

## Pesticide Residue Monitoring on Agriculture in Indonesia

### *Pemantauan Residu Pestisida pada Produk Pertanian di Indonesia*

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**Abstract.** Most agricultural producers use pesticides to prevent pests and increase yield and quality of the food they grow. Pesticides can damage people's health, and lead to birth defects (*teratogenic* in character) and death in humans and animals. Many of these chemical residues, especially derivatives of *organochlorine* pesticides, demonstrate dangerous bioaccumulation levels in the body and environment. The problems caused by *organochlorine* residues (*lindan, aldrin, dieldrin, endrin, heptachlor and DDT*) on agricultural lands that are still found today are generally the consequence of past usage that dates back to the 1960s. Research on pesticide residues in Indonesia was carried out several years ago by various research institutes and universities and some of these results were collected between 1985 and 2017. Data distribution of the results on pesticide residues include in Aceh, North Sumatra, West Sumatra, Jambi, Bengkulu, Lampung, Banten, Jakarta, West Java, Central Java, East Java, Yogyakarta, Bali, South Kalimantan, North Sulawesi, South Sulawesi, Gorontalo, Maluku, and Papua. Most of the pesticide residue research has been conducted on vegetables. Pesticide residues were found in various commodities and matrices such as rice, soybeans, cow's milk, chicken eggs, fruit ingredients, vegetables, soil, paddy water, river water, lake water, pond water, sea water, water birds, animal feed, fish, frogs, lamb, birds, eggs, tea, and honey. Pesticide residues found were insecticide (*organochlorine, organophosphate, carbamate, pyrethroid*), and fungicide (*dimethomorp, fenobucarb, propineb, benomyl, carbendazim and thiametoxam*). *Organochlorine* insecticides have been banned, but the residues are still found today. This is due to the nature of *organochlorines* which have high persistence properties. Even though insecticide residues (*organophosphate, carbamate, pyrethroid*) found in food commodities are still below the maximum residual limit (MRL), namely SNI 7313: 2008, but some close to MRL. Particularly for *organochlorine* residues in soil, water and plants insecticides must be monitored because they are persistent, toxic and accumulative. This paper aims to review of pesticide residues in various products including food, and the potential impact of pesticide residues on human health.

**Keywords:** *Distribution / organochlorine / food quality*

**Abstrak.** Sebagian besar produsen pertanian menggunakan pestisida untuk mencegah hama dan meningkatkan hasil dan kualitas makanan yang mereka tanam. Pestisida dapat merusak kesehatan manusia, dan bersifat *teratogenik* dan mematikan pada manusia dan hewan. Banyak dari residu kimia ini, terutama turunan pestisida *organoklorin*, menunjukkan tingkat bioakumulasi yang berbahaya dalam tubuh manusia dan lingkungan. Masalah tersebut disebabkan oleh residu *organoklorin* (*lindan, aldrin, dieldrin, endrin, heptachlor dan DDT*) yang digunakan sejak tahun 1960-an. Penelitian tentang residu pestisida di Indonesia dilakukan beberapa tahun yang lalu oleh berbagai lembaga penelitian dan universitas yang dikumpulkan antara tahun 1985 dan 2017. Distribusi data hasil residu pestisida tersebar di Aceh, Sumatera Utara, Sumatera Barat, Jambi, Bengkulu, Lampung, Banten, Jakarta, Jawa Barat, Jawa Tengah, Jawa Timur, Yogyakarta, Bali, Kalimantan Selatan, Sulawesi Utara dan Selatan, Gorontalo, Maluku, dan Papua. Penelitian yang telah dilakukan menemukan residu pestisida tidak hanya ditemukan di berbagai komoditas pertanian seperti beras, kedelai, susu sapi, telur ayam, bahan buah, sayuran tetapi juga pada tanah, sawah, air sungai, air danau, air kolam, air laut, burung air, pakan ternak, ikan, katak, domba, telur burung, teh, dan madu. Residu pestisida yang banyak ditemukan di lapangan adalah insektisida (*organoklorin, organofosfat, karbamat, piretroid*), dan fungisida (*dimethomorp, fenobucarb, propineb, benomyl, carbendazim dan thiametoxam*). Insektisida golongan *organoklorin* telah dilarang penggunaannya, namun residunya masih ditemukan hingga kini. Hal ini dikarenakan sifat *organoklorin* yang memiliki sifat persistensi yang tinggi. Residu insektisida (*organofosfat, karbamat, piretroid*) yang ditemukan di dalam komoditas pangan secara umum masih di bawah batas maksimum residu (BMR) yang mengacu pada standar nasional, yaitu SNI 7313: 2008, namun beberapa residu insektisida telah mendekati BMR. Khusus untuk residu insektisida golongan *organoklorin* di dalam tanah, air dan tanaman harus dipantau karena sifatnya yang persisten, beracun, dan akumulatif. Makalah ini bertujuan untuk mengkaji residu pestisida dalam berbagai produk termasuk makanan, dan dampak potensial residu pestisida pada kesehatan manusia.

