Chapter 1

Pesticide Use in Malaysia and its Health Implications

Agrochemicals are widely used in Malaysia especially in the plantations. Mainly dominated by herbicides, these are most commonly used in the approximately 4 million hectares of plantation crops—palm oil, rubber and cocoa. In 1993, the agrochemical market in Malaysia was worth RM262 million, with herbicides accounting for 76.3 per cent of the share. In 1997, the figure rose to the level of RM326 million, with herbicides still accounting for three-quarters of the share at 75.1 per cent. The herbicide market itself was estimated at RM200 million in 1993 and at RM245 million in 1997. *(Figure 1 and 2)*

FIGURE 1: Trends in the Agrochemical Market in Malaysia

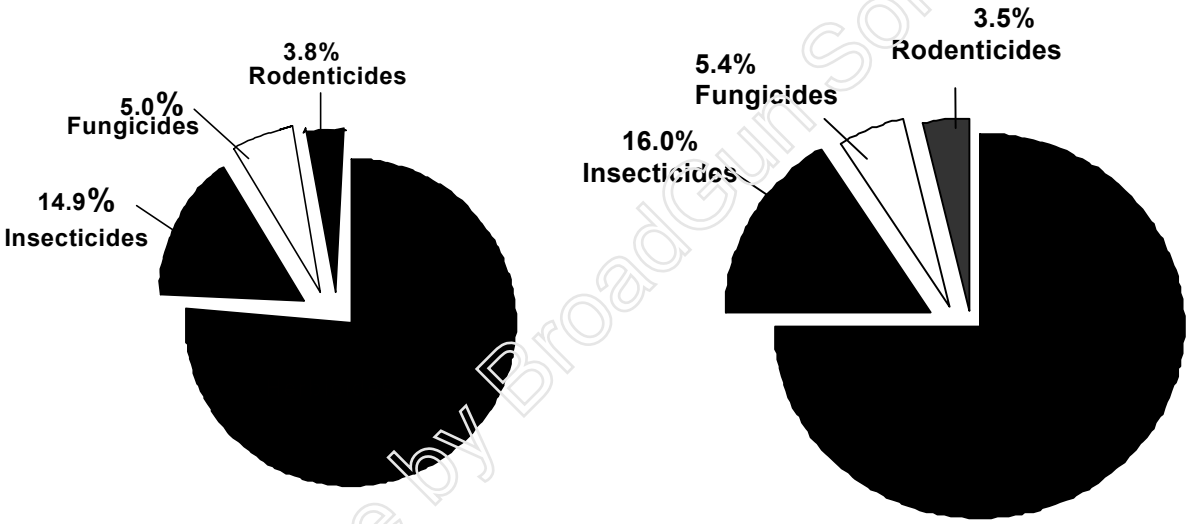
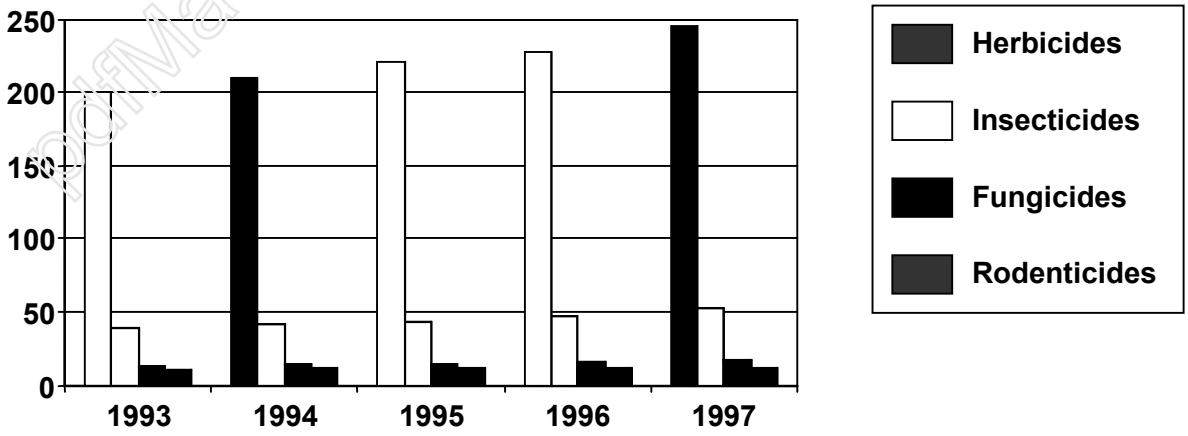


