as headache, nausea, and skin problems will occur (Hu et al., 2015).

Even though farmers are aware of the detrimental effects that pesticides can have on both their own health and the environment, they may lack knowledge to manage and mitigate the risks effectively. For example, study by Jallow (et al., 2017) reveals that farmers demonstrated a lack of understanding regarding the proper disposal methods for pesticides; another study by Sai (et al. 2019) indicates that farmers consciously decide not to wear personal protective equipment (PPE) when spraying pesticides. Given the knowledge, attitude and behavior among farmers who regularly use pesticides in their farming practices, it is important to investigate the extent to which the use of synthetic pesticides affects the liver and kidney function of vegetable farmers in Cameron Highland.

### 1.3 Study Justification

Farmers often come into contact with pesticides through breathing, swallowing, or skin contact. These chemicals then travel through the body, affecting various target organs. The liver and kidneys play a vital role in the metabolism and excretion of these exogenous compounds. These organs can be adversely affected by synthetic pesticides from either cumulative chronic exposure or acute exposure (Brzoska et al., 2003). Past study conducted on laboratory animals has further confirmed the harmful effects of synthetic pesticides on kidney and liver (El-Bini Dhouib et al., 2015). Recent study has indicated alterations in liver and kidney functions among farmers from Palestine and India (El-Nahhal, 2016); another study has also found a correlation between exposure to synthetic pesticides and the manifestation of liver abnormalities (Araoud et al., 2012; Kumar et al., 2014).

Despite the widespread use of synthetic pesticides in Cameron Highland, the impact on the health of farmers who used them remained poorly comprehended. In fact, there is a scarcity of studies in Malaysia that seek to comprehend the health effects caused by pesticides through the examination of both exposure biomarkers and effects biomarkers. One of the study from Damalas and Eleftherohorinos (2011) found that non-occupational exposure to pesticide residues in food, air, and water is typically chronic or semi-chronic, involving low doses. Although animal studies link individual pesticides to health effects, the doses used far surpass legal limits, making the risk to human health negligible (Damalas & Eleftherohorinos, 2011). So, to make human

health effects seen, the objective of this study was to present crucial insights into the impact of synthetic pesticides on the liver and kidneys of farmers, both organic and conventional, in Cameron Highland. The findings should be utilized to educate farmers and the community about the potential health hazards linked to pesticides and their impact on human health, to enhance their quality of life and promote higher living standards in this agricultural sector. The acquired information holds potential value for regulatory bodies and policymakers in enhancing current regulation of agricultural health and safety.

#### **1.4 Research Question**

1. What are the socio-demographic and occupational backgrounds among vegetable farmers from Cameron Highland?
2. What are the differences in the level of serum cholinesterase among organic and conventional vegetable farmers in Cameron Highland?
3. What are the differences in liver function indicators which are serum aspartate transaminase (AST) and serum alanine transaminase (ALT) among organic and conventional vegetable farmers in Cameron Highland?
4. What are the differences in kidney function indicators which are the level of serum creatinine and urea among organic and conventional vegetable farmers in Cameron Highland?

5. What is the association of pesticide-induced changes in cholinesterase activity, kidney function and liver function among organic and conventional vegetable farmers?

## **1.5 Research Objectives**

### **1.5.1 General Objective**

To compare the effects of synthetic pesticide use on liver and kidney function among vegetable farmers from Cameron Highland.

### **1.5.2 Specific Objective**

1. To determine the socio-demographic and occupational background among vegetable farmers from Cameron Highland.
2. To compare the level of serum cholinesterase among organic and conventional vegetable farmers in Cameron Highland.
3. To examine the differences in liver function indicators which are serum aspartate transaminase (AST) and serum alanine transaminase (ALT) among organic and conventional vegetable farmers in Cameron Highland.
4. To examine the differences in kidney function indicators which are the level of serum creatinine and urea among organic and conventional vegetable farmers in Cameron Highland.

5. To associate pesticide-induced changes in cholinesterase activity, kidney function and liver function among organic and conventional vegetable farmers.

## **1.6 Hypotheses**

1. There is a significant difference in the level of serum cholinesterase among organic and conventional vegetable farmers in Cameron Highland.
2. There is a significant difference in liver function indicators which are serum aspartate transaminase (AST) and serum alanine transaminase (ALT) among organic and conventional vegetable farmers in Cameron Highland.
3. There is a significant difference in kidney function indicators which are the level of serum creatinine and urea among organic and conventional vegetable farmers in Cameron Highland.
4. There is an association between pesticide-induced changes in cholinesterase activity, kidney function, and liver function among organic and conventional vegetable farmers.

## **1.7 Variable Definition**

### **1.7.1 Conceptual Definition**

**a) Pesticide**

Pesticides are chemicals used to prevent, destroy and manage pests which include insects, animals, fungi or other microorganisms that may impact people, animals and the environment based on their dose (Environmental Protection Agency, 2023).

**b) Cholinesterase**

Cholinesterase is an enzyme that is involved in the hydrolysis neurotransmitter acetylcholine into choline and acetic acid that involves two types which are acetylcholinesterase and Pseudocholinesterase (Colovic et al., 2013).

**c) Liver function**

The liver is an important organ in the human body because it supports metabolism, immunity, and digestion and receives blood from the portal vein and hepatic vein (Kalra, 2023).

**d) Kidney function**

The kidney has a significant role in regulating blood pressure with the interaction between the kidney, cardiovascular system and autonomic nervous system (Robson, 2014b).

## 1.7.2 Operational Definition

### a) Pesticide

Pesticides were used by agriculture farmers especially conventional vegetable farmers at Cameron Highland, Pahang.

### b) Cholinesterase

The level of serum cholinesterase was measured among organic and conventional farmers using a cholinesterase kit (Elabscience CHE Activity Assay Kit)

### c) Liver function

Liver function test includes alanine transaminase (ALT) and aspartate transaminase (AST) and they were measured using a liver function test kit (Biochemistry analyzer Brand Dirui, Model CS400) among organic and conventional farmers in Cameron Highland.

### d) Kidney function

Kidney function test includes creatine and urea and they were measured using a kidney function test kit (Biochemistry analyzer Brand Dirui, Model CS400) among organic and conventional farmers in Cameron Highland.

## 1.8 Conceptual Framework

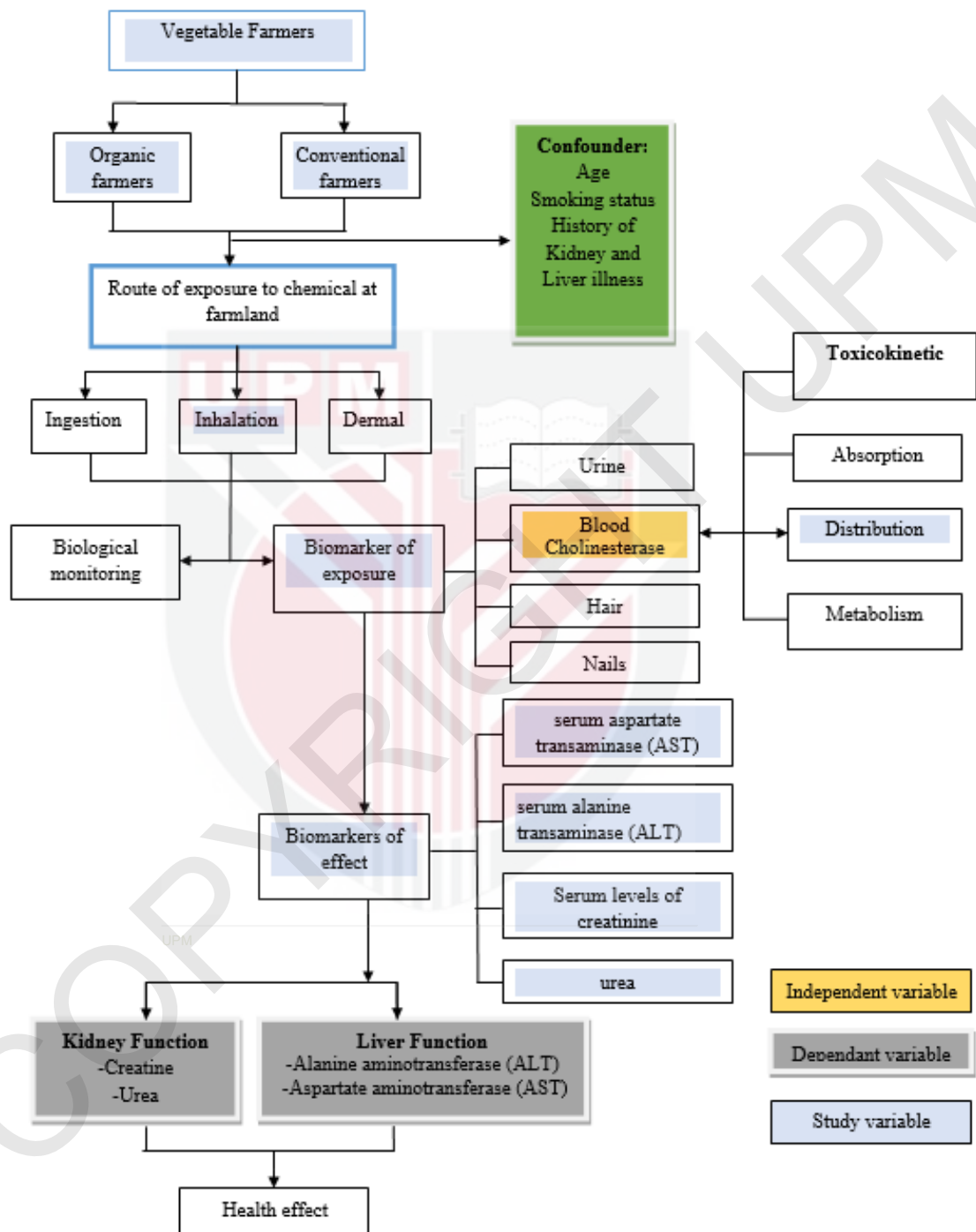


Figure 1.1: Conceptual Framework

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Organic and Conventional Farming Practices

Conventional farming relies on the use of chemicals to promote plant growth, whereas organic farming utilizes natural substances such as manure and compost for the same purpose conventional farming employs pesticides as a means of pest control, whereas organic farmers utilize techniques such as the introduction of beneficial insects and birds, disrupting pests' mating patterns, or traps to manage pests (Marsh, 2023).

Agriculture has historically served as a key contributor to the national economy through its impact on domestic production, foreign exchange earnings, and employment, especially in rural areas (Dardak, 2020). Dardak (2020) stated that in 2013, it provided jobs for over 1.6 million people, accounting for 10.9% of total employment, and contributed more than 23% to export earnings and 7.2% to Malaysia's GDP. Also, the agricultural sector's proportion in the country's economy has been steadily diminishing. Although its absolute contribution increased from RM51.3 billion in 2010 to nearly RM56.0 billion in 2013, the sector's GDP share declined from 7.58% in 2010 to around 7.0% in 2014 (Dardak, 2020).

The inception of organic farming in Malaysia can be traced back to 1986, when the Center for Environment, Technology and Development (CETDEM) established a one-hectare plot in Sungai Buloh. In the mid-1990s, the importation of organic products became increasingly popular, particularly among individuals diagnosed with cancer. Since then, the Malaysian government endeavoured to promote the adoption of organic farming among small-scale producers, not only to enhance income but also to protect the environment and stimulate exports, acknowledging its potential to support sustainable agriculture. For instance, the National Agriculture Policy 3 (NAP3) identified organic agriculture as a market opportunity, especially for vegetable and fruit growers. During the eighth Malaysia Plan (2001-2005), the government set a target to increase organic production by 250 hectares, providing financial support and infrastructure development, along with implementing a certification scheme for the domestic market (Tiraieyari et al., 2014). Besides, government regulations have led to the establishment of the Malaysian Organic Certification Program (Sijil Organik Malaysia - SOM) in 2003, ensuring adherence to Malaysian standards for organic farming. The Department of Agriculture (DOA) oversees the organic scheme, deploying trained agricultural officers for field inspections. Government support for organic agriculture persisted in the ninth Malaysia Plan (2006-2010), with a vision of a US\$200 million industry over five years, aiming for 20,000 hectares of organic farming by 2010 and an annual increase of 4,000 hectares in local production.

Conversely, conventional farming typically treats fields uniformly, applying resources like chemical fertilizer, water, amendments, and synthetic pesticides without considering the natural variations in soil and crop conditions within and between fields. This uniform approach often leads to both overuse and underuse of resources. According to Wolińska (2019), many farmers tend to overapply inputs in an attempt to maximize crop yield across the entire field, resulting in reduced profitability and negative environmental effects on soil, surface water, groundwater, and drainage (Wolińska, 2019).

In a recent study conducted by Staudacher et al. (2020), farming practices in Costa Rica and Uganda were compared. It found that even though most pesticides used were highly dangerous, farmers possessed knowledge regarding the health risks, yet very few equipped themselves with protective equipment. Hygiene practices were also lacking, especially among farmers using more hazardous pesticides. Some farmers even disposed of pesticide waste in rivers. Staudacher et al. (2020) also found that organic farmers were better trained in safe pesticides. Many farmers resort to using pesticides as a convenient remedy for pest control, primarily because they lack knowledge about sustainable farming methods and are unaware of the potential long-term health consequences. Due to their lack of comprehensive knowledge and training, these farmers inadvertently contribute to a significant decline in health and overall well-being.

## 2.2 Pesticide and Health Effects

According to the U.S. Environmental Protection Agency (USEPA), a pesticide is defined as a substance that is used to prevent, destroy, repel, and mitigate any pest. Pesticide is known as a chemical agent which consists of insecticides, nematicides, fungicides, herbicides, and rodenticides. Several classes of pesticides can be divided which are organophosphorus (OPs), organochlorine (OC), triazines, carbamates, and synthetic pyrethroid. However, the use of chemical pesticides has been associated with health effects (Nicolopoulou-Stamati et al., 2016). Organochlorines, such as dichloro-diphenyl-trichloroethane (DDT), have various health effects on humans, including endocrine disorders, impact on embryonic development, changes in lipid metabolism, and alterations in haematological and hepatic functions (Nicolopoulou-Stamati et al., 2016).

Furthermore, pesticide exposure has been linked to the development of various diseases, including cancer, hormone imbalances, asthma, leukemia, allergies, and hypersensitivity (Van Maele-Fabry et al., 2010). Another study by Kim et al. (2017) also suggested that there was a correlation between pesticides and health conditions such as cancers, leukaemia, and asthma. The likelihood of experiencing health issues due to pesticide exposure is reliant upon the toxicity of the chemicals as well as the extent of one's exposure to them (Kim et al., 2017). Also, a prospective cohort study involving 57,310 pesticide applicators in the USA found links between two imidazolinone herbicides, namely imazethapyr and imazaquin, and bladder cancer

(Koutros et al., 2014). Another study in Egypt, which included 953 cases and 881 controls among male agricultural workers, showed an increased risk of bladder cancer associated with pesticide exposure in a dose-dependent manner (Amr et al., 2015). In a different prospective cohort study with 57,311 licensed pesticide applicators in Iowa and North Carolina, USA, significant risks of bladder cancer and colon cancer were identified with imazethapyr, a heterocyclic aromatic amine herbicide (Koutros et al., 2008).

### **2.2.1 Pesticide Toxicity and Toxicokinetic Mechanism**

Pesticides operate through a toxicokinetic mechanism, involving absorption, distribution, metabolism, and excretion in the body. Toxicokinetics refers to the examination of how a toxic substance is absorbed, distributed, metabolized, and excreted (ADME) in the body over period of time (Sinha et al., 2021). Furthermore, comprehending the toxicity of pesticides necessitates a thorough examination of their effects on particular organs and enzyme systems, including cholinesterase inhibition, liver function, and kidney function. Pesticides can enter the bloodstream through ingestion, dermal contact, or inhalation, and the specific route of absorption determines the rate at which they are absorbed under the absorption.

Dermal is an effective route of exposure for pesticide applicators to encounter pesticides, as highlighted by Anderson and Meade (2014). Dermal absorption can arise from incidents like splashes, spills, or spray drift during activities such as mixing,

loading, disposal, and cleaning of pesticides, as highlighted by Salvatore et al. (2008). The absorption process may also be triggered by exposure to substantial residue amounts. Beard et al. (2014) emphasize the wide-ranging differences among pesticide formulations concerning physicochemical properties and skin absorption potential. This potential is subject to factors like the extent and duration of exposure, concurrent presence of other substances on the skin, environmental conditions like temperature and humidity, and the use of personal protective equipment, as explained by Macfarlane et al. (2013). Generally, solid pesticide forms, including powders, dust, and granules, exhibit lower skin absorption rates compared to liquid formulations. However, the risk of skin absorption elevates when workers handle concentrated pesticides, characterized by a high active ingredient percentage. Moreover, specific body areas, such as the genital areas and ear canal, are more susceptible to pesticide absorption than other regions of the body, as indicated by Dennis et al. (2010).

Another study by Damalas and Koutroubas (2016) found that pesticides entering the body through oral exposure, either accidentally or intentionally, can lead to severe illness, injury, or, in extreme cases, fatalities. Accidental oral exposure may occur when individuals unknowingly consume these products, while intentional exposure can result from deliberate self-poisoning. Damalas and Koutroubas (2016) stated that inadequate hand hygiene before eating or smoking and the improper storage of pesticides in food containers are additional routes of oral exposure. Gastrointestinal absorption primarily occurs in the small intestine, serving as a major site for the entry of these substances into the bloodstream. Once absorbed, pesticides can swiftly

distribute throughout the entire body via the bloodstream. Common instances of accidental oral exposure often involve the transfer of pesticides from their original labelled containers to unlabeled bottles or food containers (Robb, 2023). Tragically, there have been numerous cases of poisoning due to the ingestion of pesticides or water stored in containers contaminated with pesticides.