**Kata kunci:** *Distribusi / organoklorin / kualitas pangan*

## INTRODUCTION

For more than three decades agricultural development has paid more attention to food crop production, given the need to produce greater amounts of food due to the world's rising population. Food crop production increases were achieved through a variety of intensification programs, by introducing high yielding varieties, high input uses of fertilizers and pesticides (Soejitno and Ardiwinata 1999). In 2016, it was estimated that 3,207 formulations of pesticides in Indonesia were registered for pest control on many commodities. When the agriculture industry was still in its development phase, *organochlorine* and *organophosphate* pesticides were predominantly used, followed later by *carbamate* and *pyrethroid* groups. However, the overuse or misuse of pesticides endangered the health of consumers and generated hazardous outcomes for the environment. Our studies revealed that some pesticide residues were found in rice grain and soybean in Java, in several vegetables in Sumatra, Kalimantan, Sulawesi, West Java, Central Java, East Java, Yogyakarta, Bali, Maluku, Papua, and in the coastal areas of Java. In Java island, our study discovered some residues of *organochlorine*, *organophosphate* and *carbamate* in rice grain, soils, in the irrigation and water.

Tuhumury *et al.* (2012) reported the presence of *organochlorine* residues (*heptachlor*, *aldrin*, *lindan* and *endosulfan*) in fresh vegetable products in Ambon City, situated in the Indonesian province of Maluku. Ohorella *et al.* (2013) and Purnama *et al.* (2013) reported lind residues in carrots and tomatoes in traditional markets and modern markets in Makassar. Furthermore, Andina (2015) found residues of *endosulfan*, *endrin*, *dieldrin*, *aldrin*, *pp-DDT* and *heptachlor* in rice varieties of Siam Unus on South Kalimantan. It is worth noting there are types of pesticides which are prohibited because they are toxic and persistent. The type of pesticide examined here is *organochlorine* insecticide. Some *organochlorine* insecticides are included in the group of persistent organic pollutants (POPs), these being pollutants which are a problem worldwide because they are chronic, persistent and bioaccumulative.

Implementation of Integrated Pest Management (IPM) is a strategy that will be able to guarantee production optimization by minimizing damage to the environment (Untung 1990). IPM aims to increase

production to a high level by maintaining environmental sustainability and benefiting farmers. Furthermore it is now part of government policy to overcome the pest problems besetting agricultural crops in Indonesia. Close cooperation between researchers, extension agents (i.e. officers who work directly with farmers and companies on agriculture-related matters and help them make better decisions to increase production), regional officials, interested private parties and farmers needs to be improved so that the obstacles can be overcome (Oka 1990). In order to accelerate the solving of various agricultural problems thoroughly, interdisciplinary collaboration is needed, if possible inter-subsectoral and even inter-sectoral (Hadiwijaya 1990).

