CHAPTER II

LITERATURE REVIEW

This chapter presents the literature review, divided into the following topics:

- The general knowledge of pesticides.

- The symptoms and illnesses associated with pesticide exposure.

- Regulations in using pesticide.

- Relevant scientific finding in pesticide health effects.

2.1 The general knowledge of pesticides

2.1.1 Pesticide Classification

The term pesticide is generic and applied to all chemicals used in pest control. Pesticides are classified according to the type of pest they are active against: insecticides (aphids, caterpillars, moths, bugs), herbicides (weeds, grasses), fungicides (mildew, mildew, plant diseases), acaricides (mites, ticks), rodenticides (rats, gophers, ground squirrels), and nematocide or non-segmented soil worms.

Pesticides can be classified in many different ways: according to the target pest, the chemical structure of the compound used or the degree or type of health hazard involved.

In general, we can classify agricultural pesticides into 6 categories (Siter et al., 2001).

a) Insecticide

It is one type of pesticides, which is used for vector control. It is divided as organic and inorganic substances Insecticide may be derived from synthetic substances or natural substances. Synthetic insecticides are divided into 4 categories as follows.

a.1) Organophosphate

Phosphorus is a major component of this insecticide and organophosphate compound has a short half-life so it is easily degraded. The toxicity of organophosphate affects human by irreversible inhibiting acetyl cholinesterase at nerve endings. Exposure may be fatal.

a.2) Carbamate

Carbamate insecticides are similar to the organophosphate on their acute toxic effects and are inhibitors of the enzyme cholinesterase. However, the inhibition of the enzyme is reversible. Widely used toxic carbamate includes aldicarb (TemiK), methomyl (Lannate), carbofuran (Furadan), and oxamyl (Vydate).

a.3) Organochlorine

It is one type of insecticides that has a long half-life and very stable. So, this insecticide could contaminate in the nature by prolonged period and chlorine is a major composition in this insecticide.

The organochlorine insecticides are chlorinated hydrocarbon compounds of cyclic structure and high molecular weight. In contrast to chlorinated hydrocarbon solvents and fumigants. They are central nervous system stimulants with have volatility. DDT, a prototype organochlorine chlorphenothane was discovered in 1939, and it was banned in the USA in 1973. Organochlorine insecticides were also applied in agriculture and in control programs aimed at mosquitoes and other insects that transmit diseases i.e. yellow fever and malaria. From 1940 through 1970, a number of other organochlorine compounds were widely used as insecticides. The later recognition of their persistence in the environment, bioaccumulation in animals and humans, adverse effects on some wildlife, and carcinogenicity in laboratory animals, caused them to be deregistered or severely restricted. Examples are dieldrin, DDT, heptachlor, mirex, chlordecone, endosulfan and chlordane.

a.4) Minor Types

Groups of this insecticide include quinones and phenols.

b) Herbicides

The production and use of chemicals for destruction of noxious weeds have increased markedly during the last decade. Herbicides rival or exceed insecticides in quantity and value of sales. Since herbicides used to kill plants rather than animals, it may present little hazard of chemical toxicity in mammals due to differences in morphology and physiology between plants and animals, but even among the herbicides there are highly toxic chemicals for instance chlorophenoxy compound, dinitorphenols and bipyridyl compounds.

c) Fungicides

Fungicides comprise a heterogeneous group of chemical compounds including Captan, Cymeb, Maneb, Mabam and benlet. With a few exceptions, the fungicides have not attracted the detailed toxicological research as have insecticides. Although many of the fungicide compounds, used to control fungus diseases on plants, seeds, and produce, are rather non-toxic acutely, there are some notable exceptions. The mercury containing fungicides comprise the group that has been of greatest concern for hazard to health, and they have been responsible for many deaths or permanent neurological disability resulting from the misdirection of mercury fungicide treated seed grains into human and animal food.

d) Algicide

Copper sulphate is very harmful to algae and is widely used. Mixing chlorine with copper sulphate is popular practice because chlorine could eliminate some other algae as well as eradicate bad odour of decayed algae. Algicide compounds include calcium carbonate, sodium arsenite, sodium chloraate, ammonium sulfamate and dichlorphenoxyacetic acid.