After absorption, pesticides travel through the bloodstream to reach different tissues and organs. Certain pesticides like organophosphates and carbamates induce toxicity by inhibiting acetylcholinesterase, a crucial enzyme for nerve signal transmission. This inhibition can take place in both the nervous system and peripheral tissues, causing an accumulation of acetylcholine and subsequent neurotoxic effects

After distribution process, pesticides undergo a process of biotransformation within the liver, where they undergo metabolism to form more water-soluble compounds. The liver's pivotal role in pesticide metabolism involves crucial enzymatic activities, particularly those facilitated by cytochrome P450 during Phase I reactions. These reactions convert pesticides into more reactive or polar metabolites. Subsequently, in Phase II, conjugation reactions further enhance water solubility, facilitating their excretion from the body. Notably, the metabolism of organophosphates and carbamates, known for their cholinesterase-inhibiting properties, takes place in the liver. Certain metabolites resulting from this process contribute to the inhibition of cholinesterase enzymes.

In excretion, the body expels both metabolites and unchanged pesticides through diverse pathways. Water-soluble metabolites are commonly excreted through the kidneys, highlighting the pivotal role of kidney function in eliminating such compounds from the organism. Additionally, biliary excretion represents another significant route for the elimination of pesticides and their metabolites, with the liver assuming a central role in this elimination process. The process of elimination involves the excretion of urine and faeces, which occurs through the kidney (Leskovac & Petrović, 2023).

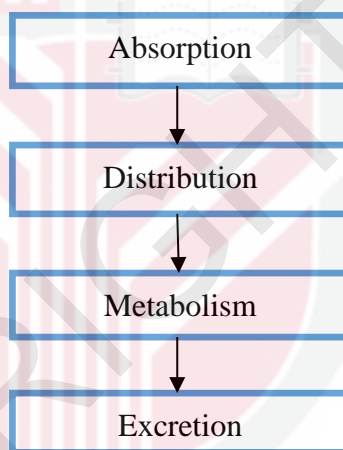


Figure 2.1: Toxicokinetic mechanism (ADME)

A pesticide's ability to cause injury or disease is referred to as its toxicity. The chemical component in a pesticide product that is in charge of controlling pests is known as the active ingredient. By selecting a pesticide with the lowest toxicity that nevertheless effectively controls the intended pest, users can reduce potential risks by analyzing the differences in toxicity levels between pesticides. By using an informed

selection procedure, the health concerns connected to pesticide use are reduced. Exposure to pesticides can be absorbed through contact with the skin, ingestion, or inhalation. The type of pesticide, the duration and route of exposure, and the individual health status are determining factors in the possible health outcome (Nicolopoulou-Stamati et al., 2016).

According to Robb (2023), during the subsequent distribution phase, pesticides disperse throughout various tissues and organs. This process is affected by factors such as the chemical properties of the pesticides and the circulation of blood through the bloodstream. The majority of pesticides are lipophilic, meaning they have an affinity for fat tissues and can build up in them. This accumulation can lead to potential risks when individuals are exposed to them for extended periods. The liver is primarily responsible for metabolizing pesticides, converting them into metabolites, which can impact their persistence and toxicity (Damalas & Koutroubas, 2016).

### **2.2.2 Pesticide Toxicity and Cholinesterase Level**

There are certain chemicals used as insecticides and in chemical warfare that can lower the levels of cholinesterase in the body. Cholinesterase is an enzyme found in the blood that helps with various bodily functions. The primary function of acetylcholinesterase (AChE) is to stop or terminate the transmission of signals between nerve cells at synapses. It does this by preventing the dispersion of acetylcholine (ACh), a neurotransmitter, and the activation of nearby receptors (Trang, 2023). By checking

the levels of cholinesterase in a person's blood, exposure to this chemical can be determined even before they start showing symptoms of poisoning. This information is important in assessing whether someone has come into contact with these harmful substances or not. However, Ix and Sharma (2010) found that obesity is one of the risk factors for chronic disease. According to the World Health Organization (WHO, 2021), the underweight category falls when Body Mass Index (BMI) is below 18.5, normal when BMI is 18.5 – 24.9, overweight is when BMI is 25 – 29.9 and obesity is when BMI is 30 - 39.9.

Other than that, Del Prado-Lu (2007) has researched to examine the health of cut flower farmers in La Trinidad, Benguet, focusing on the effects of pesticide exposure. Del Prado-Lu (2007) found that farmers who had been using pesticides for a longer time, had health issues related to pesticide use, and engaged in certain unsafe practices such as selling used pesticide containers or using contaminated cloth, had abnormal levels of blood marker called red blood cell cholinesterase (RBC). These findings can be shown when abnormal cholinesterase levels were positively associated with age and pesticides. This is due to pesticides binding to cholinesterase enzymes and inhibiting their activity. According to Garmavy et al. (2023), the normal range for blood cholinesterase in the human body should be 150 -310 u/L.

Another research by Ntow et al. (2009) was conducted in two vegetable-farming communities in Ghana to examine pesticide exposure among farmers. Blood cholinesterase activity was used as a marker to assess exposure levels. The results

showed that the exposed participants had significantly lower blood cholinesterase levels compared to the control group.

### **2.2.3 Pesticide Toxicity and Liver Function**

Exposure to pesticides can lead to alterations in liver enzyme levels such as alanine transaminase (ALT) and aspartate transaminase (AST). Examine levels of these enzymes in the bloodstream and serve as markers for potential liver damage. These changes can be identified through blood tests, providing a means to assess the impact of pesticide exposure on the liver. Therefore, in a study conducted in Western Maharashtra, India by Patil et al. (2009), they compared a group of pesticide sprayers working in grape gardens (60 respondents) to a group of healthy individuals (30 respondents). They collected blood samples from both groups to evaluate various health parameters. Patil et al. (2009) found that the sprayers had several significant differences compared to the control group. They had higher levels of aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase, bilirubin, creatinine, blood glucose, and urea indicating a decrease in liver function. In another study by Siddiqui et al. (2019), the normal range for AST should be between 7-55 u/L, and for ALT should be 8 – 33 u/L. This was supported by another study from Payan-Rentería et al. (2012) stated farm workers exposed to pesticides had a high risk of liver damage.

#### **2.2.4 Pesticide Toxicity and Kidney Function**

Atrazine one of the pesticide has demonstrated significant potency as an endocrine-disrupting chemical (Kucka et al., 2012). A study by Fraites et al. (2009) indicated that it can stimulate the hypothalamic-pituitary-adrenal axis. The activation of this axis has been linked to the advancement of kidney disease (Asao et al., 2016). In addition, a study by Andreotti et al. (2020) found that certain pesticides have been linked to end-stage renal disease and renal cell carcinoma. This evidence is supported by Hamdi et al. (2019) in their study where there is an association between pesticide and kidney dysfunction. Although a study by Shearer et al. (2021) among 19 individual insecticide users and found no association between any of them with the decline in kidney function, but both malathion and diazinon were associated with the lower odds of chronic kidney disease.

#### **2.3 Biological Monitoring of Pesticide Toxicity**

Biomonitoring, or biological monitoring, is a way to check how much exposure people have to chemicals or their effects (Ramirez-Santana et al., 2018). This is done by measuring these chemicals, their byproducts, or the results of reactions in human samples. The basic principle for biomonitoring includes measuring biomarkers in bodily fluids like blood, urine, saliva, breast milk, sweat, and other samples like feces, hair, teeth, and nails (Ramírez-Santana et al., 2018).

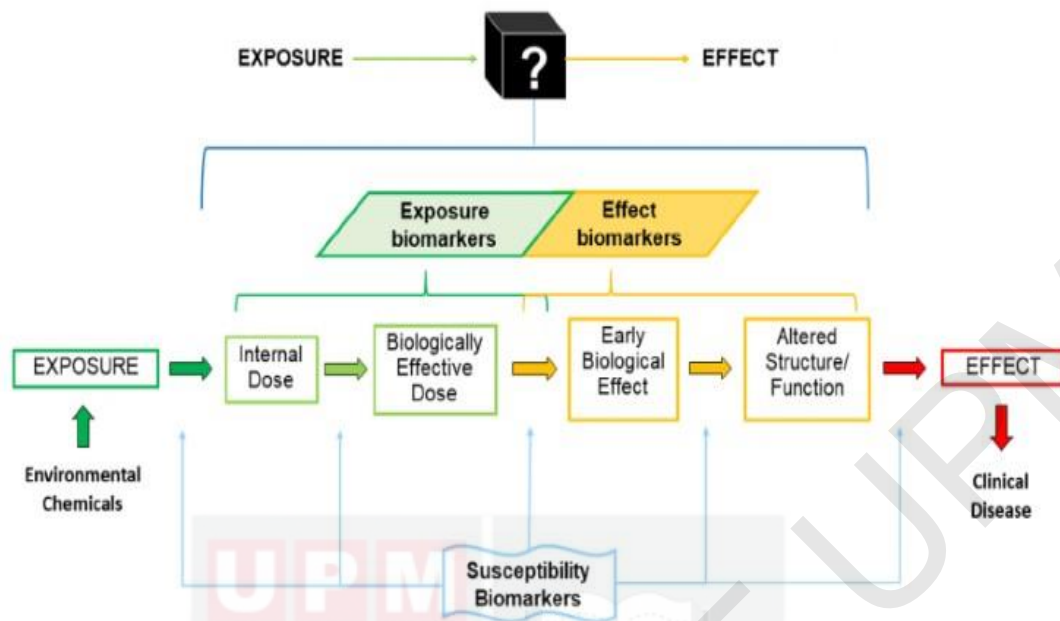


Figure 2.2: Conceptual of Biological Monitoring

(Source: Mustieles et al., 2020)

### 2.3.1 Biomarker of Exposure

According to the United States Environmental Protection Agency (USEPA), biomarkers of exposure are used to assess the presence of chemicals within the body with the measurement obtained in bodily fluids such as urine, blood, and saliva, as well as in fat-soluble compartments like body fat and breast milk, particularly for substances like DDT (pesticide). These biomarkers provide valuable insights into individual chemical exposures and levels of exposure among humans. There are 3 categories for biomarkers of exposure such as chemical, metabolite and response. Therefore, blood cholinesterase usually is taken to measure the biomarkers of exposure to pesticides. Blood cholinesterase can decrease after pesticide exposure. It is because

a pesticide can interfere with the function of cholinesterase, preventing it from breaking down acetylcholine, is known as a "cholinesterase inhibitor".

Usually, the main types of these pesticides include organophosphates (OPs) and carbamates (CMs). Excessive exposure to these organophosphate and carbamate insecticides can lead to the inhibition of cholinesterase. These pesticides bind with acetylcholinesterase at nerve endings in the brain and nervous system and cholinesterase is present in the blood. This results in an accumulation of acetylcholine, coupled with a reduction in the protective levels of the cholinesterase enzyme. As cholinesterase levels decline, the symptoms associated with poisoning from these pesticides increase. This was supported by a study from Sine et al. (2019), their study assessed 133 respondents (71 farmers and 62 non-farmers) and the results showed that there is lower cholinesterase activity among farmers exposed to pesticides compared to the non-exposed group. Moreover, the measurement of blood cholinesterase levels from the human body is an effective way to determine whether they are exposed or not to pesticides (Silverio et al., 2017). This method was applied in study by Hernandez et al. (2006) and found that 64% of greenhouse workers had decrease in cholinesterase level for 25% from normal range of cholinesterase levels in human.

### **2.3.2 Biomarker of Effect**

Indicators that change biological function in response to chemical exposure are called biomarkers of effect. The measurement of creatine and urea levels in the human

body is used to know the kidney function damage, while the level of Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT) enzymes are used to know about liver function damage.

Therefore, Manfo et al. (2020) conducted a study in Buea, Cameroon, to examine the effects of occupational exposure to agro-pesticides on the health of farmers. The study involved comparing 58 farmers who used pesticides with a reference group of 32 men who did not have occupational pesticide exposure. Blood samples were taken from all participants to assess liver function markers (alanine aminotransferase and aspartate aminotransferase). Manfo et al. (2020) found farmers commonly utilized insecticides, fungicides, and herbicides in their agricultural practices. The researchers observed that these farmers often faced immediate health issues such as skin rashes, eye irritation, and facial burns due to their exposure to pesticides. When compared to a group that was not exposed to pesticides, the farmers had considerably higher levels of alanine aminotransferase activity, which suggests that their liver function was affected. These results showed that farmers in the studied area were exposed to various types of pesticides, which caused eye and skin issues. The exposure to pesticides also resulted in liver function changes, as indicated by increased levels of alanine aminotransferase.

Also, a study from A. J. Patil et al. (2009) believe that occupational exposure to pesticides among grape garden sprayers can lead to impaired kidney function and this is due to the decrease in acetylcholinesterase activity and the increase of creatine

and urea level. Also, Hosten (1990) indicated that the normal range for creatine was 61.9-114.9  $\mu\text{mol/L}$  and for urea should be 1.8 -7.1  $\mu\text{mol/L}$ . The level that is outside this range can be dangerous and decrease kidney function. Ramírez-Santana et al. (2018) agreed that serum creatine leads to an increase in urea and results in kidney function.

## **2.4 Factors that Affect Pesticide Toxicity**

### **2.4.1 Age**

Age can affect pesticide toxicity in humans. As individuals age, the outer layers of their skin tend to thin. This resulted in older adults experiencing a faster absorption of pesticides through their skin compared to young and healthy adults even though the amount exposed to pesticides are same in quantity (Parrado et al., 2019). Furthermore, the human heart becomes less effective at pumping blood throughout the body. This leads to less blood reaching the liver and kidneys, which also shrink with age. Because of this, the process of breaking down and getting rid of pesticides from the body slows down (Mangoni & Jackson, 2003).

### **2.4.2 Gender**

Gender is one of the factors that affect pesticide toxicity. The severity of pesticide exposure in women is different in men. Women usually have more body fat,

so they tend to store pollutants that can build up in fat and more tissues sensitive to hormones making them more at risk from pesticides especially those that affect hormones or disrupt the endocrine system (Jors et al., 2013). However, another study by Bretveld et al. (2006) claimed that men had a higher potential risk of pesticides compared to women. One factor contributing to the difference in pesticide impact between men and women is that men often have higher exposure levels since they typically handle pesticide applications, while women are mainly exposed during re-entry activities (Bretveld et al., 2006).

#### **2.4.3 Year of Employment**

Duration to work with pesticides will determine the severity of pesticide exposure to humans. Exposure to pesticides in a short time is called acute toxicity. When someone is exposed to a substance through skin contact, it is considered an incident of acute dermal exposure and the resulting toxicity is termed acute dermal toxicity. (Damalas & Koutroubas, 2016). Chronic exposure is caused by continuous pesticide exposure by the farmers. Pesticides can be harmful over a long time, even if the exposure happens repeatedly. Just because a pesticide is very harmful in one exposure (acute toxicity) doesn't mean it will always cause harm over time (chronic toxicity). Even a pesticide with low acute toxicity can have lasting effects. The more you're exposed, the more harm it can cause (Damalas & Koutroubas, 2016).

#### **2.4.4 Personal Protective Equipment (PPE)**

Using complete Personal Protective Equipment (PPE) will reduce the harmful effects of pesticides on health (Lari et al., 2023). This was supported by Garrigou et al. (2020) claimed that PPE such as gloves, masks, and protective clothing serves as an important barrier in minimizing direct contact with pesticides and reducing the risk of skin absorption, inhalation, or ingestion. Also, proper selection and use of PPE determine the severity of pesticides enter the human body.

## CHAPTER 3

### METHODOLOGY

#### 3.1 Study Location

This study was carried out in Cameron Highlands located in Pahang, Malaysia. The selection of this location was based on the renowned agricultural activity in Cameron Highlands (Figure 3.2), particularly for its cultivation of fruits and vegetables. Four districts at Cameron Highland were selected, such as Brincang, Tanah Rata, Bertam Valley and Tringkap (Figure 3.3). The area exhibits a significant density of agricultural establishments where synthetic pesticides are frequently employed to safeguard crops against pests and diseases. Vegetable farmers in Cameron Highlands were deemed a vulnerable group as a result of their frequent and direct exposure to pesticides, which are used extensively in the area. They faced a greater susceptibility to exposure and potential health consequences compared to the general public.

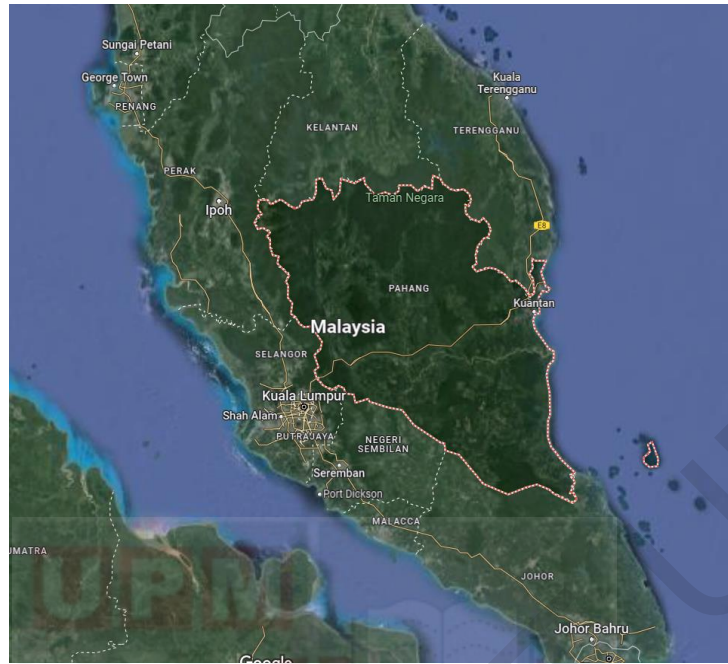


Figure 3.1: The State of Pahang, Malaysia  
(Source: Google maps, 2023)



Figure 3.2: Cameron Highland, Pahang  
(Source: Google maps, 2023)

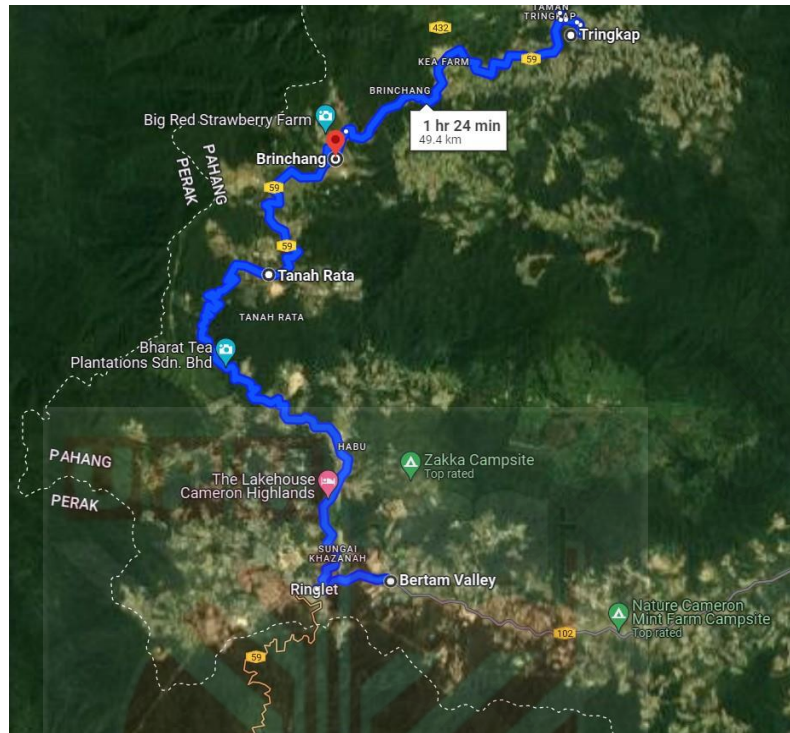


Figure 3.3: Study Location (Tringkap, Brinchang, Tanah Rata and Bertam Valley) in Cameron Highland.