The use of pesticides for agricultural products is increasing, but research on the impact of pesticide residues on developing countries is limited. Building awareness and information for the community about the impact of pesticide residues and how to maintain food security is also lacking. For this reason the paper seeks to build knowledge on the subject by review of pesticide residues in a variety of products including food, and the potential impact of pesticide residues on human health and the environment.

## HISTORY OF PESTICIDE USE IN INDONESIA

The use of pesticides in Indonesia began in the 1950s. The most widely used pesticides in Indonesia from the 1950s to the late 1960s were *hydrocarbon-chlorinated* insecticides, such as *dichlor diphenol trichloroethane (DDT)*, *endrin*, *aldrin*, *dieldrin*, *heptachlor* and gamma BHC (Tarumingkeng 1992). It is evident that the post-war period was one where pest control efforts relied more on pesticide use. Modern agriculture has strongly emphasized the use of pesticides in an effort to maintain and increase production. Pest control efforts with pesticides often provide amazing results because they are real and occur rapidly, so the use of pesticide quickly spreads due to their popularity (Soejitno 1990). However, pest control through the employment of pesticides without regard to the balance of the agricultural ecosystem has resulted in environmental damage or unwanted side effects. These events serve as a warning about the dangers of using unauthorized pesticides that the community is not

aware of. The publication of Rachel Carson's famous book *Silent Spring* in 1962, which revealed the facts behind the side effects caused by using DDT, made people realize the dangers of using pesticides (Soejitno 1990).

Based on data and information about the side effects of pesticide use, Prof. Dr. Ida Nyoman Oka and other environmental scientists began to rethink the concept of pest and disease control, which combines pest control with biological control (De Bach 1964). This concept was further developed as a pest population management system that uses suitable and compatible techniques to reduce pest populations to below the economically acceptable level. This concept became known as Integrated Pest Management (IPM) (Soejitno 1990). Prof. Oka is the father of Indonesian IPM and played a prominent role in banning a number of pesticides through Presidential Instruction No. 3 of 1986 (Anonim 2014). Based on information provided by Prof. Oka (personal communication around 1989), agricultural land in Java had been sprayed from airplanes with *organochlorine* pesticides in the 1960s, principally to control brown plant-hopper attacks. Another person who had witnessed the use of *organochlorine* pesticides in the 1960s was Mr. Salim from Banjaratma Village, Bulakamba, Brebes, Central Java (personal communication March 14 2018).

## SUMMARY OF PESTICIDE RESIDUE IN INDONESIA

Research on pesticide residues in Indonesia was carried out several years ago by various research institutes and universities and results were collected from 1985–2017 (Table 1). Data distribution of research results on pesticide residues was extensive and included the following: Aceh (Banda Aceh; Desa Ujong Baroh, Kecamatan Johan Pahlawan, Kabupaten Aceh Barat), North Sumatra (Berastagi, Kabupaten Karo), West Sumatra (Padang Luar, Kabupaten Agam), Jambi (Danau Kerinci, Kabupaten Kerinci), Bengkulu (Desa Sumber Urip, Kecamatan Rejang Lebong), Lampung (Kecamatan Gisting), Banten (Pandeglang), Jakarta (traditional market), West Java (Desa Cihanjuang, Kecamatan Parongpong, Kabupaten Bandung Barat; Bogor), Central Java (Kabupaten Brebes, Grobogan, Jepara), East Java (Kecamatan Dau, Malang; Desa Sumber Gondo, Kecamatan Glenmore, Kabupaten Banyuwangi), Yogyakarta (Kabupaten Bantul,

Kabupaten Kulon Progo), Bali (Danau Buyan Buleleng), South Kalimantan (Pasar Banjarbaru dan Martapura), North Sulawesi (Kecamatan Langowan Barat, Bahu market, Karombasan market, Bersehati market and Rurukan village), South Sulawesi (Makassar), Gorontalo (Tabongo, Kabupaten Gorontalo), Maluku (Ambon), and Papua (Merauke)..