FIGURE 2: Consumption of Agrochemicals in Malaysia (RM million)* 1993 – 1997



Source: Malaysian Agricultural Directory & Index, 1999/2000

The Third National Agricultural Policy (1998-2010) for Malaysia states that the rapid growth of the oil palm industry in the country will be sustained, with future expansion into Sabah and Sarawak and through reverse investment in neighbouring countries. Oil palm and rubber are viewed as important exports and significant revenue earners for the country.

With limited land availability, the plantation area has remained constant over the years. However, large areas of land under cocoa and rubber crops have been replanted with the more lucrative oil palm, which is expected to further expand agrochemical usage in the country. The area of oil palms in Malaysia is expected to rise from 2.7 million ha (in 1998) to 4.3 million ha in 2020, with a subsequent rise in the utilisation of agrochemicals such as herbicides, rodenticides, insecticides and fungicides as indicated in *Table 1* (AGROW, 1998).

Table 1: Agrochemical usage on Oil Palms in Malaysia (1998-2020)

Year	1998	2000	2005	2010	2020
Oil palm area (000 ha)	2742	2874	3192	3518	4251
Herbicides (million litres)					
Glyphosate	7.7	8	8.9	9.9	11.9
Paraquat	4.8	5.0	5.6	6.1	7.4
2,4-D amine	1.0	1.0	1.1	1.2	1.5
Spray adjuvants	0.5	5.2	5.7	6.3	7.7
Rodenticides (tonnes)					
Warfarin	2.8	2.9	3.3	3.6	4.3
Bromadioline	0.5	0.5	0.6	0.7	0.8
Insecticides					
Cypermethrin (000 litres)	1974	2069	2298	2533	3061
Carbofuran (000 kg)	1398	1466	1628	1794	2168
Sime RB Pheromone (000 sachets)	129	135	150	165	200
Fungicides (kg)					
Thiram	4524	4742	5267	5805	7014
Benomyl	2550	2673	2968	3272	3953

Herbicides (Glyphosate and Paraquat) and rodenticides are the major pesticides used in oil palm plantations. The state and sector-wide distribution of oil palm area is indicated in *Table 2*.

In Malaysia, over 3,000 retail outlets are involved in the manufacture, formulation and packaging of pesticides (Lum et al. 1990). There are presently 1,600 pesticide products registered in the country, comprising about 250 active ingredients (Ong, 1996).

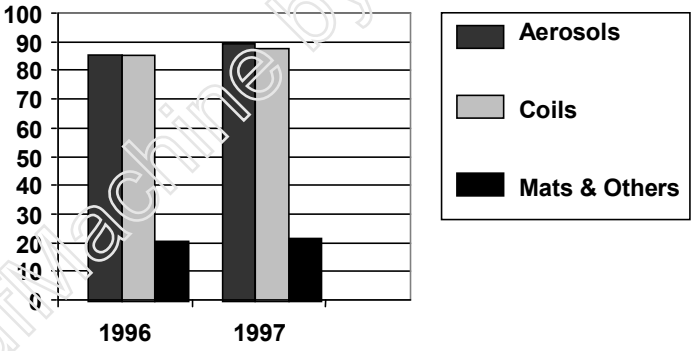
Although not strictly referred to as agrochemicals, household chemicals contain pesticides as active ingredients, and are a source of exposure to households especially to young children. These are largely insecticides packaged differently for household needs. The use of aerosols and mats is increasing at a steady rate of 5-6 per cent annually, much higher than the conventional coil usage, expanding only at 1-2 per cent annually *(Figure 3*). Though coils are the cheapest product in the market, consumers object to the stench and sticky residue left behind by smoke, and hence prefer the more expensive aerosols and mats.