e) Rodenticides

Varieties of chemicals, which are difficult to classify, have been used in the control of rat and mice. Although they are used to kill mammals, which resemble man in their physiology and biochemistry, there are wide differences in degree of hazard to man. In some cases, the rodenticidal selectivity of these compounds is based on the peculiar physiology of rodents, which differs from that of primates and other species, and in some cases it is merely a question of taking advantage of the habits of rodents as opposed to species that are to be protected. In addition to potential widespread destruction of food and fiber by rodents. Another primary reason for their control is to eliminate intermediate hosts in the transmission of various vectorborne diseases, i.e. bubonic plague. Since rodenticides can be used as baits and placed in restricted places, their likelihood of becoming widespread contaminants of the environment is much less than that associated with the use of insecticides and herbicides. The toxicological problem posed by rodenticides, therefore, is primarily acute accidental or suicidal ingestion.

A group of rodenticides include zinc phosphide, sodium monofluoroacetate and cyanogas.

f) Nematocide (worm killers)

Birlane, Sumithion and Sevin are the most widely used nematocides in Thailand.

2.1.2 Routes of entry

For pesticide to causes illness or death in human, they must get into the body. They can occur in one of three ways: through the skin, the lungs, or the alimentary tract (Jeyaratnam, J., 1990).

Skin

Pesticide uptake occurs mainly through the skin and eyes by inhalation, or by ingestion. The fat-soluble pesticides and, to some extent, the water-soluble pesticides are absorbed through in tact skin. Sore and abrasions may facilitate uptake through the skin. Skin absorption is probably of particular importance when pesticides are used in developing countries. Because adequate protective clothing is often not available or not worn. If a pesticide has direct contact with the skin, it can pass quickly through the dermis and epidermis into the blood. This is the most common route of entry into the body, as contamination of the skin can occur easily and often goes unnoticed.

Such skin contact may be: a result of:

(1) spills or splashes on to the skin when handling a pesticide:

(2) Wearing clothes gloves hats, boots, or socks contaminated with pesticides.

(3) Cleaning or handling equipment that has pesticide on it; and

(4) Being accidentally sprayed either directly or by spray drifting from the next field.

The danger of pesticides entering through the skin is greatest when:

(1) the temperature is high;

(2) the skin is wet; and having an abrasion in the skin.

Lungs

Pesticide that is present in the air is breathed into the lungs. The pesticide passes from the lungs into the blood and is then carried all over the body.

Lung contact may occur:

(1) during mixing and preparation of pesticides for spraying;

(2) during spraying, and

(3) when entering a treated area before the dust settles or the spray dries.

Digestive System

When pesticides are taken directly into the mouth and swallowed, the enter the body from the stomach and intestine. While most people would not intentionally eat or drink a pesticide, they may do so by:

(1) consuming food or drink that have been contaminated by spills of pesticide or by being stored near pesticides;

(2) consuming food or drink that has been prepared or stored in empty pesticide containers;

(3) handling and eating food with hands that are contaminated with pesticide;

(4) touching the mouth with contaminated hands.

Most of the pesticides are toxic chemicals, which induce adversely affect health when absorbed in sufficient dosage, This is perhaps best illustrated in the widespread use of organophosphate and crabmeat ester pesticides. There have been many reports of acute poisoning associated with the use of these groups of pesticides (Lee Hin Peng, 1992: 123-126).

Acute occupational exposure may also occur during the manufacture, formulation, packaging, and transport of pesticides, and transport of pesticides, and among people re-entering a previously treated area.

Accidents resulting from unsafe packing and leakage of pesticides during storage or transport may involve large numbers of people. On a number of occasions food has been contaminated in this way. Parathion and endrin have been involved most frequently in such accidents.