Pesticide residue research has mostly been conducted on vegetables. Pesticide residues were found in various commodities such as rice, soybeans, cow's milk, chicken eggs, fruit ingredients, vegetables, soil, paddy water, river water, lake water, pond water, sea water, water birds, animal feed, fish, frogs, lamb, birds' eggs, tea, and honey. The pesticide residues which were found originated from the following insecticides: *organochlorine*: lindane, heptachlor, aldrin, dieldrin, DDT, endrin, endosulfan. *Organophosphate*: diazinon, fenitrothion, malathion, fenthion, fonofos, quinalphos, profenophos, chlorpyrifos, parathion, ethion, acephate, dimethoate, monocrotophos, fenvalerate, penhoate, and triazophos. *Carbamate*: carbofuran, carbosulfan, carbaryl, dithiocarbamate, BPMC and MIPC; *Pyrethroid*: cyhalothrin, deltamethrin, beta cyfluthrin, pyrethrin, cypermethrin and bifenthrin; and *fifthly, fungicide*: dimethomorp, fenobucarb, propineb, benomyl, carbendazim and thiametoxam.

*Organochlorine* residues are still being detected in soil, water and food commodities despite the fact they were banned decades ago. This is because the inheritance residues of the 1960s were persistent and remained in the land, which was then carried away by the flow of water. Pesticide residues found in food commodities in general are still below the maximum residue limits (MRLs) which refer to the national standard SNI 7313: 2008. However, *organochlorine* pesticide residues in soil and water must still be monitored carefully and diligently because they are persistent, toxic, and accumulative.

### Pesticide Residues in Vegetables

Monitoring of vegetables has been carried out throughout Indonesia since the 1980s by the Directorate of Food Crop Protection (Siswomihardjo 1990). Monitoring activities were mainly carried out in the vegetable production centers of North Sumatra (Tanah Karo), West Java (Lembang), Central Java (Wonosobo), East Java (Batu), South Sulawesi (Enrekang), and Bali (Tabanan). Extensive monitoring activities were conducted in 1986, 1988, 1990, 1991 and 1993, and targeted here were commodities such as

Table 1. Summary of pesticide residues on the various agricultural products in Indonesia