*(Source: Google maps, 2023)*

### 3.2 Study Design

This research was quantitative research that was conducted on 62 farmers who had worked for at least 1 year, including males and females from Cameron Highland. The 62 farmers comprised 47 conventional farmers and 15 organic farmers. This study employed a comparative cross-sectional study design to investigate the effects of

synthetic pesticide use on liver and kidney function among vegetable farmers from Cameron Highland.

### 3.3 Study Sampling

#### 3.3.1 Study Population

The study included 47 farmers who were engaged in synthetic pesticide handling activities that included mixing and spraying. Meanwhile, 15 organic farmers who shared a similar socio-demographic background and fulfilled the inclusion criteria would recruited to participate in this study as the comparative group.

#### 3.3.2 Study Sample

The sample size for the 2 groups comparison design, the formula of combined standard deviation ( $2\sigma^2$ ) is adopted (Lemeshow et al., 1990) as below.

Formula,

$$n = \frac{2\sigma^2 [Z_{1-\alpha/2} + Z_{1-\beta}]^2}{(\mu_1 - \mu_2)^2}$$

Where,

$\sigma$  = Estimated standard deviation (assumed to be equal to each group)

$\mu_1$  = Estimated mean (larger)

$\mu_2$  = Estimated mean (smaller)

$Z_{1-\alpha}$  = Standardized value for the confidential interval, 95% CI=1.96

$Z_{1-\beta}$  = Standardized value for power, 80% of power = 0.84

Substituted the value into the formula sample size:

$$n = \frac{2 \times (18.9)^2 [1.96 + 0.84]^2}{(35.3 - 20.9)^2}$$

$n = 27 + 5$  ( 20% non-response rate) = 32 participants

For the two groups of respondents (organic and conventional farmers),

$N = 2 \times n = 64$  Participants

The sample size for the vegetable farmers in Cameron Highland is 32, accounting for a 20% dropout rate from the study. Hence, it is necessary to recruit at least 32 participants from both organic and conventional farmland. The study's sample was chosen through the utilization of the simple random sampling technique. As a result of the scarcity of organic farmers in Cameron Highland. However, only 46.88% of the organic farmers from the actual sample size and 146.88% of the conventional farmers had participated in this study, relative to their respective sample sizes.

### 3.3.3 Study Frame

The sampling frame of this study were organic and conventional vegetable farmers obtained from Pertubuhan Pengusaha Pertanian Cameron Highland Pahang (PPCH) Pahang and which fulfilled the pre-selection and met the inclusive criteria. The pre selection among organic and conventional farmers were showed in the figure 3.4 and figure 3.5.



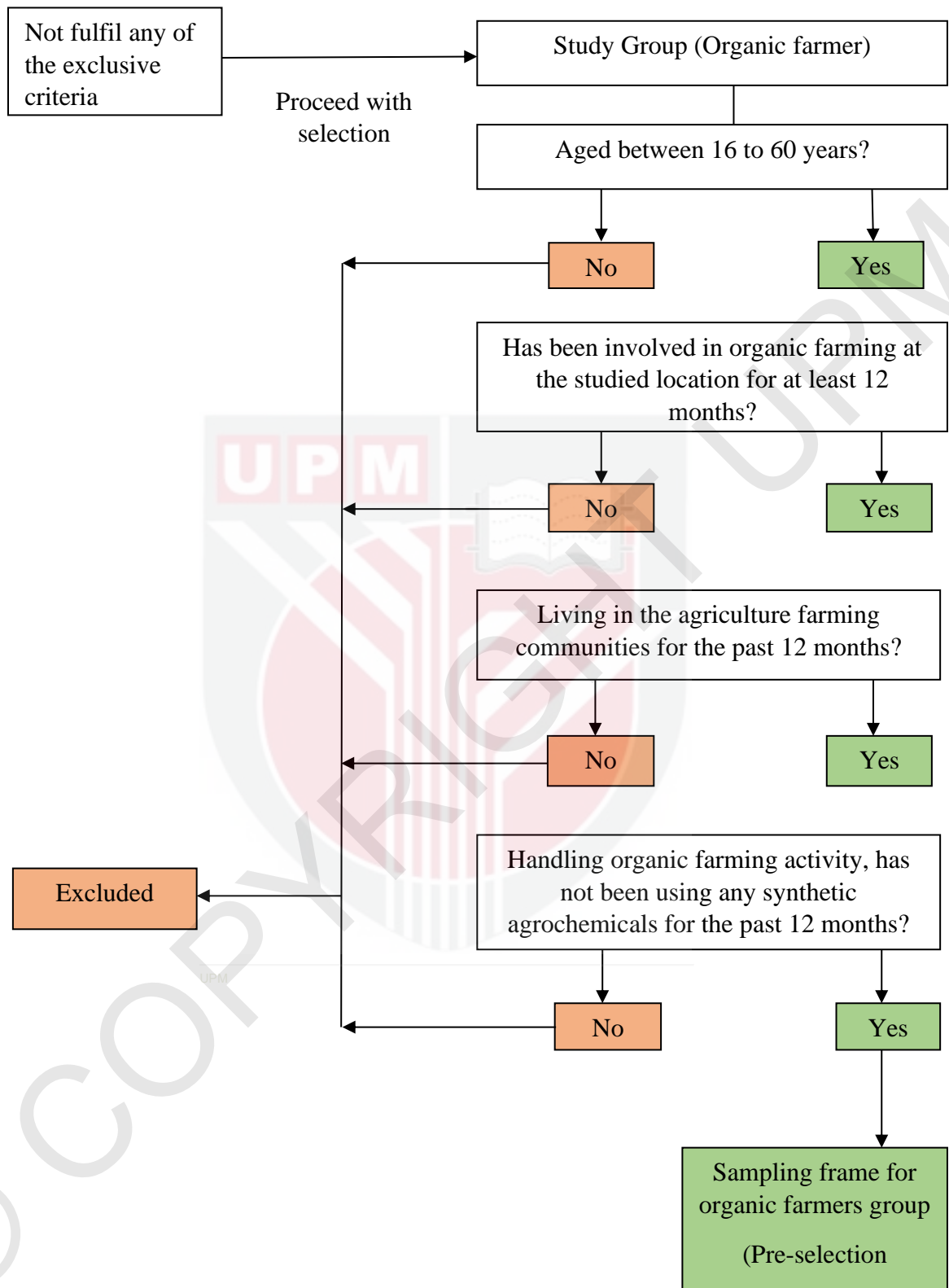


Figure 3.4: Flow Chart for Pre- Selection Organic Farmer

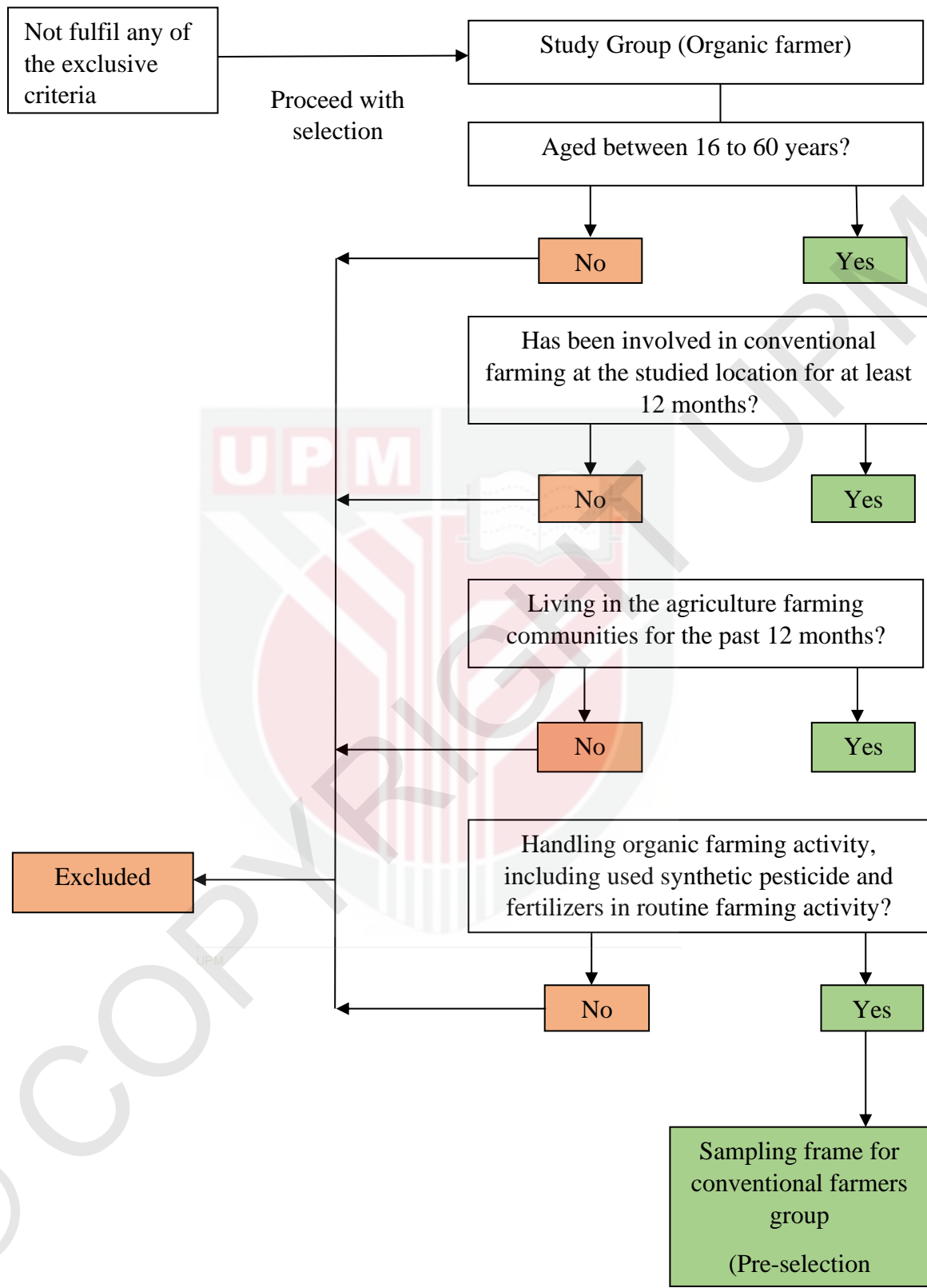


Figure 3.5: Flow Chart for Pre- Selection Conventional Farmer

### **3.3.4 Sampling Criteria**

#### **3.3.4.1 Inclusive Criteria**

The study group comprised vegetable farmers who lived and worked in the study area for a certain time. For both conventional and organic farmers, the minimum required duration of work is at least 12 months of working experience in vegetable farmland (Hu et al., 2015). They were aged between 18 to 60 years old and were recruited to participate in the study (Manfo et al., 2020). They lived in Cameron Highland for at least 12 months in farmers' occupation. For organic farmers, they handled organic farming activity and had not been using any synthetic agrochemicals for the past 12 months. Conventional farmers handled conventional farming activity including using synthetic pesticides and fertilizers in routine farming activity.

#### **3.3.4.2 Exclusive Criteria**

For exclusive criteria, both organic and conventional farmers who had chronic diseases such as liver and kidney diseases and were undergoing medication or post-operation of liver and kidney diseases were not included in this study (Manfo et al., 2020). Also, farmers who self-reported having trypanophobia (needle injection phobia) were excluded from this study.

### 3.3.5 Sampling Unit

The sampling unit of this study is an individual who meets the inclusive criteria, specifically, the farmer who,

- Is between 18 to 60 years old.
- Has lived in Cameron Highlands for at least 12 months.
- Is not under medication for liver and kidney diseases.
- Has not undergone a post-operation related to liver and kidney diseases.

Each meeting these criteria would be considered a sampling unit for this study.

### 3.3.6 Sampling Method

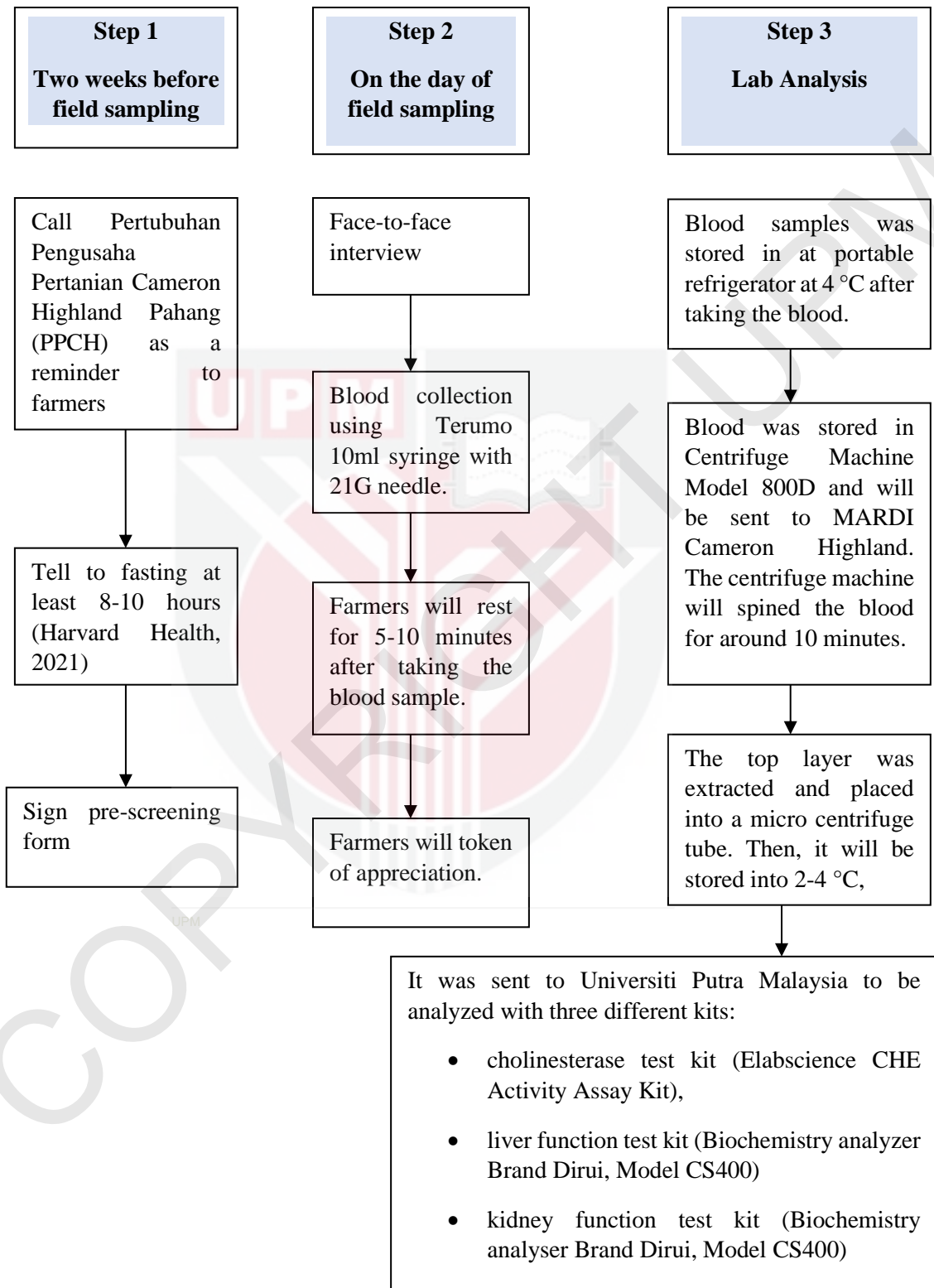


Figure 3.6: Flow Chart for sampling method

This study applied several random samplings approach to ensure representativeness and minimize the possibility of selection bias. Cluster random sampling was used to select vegetable farmland in Cameron Highland. Then, all farmers were recruited based on their willingness to participate and after taking into consideration inclusive and exclusive criteria used stratified random sampling. Simple random sampling was used to get an equal representation of respondents from both organic and conventional farmers.

Two weeks before field sampling, Pertubuhan Pengusaha Pertanian Cameron Highland Pahang (PPCH) was contacted to remind the participating farmers after the sampling frame was done. Farmers were asked to fast for at least 10 hours (Hanvard Health, 2021) and asked to sign the pre-screening form before the data collection day.