2.2 The symptoms and illness associated with pesticide exposure

Acute effects

A large number of reports are available on the acute effects associated with high occupational exposure to pesticides. These include reports of acute chemical burns of the eyes, skin damage, neurological effects, and liver effects. Organophosphate insecticides exert their acute effects in both insects and mammals by inhibiting acetyl cholinesterase (AchE) in the nervous system with subsequent accumulation of toxic levels of acetylcholine (Ach) which is a neurotransmitter. In many cases, the organophosphorylated enzyme is fairly stable, so that recover from intoxication may be slow. The severity of any adverse effects from exposure to a pesticide depends on the dose, the route of exposure, hour easily the pesticide is absorbed, the types of effect of the pesticide and its metabolites, and its accumulation and persistence in the body,

The toxic effects also depend on the health status of the individual; malnutrition and dehydration are likely to increase sensitivity to pesticides.

The vapors of pesticides or aerosol droplets smaller than 5, μm (micrometers) in diameter are absorbed effectively through the lungs. Larger inhaled particles or droplets may be swallowed after being cleared from the airways, Ingestion can also occur from the contaminated hands may also lead to intake of pesticides, for example from cigarettes,

In the body, the pesticide may be metabolized, or it may be stored in the fat or excreted unchanged. Metabolism will probably make the pesticide more water-soluble and thus more easily excreted, The clinical picture of organophosphate intoxication results from the accumulation of ACh at nerve endings. The symptoms may be summarized as follows,

a) muscarinic manifestations.

- increased bronchial secretion, excessive sweating, salivation and lachrymation;
- pinpoint pupils, bronchoconstriction, abdominal cramps(vomiting and diarrhea);and
- bradycardia (unduly slow heartbeat).

b) Nicotinic manifestations

- fasciculation of fine muscles and, in more severe cases, of diaphragm and respiratory muscles: and

c) Central nervous system (CNS) manifestations

- headache, dizziness, restlessness, and anxiety;
- mental confusion, convulsions and coma; and
- depression of the respiratory center.

All these symptoms can occur in different combinations and can vary in time of onset, sequence, and duration, depending on the chemical, dose and route of exposure. Mild poisoning might include muscarinic and nicotinic signs only. Severe cases virtually always show CNS involvement. The clinical picture may include respiratory failure, sometimes leading to pulmonary edema, due to the combination of the above (Lee H P., 1992).

2.3 Regulations in using pesticide.

Protective equipment and personal hygiene

The various items of protective clothing that may have to be used are described below, with descriptions their proper care.

(1) Hats. These should be made of impervious material with a broad brim to protect the face and neck. Unless made from cheap material, they should be able to withstand regular cleaning.

(2) Veil. A plastic mesh net will have on adequate protection of the face from the larger spray droplets and permit adequate visibility.

(3) Capes. Short capes of light plastic may be suspended from the hat to protect the shoulders.

(4) Overalls. All of above should be made of light, durable cotton fabric. They must be washed regularly. The frequency depends on the pesticides being used. Washing with soap, detergent, or soda is adequate in the case of organophosphorus and crabmeat compounds A rinse in light kerosene may be needed for compounds such as organochlorines and this should be followed by washing with soap, detergent, or soda.

(5) Rubber boots should be worn to protect the feet and legs.

(6) Gloves. Poly (vinylchloride) or rubber gloves or gauntlets should be used when handling concentrates with an organic solvent base. Cotton gloves offer some protection for hands when regularly washed. Impervious gloves must be cleaned regularly, inside and out, but are unsuitable for continuous wear.

(7) Face masks. Masks of gauze or similar material are capable of filtering the particles from a water-dispersible powder spray and may be worn to reduce inhalation of the spray and dermal exposure of the face, if such protection is considered desirable. They must be washed regularly and, in

some instances, fresh masks may need to be used for the second half of the day's spraying, so that the face is not contaminated.

Scrupulous attention to personal hygiene among spray operators is essential. For professional spray men operating in the tropics, safety precautions may depend largely on personal hygiene, including washing and changing of clothes. A drill for carrying out and supervising personal hygiene, and the regular washing of protective clothes and cleaning of equipment should be organized along the following lines:

(a) Spray men should be provided with at least two uniforms to allow for a change when required.

(b) Washing facilities with sufficient water and soap should be made available in the field at appropriate locations.

(c) All working clothes must be washed regularly. The frequency depending on the toxicity of the formulation.

(d) Particular attention should be given to washing gloves as wearing of contaminated gloves may be more dangerous than not wearing gloves at all.