Tabel 1. Ringkasan residu pestisida pada berbagai produk pertanian di Indonesia

Commodity	Residue	References
Rice	<i>Lindane, Aldrin, Endosulfan, Chlorpyrifos, Diazinon, Heptachlor, DDT, Carbaryl</i>	Ardiwinata <i>et al.</i> (1997) Harsanti <i>et al.</i> (1999) Jatmiko <i>et al.</i> (1999) Ardiwinata <i>et al.</i> (1999) Ismaya (1996)
	<i>Endosulfan, Endrin, Dieldrin, Aldrin, pp-DDT, Heptachlor</i>	Andina (2015)
	<i>Endosulfan</i>	Jafar <i>et al.</i> (2016)
Soybean	<i>Lindane, Dieldrin, BPMP, MIPC, Chlorpyrifos, Fention, Carbofuran, Heptachlor, DDT, Carbaryl, Diazinon</i>	Samudra <i>et al.</i> (1992) Ardiwinata <i>et al.</i> (1997)
Cow's milk	<i>Lindane, Dieldrin, Endosulfan, DDT</i>	Iljas <i>et al.</i> (1986)
Chicken eggs	<i>DDT, Aldrin, Dieldrin, Lindane, Endrin</i>	Ashari (1986)
Fruits	<i>Cyhalotrin, Deltamethrin, Propineb, Diazinon, Parathion, Ethion, Profenofos, Malathion, Chlorpyrifos and Carbofuran</i>	Arvina (1998) Hartini (2014)
	<i>Acephate, Carbofuran, Carbosulfan, Diazinon, Dimethomorp, Fenobucarb, Profenofos, Pyrethrin</i>	Sumiati and Julianto (2017)
Imported fruit	<i>Diazinon, Dimethoate, Chlorpyrifos, Benomyl, Carbedazim</i>	Syahbirin <i>et al.</i> (2001)
	<i>Organophosphate and Carbamate</i>	Zelila (2016)
Vegetables	<i>DDT, Endosulfan, Lindane, Aldrin, Dieldrin, Diazinon, Fenitrothion, Malathion, Fenthion, Chlorpyrifos</i>	Karindah (1995) Japanto (1992)
	<i>Dithiocarbamate</i>	Mutiaticum (2003)
	<i>Heptachlor, Aldrin, Endosulfan, Lindane, Chlorpyrifos, Profenofos, Diazinon, Monocrotophos, Parathion, Carbofuran, Cypermethrin</i>	Tuhumury <i>et al.</i> (2012)
	<i>Pyrethroid</i>	Buyang and Pasaribu (2014)
	<i>Profenofos</i>	Alen <i>et al.</i> (2015)
	<i>Profenofos</i>	Wariki <i>et al.</i> (2015)
	<i>Thiametoxam</i>	Muslim <i>et al.</i> (2015)
	<i>Profenofos and Chlorpyrifos</i>	Nur <i>et al.</i> (2015)
	<i>Chlorpyrifos</i>	Harsanti <i>et al.</i> (2015)
	<i>Chlorpyrifos</i>	Amilia <i>et al.</i> (2016)
<i>Chlorpyrifos</i>	Kapoh <i>et al.</i> (2016)	
<i>Diazinon</i>	Prasasti and Perwitasari (2017)	
Soil	<i>Lindane, Aldrine, Endosulfan, Carbofuran, MIPC, BPMP</i>	Gunlazuardi <i>et al.</i> (1992) Sulaksono (2001) Ardiwinata (1996) Harsanti <i>et al.</i> (1999) Jatmiko <i>et al.</i> (1999) Ardiwinata <i>et al.</i> (1999) Ohsawa <i>et al.</i> (1985)
	<i>Organochlorine</i>	Oginawati <i>et al.</i> (2009)
	<i>Chlorpyrifos</i>	Harsanti <i>et al.</i> (2015)

Commodity	Residue	References
Soil	<i>Lindane, Aldrine, Endosulfan, Carbofuran, MIPC, BPMC</i>	Gunlazuardi <i>et al.</i> (1992) Sulaksono (2001) Ardiwinata (1996) Harsanti <i>et al.</i> (1999) Jatmiko <i>et al.</i> (1999) Ardiwinata <i>et al.</i> (1999) Ohsawa <i>et al.</i> (1985)
	<i>Organochlorine</i>	Oginawati <i>et al.</i> (2009)
	<i>Chlorpyrifos</i>	Harsanti <i>et al.</i> (2015)
Rice field water	<i>Lindane, Aldrin, Endosulfan</i>	Sulaksono (2001) Ardiwinata (1996) Harsanti <i>et al.</i> (1999) Jatmiko <i>et al.</i> (1999) Ardiwinata <i>et al.</i> (1999) Ohsawa <i>et al.</i> (1985)
River water	<i>Organochlorine</i>	Ardiwinata and Djazuli (1992)
	<i>Organochlorine</i>	Oginawati <i>et al.</i> (2009)
	<i>No residue</i>	Putri <i>et al.</i> (2014)
Lake water	<i>Organophosphate (Dimethoate, Chlorpyrifos, and Profenofos)</i>	Manuaba (2008)
	<i>Organochlorine, Organophosphate and Carbamate</i>	Haryadi <i>et al.</i> (2010)
Reservoir / pond water	<i>Lindane, Endosulfan</i>	Ardiwinata <i>et al.</i> (1999)
Sea water	<i>Organochlorine</i>	Ardiwinata and Djazuli (1992)
	<i>Organophosphate (Chlorpyrifos)</i>	Nugroho <i>et al.</i> (2015)
Water bird	<i>Lindane, Aldrin, Endosulfan, Dieldrin, DDT, Endrin, Chlorpyrifos, Diazinon, Carbofuran</i>	Ginoga (1999) Nursoleh (1998)
Cattle Feed	<i>Endosulfan, Chlorpyrifos</i>	Nuraini (2002)
Fish	<i>Carbofuran, Diazinon, Quinalphos, Fonophos</i>	Samudra <i>et al.</i> (1989)
Frog	<i>Carbofuran</i>	Winoto (1995)
Lamb	<i>Endosulfan, Chlorpyrifos, Profenophos, Beta Cyflutrin</i>	Nuraini (2002)
Bird egg	<i>Organochlorine</i>	Ginoga (1999) Indraningsih <i>et al.</i> (1988)
Tea	<i>Alfa-endosulfan dan Bifentrin</i>	Yusiasih <i>et al.</i> (2014)
Honey	<i>(no residue)</i>	Saefudin <i>et al.</i> (2017)