During the field sampling, farmers were required to participate in a face-to-face interview before collecting blood using a 10ml syringe with a 21G needle. Subsequently, farmers took a brief break of 5-10 minutes before receiving the token of appreciation.

The blood was analyzed in the laboratory after it was collected. The blood samples were stored in a portable refrigerator at a temperature of 4 °C immediately after collection. Blood samples were run in Centrifuge Machine (Model 800D) at MARDI Cameron Highland to separate components of a liquid mixture based on their densities. The centrifuge machine was used to spin the blood for approximately 10

minutes. Subsequently, the uppermost layer was isolated and transferred into a microcentrifuge tube. Then, it was stored at a temperature range of 2-4 °C. Subsequently, it was sent to Universiti Putra Malaysia for analysis using three distinct kits:

- cholinesterase test kit (Model: Elabscience CHE Activity Assay Kit)
- liver function test kit (Model: Biochemistry analyzer Brand Dirui, Model CS400)
- kidney function test kit (Model: Biochemistry analyser Brand Dirui, Model CS400)

### **3.4 Data Collection and Instrument**

#### **3.4.1 Questionnaire**

A validated questionnaire adapted from Manfo et al. (2020) was used to assess the study population's background information, which included five sections. A face-to-face interview was conducted to obtain the information. Five sections were:

- Section A: Personal Information
- Section B: Lifestyle Information
- Section C: Occupational Background
- Section D: Information on the Use of Synthetic Pesticides and Fertilizers
- Section E: Information on Use of Personal Protective Equipment (PPE)

### **3.4.2 Blood Sampling**

Blood samples among the farmers were conducted by the registered nurse. The registered nurse collected 5ml of blood samples from farmers using the venipuncture procedure (WHO, 2010) at vegetable farms located in Brinchang, Tringkap, Tanah Rata and Bertam Valley, Cameron Highland.

### **3.4.3 Cholinesterase Kit**

Before running the serum of cholinesterase, pre-assay preparation was done using a reagent. There were 6 solutions in reagent preparation. The six solutions were reagent stock solution, reagent 2 application solution, 4 stock solution, 4 application solution, 9 application solution, 9 application solution and 8 application solution. After that, the assay protocol was done by adding 0.5 mL of reagent 1 to each tube and mixed fully. The tubes were incubated at 37 °C for 20 minutes. 1 mL of reagent 4 application solution, 0.5 mL of reagent 6, 0.25 mL of reagent 7, 0.5 mL of reagent 8 application solution were added and mixed fully. Then, all of the tubes were centrifuged at 2325 g for 10 minutes and then took supernatant. The spectrophotometer was set to zero blank tubes and measured the OD values of each tube at 520 nm with 1 cm optical path cuvette.

#### **3.4.4 Liver Function Test Kit**

Serum aspartate transaminase (AST) and serum alanine transaminase (ALT) of organic and conventional farmers were put in the Biochemistry analyzer (Brand Dirui, Model CS400) with AST and ALT reagent using a liver function test kit to obtain the result.

#### **3.4.5 Kidney Function Test Kit**

Creatine and urea of organic and conventional farmers were put in the Biochemistry analyzer (Brand Dirui, Model CS400) with creatine and bun reagent using a kidney function test kit to obtain the result.

#### **3.5 Statistical Analysis**

All data gathered for this study were analysed using SPSS Version 29. Univariate tests were used to analyse the descriptive analysis. Descriptive statistics such as mean, standard deviation and percentage were used to explain socio-demographic, occupational background and social lifestyle among organic and conventional farmers at Cameron Highland. Meanwhile, a bivariate test was done to compare the effects of synthetic pesticide use on liver and kidney function among vegetable farmers from Cameron Highland. Kolmogorov-Smirnov test was used to

determine the normality of all the variables. The variable was defined as normally distributed if the p-value was more than 0.05. Mann Whitney-U tests were done to make a comparison in the differences in the median for all the variables such as kidney and liver function tests among organic and conventional farmers. For correlation test, Spearman correlation test was performed to determine the association between pesticide-induced changes in cholinesterase activity, liver function and kidney function among organic and conventional farmers.

### **3.6 Study Limitation**

This study was limited by a low participation rate among organic farmers, which can be attributed to the wide variation in pesticide usage within the farming practices in Cameron Highland. In addition, the insufficient number of participants and unwillingness to participate due to the requirement of blood samples. Lastly, the comparison of organic and conventional farmers only within the Cameron Highland. It will give bias for organic farmers due to probably the soil was contaminated with the pesticides.

### **3.7 Quality Control**

A pre-test questionnaire was conducted among 20 percent of the total respondents which aimed to ensure the validity and reliability of the questionnaire set. A guideline on the standard operating procedure for haematology by the World Health

Organization (WHO, 2000) for blood sampling was followed to ensure the sample was collected properly. The respondents were briefed before running the test.

### **3.8 Study Ethic**

Before data collection, human subject's approval was obtained from Ethics Committee, University Putra Malaysia (JKEUPM-2022-410). The identity of respondents was remained as confidential, and the data obtained was not publish to any party. The respondents need to sign consent form before participated in this study and the participation were voluntarily.

## CHAPTER 4

### RESULT

#### 4.1 Normality Test

The assumptions of normality were checked statistically. In this context, the Kolmogorov-Smirnov Test is used to determine the normality distributions of each studied variable before statistical analysis is performed. Data shows significant normal distribution if  $p > 0.05$  or data which achieves skews at  $\pm 3$  distribution are considered to have attained normal distribution (Leech, Barrett and Morgan, 2005).

As shown in Table 4.1, all the relevant study variables are not normally distributed. As such, bivariate analyses were proceeding with a non-parametric test on not normality distributed data.

**Table 4.1 Normality Distribution of Study Variables among Farmers**

Variable(s) <sup>a</sup>	Statistic	Skewness	Standard Error	p- value	Normality
<b>Conventional farmers (n=47)</b>					
Age (year) (example)	0.094	0.484	0.347	0.200*	Normal
BMI (kg/m <sup>2</sup> )	0.090	0.333	0.347	0.200*	Normal
Year of Working	0.161	1.080	0.347	0.004	Not normal

Variable(s) <sup>a</sup>	Statistic	Skewness	Standard Error	p- value	Normality
Blood Cholinesterase	0.190	- 1.253	0.347	<0.001	Not normal
Aspartate amino transferase (AST)	0.286	0.855	0.347	<0.001	Not normal
Alanine aminotransferase (ALT)	0.256	0.759	0.347	<0.001	Not normal
Creatine	0.153	0.170	0.347	0.007	Not Normal
Urea	0.239	0.700	0.347	<0.001	Not normal
<b>Organic Farmer (n=15)</b>					
Age (year) (example)	0.195	0.566	0.580	0.131*	Normal
BMI (kg/m <sup>2</sup> )	0.152	- 0.318	0.580	0.200*	Normal
Year of Working	0.176	1.267	0.580	0.200*	Normal
Blood Cholinesterase	0.239	- 0.724	0.580	0.021	Not normal
Aspartate amino transferase (AST)	0.234	1.378	0.580	0.027	Not normal
Alanine aminotransferase (ALT)	0.185	1.292	0.580	0.179*	Normal
Creatine	0.109	0.259	0.580	0.200*	Normal
Urea	0.131	0.486	0.580	0.200*	Normal

<sup>a</sup> Kolmogorov-Smirnov Test

\* Normality at  $p>0.05$

## **4.2 Socio-Demographic, Occupational background and Social Lifestyle among vegetable farmers at Cameron Highland**

### **4.2.1 Socio-Demographic Factor among Vegetable Farmers at Cameron Highland**

A total of 62 respondents participated in this study at Cameron Highland. Of the total of 62 respondents, 47 were conventional farmers and 15 were organic farmers. The socio-demographics of this study included gender, age, weight, height, Body Mass Index (BMI) and education level. The 34 male farmers (72.3%) were higher compared to the 13 female farmers (27.7%) from conventional farmland. Similarly, 14 male farmers (93.3%) were higher compared to the 1 female farmer (6.7%) from organic farmland. The mean age of the farmers from conventional farmland was  $43.0 \pm 12.0$  years old compared to organic farmland was  $48.0 \pm 14.0$  years old. The mean weight from conventional farmers was  $72.2 \pm 13.2$  kg which was higher than organic farmers'  $71.8 \pm 15.0$  kg. Meanwhile, the mean height of conventional farmers was lesser compared to organic farmers which were  $167.1 \pm 6.7$  and  $169.2 \pm 6.2$  respectively. Most of the conventional farmers had a Body Mass Index in the overweight category of 48.9% followed by the normal category at 38.3% followed by obesity at 12.8% compared to organic farmers in the normal category at 40.0% followed by the overweight category at 26.7% followed by obesity at 20.0% and lastly was an overweight category at 13.3%. For conventional farmers 'education level, 72.3% had a primary educational level followed by 19.1% farmers had a secondary educational level, 6.4% farmers had a

tertiary diploma and 1.0% farmers had a tertiary degree for their educational level. For organic farmers 'education level, 44.4% of farmers had tertiary degrees followed by 22.2% of farmers who had primary and secondary education levels and lastly, 11.1% of them had tertiary diplomas.

**Table 4.2: Socio-demographic Background among farmers at Cameron Highland. (N=62)**

	Conventional (n=47)		Organic (n=15)	
	Mean (SD)	n (%)	Mean (SD)	n (%)
<b>Gender</b>				
Female		13 (27.7)		1 (6.7)
Male		34 (72.3)		14 (93.3)
<b>Age (Years)</b>	43 (12)		48 (14.0)	
<b>Weight (kg)</b>	72.2 (13.2)		71.8 (15.0)	
<b>Height (cm)</b>	167.1 (6.7)		169.2 (6.2)	
<b>BMI (kg/m<sup>2</sup>)</b>				
under 18.5 (underweight)		-		2 (13.3)
18.5 - 24.9 (normal)		18 (38.3)		6 (40.0)
25 - 29.9 (overweight)		23 (48.9)		4 (26.7)
30-39.9 (obesity)		6 (12.8)		3 (20.0)
<b>Education Level</b>				
Primary		34 (72.3)		2 (22.2)
Secondary		9 (19.1)		2 (22.2)
Tertiary Diploma		3 (6.4)		1 (11.1)
Tertiary Degree		1 (2.1)		4 (44.4)

#### 4.2.2 Occupational background among farmers at Cameron Highland

The occupational background of this study included the duration of the year working in the farmland, type of personal protective equipment, symptoms after handling pesticide, symptoms after handling pesticide, symptoms during handling pesticide, washing pesticide containers, pesticide storage and pesticide container disposal. The mean duration of the year working in the farmland for conventional

farmers was  $17.0 \pm 12.0$  years compared to organic farmers was  $14.0 \pm 12.0$  years. From the conventional farmland, 74.5% of farmers did not wear Personal Protective Equipment. 12.8% of farmers wore high-cut safety shoes during working, 8.5% of them wore disposable face masks followed 2.1% wore half masks and short-cut safety shoes. Meanwhile, in the organic farmland, 60% of farmers did not wear PPE but 33% of farmers wore rubber shoes and 6.7% wore raincoats. From the study, none of the conventional farmers and organic farmers were recorded as having symptoms while handling pesticides. 93.3% of organic farmers and 74.5% of conventional farmers were recorded as having no symptoms after handling pesticides while 6.7% of organic farmers and 25.5% of conventional farmers were recorded as having symptoms after handling pesticides. None of the organic farmers used pesticides, while all conventional farmers purchased pesticides from physical stores. Additionally, neither the conventional nor the organic farmers obtained pesticides from online platforms. None of the organic farmers had a disposal method, whereas none of the conventional farmers had one either. 61.7% of conventional farmers dispose of pesticide containers as general waste, while none of the organic farmers do so. 38.3% of conventional farmers dispose of their pesticide containers at recycling centres, while none of the organic farmers does so. Not a single one of them incinerated their pesticide container.



Figure 4.1: safety shoes worn by farmers.

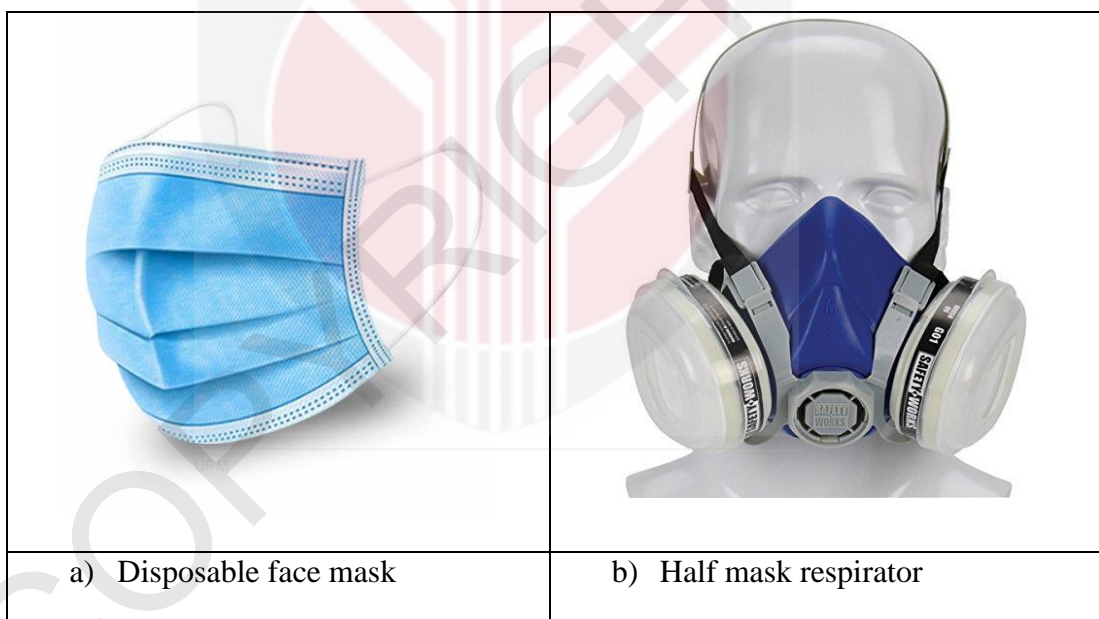


Figure 4.2: Disposable and Half mask respirator that worn by farmers.

**Table 4.3: Occupational Background among Farmers at Cameron Highland. (N=62)**

	Conventional (n=47)		Organic (n=15)	
	Mean (SD)	n (%)	Mean (SD)	n (%)
<b>Duration of Year Working in The Farmland</b>	17 (12)		14 (12)	
<b>Type of PPE</b>				
Disposable Face mask		4 (8.5)	-	
Half face mask		1 (2.1)	-	
No PPE		35 (74.5)	9 (60.0)	
Raincoat		-	1 (6.7)	
High-cut safety shoes		6 (12.8)	5 (33.3)	
Short-cut safety shoes		1 (2.1)	-	
<b>Symptoms During Handling Pesticide</b>				
No symptoms		47 (100.0)	15(100.0)	
Have symptoms		-	-	
<b>Symptoms After Handling Pesticide</b>				
No symptoms		35 (74.5)	14 (93.3)	
Have symptoms		12 (25.5)	1 (6.7)	
<b>Pesticide Purchase</b>				
Not Using		-	15 (100.0)	
Physical Store		47 (100.0)	-	
Online		-	-	
<b>Wash Pesticide Container</b>				
No washing is practiced		34 (72.3)	-	
Rinse with water in the farm		12 (25.5)	-	
Not Using		1 (2.1)	15 (100.0)	
<b>Pesticide Storage</b>				
Not Using		-	15 (100.0)	
In the farm		47 (100.0)	-	

	Conventional (n=47)		Organic (n=15)	
	Mean (SD)	n (%)	Mean (SD)	n (%)
<b>Pesticide Container Disposal</b>				
No disposal method is practised		-		15 (100.0)
Throw as general waste		29 (61.7)		-
Gather to recycle centre		18 (38.3)		-
Burn		-		-



#### **4.2.3 Social Lifestyle among Farmers at Cameron Highland**

The social lifestyle of this study included smoking habits, alcohol consumption and coffee habits. There 66.0% of conventional farmers and 86.7% of organic farmers did not smoke while 34.0% of conventional farmers and 13.3% of organic farmers were smoking. There 44.7% of conventional farmers and 66.7% of organic farmers did not take alcohol in daily life. 17.0% of conventional farmers and none of the organic farmers took the alcohol once a week. 14.9% of conventional farmers and none of the organic farmers took the alcohol 3 to 4 times a week. 23.4% of conventional farmers and 33.3% of organic farmers took alcohol 3 times a month. None of the organic and conventional farmers took alcohol 1 to 1 times a year.

**Table 4.4: Social Lifestyle among Farmers at Cameron Highland (N=62)**

	<b>Conventional (n=47)</b>	<b>Organic (n=15)</b>
	<b>n (%)</b>	<b>n (%)</b>
<b>Smoking Habits</b>		
No	31 (66.0)	13 (86.7)
Yes	16 (34.0)	2 (13.3)
<b>Alcohol Consumption</b>		
No Alcohol	21 (44.7)	10 (66.7)
Once a week	8 (17.0)	-
3 to 4 times a week	7 (14.9)	-
3 times a month	11 (23.4)	5 (33.3)
1 to 2 times a year	-	-
<b>Coffee Habit</b>		
No Coffee	33 (70.2)	10 (66.7)
Once a day	10 (21.3)	3 (20.0)
Twice a day	1 (2.1)	-
Once per week	2 (4.3)	1 (6.7)
3/4 times a week	1 (2.1)	1 (6.7)

### **4.3 Comparison Level of Serum Cholinesterase among Organic and Conventional Vegetable Farmers in Cameron Highland**

Based on Table 4.5, the Mann-Whitney U test was done after running the normality test. The normality was done using the analytical method which was the Kolmogorov-Smirnov test. The significance values (p-value) for conventional and organic farmers that were obtained during the test were 0.001 and 0.021 respectively. Both of these p-values were less than 0.05 ( $P < 0.05$ ) which indicated the data was not normally distributed. Confirming that the normality assumption was violated.