(e) Spray operators must clean hand and take a shower themselves before eating.

(f) Smoking during work should be forbidden.

(g) When work involves insecticides of relatively high toxicity, the hours of work must be arranged so that exposure to the material used is not excessive; transport should be arranged so that there is not a long delay between the end of the day's operations and the return to the base for washing.

Personal protective equipment, decontamination supplies, and pesticide safety and training are among the requirements of the standard. Showering and changing areas employer supplied laundry services for work clothes, and protective equipment reduce worker exposure and prevent transfer of workplace hazards to the home. In the absence of employer supplied laundry services, workers should be advised to wash work clothes separately from other clothes, and not to wear work clothes at home (Lee H P., 1992).

2.4 The relevant scientific finding in pesticide health effects.

2.4.1 Studies in Thailand

Lojananont, V. (2001) studied the agriculturist's self-care behavior, environment and consumer protection in pesticide uses of 267 agriculturists in Pathumthani province. The results showed that information obtaining, level of knowledge, satisfaction in governmental official's performance related with safe use of pesticide. There was no significant difference in agriculturist self-care behavior between those who practiced monoculture and integrated farming. It was found that 57.8% had the satisfactory level to governmental officer's performance , 68.1% had good health perception, and 60.6% had the knowledge and proper level from using pesticide of subjects were in the middle. The 86.7% of agriculturists sample got the information from agricultural officers. Self-care behavior, environment and consumer were found that 49.6% of agriculturists sample knew the total data of this topic in the middle level.

Sorat Warisara. (2004), studied the relationship between health belive, pesticide use and safty behaviors with acute poisoning of 338 rice farmers, found that the majority of farmers had a moderate level of belief in the danger of pesticides and their susceptibility to pesticides, and also a moderate belief in the benefits of and barriers to taking action about pesticide use. However, their safety behavior was at a low level. Acute pesticide poisoning symptoms mostly found were nervous symptoms: headache and fainting; respiratory symptoms: runny nose and cough; digestive symptoms: nausea vomiting; toxic allergic symptoms of skin: skin rash; and toxic allergic symptoms with eyes: runny eyes / tearing. Unsafe use of pesticide and low knowledge of proper pesticide use is related to poor health in farmers. Where there were high perceptions of the existence of barriers to take action in safety behavior, there were correspondingly low safety behaviors ($r = -0.176$, p-value<0.001). Pesticide usage such as frequency of pesticide use, duration of spraying, concentration of pesticide use and method of pesticide use had a significant relationship with acute pesticide poisoning symptoms. Based on the finding of this study, she suggested that the responsible organizations should provide the knowledge on appropriate and safe use of pesticide and develop an education program on using personal protective equipment for farmers. Moreover, other methods for farmers to avoid using pesticides should also be promoted.

2.4.2 Studies outside Thailand

London et al., (1998) studied 164 pesticide applicators and 83 non spraying reference workers on deciduous fruits farms, aiming to access the relationship between effects of long-term organophosphate exposures and neurological symptoms, vibration sense and tremor among South African farm workers. They found that compared with non-applicators, current applicators reported significantly more dizziness, sleepiness, and headache and had a higher overall neurological symptom score. This association remained statistically significant after multiple logistic regression analyses controlling for a range of confounders and effect modifiers [odds ratio (OR) 2.25, for current applicators having high neurological score, 95% confidence interval (95% CI) 1.15-4.39]. The average lifetime intensity of organophosphate exposure was non-significantly associated with both neurological (OR 1.98, 95% CI 0.49-7.94) and "dummy" symptoms (OR 2.37, 95% CI 0.54-10.35). Previous pesticide poisoning was significantly associated with the neurological scores (OR 4.08, 95% CI 1.48-11.22) but not with the "dummy" symptoms. Vibration sense outcomes were associated with age and height, but not with the organophosphate exposure measures. In the multiple linear regression modeling for tremor intensity in the dominant hand, recent organophosphate exposure in the past 10 days was a significant predictor (partial correlation coefficient = 0.04), but none of the long-term organophosphate exposure measures were significant.