Table 2: Distribution of Oil Palm Planted Area by State and Sector (hectares), 1997

State	Small-holders licensed	FELDA	FELCRA	RISDA	State schemes/Govt Agencies	Private Estate	Total
Johor	108,450	129,382	19,656	3,901	17,578	308,025	586,992
Kedah	8,095	300	1,016	481	0	31,737	41,629
Kelantan	1,052	39,119	6,168	420	8,948	17,121	72,828
Malacca	3,182	1,191	1,215	763	0	29,237	35,588
N. Sembilan	10,444	24,675	5,986	1,770	0	62,404	105,279
Pahang	11,591	285,632	25,507	9,719	50,220	157,433	540,102
Penang	7,035	0	484	56	0	7,297	14,872
Perak	43,291	23,542	29,526	3,259	6,629	169,701	275,948
Selangor	35,553	8,929	3,872	269	9,880	81,183	139,686
Terengganu	3,011	42,272	19,410	16,425	14,633	47,898	143,649
P. Malaysia	*231,704*	*555,042*	*112,840*	*37,063*	*107,888*	*912,036*	*1,956,573*
Sabah	26,178	118,057	1,348	0	58,591	511,562	715,736
Sarawak	2,158	8,383	3,547	0	58,036	74,883	147,007
Sabah / Sarawak	*28,336*	*126,440*	*4,895*	*0*	*116,627*	*586,445*	*862,743*
MALAYSIA	**260,040**	**681,482**	**117,735**	**37,063**	**224,515**	**1,408,481**	**2,819,316**

Source: Malaysian Agricultural Directory & Index, 1999/2000

FIGURE 3: Consumption of Household Products in Malaysia, 1996 – 1997



Source: Malaysian Agricultural Directory & Index, 1999/ 2000

In Malaysia, the aerial application of pesticides is still permitted by the Pesticides Board in collaboration with the Department of Civil Aviation, though retaining the option only as a last resort. The seeming lack of urgency in reducing the amount of pesticides used in the plantations is a cause for concern especially with regards to the safety and well being of women workers, particularly those employed as pesticide sprayers and applicators.

Several local companies in Malaysia are diversifying into agri businesses. The country is also becoming a focal point for pesticide exports in the region, with active ingredients being sent for formulation into new products and re-export to neighbouring countries. At the global level, the European and North American markets are reaching

their limits in pesticide sales, and the industry is aggressively promoting its products to farmers, plantations and governments in the South.

The agrochemical industry is largely controlled by a handful of transnational corporations that reap enormous benefits but are subjected to little accountability. Despite having mechanisms such as pesticide legislation and stringent testing protocols for registration, the onus of proving product safety does not lie with the manufacturer. It is usually up to the governments to ban specific pesticide products if found hazardous to health.

Currently, over 120 tests have to be carried out prior to issuing a permit to register a pesticide in the U.S. Despite this, and given the hundreds of new chemicals introduced globally every year, it is no surprise that systematic health and environmental poisoning are believed to be common. Pesticide companies routinely sell products banned in their home countries to the developing world, where regulatory and legal enforcement capacities are lacking.

The Global Industry

As stated above, with the European and North American markets reaching their limits in terms of pesticide sales, the Pesticides industry is now heavily promoting its products to the South. A point of much concern is the often aggressive marketing tactics that take place to push sales. Many of their product promotion tactics even go against the codes of conduct that they have voluntarily accepted. Some of these tactics are based on untrue information and other tactics that could be considered dangerous.

For example in 1993, Malaysian NGOs and the general public heavily criticised an advertisement taken out by ICI, which appeared in the local newspapers, claiming that Paraquat is "environmentally friendly". (Rengam, 1994). In 1993, ICI spun-off its "new science" industries (pharmaceuticals, agrochemicals, seeds and specialty chemicals) into a separate company called Zeneca. Zeneca then merged with the Swedish pharmaceutical company to form AstraZeneca. In 1999, AstraZeneca merged its agrochemical divisions with Norvatis to form a company presently called Syngenta, which continues to market Paraquat in Malaysia.