Mann-Whitney U test was done to compare the level of serum cholinesterase among organic and conventional vegetable farmers from Cameron Highland. From the test, the median of blood cholinesterase for conventional farmers was 324.41 u/L with an Interquartile Range (IQR) of 115.94, whereas the median of blood cholinesterase for organic farmers was 359.73 u/L with an Interquartile Range (IQR) of 73.1. The p-value was 0.037 ( $p < 0.05$ ), and there was a significant difference in the median of conventional and organic farmers. So, there was the need to reject  $H_0$ .

**Table 4.5: Comparison level of Serum Cholinesterase among Organic and Conventional Vegetable Farmers (N=62)**

	<b>Conventional Farmland (n=47)</b>	<b>Organic Farmland (n=15)</b>	<b>z-value</b>	<b>p-value</b>
	Median (IQR) (u/L)	Median (IQR) (u/L)		
Cholinesterase level	324.41 (115.94)	359.73 (73.18)	-2.088	0.037*

\*p-value is significant at 0.05

\*\* p-value is significant at 0.001

#### **4.4 The Liver Function Indicators (Serum Aspartate Transaminase (AST) and Serum Alanine Transaminase (ALT)) among Organic and Conventional Vegetable Farmers in Cameron Highland.**

Based on Table 4.6, the Mann-Whitney U test was done after running the normality test. The normality was done using the analytical method which was the Kolmogorov-Smirnov test. The significance values (p-value) for Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) from conventional farmers that were obtained during the test were 0.001 and 0.001 respectively. The significance values (p-value) for Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) from organic farmers that were obtained during the test were 0.027 and 0.179 respectively. These p-values were less than 0.05 ( $P < 0.05$ ) which indicated the data was not normally distributed. Confirming that the normality assumption was violated.

The Mann-Whitney U test was done to compare the level of serum aspartate transaminase (AST) and serum alanine transaminase (ALT) among organic and conventional vegetable farmers in Cameron Highland. From the test, the median of serum aspartate transaminase (AST) and serum alanine transaminase (ALT) for conventional farmers were 22.00 u/L and 20.00 u/L respectively with an Interquartile Range (IQR) of 58.00 and 50.00, whereas the median of serum aspartate transaminase (AST) and serum alanine transaminase (ALT) for organic farmers were 21.00 u/L and

20.00 u/L respectively with an Interquartile Range (IQR) of 6.00 and 16.00. The p-values for serum aspartate transaminase (AST) and serum alanine transaminase (ALT) were 0.134 ( $p>0.05$ ) and 0.622 ( $p>0.05$ ) respectively. There was no significant difference in the median of conventional and organic farmers. So, there was a failure to reject  $H_0$ .

**Table 4.6: Comparison of liver function indicators which are serum aspartate transaminase (AST) and serum alanine transaminase (ALT) among organic and conventional vegetable farmers in Cameron Highland. (N=62)**

	<b>Conventional Farmland (n=47)</b>	<b>Organic Farmland (n=15)</b>	<b>z-value</b>	<b>p-value</b>
	Median (IQR) (U/L)	Median (IQR) (U/L)		
Aspartate amino transferase (AST)	22.00 (58.00)	21.00 (6.00)	-1.499	0.134
Alanine aminotransferase (ALT)	20.00 (50.00)	20.00 (16.00)	-0.494	0.622

\*p-value is significant at 0.05

\*\* p-value is significant at 0.001

#### **4.5 The Kidney Function Indicators (The Level of Serum Creatinine and Urea) Among Organic And Conventional Vegetable Farmers In Cameron Highland**

Based on Table 4.7, the Mann-Whitney U test was done after running the normality test. The normality was done using the analytical method which was the Kolmogorov-Smirnov test. The significance values (p-value) for creatine and urea from conventional farmers that were obtained during the test were 0.007 and 0.001 respectively. The significance values (p-value) for creatine and urea from organic farmers that were obtained during the test were 0.2 and 0.2 respectively. These p-values were less than 0.05 ( $P < 0.05$ ) which indicated the data was not normally distributed. Confirming that the normality assumption was violated.

The Mann-Whitney U test was done to examine the differences in the level of serum creatine and urea among organic and conventional vegetable farmers in Cameron Highland. From the test, the median of serum creatine and urea for conventional farmers were 87.00 and 5.50 respectively with an Interquartile Range (IQR) of 45.00 and 4.40 respectively, whereas the median of serum creatine and urea for organic farmers was 82.00 and 4.54 respectively with an Interquartile Range (IQR) of 17.00 and 1.65 respectively. The p-values for serum creatine and urea were 0.397 ( $p > 0.05$ ) and 0.049 ( $p < 0.05$ ) respectively. There are no significant differences in the median of conventional and organic farmers for creatine and there are significant

differences in the median of conventional and organic farmers for urea. So, there was a failure to reject  $H_0$  for creatine and there was a need to reject  $H_0$  for creatine.

**Table 4.7: Comparison of kidney function indicators (level of serum creatinine and urea) among organic and conventional vegetable farmers in Cameron Highland. (N=62)**

	<b>Conventional Farmland (n=47)</b>	<b>Organic Farmland (n=15)</b>	<b>z-value</b>	<b>p-value</b>
	Median (IQR) (umol/L)	Median (1QR) (umol/L)		
Creatine	87.00 (45.00)	82.00 (17.00)	-0.84	0.397
Urea	5.50 (4.40)	4.54 (1.65)	-1.964	0.049*

\*p-value is significant at 0.05

\*\* p-value is significant at 0.001

#### **4.6 Association Pesticide-Induced Changes in Cholinesterase Activity, Kidney Function and Liver Function among Organic and Conventional Vegetable Farmers**

To associate pesticide-induced changes in cholinesterase activity, kidney function and liver function among organic and conventional vegetable farmers, a statistical analysis was performed by using the Spearman correlation test. First, a normality test was done by using an analytic method which was Kolmogorov-Smirnov,  $P < 0.05$  for all variables. So, the data is not normally distributed because  $p < 0.05$ . Confirming that the normality assumption is violated.

From Table 4.8, the bivariate correlation between cholinesterase level and liver function indicator (AST and ALT) from conventional farmers was negative and poor,  $r(45) = -0.422$ ,  $p < 0.05$  for AST and negative and poor,  $r(45) = -0.403$ ,  $p < 0.05$  for ALT. The null hypothesis ( $H_0$ ) will be rejected as the significance value for the correlation test is  $p < 0.05$ . Meanwhile, the bivariate correlation between cholinesterase level and liver function indicator (AST and ALT) from organic farmers was negative and poor,  $r(45) = -0.161$ ,  $p > 0.05$  for AST and negative and poor,  $r(45) = -0.218$ ,  $p > 0.05$  for ALT. the null hypothesis ( $H_0$ ) will be failed to reject as the significance value for the correlation test is  $p > 0.05$ . However, the bivariate correlation between cholinesterase level and liver function indicator (AST and ALT) from overall farmers was negative and poor,  $r(45) = -0.409$ ,  $p < 0.05$  for AST and negative and poor,  $r(45)$

= -0.401,  $p < 0.05$  for ALT. the null hypothesis ( $H_0$ ) will be rejected as the significance value for the correlation test is  $p < 0.05$

The bivariate correlation between cholinesterase level and kidney function indicator (creatinine and urea) from conventional farmers was negative and poor,  $r(45) = -0.359$ ,  $p < 0.05$  for creatinine and negative and poor,  $r(45) = -0.332$ ,  $p < 0.05$  for urea. The null hypothesis ( $H_0$ ) was rejected as the significance value for the correlation test is  $p < 0.05$ . Meanwhile, the bivariate correlation between cholinesterase level and kidney function indicator (creatinine and urea) from organic farmers was negative and poor,  $r(45) = -0.046$ ,  $p > 0.05$  for creatinine and negative and poor,  $r(45) = -0.243$ ,  $p > 0.05$  for urea. The null hypothesis ( $H_0$ ) failed to reject as the significance value for the correlation test is  $p > 0.05$ . However, the bivariate correlation between cholinesterase level and kidney function indicator (creatinine and urea) from overall farmers was negative and poor,  $r(45) = -0.337$ ,  $p < 0.05$  for creatinine and negative and poor,  $r(45) = -0.332$ ,  $p < 0.05$  for urea. The null hypothesis ( $H_0$ ) was rejected as the significance value for the correlation test is  $p < 0.05$ .

**Table 4.8: Association Pesticide-Induced Changes in Cholinesterase Activity, Kidney Function and Liver Function among Organic and Conventional Vegetable Farmers**

	<b>Cholinesterase level</b>					
	Conventional (N=47)		Organic (N=15)		Overall (N=62)	
	Correlation Coefficient, r	p-value	Correlation Coefficient, r	p-value	Correlation Coefficient, r	p-value
<b>Liver Function Indicator</b>						
AST	-0.422	0.003	-0.161	0.566	-0.409	<0.001**
ALT	-0.403	0.005	-0.218	0.434	-0.401	0.001*
<b>Kidney Function Indicator</b>						
Creatine	-0.359	0.013	-0.046	0.869	-0.337	0.007*
Urea	-0.327	0.025	-0.243	0.383	-0.332	0.008*

\*p-value is significant at 0.05

\*\* p-value is significant at 0.001

## CHAPTER 5

### DISCUSSION

#### **5.1 Socio-Demographic, Occupational Background and Social Lifestyle among Vegetable Farmers at Cameron Highland.**

This study comprised a total of 64 farmers which were made up of 15 respondents from the organic farming sector and 47 respondents from the conventional farming sector. The number of male farmers in both groups was greater than the number of female farmers. This was supported by Wang et al. (2017) in a study involving Chinese farmers, who found that gender played a role in pesticide knowledge. Men showed a higher level of awareness regarding the adverse effects of pesticides compared to women. The study suggested that a lower level of education among women was one factor that contributed to this disparity. Men, being more educated, had greater access to information and resources related to pesticides.

This contradicts our findings. Our study revealed that the majority of conventional farmers have only completed primary education and possess limited knowledge about pesticides, in contrast to organic farmers who have a higher proportion of individuals with tertiary education. The differences in educational level were supported by Damalas and Koutroubas (2017) who stated that farmers who received training had higher levels of knowledge regarding pesticide use compared to

those who did not receive any training. This supports the notion that differences in educational level contribute to variations in understanding. Nevertheless, farmers possessing lower levels of education may encounter difficulties when it comes to crucial responsibilities such as calibrating sprayers or accurately quantifying and blending pesticides. This could affect their farming routine and increase the risks to their health when handling chemicals (Okoffo et al., 2016). Based on our results, the prevalence of overweight farmers was greater among conventional farmers compared to organic farmers. These findings are similar to Damalas and Koutroubas (2017) who found that 28.7% of the 515 participants were found to be obese, while 54.8% were diagnosed with chronic kidney disease.

Our study found that only 25.5% of conventional farmers utilized PPE while handling pesticides, in contrast to 93.3% of organic farmers who wore PPE. This finding was consistent with a study conducted by Okoffo et al. (2016), which revealed that despite being conscious of the risks, most farmers do not exercise caution when handling pesticides and disregard the importance of using PPE, thereby increasing the potential dangers associated with pesticide exposure. Our study revealed that 31.9% of conventional farmers stored the pesticide on the farm, while organic farmers did not. This was similar to the study of Okoffo et al. (2016) where at least 43.3% of their farmers opted to store pesticides on farms.

According to a report by the Northern Presbyterian Agricultural Services (NPAS) in 2012, a total of 15 farmers in the upper East region of Ghana reportedly

died as a result of losing their lives in 2010 due to suspected pesticide poisoning. The primary cause of these fatalities was attributed to inadequate storage of pesticides. None of the conventional farmers failed to properly dispose of their pesticide containers after use, a contrast to the findings of Okoffo et al. (2016) where 65% of farmers left the empty chemical containers on the farm without proper handling before discharging them. Our study found that 25.5% of conventional farmers and 6.7% of organic farmers experienced symptoms following pesticide handling. In contrast to the findings of Jambari et al. (2020), all the respondents in their study reported experiencing pesticide-like poisoning symptoms. Specifically, 34.7% of respondents reported experiencing excessive sweating and blurred vision, while headaches, cough, and numbness in the legs were the next most common symptoms, each reported by 22.9% of participants. A smaller percentage, 11.1% encountered numbness in their hands, while 10.4% reported experiencing chest pain. Only a small portion of the subjects reported symptoms like nausea (2.8%) and stomach pain (1.4%).

In exploring alternative explanations for the observed comparison between organic and conventional farmers, it was important to potential contributing factors influencing variations in health markers. Beyond agricultural practices, lifestyle behaviors including tobacco use, or alcohol consumption may exert considerable influence.

Our study found that 34% of conventional farmers and 13.3% of organic farmers reported being regular smokers. Okoffo et al. (2016) reported that their farmers

exhibited a greater prevalence of smoking compared to our findings, which indicated a smoking rate of 20.4 % among all farmers. The study consisted of 55.3% conventional farmers and 33.3% organic farmers who consumed alcohol. The aforementioned study revealed that 55.8% of the farmers surveyed reported engaging in alcohol consumption. 29.8% of conventional farmers and 33.3% of organic farmers consumed coffee regularly. Consuming more than two cups of coffee daily in individuals with pre-existing liver conditions has been linked to a reduced likelihood of developing fibrosis and cirrhosis, lower rates of hepatocellular carcinoma, and a decreased risk of mortality (Wadhawan & Anand, 2016). Contrary to popular belief, the notion that consuming coffee can have negative health effects is unfounded.

## **5.2 Comparison Level of Serum Cholinesterase among Organic and Conventional Vegetable Farmers in Cameron Highland**

Mann-Whitney U test was conducted to compare the serum cholinesterase levels between organic and conventional vegetable farmers in Cameron Highland. Based on our findings, the median blood cholinesterase for conventional farmers was 324.41 u/L, while the median of blood cholinesterase level for organic farmers was 359.73 u/L. The p-value was 0.037 ( $p < 0.05$ ), indicating a statistically significant difference in the median values between conventional and organic farmers. Garmavy et al. (2023) established that the acceptable range for blood cholinesterase levels in the human body is 150 - 310 u/L. Although the findings for both groups exceeded the normal range, conventional farmers faced a higher risk due to the inverse relationship

between the value and the danger level of blood cholinesterase. Santarpia et al. (2012) state that measuring cholinesterase levels is crucial for investigating cases of organophosphate pesticide poisonings following both acute and chronic pesticide exposure.

Sawarng et al. (2021) found that farmers at Akumadan had significantly lower blood Cholinesterase activity compared to the control group, with a statistically significant difference ( $p < 0.001$ ). Thus, our findings and their findings exhibited comparable significant disparities between organic and conventional farmers. According to Sawarng et al. (2021), the decreased blood cholinesterase levels observed in conventional farmers can likely be attributed to unsafe work practices and the need to manage pests in agriculture. The blood cholinesterase levels of individuals were influenced by their education level. In Akumadan, the majority of farmers (64.9%) had only primary and middle school education, while a small percentage (12.7%) had no formal education (Ntow et al., 2006). According to Nielsen and Andersen (2002), decreased blood cholinesterase levels may be attributed to factors such as age, gender, body weight, and height.

### **5.3 Comparison of Liver Function Indicators (Serum Aspartate Transaminase (AST) And Serum Alanine Transaminase (ALT)) among Organic and Conventional Vegetable Farmers in Cameron Highland**

The Mann-Whitney U test was conducted to compare the level of serum aspartate transaminase (AST) and serum alanine transaminase (ALT) between organic and conventional vegetable farmers in Cameron Highland. The test results indicate that the median levels of serum aspartate transaminase (AST) and serum alanine transaminase (ALT) were 22.00 u/L and 20.00 u/L, respectively, for conventional farmers. On the other hand, the median levels of serum aspartate transaminase (AST) and serum alanine transaminase (ALT) were 21.00 u/L and 20.00 u/L, respectively, for organic farmers. The p-values for serum aspartate transaminase (AST) and serum alanine transaminase (ALT) were 0.134 ( $p>0.05$ ) and 0.622 ( $p>0.05$ ) respectively. There was no significant difference in the median of conventional and organic farmers. Siddiqui et al. (2019) established that the acceptable range for AST levels is 7-55 u/L, while for ALT levels it is 8-33 u/L. While the AST and ALT levels of all farmers fell within the normal range, conventional farmers still have a higher risk compared to organic farmers.

In contrast, Bunsri et al. (2023) reported an opposite result in their study, with p-values for AST and ALT in vegetable farmers being less than 0.01. This suggests that there are significant differences among all the farmers. The elevated AST and ALT levels were a result of liver cell lysis and the subsequent release of enzymes into the bloodstream, which can have cytotoxic effects (Manfo et al., 2020). Another reason for higher level of AST and ALT was due to exposure to pesticides, such as organophosphates, which can lead to disturbances in liver metabolism and mitochondrial metabolic pathways due to oxidative damage (Karami-Mohajeri et al.,

2017). This because organophosphates inhibit acetylcholinesterase, causing acetylcholine accumulation and oxidative stress, impairing liver function. Pyrethroids induce liver inflammation and oxidative stress, potentially elevating AST and ALT levels. Conversely, organic farming relies less on synthetic pesticides, lowering exposure levels and reducing liver enzyme effects. Though organic pesticides may still pose risks, their lower toxicity likely results in milder impacts on AST and ALT levels compared to conventional pesticides

#### **5.4 Comparison of Kidney Function Indicators (Level of Serum Creatinine and Urea) among Organic and Conventional Vegetable Farmers in Cameron Highland**

The Mann-Whitney U test was conducted to examine the differences in the level of serum creatine and urea among organic and conventional vegetable farmers in Cameron Highland. The test results indicate that the median levels of serum creatine and urea for conventional farmers were 87.00 and 5.50 respectively. In contrast, the median levels of serum creatine and urea for organic farmers were 82.00 and 4.54 respectively. The p-values for serum creatine and urea were 0.397 ( $p > 0.05$ ) and 0.049 ( $p < 0.05$ ) respectively. There is no substantial disparity in the median values of creatine between conventional and organic farmers. However, there are significant differences in the median values of urea between conventional and organic farmers. According to (Hosten, 1990), the acceptable range for creatine levels was found to be between 61.9

and 114.9  $\mu\text{mol/L}$ , while the range for urea levels was between 1.8 and 7.1  $\mu\text{mol/L}$ . Both groups exhibited normal ranges, however, conventional farmers demonstrated a greater susceptibility to kidney health as a result of elevated levels of creatine and urea in comparison to organic farmers. This disparity can be attributed to the vital function of the kidneys in eliminating foreign substances, such as pesticides and their by-products. The kidney receives approximately 25% of the cardiac output, making it susceptible to the accumulation of foreign substances in the bloodstream at a relatively elevated level (Kaufman et al., 2022).