Davanzo and Faraoni, (2001) studied pesticide-related illnesses in Italy. They found that Dormex R, a plant growth regulator, has hydrogen cyanide as the active ingredient. These cases were identified during a pilot project for acute pesticide-related illness surveillance. All 22 workers were male with a median age of 41 years. Eighteen of the workers reported dermatologic manifestations, including macular or papular rash (11), erythema / hyperemia (9), pruritus (2), and caustic burns to the hand (2). Two workers reported eye irritation. Fourteen workers had systemic signs and/or symptoms characteristic of adverse effects of the active ingredient, including tachycardia weakness (4), dizziness (4), palpitations (3), headache (3), vomiting and/or nausea (3), dyspnea (3), and hypo tension (1). Of 21 persons initially treated in an emergency department, 12 (52%) were hospitalized; a local physician treated one person. Thirteen patients had low severity effects (i.e., minimal effects that rapidly resolved), and nine had moderate severity effects(i.e., nonlife threatening effects that are more pronounced, prolonged, or of a systemic nature).

Nordi et al. (2001) studied the effects of safety behaviors associated with pesticide use on the occurrence of acute organ symptoms in 496 tobacco-growing farmers in Malaysia. The results study indicated that no smoking while spraying, good sprayer-condition, and changing clothes immediately after spraying significantly prevented occurrence of acute symptoms just after pesticide spraying in male farmers. In female farmers, only wearing a hat while spraying significantly prevented the symptoms.

Kimbell-Dunn et al. (2001) found that response rate was 77.6% of 1,706 participants. Breathing problems at work were reported by 17.6% of farmers. Working with oats was strongly associated with work-related breathing problems (OR = 3.3, 95% CI 2.1-5.2). Dyspnea was more common in female farmers, whereas chronic bronchitis was higher in males. Orchardists (OR = 2.3, 95% CI 1.3-4.0), those growing oat crops (OR = 3.0, 95% CI 1.7-5.4) and using the grain mill (OR = 2.8, 95% CI 1.3-6.3) reported the highest symptom rates of ODTS/FL. Having hay fever or eczema, and smoking were risk factors for all respiratory symptoms.

Yasinn et al. (2002) studied 183 farm workers in Gaza Strip, Egypt, found that farm workers reported high levels of knowledge on the health impact of pesticides (97.9%). Moderates to high levels of knowledge were recorded on toxicity symptoms related to pesticides. Most farm workers were aware of the protective measures to be used during applying pesticides. However, no one took precautions unless they knew about the measures. Burning sensation in eyes/face was the commonest symptom (64.3%). The prevalence of self-reported toxicity symptoms was dependent on mixing and use of high concentrations of pesticides. The highest percentage of self-reported toxicity symptoms was found among the farm workers who returned to sprayed fields within one hour of applying pesticides.

Stallones & Beseler (2002) studied 1,877 agriculturally employed population in Colorado, ffound that symptoms that were significantly associated with a previous poisoning were difficultly concentrating [OR 2.07, 95% confidence interval (CI) 1.22, 3.50]; relatives noticing person had trouble remembering things (OR) 2.45, 95% CI 1.47, 4.39); making notes to remember things (OR 2.18, 95% CI 1.20, 3.97); felt irritable (OR 1.80, 95% CI 1.08, 3.12); felt depressed (OR 2.82, 95% CI 1.65, 4.81); had heart palpitations without exertion (OR 2.83, 95% CI 1.22, 6.54); sleeping more than usual (OR 3.58, 95% CI 1.95, 6.58); difficulty moving fingers or grasping things (OR 2.08, 95% CI 1.06, 3.24); and headaches at least once a week (OR 1.85, 95% CI 1.06, 3.24). Stepwise regression was used to identify the best explanatory model of pesticide-related illness. Variables that were associated with increased odds of illness were being male, being depressed, sleeping too much, and using crop organophosphates.

Martin et al. (2002) studied in 891 black farmers and 11,909 white farmers in North Carolina, found that black farmers reported lower lifetime pesticide use, less use of each class of pesticides (e.g., herbicides, insecticides), less use of high exposure application methods, and fewer pesticide-related symptoms such as headaches or dizziness, skin irritation, chest discomfort and feeling nervous or depressed than did white farmers.