In another case, in an interview with a reporter from the Bangkok Post, dated June 9th 1999, the manager of Monsanto Thailand boasted that Roundup (trade name for glyphosate) was safer than coffee or table salt. He also maintained, "In another study on rabbits, Roundup has been found to cause less irritation than baby shampoo". (Chinvarakorn, 1999). Such statements clearly violate the Food and Agriculture Organisation's (FAO) International Code on the Distribution and Use of Pesticides, which the company is known to voluntarily honour.

Since the early trends in the 1970s, the pesticides industry has gone through a period of consolidation. After a flurry of mergers and acquisitions in the last few years, corporate domination of the food system has reached a peak. As reported by AGROW Crop protection News in 1999, the top five agrochemical companies, Syngenta (merger of Novartis and Astra-Zeneca, as mentioned above), Aventis (Rhone-Poulanc and AgrEvo), Monsanto (Pharmacia[1]), BASF and Du Pont, building up strategic monopolies incorporating dominant positions in the seed, agrochemicals, pharmaceuticals and related markets. As reported by the Canada-based ETC Group (Action Group on Erosion, Technology and Concentration), in 2000 the top two companies-Syngenta and Pharmacia-control 34 per cent of the global agrochemical market, valued at US$29,880 million.

Pesticides and Human Health

Pesticide Exposure and Toxicity in Humans

Pesticides are classified into four categories depending on their toxicity (by U.S. Environmental Protection Agency EPA and World Health Organisation WHO). The most dangerous pesticides are in EPA Category 1, and WHO Category 1A and 1B.

There are four ways pesticides can enter the human body – by breathing, by swallowing, through skin contact and through the eyes in cases of splashes or spills. The most common route of pesticide absorption is through the skin.

Table 3: Top 10 Agrochemical Companies

Company	*Agchem Sales in US$ millions*	*% share of world market*
1. Syngenta (Novartis + AstraZeneca)	$6,100	20%
2. Pharmacia (Monsanto)	$4,100	14%
3. Aventis (AgrEvo +Rhone Poulenc)	$3,400	11%
4. BASF (+ Cyanamid)	$3,400	11%
5. DuPont	$2,500	8%
6. Bayer	$2,100	7%
7. Dow AgroSciences	$2,100	7%
8. Makhteshim-Agan	$675	2%
9. Sumitomo	$625	2%
10. FMC	$575	2%

Source: ETC Group, based on data provided by Allan Woodburn Associates cited in Agrow. July/August, 2001

Some parts of the skin, such as the genital area, the face and neck followed by the back of the hands, armpits and forearm absorb pesticides more easily than others. If the skin is damp or wet, or if there is a cut or rash, pesticides will go through the skin faster and in larger amounts. Children absorb more pesticides than adults at the same level of exposure, due to a large skin surface for their size, and because of rapid breathing rate.

Pesticides affect human health in three major ways:

- *Immediate / acute effects*: reactions to pesticides that occur due to direct contact with pesticides and manifest within a very short time. The most common effects are irritation of the eyes, nose and throat such as tearing, stinging, burning and coughs, skin irritation and rashes. Almost 76 per cent of all acute poisonings in Asian countries are caused by organophosphates (Jeyaratnam et al, 1987).
- *Delayed / Chronic effects*: reactions that occur due to low levels of exposure over a long period of time, which may take months or years to manifest as cancers, neurological damage or reproductive system disorders.
- *Effects on existing conditions*: aggravation of existing medical condition conditions such as asthma and allergies, heart and immune system disorders.

Of late, there has been growing concern over the use of chemicals that can disrupt the endocrine system, which controls key developmental, reproductive, behavioral and immunological functions. Of all the endocrine disrupting effects of pesticides, the most serious ones arise from changes that occur during foetal development in the womb, as these changes are irreversible. For example, changes in the developing brain can alter neural pathways leading to alterations in behavior and endocrine function. Changes to the thymus and bone marrow cells can lead to immune suppression. Changes to the developing testes or ovaries can affect sperm or egg quality and quantity (PAN AP, 1999).