Although this study did not observe a statistically significant difference in the median creatine level between the two groups, the urea level exhibited contrasting results. These findings align with a previous study conducted by Manfo et al. (2020), where the p-values for creatine were 0.090, indicating no statistical significance, but contrasting results were observed for urea. The absence of statistical significance in creatine levels was also confirmed by Aroonvilairat et al. (2015) in their study investigating the impact of pesticide exposure on immunological, haematological, and biochemical parameters in Thai orchid farmers. Nickson (2023) claimed that creatine levels may not show significant changes in response to pesticide exposure because creatine primarily reflects muscle metabolism and may not be directly affected by the toxic effects of pesticides. On the other hand, an increase in urea levels could indicate renal dysfunction, as the kidneys can excreting waste products, including urea. Elevated urea due to impaired renal function due to pesticide toxicity, as pesticides can potentially damage the kidneys. Therefore, from a biomarker of effects and

toxicological perspective, changes in urea levels are more indicative of renal involvement in pesticide exposure, emphasizing the importance of monitoring kidney function as a potential target organ for toxicity assessment in the context of pesticide exposure. However, a study from Green et al. (2004) said that evaluating only creatine and urea levels is insufficient to accurately detect renal changes caused by pesticides. It is necessary to additionally assess other enzymes, such as serum cystatin and albuminuria, to obtain a comprehensive understanding of the situation.

### **5.5 Association Pesticide-Induced Changes in Cholinesterase Activity, Kidney Function and Liver Function among Organic and Conventional Vegetable Farmers**

From Table 4.8, the correlation between cholinesterase level and liver function indicators (AST and ALT) among conventional farmers was negative and weak. Specifically, the correlation coefficient ( $r$ ) was  $-0.422$  ( $p < 0.05$ ) for AST and  $-0.403$  ( $p < 0.05$ ) for ALT. Meanwhile, the bivariate correlation between cholinesterase level and liver function indicators (AST and ALT) among organic farmers was found to be negative and weak. Specifically, the correlation coefficient ( $r$ ) for AST was  $-0.161$  ( $p > 0.05$ ), indicating a negative but insignificant relationship. Similarly to the study by Awad et al. (2014), they got a negative correlation too between AST, ALT and cholinesterase levels among the non-exposed group and contrasted with our result in terms of the exposed group, Exposure to pesticides with heterogeneous chemicals among farmers could give several adverse effects such as acute or chronic exposure to pesticide may associated with liver damage (Huang et al., 2016).

The bivariate correlation between cholinesterase level and kidney function indicators (creatinine and urea) among conventional farmers was found to be negative and weak. Specifically, the correlation coefficient (r) for creatinine was -0.359 ( $p < 0.05$ ), and for urea it was -0.332 ( $p < 0.05$ ). Meanwhile, the bivariate correlation between cholinesterase level and kidney function indicators (creatinine and urea) among organic farmers was found to be negative and weak. Specifically, the correlation coefficient (r) for creatinine was -0.046 ( $p > 0.05$ ), indicating a weak negative relationship. Similarly, the correlation coefficient for urea was -0.243 ( $p > 0.05$ ), also indicating a weak negative relationship. Studies by Tayeb et al. (2012) using animals have shown that herbicides and pesticides can lead to tissue damage and impair kidney function. Their investigation entailed subjecting rats to pesticide exposure for a duration of 28 days. This resulted in a noticeable increase in both plasma urea level and creatinine, suggesting the presence of possible renal complications. However, Wesseling et al. (2016) observed a discrepancy as they did not discover any correlation between pesticide exposure and decreased kidney function in farmers. Another study by Sombatsawat et al. (2021) revealed a decline in renal function among farmers who were exposed to pesticides. Our findings supported this by presenting evidence of impaired kidney function in individuals who were exposed to synthetic pesticides, thus emphasizing the potential contribution of synthetic pesticides to kidney damage.

## CHAPTER 6

### CONCLUSION AND RECOMMENDATION

#### 6.1 Conclusion

In conclusion, the main objective of this study is to compare the effects of synthetic pesticide use on liver and kidney function among vegetable farmers from Cameron Highland has been achieved by taking blood sampling of the organic and conventional farmers.

Besides, farmers who were involved in this study were also higher in males compared to females even in both groups. The results show that there was a significant in the median blood of conventional and organic farmers. Cholinesterase is an enzyme crucial for the proper functioning of the nervous system, and its inhibition by certain pesticides can lead to neurotoxic effects. The study also shows no significant difference in the median liver indicator (AST and ALT) among organic and conventional farmers. Also, we found there was no significant difference in the median of creatine but a significant difference in the median of urea among both groups of

farmers. Lastly, there were adverse correlations observed among all vegetable farmers between cholinesterase activity, kidney function, and liver function.

## **6.2 Recommendation**

As a recommendation, since the study finds evidence of adverse effects on liver and kidney function among vegetable farmers due to synthetic pesticide use, one recommendation could be the implementation of educational programs. These programs could focus on safe pesticide handling, proper protective measures, and alternatives to minimize health risks. We recommend implementing educational programs tailored to the specific needs identified in our study. For instance, targeting topics such as proper pesticide storage, application techniques, and the use of personal protective equipment can help mitigate the risks associated with pesticide exposure. By directly addressing the knowledge gaps identified among conventional farmers, these educational initiatives can empower individuals to adopt safer practices and reduce their risk of adverse health effects.

Furthermore, given the potential health risks, regular health check-ups for farmers could be recommended. Early detection of any adverse health effects related to pesticide exposure can facilitate timely intervention and treatment. Based on our findings indicating significant correlations between pesticide exposure and liver and kidney function, we recommend implementing regular health check-ups for farmers in the region. These check-ups should include comprehensive assessments of liver

function to facilitate early detection and intervention for any abnormalities. By directly linking this recommendation to the observed association between pesticide exposure and liver dysfunction, we emphasize the importance of proactive health monitoring to safeguard the well-being of agricultural workers.

Other than that, given our findings indicating significant impacts of pesticide exposure on liver and kidney function among farmers in Cameron Highlands, it is imperative to involve the local community, particularly farmers, in discussions about the study findings. This recommendation is underscored by the observed correlations between pesticide exposure and markers of liver and kidney dysfunction. Engaging farmers in dialogue sessions and community meetings to share study findings and raise awareness about the potential health risks associated with pesticide use can empower them to make informed decisions about agricultural practices.

Lastly, since the study identifies potential long-term health effects, recommendations might include the initiation of longitudinal studies to track the health of farmers over an extended period. This could provide more comprehensive insights into the cumulative effects of synthetic pesticide exposure.

## REFERENCES

- Amr, S., Dawson, R., Saleh, D. A., Magder, L. S., St George, D. M., El-Daly, M., Squibb, K. S., Mikhail, N., Abdel-Hamid, M., Khaled, H., & Loffredo, C. A. (2014). Pesticides, gene polymorphisms, and bladder cancer among Egyptian agricultural workers. *Archives of Environmental & Occupational Health*, 70(1), 19–26. <https://doi.org/10.1080/19338244.2013.853646>
- Anderson, S. E., & Meade, B. J. (2014). Potential Health Effects Associated with Dermal Exposure to Occupational Chemicals. *Environmental Health Insights*, 8(1), EHI.S15258. <https://doi.org/10.4137/ehi.s15258>
- Asao, T., Oki, K., Yoneda, M., Tanaka, J., & Kohno, N. (2016). Hypothalamic-pituitary-adrenal axis activity is associated with the prevalence of chronic kidney disease in diabetic patients. *Endocrine Journal*, 63(2), 119–126. <https://doi.org/10.1507/endocrj.ej15-0360>
- Azarbad, H. (2022). Conventional vs. Organic Agriculture—Which One Promotes Better Yields and Microbial Resilience in Rapidly Changing Climates? *Frontiers in Microbiology*, 13. <https://doi.org/10.3389/fmicb.2022.903500>
- Azmi Jr, M. Y., Junidah, R., Siti, M. A., Safiah, M. Y., Fatimah, S., Norimah, A. K., ... & Tahir, A. (2009). Body mass index (BMI) of adults: findings of the Malaysian Adult Nutrition Survey (MANS). *Malaysian journal of nutrition*, 15(2), 97-119.

- Bach, C., Dauchy, X., Chagnon, M.-C., & Etienne, S. (2012). Chemical compounds and toxicological assessments of drinking water stored in polyethylene terephthalate (PET) bottles: A source of controversy reviewed. *water research*, 46(571), e583.
- Beard, J. D., Umbach, D. M., Hoppin, J. A., Richards, M., Alavanja, M. C., Blair, A., Sandler, D. P., & Kamel, F. (2014). Pesticide Exposure and Depression among Male Private Pesticide Applicators in the Agricultural Health Study. *Environmental Health Perspectives*, 122(9), 984–991. <https://doi.org/10.1289/ehp.1307450>
- Beck, I. C., Bruhn, R., Gandrass, J., & Ruck, W. (2005). Liquid chromatography–tandem mass spectrometry analysis of estrogenic compounds in coastal surface water of the Baltic Sea. *Journal of Chromatography A*, 1090(1), 98–106.
- Bretveld, R., Thomas, C. M., Scheepers, P. T., Zielhuis, G. A., & Roeleveld, N. (2006). Pesticide exposure: the hormonal function of the female reproductive system disrupted? *Reproductive Biology and Endocrinology*, 4(1). <https://doi.org/10.1186/1477-7827-4-30>
- Brzóška, M. M., Moniuszko-Jakoniuk, J., Piłat-Marcinkiewicz, B., & Sawicki, B. (2003). LIVER AND KIDNEY FUNCTION AND HISTOLOGY IN RATS EXPOSED TO CADMIUM AND ETHANOL. *Alcohol and Alcoholism*, 38(1), 2–10. <https://doi.org/10.1093/alcalc/agg006>
- Bunsri, S., Muenchamnan, N., Naksen, W., & Ong-Artborirak, P. (2023). The Hematological and Biochemical Effects from Pesticide Exposure on Thai

Vegetable Farmers. *Toxics*, 11(8), 707.

<https://doi.org/10.3390/toxics11080707>

Čolović, M. B., Krstić, D., Lazarević-Pašti, T., Bondžić, A. M., & Vasić, V. (2013).

Acetylcholinesterase inhibitors: Pharmacology and toxicology. *Current Neuropharmacology*, 11(3), 315–335.

<https://doi.org/10.2174/1570159x11311030006>

Costa, C., García-Lestón, J., Costa, S., Coelho, P. M. F., Silva, S., Pingarilho, M., Valdiglesias, V., Mattei, F., Dall'Armi, V., Bonassi, S., Laffon, B., Snawder, J. E., & Teixeira, J. A. (2014). Is organic farming safer to farmers' health? A

comparison between organic and traditional farming. *Toxicology Letters*, 230(2), 166–176. <https://doi.org/10.1016/j.toxlet.2014.02.011>

CS-400 Auto-Chemistry Analyzer / Dirui Industrial Co., Ltd. (n.d.).

<https://www.omnia-health.com/product/cs-400-auto-chemistry-analyzer>

Damalas, C. A., & Eleftherohorinos, I. G. (2011). Pesticide exposure, safety issues, and risk assessment indicators. *International Journal of Environmental Research and Public Health*, 8(5), 1402–1419.

<https://doi.org/10.3390/ijerph8051402>

Damalas, C. A., & Koutroubas, S. D. (2016). Farmers' exposure to pesticides: toxicity types and ways of prevention. *Toxics*, 4(1), 1.

<https://doi.org/10.3390/toxics4010001>

Damalas, C. A., & Koutroubas, S. D. (2017). Farmers' Training on Pesticide Use Is Associated with Elevated Safety Behavior. *Toxics*, 5(3), 19.

<https://doi.org/10.3390/toxics5030019>

Dardak, R. A. (2020, July 16). *Transformation of agricultural sector in Malaysia through agricultural policy*. FFTC Agricultural Policy Platform (FFTC-AP). <https://ap.fftc.org.tw/article/818>

Dardak, R. A. (2020, July 16). Transformation of agricultural sector in Malaysia through agricultural policy. FFTC Agricultural Policy Platform (FFTC-AP). <https://ap.fftc.org.tw/article/818>

*Defining Pesticide biomarkers* | US EPA. (2023, March 10). US EPA. <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/defining-pesticide-biomarkers>

Del Prado-Lu, J. L. (2007). Pesticide exposure, risk factors and health problems among cutflower farmers: a cross sectional study. *Journal of Occupational Medicine and Toxicology*, 2(1), 9. <https://doi.org/10.1186/1745-6673-2-9>

Dennis, L. K., Lynch, C. F., Sandler, D. P., & Alavanja, M. C. (2010). Pesticide use and cutaneous melanoma in pesticide applicators in the Agricultural Health study. *Environmental Health Perspectives*, 118(6), 812–817. <https://doi.org/10.1289/ehp.0901518>

Dhouib, I. E., Lasram, M. M., Annabi, A., Gharbi, N., & El-Fazâa, S. (2015). A comparative study on toxicity induced by carbosulfan and malathion in Wistar rat liver and spleen. *Pesticide Biochemistry and Physiology*, 124, 21–28. <https://doi.org/10.1016/j.pestbp.2015.03.012>

Fraites, M. J., Cooper, R. L., Buckalew, A. R., Jayaraman, S., Mills, L. J., & Laws, S. C. (2009). Characterization of the Hypothalamic-Pituitary-Adrenal axis

response to atrazine and metabolites in the female rat. *Toxicological Sciences*, *112*(1), 88–99. <https://doi.org/10.1093/toxsci/kfp194>

Garmavy, H. M. S., Mohammed, A. A., Rashid, H. M., & Mohammad, F. K. (2023).

A meta-analysis of normal human blood cholinesterase activities determined by a modified electrometric method. *Journal of Medicine and Life*, *16*(1), 22–34. <https://doi.org/10.25122/jml-2022-0215>

Green, T., Dow, J., Ong, C., Ng, V. S., Ong, H. T., Zhuang, Z., Xiao-Hui, Y., & Bloemen, L. (2004). Biological monitoring of kidney function among workers occupationally exposed to trichloroethylene. *Occupational and Environmental Medicine*, *61*(4), 312–317. <https://doi.org/10.1136/oem.2003.007153>

Ho, Y. B., Zakaria, M. P., Latif, P. A., & Saari, N. (2012). Simultaneous determination of veterinary antibiotics and hormone in broiler manure, soil and manure compost by liquid chromatography–tandem mass spectrometry. *Journal of Chromatography A*, *1262*(0), 160–168.

Hu, R., Huang, X., Huang, J., Li, Y., Zhang, C., Yin, Y., Chen, Z., Jin, Y., Cai, J., & Cui, F. (2015). Long- and Short-Term Health Effects of Pesticide Exposure: A Cohort Study from China. *PLOS ONE*, *10*(6), e0128766. <https://doi.org/10.1371/journal.pone.0128766>

Huang, X., Zhang, C., Hu, R., Li, Y., Yin, Y., Chen, Z., Cai, J., & Cui, F. (2016). Association between occupational exposures to pesticides with heterogeneous chemical structures and farmer health in China. *Scientific Reports*, *6*(1). <https://doi.org/10.1038/srep25190>

- Huyen, V. N., Van Song, N., Thuy, N. T., Dung, L. T., & Hoan, L. K. (2020). Effects of pesticides on farmers' health in Tu Ky district, Hai Duong province, Vietnam. *Sustainable Futures*, 2, 100026. <https://doi.org/10.1016/j.sftr.2020.100026>
- Ibrahim, I. Z. (2020, July 16). *Organic agriculture in Malaysia*. FFTC Agricultural Policy Platform (FFTC-AP). <https://ap.ffc.org.tw/article/1010>
- Ix, J. H., & Sharma, K. (2010). Mechanisms linking obesity, chronic kidney disease, and fatty liver disease. *Journal of the American Society of Nephrology*, 21(3), 406–412. <https://doi.org/10.1681/asn.2009080820>
- Jors, E., Hay-Younes, J., Condarco, M. A., Condarco, G., Cervantes, R., Huici, O., & Bælum, J. (2013). Is gender a risk factor for pesticide intoxications among farmers in Bolivia? A Cross-Sectional study. *Journal of Agromedicine*, 18(2), 132–139. <https://doi.org/10.1080/1059924x.2013.767102>
- Kalra, A. (2023, May 1). *Physiology, liver*. StatPearls - NCBI Bookshelf. <https://www.ncbi.nlm.nih.gov/books/NBK535438/>
- Karami-Mohajeri, S., Ahmadipour, A., Rahimi, H. R., & Abdollahi, M. (2017). Adverse effects of organophosphorus pesticides on the liver: a brief summary of four decades of research. *Arhiv Za Higijenu Rada I Toksikologiju*, 68(4), 261–275. <https://doi.org/10.1515/aiht-2017-68-2989>
- Kim, K., Kabir, E., & Jahan, S. A. (2017). Exposure to pesticides and the associated human health effects. *Science of the Total Environment*, 575, 525–535. <https://doi.org/10.1016/j.scitotenv.2016.09.009>