Delgado & Paumgartten (2004) studied pesticide use and poisoning among farmers from the county of Paty do Alferes, Rio de Janeiro, Brazil found that the most widely used pesticides were insecticides such as abamectin, organophosphate compounds, and pyrethroids, and fungicides such as mancozeb, chlorothalonil, and copper products. As a rule, pesticides are handled carelessly, and 92% of workers involved in the mixing, loading, and spraying of insecticides and fungicides used no protective clothing or equipment whatsoever. 62% of workers reported at least one illness associated with mixing or spraying pesticides. The most frequently reported symptoms were headache, nausea, vomiting, dizziness, skin irritation, and blurred vision, and 21% of affected workers required medical care. In more than half (51%) of the cases, workers reported using organophosphate insecticides from toxicological class I when they felt sick.

Strong et al. (2004) studied relationship between self-reported symptoms and indicators of exposure to pesticides in 211 farm workers in Eastern Washington, found that the health symptoms most commonly reported included headaches (50%), burning eyes (39%), pain in muscles, joints, or bones (35%), a rash or itchy skin (25%), and blurred vision (23%). Exposure to pesticides was prevalent. The proportion of detectable samples of various pesticide residues in house and vehicle dust was weakly associated with reporting certain health symptoms, particularly burning eyes and shortness of breath. No significant associations were found between reporting health symptoms and the proportion of detectable urinary pesticide metabolites.

Lu (2005). looked into the risk factors associated with pesticides exposure among cut-flowers in 102 respondents in Baranggay Bahong, La Trinidad, Philippines, found that 32% were symptomatic or had experienced pesticide-related illnesses since their first use of pesticides. The majority of the pesticides used by the farmers were Categories Ib and II, which are moderately, or highly hazardous chemicals. Individuals with signs and symptoms most often centered on the eye, ear, nose and throat (EENT) (44 respondents reporting these symptoms) followed by general and neuralgic (16 respondents) and the integumentary (14 respondents). The most common general signs and symptoms manifested were weakness followed by fatigue and muscle pain then by chills and fever. The most common EENT manifestations were eye itchiness and blurring of vision. For neurological signs and symptoms, dizziness followed by headache was reported. Logistic regression showed that illnesses for the past 12 months were associated with certain risk factors such as farm use of pesticides, exposure to pesticide while applying it, respiratory inhalation of pesticide vapours and mists ($p = 0.05$). Moreover, those who re-entered a recently sprayed area were 20 times more likely to get ill during the past 12 months than those who did not. Those who used pesticide-contaminated pieces of fabric to wipe sweat off their faces were 2% more likely to get ill, and those who had spills on their bodies while applying pesticide were 26 times more likely to get ill.

Kammel et al. (2005) studied 18,782 white male licensed private pesticide applicators enrolled in agriculture Health Study, U.S.A. Applicators provided information on lifetime pesticide use and 23 neurologic symptoms typically associated with pesticide intoxication. An indicator of more symptoms (≥ 10 vs. < 10) during the year before enrollment was associated with cumulative lifetime days of insecticide use: odds ratios (95% confidence intervals) were 1.64 (1.36–1.97) for 1–50 days, 1.89 (1.58–2.25) for 51-500 days, and 2.50(2.00-3.13) for > 500 days, compared with never users. A modest association for fumigants [>50 days, 1.50 (1.24-1.81)] and weaker relationships for herbicides [>500 days, 1.32 (0.99-1.75)] and fungicides [>50 days, 1.23 (1.00-1.50)] were observed Pesticide use within the year before enrollment was not associated with symptom count Only associations with insecticides and fumigants persisted when all four-pesticide groups were examined simultaneously Among chemical classes of insecticides, associations were strongest for organophosphates and organochlorines Associations with cumulative exposure persisted after excluding individuals who had a history of pesticide poisoning or had experienced an event involving high personal pesticide exposure These results suggested that self-reported neurologic symptoms are associated with cumulative exposure to moderate levels of fumigants and organophosphate and organochlorine insecticides, regardless of recent exposure or history of poisoning