Chemical pesticides known to disrupt the endocrine system among others include DDT and its degradation products such as DDD and DDE, Alachlor, Aldicarb, Aldrin, Atrazine, Carbaryl, Carbofuran, Dimethoate, Dinoseb, Endosulfan (thiodan), Endrin, Fenitrothion, Fipronil, Lindane, Malathion, Maneb, Methoxychlor, Parathion, 2,4,5-T, 2,4-D, Toxaphene, di (2-ethylhexyl) phthalate), dicofol, hexachlorobenzene and synthetic pyrethroids, Chlorpyrifos and Deltamethrin.

There is also a significant association of congenital limb defects in children whose mothers have been exposed to pesticides in close proximity (Kricker et al, 1986).

Factors Affecting Toxicity in Humans (WHO/UNEP 1990)

The severity of any adverse effect from exposure to pesticides depends on the dose, the route of exposure, how easily the pesticide is absorbed, the types of effects of the pesticide and its metabolites, and its accumulation and persistence in the body.

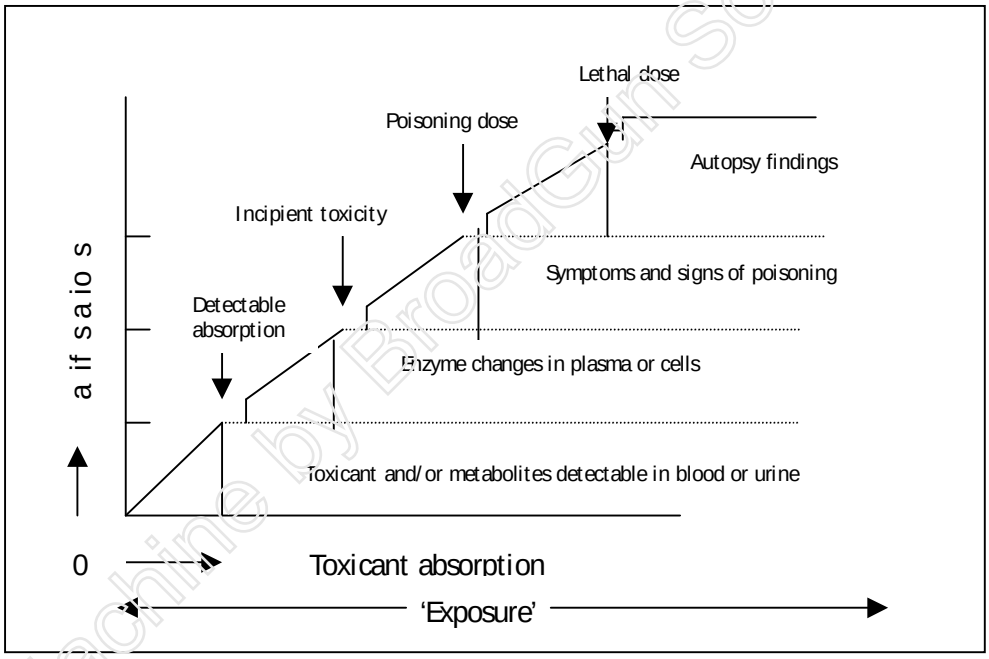
Further, the toxic manifestations depend on the health status of the individual. Malnutrition and dehydration are likely to increase sensitivity to pesticides. Sores and skin abrasions may facilitate uptake of pesticides through the skin, which is of particular importance when adequate protective clothing is not available or not worn.

Nutritional deficiencies such as Protein Energy Malnutrition may aggravate pesticide toxicity. Water deprivation may make people more susceptible to the effects of anticholinesterase pesticides. Hence field workers suffering from dehydration are more susceptible to poisoning by organophosphorous and carbamate pesticides. A rise in ambient temperature often makes the toxic effects of pesticides worse.