- Koutros, S., Lynch, C., Ma, X., Lee, W., Hoppin, J. A., Christensen, C. H., Andreotti, G., Freeman, L. B., Rusiecki, J., Hou, L., Sandler, D. P., & Alavanja, M. (2008). Aromatic amine pesticide use and human cancer risk: Results from the U.S. Agricultural Health Study. *Annals of Epidemiology*, 18(9), 720. <https://doi.org/10.1016/j.annepidem.2008.08.043>
- Koutros, S., Silverman, D. T., Alavanja, M. C., Andreotti, G., Lerro, C. C., Heltshe, S. L., Lynch, C. F., Sandler, D. P., Blair, A., & Freeman, L. E. B. (2015). Occupational exposure to pesticides and bladder cancer risk. *International Journal of Epidemiology*, 45(3), 792–805. <https://doi.org/10.1093/ije/dyv195>
- Kučka, M., Pogrmic-Majkić, K., Fa, S., Stojilković, S. S., & Kovačević, R. (2012). Atrazine acts as an endocrine disrupter by inhibiting cAMP-specific phosphodiesterase-4. *Toxicology and Applied Pharmacology*, 265(1), 19–26. <https://doi.org/10.1016/j.taap.2012.09.019>
- Lee, T. H., Kim, W., & Poterucha, J. J. (2012b). Evaluation of elevated liver enzymes. *Clinics in Liver Disease*. <https://doi.org/10.1016/j.cld.2012.03.006>
- Leskovac, A., & Petrović, S. (2023). Pesticide Use and Degradation Strategies: Food safety, challenges and perspectives. *Foods*, 12(14), 2709. <https://doi.org/10.3390/foods12142709>
- MacFarlane, E., Carey, R., Keegel, T., El-Zaemay, S., & Fritschi, L. (2013). Dermal Exposure Associated with Occupational End Use of Pesticides and the Role of Protective Measures. *Safety and Health at Work*, 4(3), 136–141. <https://doi.org/10.1016/j.shaw.2013.07.004>

- Manfo, F. P. T., Mboe, S. A., Nantia, E. A., Ferdinand, N., Telefo, P. B., Moundipa, P. F., & Cho-Ngwa, F. (2020). Evaluation of the Effects of Agro Pesticides Use on Liver and Kidney Function in Farmers from Buea, Cameroon. *Journal of Toxicology*, 2020, 1–10. <https://doi.org/10.1155/2020/2305764>
- Mangoni, A. A., & Jackson, S. (2003). Age-related changes in pharmacokinetics and pharmacodynamics: basic principles and practical applications. *British Journal of Clinical Pharmacology*, 57(1), 6–14. <https://doi.org/10.1046/j.1365-2125.2003.02007.x>
- Marsh, J. (2023, July 27). The differences between organic and conventional farming. *Environment Co.* <https://environment.co/the-differences-between-organic-and-conventional-farming/>
- Mesnage, R., Arno, M., Costanzo, M., Malatesta, M., Séralini, G., & Antoniou, M. (2015). Transcriptome profile analysis reflects rat liver and kidney damage following chronic ultra-low dose Roundup exposure. *Environmental Health*, 14(1). <https://doi.org/10.1186/s12940-015-0056-1>
- Midmore, D. J., Jansen, H., & Dumsday, R. G. (1996). Soil erosion and environmental impact of vegetable production in the Cameron Highlands, Malaysia. *Agriculture, Ecosystems & Environment*, 60(1), 29–46. [https://doi.org/10.1016/s0167-8809\(96\)01065-1](https://doi.org/10.1016/s0167-8809(96)01065-1)
- Mustieles, V., D’Cruz, S. C., Couderq, S., Rodríguez-Carrillo, A., Fini, J., Hofer, T., Steffensen, I., Dirven, H., Barouki, R., Olea, N., Fernández, M. F., & David, A. (2020). Bisphenol A and its analogues: A comprehensive review to identify

- B. and prioritize effect biomarkers for human biomonitoring. *Environment International*, 144, 105811. <https://doi.org/10.1016/j.envint.2020.105811>
- NephCure Kidney International. (2014, December 4). *What is the Function of Our Kidneys?* - *NephCure*. NephCure. <https://nephcure.org/livingwithkidneydisease/what-is-kidney-disease/what-is-the-function-of-our-kidneys/>
- Nickson, C. (2023, February 23). Urea-Creatinine ratio. Life in the Fast Lane • LITFL. <https://litfl.com/urea-creatinine-ratio/>
- Nicolopoulou-Stamati, P., Maipas, S., Kotampasi, C., Stamatis, P. J., & Hens, L. (2016). Chemical pesticides and human health: The urgent need for a new concept in agriculture. *Frontiers in Public Health*, 4. <https://doi.org/10.3389/fpubh.2016.00148>
- Nielsen, J. B., & Andersen, H. R. (2002). Cholinesterase activity in female greenhouse Workers—Influence of work practices and use of oral contraceptives. *Journal of Occupational Health*, 44(4), 234–239. <https://doi.org/10.1539/joh.44.234>
- Ntow, W. J., Gijzen, H. J., Kelderman, P., & Drechsel, P. (2006). Farmer perceptions and pesticide use practices in vegetable production in Ghana. *Pest Management Science*, 62(4), 356–365. <https://doi.org/10.1002/ps.1178>
- Ntow, W. J., Tagoe, L. M., Drechsel, P., Kelderman, P., Nyarko, E., & Gijzen, H. J. (2009). Occupational Exposure to Pesticides: Blood Cholinesterase Activity in a Farming Community in Ghana. *Archives of Environmental Contamination and Toxicology*, 56(3), 623–630. <https://doi.org/10.1007/s00244-007-9077-2>

- Okoffo, E. D., Mensah, M., & Fosu-Mensah, B. Y. (2016). Pesticides exposure and the use of personal protective equipment by cocoa farmers in Ghana. *Environmental Systems Research*, 5(1). <https://doi.org/10.1186/s40068-016-0068-z>
- Pang, J. M., & Tan, K. W. (2022). Development of Regional Climate Model (RCM) for Cameron Highlands based on Representative Concentration Pathways (RCP) 4.5 and 8.5. *E3S Web of Conferences*, 347, 05014. <https://doi.org/10.1051/e3sconf/202234705014>
- Parrado, C., Mercado-Saenz, S., Pérez-Davó, A., Gilaberte, Y., González, S., & Juarranz, Á. (2019). Environmental Stressors on skin aging. Mechanistic Insights. *Frontiers in Pharmacology*, 10. <https://doi.org/10.3389/fphar.2019.00759>
- Patil, A. J., Patil, A. A., Sontakke, A. V., & Govindwar, S. P. (2009). Occupational pesticides exposure of sprayers of grape gardens in Western Maharashtra (India): effects on liver and kidney function. *Journal of Basic and Clinical Physiology and Pharmacology*, 20(4). <https://doi.org/10.1515/jbcpp.2009.20.4.335>
- Payán-Rentería, R. A., Garibay-Chávez, G., Rangel-Ascencio, R., Preciado-Martínez, V., Muñoz-Islas, L., Beltrán-Miranda, C. P., Mena-Munguía, S., Jave-Suárez, L. F., Feria-Velasco, A., & De Celis, R. (2012). Effect of Chronic Pesticide Exposure in Farm Workers of a Mexico Community. *Archives of Environmental & Occupational Health*, 67(1), 22–30. <https://doi.org/10.1080/19338244.2011.564230>

Pizzorno, J. (2015, December 1). *The Kidney Dysfunction Epidemic, Part 1: Causes.*

PubMed

Central

(PMC).

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4718206/>

Ramírez-Santana, M., Farías-Gómez, C., Zúñiga-Venegas, L., Sandoval, R.,

Roeleveld, N., Van Der Velden, K., Scheepers, P. T., & Pancetti, F. (2018).

Biomonitoring of blood cholinesterases and acylpeptide hydrolase activities in

rural inhabitants exposed to pesticides in the Coquimbo Region of Chile. *PLOS*

*ONE*, 13(5), e0196084. <https://doi.org/10.1371/journal.pone.0196084>

Robb, E. L. (2023, November 12). *Organophosphate toxicity.* StatPearls - NCBI

Bookshelf. <https://www.ncbi.nlm.nih.gov/books/NBK470430/>

Robson, L. (2014b). The kidney – an organ of critical importance in physiology. *The*

*Journal of Physiology*, 592(18), 3953–3954.

<https://doi.org/10.1113/jphysiol.2014.279216>

Salvatore, A. L., Bradman, A., Castorina, R., Camacho, J., López, J., Barr, D. B.,

Snyder, J. C., Jewell, N. P., & Eskenazi, B. (2008). Occupational behaviors

and farmworkers' pesticide exposure: Findings from a study in monterey

county, California. *American Journal of Industrial Medicine*, 51(10), 782–794.

<https://doi.org/10.1002/ajim.20622>

Santarpia, L., Grandone, I., Contaldo, F., & Pasanisi, F. (2012). Butyrylcholinesterase

as a prognostic marker: a review of the literature. *Journal of Cachexia,*

*Sarcopenia and Muscle*, 4(1), 31–39. [https://doi.org/10.1007/s13539-012-](https://doi.org/10.1007/s13539-012-0083-5)

0083-5

- Sarkar, S., Gil, J., Keeley, J., & Jansen, K. (2021). The use of pesticides in developing countries and their impact on health and the right to food. *europa.eu*.  
<https://doi.org/10.2861/28995>
- Sawarng, N., Hongsibsong, S., Sapbamrer, R., Wongta, A., & Tongjai, P. (2021). Effectiveness of a participatory program on pesticide use behavior and blood cholinesterase levels in Chiang Mai province, northern Thailand. *Journal of Environmental and Public Health*, 2021, 1–5.  
<https://doi.org/10.1155/2021/6746367>
- Sharma, A., Kumar, V., Shahzad, B., Tanveer, M., Sidhu, G. P. S., Handa, N., Kohli, S. K., Yadav, P., Bali, A. S., Parihar, R. D., Dar, O. I., Singh, K., Jasrotia, S., Bakshi, P., Ramakrishnan, M., Kumar, S., Bhardwaj, R., & Thukral, A. K. (2019). Worldwide pesticide usage and its impacts on ecosystem. *SN Applied Sciences*, 1(11). <https://doi.org/10.1007/s42452-019-1485-1>
- Shentema, M. G., Kumie, A., Bråtveit, M., Deressa, W., Ngowi, A. V., & Moen, B. E. (2020). Pesticide Use and Serum Acetylcholinesterase Levels among Flower Farm Workers in Ethiopia—A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, 17(3), 964.  
<https://doi.org/10.3390/ijerph17030964>
- Siddiqui, M., Patel, S., Bhati, C., Reichman, T., Williams, K., Driscoll, C., Liptrap, E., Rinella, M. E., Sterling, R. K., & Siddiqui, M. S. (2019). Range of normal serum aminotransferase levels in liver transplant recipients. *Transplantation Proceedings*, 51(6), 1895–1901.  
<https://doi.org/10.1016/j.transproceed.2019.04.062>

- Silvério, A. C. P., Machado, S. C., Azevedo, L., Nogueira, D. A., De Castro Graciano, M. M., Simões, J. S., Viana, A. L. M., & Martins, I. S. (2017). Assessment of exposure to pesticides in rural workers in southern of Minas Gerais, Brazil. *Environmental Toxicology and Pharmacology*, 55, 99–106. <https://doi.org/10.1016/j.etap.2017.08.013>
- Sine, H., Grafel, K. E., Alkhammal, S., Achbani, A., & Filali, K. (2019). Serum cholinesterase biomarker study in farmers – Souss Massa region-, Morocco: case–control study. *Biomarkers*, 24(8), 771–775. <https://doi.org/10.1080/1354750x.2019.1684564>
- Sinha, S. N., Kumar, K. R., Ungarala, R., Kumar, D., Deshpande, A., Vasudev, K., Boiroju, N. K., Singh, A., Naik, R. P., & Pokharakar, S. (2021). Toxicokinetic analysis of commonly used pesticides using data on acute poisoning cases from Hyderabad, South India. *Chemosphere*, 268, 129488. <https://doi.org/10.1016/j.chemosphere.2020.129488>
- Sinha, S. N., Rao, M. S. R., & Vasudev, K. (2012). Distribution of pesticides in different commonly used vegetables from Hyderabad, India. *Food Research International*, 45(1), 161–169. <https://doi.org/10.1016/j.foodres.2011.09.028>
- Sombatsawat, E., Barr, D. B., Panuwet, P., Robson, M. G., & Siritwong, W. (2021). Pesticide-induced changes in cholinesterase activity and chronic kidney disease of unknown etiology among farmers in Nakhon Ratchasima, Thailand. *Human and Ecological Risk Assessment*, 27(8), 2038–2050. <https://doi.org/10.1080/10807039.2021.1944050>

- Tanvir, E. M., Afroz, R., Chowdhury, M. M. U., Gan, S. I., Karim, N., Islam, M. S., & Khalil, M. a. K. (2016). A model of chlorpyrifos distribution and its biochemical effects on the liver and kidneys of rats. *Human & Experimental Toxicology*, 35(9), 991–1004. <https://doi.org/10.1177/0960327115614384>
- Tayeb, W., Nakbi, A., Trabelsi, M., Miled, A., & Hammami, M. (2012). Biochemical and histological evaluation of kidney damage after sub-acute exposure to 2,4-dichlorophenoxyacetic herbicide in rats: involvement of oxidative stress. *Toxicology Mechanisms and Methods*, 22(9), 696–704. <https://doi.org/10.3109/15376516.2012.717650>
- Tee, E. (2011). Development and promotion of Malaysian Dietary Guidelines. *PubMed*, 20(3), 455–461. <https://pubmed.ncbi.nlm.nih.gov/21859667>
- Testing.com. (2021, November 9). *Cholinesterase tests - testing.com*. <https://www.testing.com/tests/cholinesterase-test/>
- Tey, Y. S., Shamsudin, M. N., Mohamed, Z. A., Jinap, S., & Ramin, A. G. (2009). Demand for quality vegetables in Malaysia. *Demand for Quality Vegetables in Malaysia*. [http://www.ifrj.upm.edu.my/16%20\(3\)%202009/5\[11%20Tey.pdf](http://www.ifrj.upm.edu.my/16%20(3)%202009/5[11%20Tey.pdf)
- Tiraieyari, N., Hamzah, A., & Samah, B. A. (2014). Organic Farming and Sustainable Agriculture in Malaysia: Organic Farmers' Challenges towards Adoption. *Asian Social Science*, 10(4). <https://doi.org/10.5539/ass.v10n4p1>
- Tudi, M., Ruan, H., Wang, L., Lyu, J., Sadler, R., Connell, D., Chu, C., & Phung, D. (2021). Agriculture Development, Pesticide Application and Its Impact on the Environment. *International Journal of Environmental Research and Public Health*, 18(3), 1112. <https://doi.org/10.3390/ijerph18031112>

- Ugwu, J. A., Omoloye, A. A., Asogwa, E. U., Nigeria, I. —, & Aduloju, A. A. (2015). Pesticide-handling practices among smallholder Vegetable farmers in Oyo state, Nigeria. *Pesticide-handling Practices Among Smallholder Vegetable Farmers in Oyo State, Nigeria*. [https://www.researchgate.net/profile/Adebayo\\_Omoloye/publication/283466188\\_Pesticide-handling\\_practices\\_among\\_smallholder\\_Vegetable\\_farmers\\_in\\_Oyo\\_state\\_Nigeria/links/563962e208ae2da875c7a60c.pdf](https://www.researchgate.net/profile/Adebayo_Omoloye/publication/283466188_Pesticide-handling_practices_among_smallholder_Vegetable_farmers_in_Oyo_state_Nigeria/links/563962e208ae2da875c7a60c.pdf)
- Van Maele-Fabry, G., Lantin, A., Hoet, P., & Lison, D. (2010). Childhood leukaemia and parental occupational exposure to pesticides: a systematic review and meta-analysis. *Cancer Causes & Control*, 21(6), 787–809. <https://doi.org/10.1007/s10552-010-9516-7>
- Wadhawan, M., & Anand, A. C. (2016). Coffee and liver disease. *Journal of Clinical and Experimental Hepatology*, 6(1), 40–46. <https://doi.org/10.1016/j.jceh.2016.02.003>
- Wang, W., Jia, J., He, R., & Gong, H. (2017). Gender differences in pesticide use knowledge, risk awareness and practices in Chinese farmers. *Science of the Total Environment*, 590–591, 22–28. <https://doi.org/10.1016/j.scitotenv.2017.03.053>
- Wesseling, C., Aragón, A., González, M., Weiss, I., Glaser, J., Rivard, C. J., Roncal-Jiménez, C. A., Correa-Rotter, R., & Johnson, R. J. (2016). Heat stress, hydration and uric acid: a cross-sectional study in workers of three occupations

in a hotspot of Mesoamerican nephropathy in Nicaragua. *BMJ Open*, 6(12), e011034. <https://doi.org/10.1136/bmjopen-2016-011034>

*What is a Pesticide?* / US EPA. (2023, March 8). US EPA. <https://www.epa.gov/minimum-risk-pesticides/what-pesticide>

Who, J., & Diet, N. F. E. C. O. (2003). Diet, nutrition and the prevention of chronic diseases : report of a Joint WHO/FAO Expert Consultation. In *World Health Organization eBooks*. <http://ci.nii.ac.jp/ncid/BA6263076X>

Willer, Helga and Julia Lernoud (eds.) (2014). *The World of Organic Agriculture: Statistic and Emerging Trends 2014*. FiBL-IFOAM, Bonn.