cabbage, tomatoes, potatoes, chili peppers, carrots, long beans, celery, cauliflower, shallots, rice and soybeans. These food crops not only contained pesticide residues but also POPs (Persistence Organic Pesticides) such as DDT compounds (Table 2).

In the period 1994-1999, the Directorate of Food Crop Protection and Laksanawati *et al.* (1994) re-examined several samples of cabbage, potatoes, celery,

tomatoes, long beans, onions, carrots and chili peppers. Based on the results of their analysis it was found that *endosulfan* compounds were potential POPs (Table 3). The research results documented by Ohsawa *et al.* (1985) in the Yogyakarta area (Pasar Sriwedari) revealed the presence of POPs (*BHC, aldrin, dieldrin, heptachlor, DDT and DDE*) compounds in cabbage, tomato and cucumber samples.

Table 2. Concentration of insecticide residues (mg kg<sup>-1</sup>) in some vegetables in Indonesia during 8 years (1986-1993)

Tabel 2. Konsentrasi residu insektisida (mg kg<sup>-1</sup>) pada beberapa jenis sayuran di Indonesia selama 8 tahun (1986-1993)

Insecticide	Vegetable					
	Cabbage	Tomato	Potato	Chili	Carrot	Long beans
<i>Dithiocarbamate</i>	1.663	4.913	0.570	0.160	0.145	-
<i>Carbaryl</i>	-	-	0,017	-	-	-
<i>Diazinon</i>	0.105	0.105	0.062	0.348	0.029	0.036
<i>Chlorpyrifos</i>	0.003	-	0.013	0.046	0.054	0.015
<i>MIPC</i>	0.006	0.020	-	-	-	-
<i>DDT*</i>	0.085	0.447	0.687	-	1.634	0.007
<i>Carbofuran</i>	0.085	0.212	0.550	-	-	-
<i>Fenitrothion</i>	0.051	0.003	0.004	0.002	0.007	-
<i>Cypermethrin</i>	1.261	0.234	0.030	-	-	0.013
<i>Permethrin</i>	0.010	0.015	-	-	-	-
<i>Phenthoate</i>	0.061	0.003	-	-	-	-
<i>Cyhalothrin</i>	0.001	0.039	0.001	-	-	0.002

Source: Untung (1990); \* POPs insecticide

Table 3. Concentration of insecticide residues (mg kg<sup>-1</sup>) of some vegetables in Indonesia during 1994-1999

Tabel 3. Konsentrasi residu insektisida (mg kg<sup>-1</sup>) dari beberapa sayuran di Indonesia selama tahun 1994-1999