In the body, the pesticide may be metabolised or it may be stored in fat, or excreted unchanged. In times of poor nutrition, the body's fat deposits are mobilised, releasing the stored pesticides into the bloodstream, with the possibility of toxic effects if the concentration reaches high levels.

When two or more pesticides are used simultaneously, they may interact and become either more toxic (synergism or potentiation, as with lindane and heptachlor) or less toxic (antagonism). Effects that result from pesticide interactions although hard to identify and quantify, are probably of more importance than generally recognised.

Figure 4: Manifestations of Toxicant Absorption (Morgan 1980)



Occupational Exposure to Pesticides

WHO estimates the total cases of pesticide poisoning worldwide at between 2 and 5 million workers each year of which 40,000 are fatal. Of these, 70 per cent of the cases are in the developing world. Copplestone (1985) states that about 60-70 per cent of all cases of unintentional acute pesticide poisoning cases are due to occupational exposure. Workers in agriculture are said to face at least twice the risk of dying on the job than other sectors. Those in developing countries such as Malaysia are especially at high risk due to inadequate education, training and safety systems.

Table 4: Factors Affecting Skin Absorption of Pesticides

Skin characteristics	- sores and abrasions - wetness of skin - location on the body (absorption occurs readily through the eyes and lips) - vascularization
Environmental factors	- temperature - humidity
Pesticide characteristics	- acidity (pH) - vehicle - physical state (solid, liquid or gas) - concentration of active ingredient

The following list shows some of the occupations at potential risk from exposure to pesticides:

- pesticide manufacturers (production workers)
- formulators
- vendors
- transporters
- mixers
- loaders
- operators of application equipment (farmers / sprayers / workers)
- growers and pickers
- rescue and clean up parties

Long-term exposure is likely to occur in the occupational groups listed above. Very few reports of such effects are available, and further studies are needed to document occupational exposure to pesticides.

Data collected from the Social Security Organisation, Malaysia, 1991 suggests that the accident rate per 1,000 workers is as high as 25 per cent in the country. In 1991, as many as 35,224 workers in the agricultural sector were affected by accidents, an increase of 8 per cent over a period of three years (ILO, 2000).

A report by the Malaysian Factories and Machinery Department, the agency that enforces the Occupational Safety and Health Act, revealed that the accident rate for improper handling of pesticides is four times higher than that of other industries, and is as high as 93 per 1000 workers as compared with the national average of 23 per 1000 workers (Rengam, 1991).

Women are at High Risk

Due to the multiple roles they play in society, women workers have special needs concerning nutrition, lifestyle and reproductive health. Women have a dual reproductive and economic role as unpaid workers at home, and as paid workers in the fields. On an average a woman works 1-3 hours per day longer than a man in the same society.

The physiological differences in women's bodies (more fatty tissue, thinner skin and lower kidney functions) make them more vulnerable to pesticide exposure than men. During pregnancy, pesticides can cross the placenta and affect the developing foetus (PAN AP, 1999). It is therefore crucial that female sprayers in plantations are monitored constantly for exposure to pesticides.

An early study in Malaysia revealed that 88 of the 100 cases of confirmed organophosphate poisonings were women of Indian origin. The study attributed this to the easy availability of pesticides on rubber plantations, which employ many Indian women (Delilkan et al, 1984).

In general, the health hazards of women workers have been traditionally under-estimated because occupational safety and health standards, and exposure limits to hazardous substances are based on male populations and laboratory tests.

Signs and Symptoms of Organophospate Poisoning

Acute organophosphate poisoning accounts for 53.6 per cent of total poisonings in Malaysia (He, 1999). Symptoms of acute organophosphate poisoning develop during or after exposure within minutes to hours, depending on the method of contact. Exposure by inhalation results in the fastest appearance of toxic symptoms, followed by the gastrointestinal route and finally the dermal route.