Wolińska, A. (2019). Metagenomic achievements in microbial diversity determination in croplands. In *Elsevier eBooks* (pp. 15–35). <https://doi.org/10.1016/b978-0-12-814849-5.00002-2>

World Health Organization: WHO. (2021, June 9). *Obesity and overweight*. <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>

## APPENDICES

### APPENDIX I

#### Questionnaire



## FACULTY OF MEDICINE AND HEALTH SCIENCES

### QUESTIONNAIRE:

#### **“COMPARISON OF THE EFFECTS OF SYNTHETIC PESTICIDE USE ON LIVER AND KIDNEY FUNCTION AMONG VEGETABLE FARMERS FROM CAMERON HIGHLAND”**

It is a pleasure to have you chosen as a respondent for this research. The objective of this research is to compare the effects of synthetic pesticides use on liver and kidney function among vegetable farmers from Cameron Highland. Please answer the questions as accurately, honestly, and completely as possible. All the answers are strictly confidential and for research purposes only. Thank you for your participation in this research./ *Sukacita kerana anda telah memilih sebagai responden untuk penyelidikan ini. Objektif kajian ini adalah untuk Bandingkan kesan penggunaan racun perosak sintetik terhadap fungsi hati dan buah pinggang di kalangan petani sayur-sayuran dari Cameron Highlands.. Sila jawab soalan setepat, jujur, dan selengkap mungkin. Semua jawapan adalah sulit dan untuk tujuan penyelidikan sahaja. Terima kasih atas penyertaan anda dalam penyelidikan ini.*

Name of Researcher: Farah Izzati binti Fakrullah

B. Sc. (Environmental & Occupational Health)

### **Instructions / Arahan**

This questionnaire has 12 printed pages including the front page/ *Soal selidik ini mempunyai 12 halaman bercetak termasuk muka depan.*

The survey form consist of / *Borang kaji selidik ini terdiri daripada:*

**Part A: Personal Information/ *Maklumat Peribadi***

**Part B: Lifestyle Information/ *Maklumat Gaya Hidup***

**Part C: Occupational Background/ *Latar Belakang pekerjaan***

**Part D: Information on the Use of Synthetic Pesticides and Chemical Fertilizers/ *Maklumat tentang Penggunaan Racun Perosak Sintetik dan Baja Kimia***

**Part E: Information on Use of Personal Protective Equipment (PPE)/ *Maklumat mengenai Penggunaan Peralatan Pelindung Diri***

Please answer ALL questions. Thank you for your cooperation./ *Sila jawab SEMUA soalan.*

*Terima kasih atas kerjasama yang diberikan.*

**Part A: Personal Information/ *Maklumat Peribadi***

**Please fill in the blanks and mark (✓) in the box below/ *Sila isi tempat kosong dan tandakan (✓) pada kotak di bawah.***

1. Respondent ID/ *ID responden*

\_\_\_\_\_

2. Name of Respondent/ *Nama responden*

\_\_\_\_\_

3. Gender/ *Jantina*

Male/ *Lelaki*

Female / *Perempuan*

4. Age/ *Umur*

\_\_\_\_\_

5. Weight/ *Berat (kg)*

\_\_\_\_\_

6. Height/ *Ketinggian (cm)*

\_\_\_\_\_

7. Phone number/ *Nombor telefon*

\_\_\_\_\_

8. Educational level/ *Tahap pendidikan*

- Primary school/ *Sekolah Rendah*
- secondary school/ *Sekolah Menengah*
- Diploma/ *Certificate*
- Degree/ *Ijazah*

9. Body Mass Index/ *Indeks Jisim Badan* (kg/m<sup>2</sup>)

- under 18.5 (underweight)/ *Kurang daripada 18.5 (Kurang berat badan)*
- 18.5 - 24.9 (normal)/ *18.5 - 24.9 (Normal)*
- 25 - 29.9 (overweight)/ *25 - 29.9 (Lebih berat badan)*
- 30-39.9 (obesity)/ *30 - 39.9 (Obesiti)*

**Part B: Lifestyle Information/ *Maklumat Gaya Hidup***

1. Smoking habit/ *Tabiat merokok*

- Yes/ *Ya*
- No/ *Tidak*

2. Alcohol consumption/ *Pengambilan alkohol*

- No Alcohol/ *Tanpa Alkohol*
- Once a week/ *Sekali seminggu*
- 3 to 4 times a week/ *3 hingga 4 kali seminggu*
- 3 times a month/ *3 kali sebulan*
- 1 to 2 times a year/ *1 hingga 2 kali setahun*

3. Frequency of consuming coffee/ *Kekerapan mengambil kopi*

- Once a day/ *Sehari sekali*
- twice a day/ *dua kali sehari*
- Once a week/ *Seminggu sekali*
- Not drinking coffee/ *Tidak minum kopi*

**Part C: Occupational Background/ Latar Belakang pekerjaan**

1. Type of farmland/ *Jenis tapak ladang*

Conventional farmland/ *Tapak ladang konvensional*

Organic farmland/ *Tapak ladang organik*

2. Duration of Year Working in The Farmland/ *empoh Bekerja dalam Ladang Sepanjang*

*Tahun?*

\_\_\_\_\_

**Part D: Information on the Use of Synthetic Pesticides and Chemical Fertilizers/ *Maklumat tentang Penggunaan Racun Perosak Sintetik dan Baja Kimia***

1. Symptoms During Handling Pesticide/ *Simptom Semasa Menangani Racun Perosak*

No symptoms/ *Tiada simptom*

Have symptoms/ *ada simptom*

2. Symptoms After Handling Pesticide/ *Simptom Selepas Menangani Racun Perosak*

No symptoms/ *Tiada simptom*

Have symptoms/ *ada simptom*

3. Where do you purchase pesticide/ *Di mana boleh membeli racun perosak?*

Not using/ *Tidak menggunakan*

Physical store/ *Kedai fizikal*

Online/ *Dalam talian*

4. Where do you wash pesticide container/ *Di mana anda mencuci bekas racun perosak?*

No washing is practiced/ *Tiada amalan mencuci*

Rinse with water in the farm/ *Bilas dengan air di ladang*

Not using/ *Tidak digunakan*

5. Where do you store the pesticide? *Di mana anda menyimpan racun serangga?*

Not Using/ *Tidak digunakan*

In the farm/ *Di ladang*

6. Where do you dispose of the pesticide container/ *Di mana anda membuang bekas racun perosak?*

No disposal method is practiced/ *Tiada kaedah pembuangan diamalkan*

Throw as general waste/ *Buang sebagai sisa biasa*

Gather to recycle centre/ *Kumpulkan untuk pusat kitar semula*

Burn/ *Bakar*

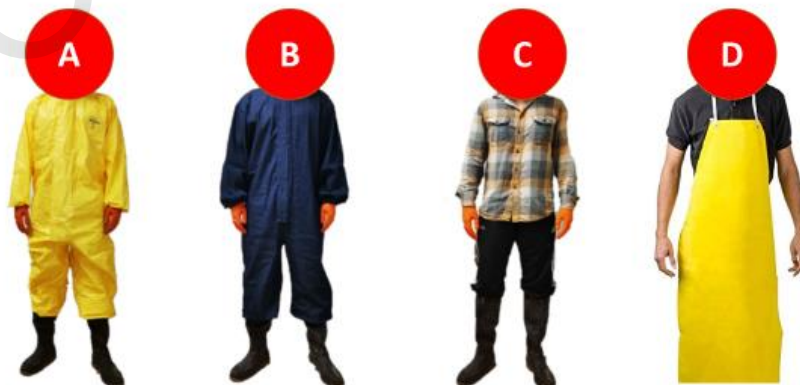
**Part E: Information on Use of Personal Protective Equipment (PPE)/ *Maklumat mengenai Penggunaan Peralatan Pelindung Diri***

1. Type of PPE (foot protection)/ *Jenis PPE (perlindungan kaki)*

- A
- B
- C
- D
- Slipper/ *Selipar*
- Sport shoes/ *Kasut sukan*
- Barefoot/ *Tidak memakai kasut*
- Other/ *Lain-lain*: \_\_\_\_\_

2. Type of PPE (body protection)/ *Jenis PPE (Perlindungan badan)*

- A
- B
- C
- D



3. Type of PPE (respiratory protection)/ *Jenis PPE (Perlindungan pernafasan)*

- A
- B
- C
- D
- E
- F
- No wearing any protection/ *Tidak memakai sebarang perlindungan*



4. Type of PPE (eye protection)/ *Jenis PPE (Perlindungan mata)*

- A
- B
- C
- D
- No eye protection/ *Tiada perlindungan mata*



7. Type of PPE (hand protection)/ *Jenis PPE (Perlindungan tangan)*

A

B

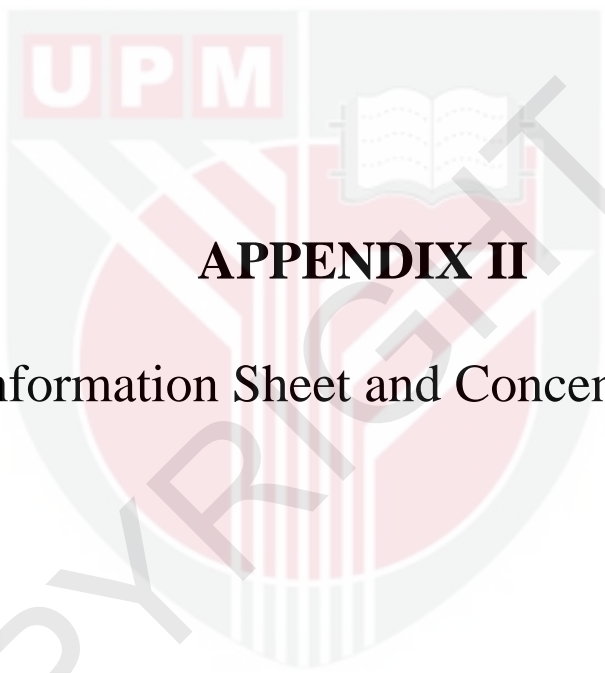
C

D

E

No hand protection/ *Tiada perlindungan tangan*





## **APPENDIX II**

### **Information Sheet and Consent Form**

28 AUGUST 2022  
VERSION 1

JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA  
(JKEUPM) UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA



**FORM 2.4: RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM**

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

**1. STUDY TITLE :** Comparison of the effects of synthetic pesticides use on liver and kidney function among vegetable farmers and non-agricultural residents from Cameron Highland, Pahang.

**2. INTRODUCTION:** Synthetic pesticides are increasingly being used to enhance crop yields around the world. However, the health risks associated with human exposure to these chemicals, particularly in Cameron Highland, Pahang are becoming increasingly concerning. Most of the vegetable's farmers are not aware of the risk associated with the use of pesticides, whereas lack of training and equipment for safely handling pesticides increases health risk. Despite the frequent and increased use of synthetic pesticides in Cameron Highland, Pahang, the effects of these chemicals on the health of vegetables farmers applying the chemicals are still unclear. Therefore, the objective of this study is to compare the effects of synthetic pesticide use on liver and kidney function among 25 vegetable farmers and 25 non-agricultural residents in Cameron Highland, Pahang.

28 AUGUST 2022  
VERSION 1

### 3. WHAT WILL YOU HAVE TO DO?

You need to involve in three (3) types of data collection methods as below;

Station 1: Face-to-face Questionnaires using structured questionnaires that will be filled by farmers and non-agricultural residents. **The information to be asked during the face-to-face interview are as follows:** (Estimate duration: 5-10 minutes)

- **Section A: Personal Information**
- **Section B: Lifestyle Information**
- **Section C: Occupational Background**
- **Section D: Information on the Use of Synthetic Pesticides and Chemical Fertilizers/**
- **Section E: Information on Use of Personal Protective Equipment (PPE)**

**Station 2:** Cardiometabolic effects of Body Mass Index (BMI), waist circumference and blood pressure. (Estimate duration: 15 minutes)

Station 3: Blood samples collection (5mL) for biomarker exposure and effect by using venipuncture procedure. **A nurse will be involved in this study.** (Estimate duration: 10 minutes)

The expected duration for overall data collection is one (1) hour. All data collection methods will be conducted in the field on the same day. **The participants will receive RM20 as a token of appreciation for participating in the study. The participation is voluntary, and participants may withdraw anytime** without penalty or loss of benefit to which the participant is entitled.

**28 AUGUST 2022  
VERSION 1**

**4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?**

If the participants are not among the subjects of vegetable farmers and non-agricultural residents from Cameron Highland, Pahang whose ages range from 18 to 60 years old and are living in the same area for at least 12 months, they should refrain from taking part in the study.

Participants who are vegetable farmers are not permitted to take part in the study if they have been diagnosed with liver or kidney diseases, are taking medication for those conditions, have undergone surgery for liver and kidney diseases or self-report having trypanophobia (needle injection phobia).

Meanwhile, non-agricultural residents who are reported to have liver and kidney diseases and are under medication, who are post-operative with liver and kidney diseases, and who self-report having trypanophobia (needle injection phobia) must not take part in the study.

**5. WHAT WILL BE THE BENEFITS OF THE STUDY:**

**(a) TO YOU AS THE SUBJECT?**

Participants will receive an incentive of Twenty Ringgit Malaysia as a token of appreciation upon completion of all data collection methods. However, your participation will increase researchers' understanding of the effects of the use of synthetic pesticides on liver and kidney function among vegetable farmers and non-agricultural residents in your area of residence. The information obtained in this study can help in the prevention of pesticide-related health risks in the future.

**(b) TO THE INVESTIGATOR?**

Researchers were able to generate new insights into the effects of the use of synthetic pesticides on liver and kidney function among vegetable farmers and non-agricultural residents in Cameron Highland, Pahang.

28 AUGUST 2022  
VERSION 1

**6. WHAT ARE THE POSSIBLE RISKS?**

The subjects may have some bleeding, bruising, or soreness at the spot where the needle was put in during blood sample collection. Fainting sometimes occurs and the infection is rare.

**7. WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?**

Yes, the information and identity of the subjects will remain confidential and will be used for research purposes only.

**8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?**

For further information or any problems related to the research, you may contact the investigators below:

<b>PRINCIPAL INVESTIGATOR:</b>  DR. VIVIEN HOW  DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH, FACULTY OF MEDICINES AND HEALTH SCIENCES, UNIVERSITY PUTRA MALAYSIA	  Email: vivien@upm.edu.my  Phone. No: 03-89472643/ 016-6193697
<b>CO-INVESTGATOR:</b>  NOOR HAFIZAH BINTI MOHAMED ROSLI  DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH, FACULTY OF MEDICINES AND HEALTH SCIENCES, UNIVERSITY PUTRA MALAYSIA	  Email: 201829@student.upm.edu.my  Phone. No: 011-37896109
<b>APPROVAL FROM:</b>  <b>JAWATANKUASA ETIKA UNIVERSITI PUTRA MALAYSIA</b>	  Email: jkeupm@upm.edu.my  Phone. No: 03-97691602/1244

Please initial here if you have read and understood the contents of this page \_\_\_\_\_

9. CONSENT

I ..... Identity Card No. ....  
address.....

.....hereby voluntarily agree to take part in the  
research stated above \*(clinical /drug trial/video recording/ focus group/interview-based/  
questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse  
effects and complications (as written in the Respondent's Information Sheet). I understand that  
I have the right to withdraw from this research at any time without giving any reason whatsoever.  
I also understand that this study is confidential and all information provided with regard to my  
identity will remain private and confidential.

I\* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be  
used in any form of publication or presentation (if applicable)

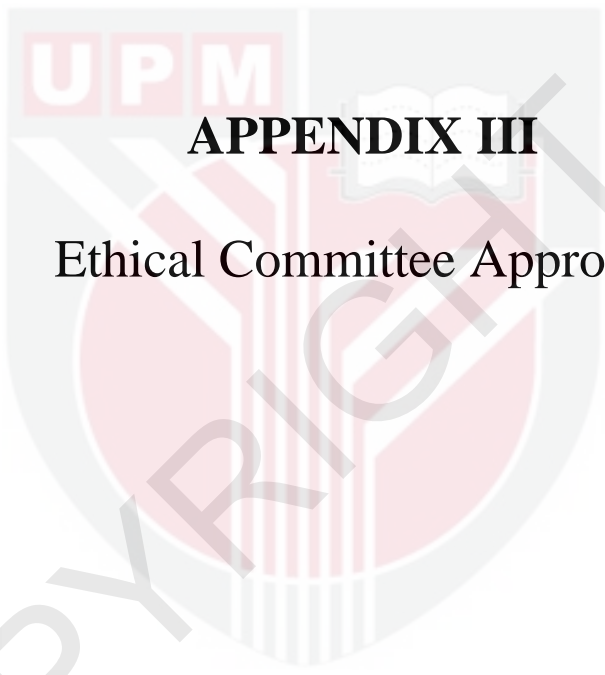
\* delete where necessary

Signature ..... Signature .....  
(Respondent) (Witness)

Date : ..... Name : .....  
I/C No. : .....

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned  
research.

Date ..... Signature .....  
(Researcher)



**APPENDIX III**

Ethical Committee Approval

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**ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS  
(JKEUPM)  
UNIVERSITI PUTRA MALAYSIA**

<b>Research title</b>	: Comparison of The Effects of Synthetic Pesticides Use on Liver and Kidney Function Among Vegetable Farmers and Non- Agricultural Residents From Cameron Highland, Pahang.
<b>Study Site</b>	: Cameron Highland, Pahang.
<b>JKEUPM Ref No.</b>	: JKEUPM-2022-410
<b>Principal Investigator</b>	: Dr. Vivien How
<b>Co-investigator</b>	: Noor Hafizah Binti Mohamed Rosli (Student)

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 02/06/2022
2. Respondent's Information Sheet / Consent (English), Version 2 dated 29/08/2022
3. Respondent's Information Sheet / Consent (Malay), Version 2 dated 29/08/2022
4. Proposal (English), Version 1 dated 02/06/2022
5. Questionnaire / Interviews (English), Version 1 dated 02/06/2022
6. Curriculum Vitae of:
  - a. Dr. Vivien How

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.

Decision by JKEUPM:

- Approved
- Permission MUST BE OBTAINED** from the respective hospitals/ institutions before conducting the research
- Disapproved

Please note that the approval is **VALID UNTIL 30 AUGUST 2023**

Researchers should comply with the following:

- I. Complete a Study Final Report upon study completion (Form 3.2).
- II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.
- III. Applicable for Clinical Trial Studies and Clinical interventional Studies only: Progress Report has to be submitted to JKEUPM at every 6 months from the date of approval (Form 3.1). Report occurrences of all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse Reaction (SUSARs) and Protocol Deviation/ Violation at all JKEUPM approved sites to JKEUPM. All serious adverse events (SAEs) detected or being notified should be reported immediately to the sponsor except for those SAEs that the protocol or other document (e.g.,