Some of the most commonly reported early symptoms include headache, nausea, dizziness and hyper secretion, the latter of which is manifested by sweating, salivation, lacrimation and rhinorrhea. Muscle twitching, weakness, tremor, incoordination, vomiting, abdominal cramps, and diarrhoea signal a worsening of the poisoned state. Meiosis is a helpful diagnostic sign and the patient may report blurred or dark vision. Anxiety and restlessness are prominent, as are a few reports of choreaform movements. Psychiatric symptoms include depression, memory loss, and confusion. Toxic psychosis manifested as confusion or bizarre behaviour has been misdiagnosed as alcohol intoxication. Children often present with slightly different clinical picture than adults. Seizures and mental changes such as lethargy and coma are common (U.S. EPA, 1999).

A study by Yusof et al (1995) revealed that in comparison to a non-exposed control population, 12.4 per cent of the agricultural workers in Ranau, Sabah suffered from nail abnormalities, and almost 50 per cent suffered from reproductive disorders and miscarriages attributable to pesticide exposure.

Confirmation of Poisoning

It is commonly advised that if pesticide poisoning is probable or suspected, it should be treated immediately, without waiting for laboratory confirmation.

For clinical confirmation, blood samples should be drawn to measure the plasma cholinesterase or red blood cell AchE (Acetyl cholinesterase enzyme) levels. A depression of plasma pseudo-cholinesterase and /or RBC acetyl cholinesterase levels is a good indicator of excessive organophosphate absorption. A significant number of organophosphates must be absorbed to depress blood cholinesterase activity, but enzyme activities especially

Table 5: Common symptoms of Acute Organophosphate Poisoning (PAN/ CTA 1995)

Mild to moderately severe poisoning	Severe poisoning (in addition to those seen in mild poisoning)	Very severe poisoning (in addition to those seen in mild and severe poisoning)
- nausea, vomiting - headache - increased salivation - extreme weakness, fatigue - dizziness - flu like symptoms - increased perspiration - blurred vision - inarticulate speech	- difficulties in walking - abdominal cramps and diarrhoea - excessive perspiration with salivation - twitching of the eyelids, tongue and gradually of other skeletal muscles - pin sized pupils, but pupils may also be dilated - uncontrollable urine excretion and bowel movements	- generalized convulsions (resembling epileptic seizures) - unconsciousness - acute breathing problems - drop in blood pressure - death due to respiratory failure, heart failure, and pulmonary oedema

plasma pseudo cholinesterase may be lowered by dosages considerably lesser than are required to cause symptomatic poisoning. Depression of the plasma levels usually persists for several days to a few weeks. The approximate lower limits of normal plasma and RBC cholinesterase measured by the BMC Reagent Set (Ellman Boehringer method) are 1875 and 3000 mU/mL/min.

In certain conditions, the activities of plasma and RBC cholinesterase are depressed in the absence of chemical inhibition. About 3 per cent of individuals have genetically determined low level of plasma pseudocholinesterase. Patients with hepatitis, cirrhosis, malnutrition, chronic alcoholism and dermatomyositis exhibit low levels. A number of toxicants including nicotine, state of early pregnancy, birth control pills may also cause depression of levels.

It is generally accepted that everyone has his or her own personal level of cholinesterase. This personal level called a 'baseline' can be lower or higher in some people than others. To confirm organophosphate poisoning, a reduction from this baseline level needs to be established. Unfortunately, in most cases, baseline levels (levels before exposure) are not available and hence two or more repeat testing are suggested to confirm poisoning (Moses, 1996).

Pesticide Poisoning Cases in Malaysia

Recording of pesticide poisoning cases in Malaysia has been limited to in-patient data, laboratory reports from government hospitals and records from the Chemistry Department of the Ministry of Science, Technology and Environment. From 1970 to 1982 there were 100 cases of organophosphate poisoning admitted to the Intensive Care Unit, University Hospital in Kuala Lumpur (Delilkan et al, 1984). Data from the Ministry suggest that most cases of poisonings from 1979 to 1986 were related to pesticides, mainly the herbicide Paraquat, and of the causes, 49.1 per cent were intentional and 37.8 per cent accidental. Hospital records from 1994 revealed that 740 poisonings related to pesticides occurred at work (Rajendra, 1996). However, data on accidental pesticide poisoning is often confused by the incidence of pesticide poisonings related to suicides.

Geographical areas with a concentration of plantations are likely to record high levels of mortality due to pesticide poisoning. Data clearly suggests that farm and plantation workers constitute 45 per cent of the reported pesticide deaths (Sinnaia, 1989). Another survey revealed that 13.3 per cent of all agricultural workers in Malaysia were poisoned, with an average of 6.7 per cent of agricultural workers poisoned per year (Jeyaretnam et al, 1987). Studies have also shown that 12.2 per cent of a total of 264 poisoning cases treated in a teaching hospital were attributable to pesticides (Awang et al, 1991).

A more recent study (Zain, 1998) reports that in the year 1995, a total of 972 cases of pesticide poisonings were admitted to Malaysian hospitals. Of these, 133 were caused by accidents, 247 by other causes, 520 were attributed as suicides, while causes were unknown for 72 cases. The same study reports that Johor and Perak had the highest number of deaths due to pesticide poisoning (33 cases) with Kedah reporting only one case; Perak reported the highest number of hospitalisations (137) and Kedah (29); Negeri Sembilan reported the highest number of suicide attempts using pesticides (125), Perak (71) and Kedah (4).

A study by the Consumer Association of Penang (CAP, 1996) revealed that as many as 90 per cent of the farmers surveyed did not observe safety measures while handling pesticides. Used pesticide containers were disposed off in water areas, and none of the farms displayed the notice "Danger: Pesticide Sprayed Area, No Entry to Unauthorized Persons", as stipulated by regulations.

A 1998 survey of pesticide use and associated incidences of poisoning in Peninsular Malaysia, reported that estate workers formed the majority of all pesticide poisonings reported. The study also revealed that organophopshorous insecticides and rodenticides were used widely in oil palm plantations, though the estate workers did not understand or were unaware of the colour coding of chemicals, and the potential hazards from pesticides (Ramasamy et al, 1988).

Poisoning cases most commonly occur during spraying, mixing, and diluting the pesticides. A study conducted in Malaysia revealed the following information on the activities associated with high incidence of pesticide poisoning (Jeyaretnam, 1982):

Some of the specific factors contributing to acute pesticide poisoning are (Jeyaretnam, 1985):

- Lack of protective clothing suitable for tropical climates,
- Poor knowledge and understanding of safe practices in pesticide use,
- Use of pesticides (by farmers) in concentrations in excess of requirements,
- Poor maintenance facilities for spray equipment, giving rise to hazardous contamination, and
- Use of pesticide mixtures.

Studies on the occupational exposure of sprayers have been limited in Malaysia. Swan (1969) carried out two fields trials on Malaysian rubber plantations to study the exposure of operators applying Paraquat with hand operated knapsack sprayers. Howard et al (1981) studied the health of Malaysian plantation workers using Paraquat sprayers. Chester and Woollen (1981) reported on occupational exposure to Paraquat. Lee and Chung (1985) carried out an extensive study on the potential contamination of various parts of a spray operator's body. Tan et al (1988) studied the potential dermal exposure of spray operators.

Table 6: Poisoning Incidents in Malaysia by type of Activity

	Incidents	Percent poisoned
Spraying	181	5.7
Mixing or diluting	107	3.4
Other (including equipment repair)	2	0.2

A study by Whitaker (1989) covering 400 Malaysian rubber and oil palm small holders in Johor, Perak, Kelantan and Pahang reports a satisfactory awareness regarding the hazards from pesticides, safety and hygiene. The study however adds that standards in storage of pesticide containers and disposal of empty containers need to be improved, and emphasises continued education and training programmes regarding the use of pesticides.

Very few studies have been undertaken to study the problem of acute pesticide poisoning among agricultural workers, and more so women workers. The inadequacy among health professionals to recognise and treat pesticide poisoning victims is also generally recognised.

End note:

[1] *When Pharmacia acquired Monsanto in November 1999 it quickly spun off the ag biotech company as a detached agribusiness unit. However, Pharmacia retains 86% control of the new, independent entity.*