Insecticide	Vegetables							
	Cabbage	Onion	Chili	Potato	Celery	Long-bean	Tomato	Carrot
<i>Endosulfan*</i>	-	0.016	0.810	0.033	-	0.009	0.008	-
<i>Chlorpyrifos</i>	0.013	0.098	0.005	0.004	-	-	0.290	0.017
<i>Profenofos</i>	0.016	0.048	0.928	0.017	5.032	-	0.064	0.210
<i>Alphamethrin</i>	-	-	0.07	-	-	-	0.100	-
<i>Cyhalothrin</i>	-	-	0.004	-	-	-	-	-
<i>Dithiocarbamate</i>	0.412	-	0.003	-	-	-	0.027	-
<i>Permethrin</i>	0.017	-	-	-	-	-	0.052	0.03
<i>Chlorothalonil</i>	-	-	-	0.004	-	-	0.290	-
<i>BPMC</i>	-	-	0.057	-	-	-	0.006	-
<i>Cypermethrin</i>	-	-	-	-	-	0.05	0.018	-
<i>Deltamethrin</i>	-	-	0.009	0.03	-	-	-	-
<i>Fenvalerate</i>	-	-	-	-	-	-	0.035	-
<i>Phenthoate</i>	-	-	-	-	-	-	0.370	-
<i>Triazophos</i>	-	-	-	0.02	-	-	-	-

Source: Laksanawati *et al.* (1994); \* potential POPs insecticide

### Insecticide Residues in Rice

Surveys were carried out in West Java (Karawang, Subang, Indramayu, Cirebon, Kuningan, Ciamis, Tasikmalaya, Garut, Bandung, Cianjur, Sukabumi, Lebak, Pandeglang and Serang) in 1995/1996 indicated that the presence of insecticide

residues (*organochlorine*) on rice, namely *lindane*, *aldrin* and *heptachlor* (Murtado *et al.* 1996). In 1999, the survey was conducted again in West Java (Subang, Indramayu, Cirebon, Karawang, Cianjur, Sukabumi and Pandeglang) with the result that insecticide residues (*organochlorine*), specifically *lindane*, *aldrin*, and

*endosulfan* were found in rice (Table 4). Again in 1999, surveys were conducted in the Central Java region including the Rembang, Grobogan, Sukoharjo, Bantul, Wonosobo and Cilacap areas. They confirmed the detection of *lindane*, *aldrin*, and *endosulfan* compounds in rice (Table 4). A survey was conducted in East Java in 1999, specifically the Bojonegoro, Ngawi, Magetan, Madiun, Malang, Lumajang, Jember, and Banyuwangi areas. It was found that potential insecticide residues (*organochlorine*) of *endosulfan* existed in rice (Ardiwinata *et al.* 1999).

The survey results for several markets in the DKI Jakarta area in 1997 which included Koja Market, Pasar Senen, Jatinegara Market, Pasar Minggu and Grogol Market, confirmed that rice samples contained insecticide residues (*organochlorine*). These were *lindane*, *heptachlor*, *endosulfan*, *aldrin*, *DDE dieldrin*, *chlorpyrifos*, *diazinon*, *fenthion*, *fenvaterate*, *carbofuran* and *BPMC* (Ardiwinata *et al.* 1997).

### Insecticide Residues in Soybeans

The survey conducted in 1992 in several markets in West Java which included the regions of Ciamis,

Cianjur, Garut, Kuningan, Majalengka and Sumedang found insecticide residues, namely *lindane*, *dieldrin*, *BPMC*, *MIPC*, *chlorpyrifos* and *fenthion* in soybeans (Table 5). It is interesting to note that imported soybeans were found to contain POPs, these being *lindane* and *dieldrin* (Table 5).

### Pesticide Residue in Central Java

Based on the data shown in Table 4, it can be seen that Central Java is the region with the highest residual content compared to all other parts of Indonesia. The most widely used type of pesticide is an insecticide (74%), the most popular one being *carbamate* (28%; see Figure 1). Using the most pesticides is the Brebes area which reported a percentage of 58% (Figure 2). The areas with the highest residual pesticides in rice are Cilacap and Brebes (Figure 3). The highest residual content of pesticides in soil is evident in the Brebes region (Figure 4). Meanwhile the highest residual content of pesticides that has been found in water is the Klaten area (Figure 5). The residual content of *organochlorine* insecticide in terms of size has the following order: rice > soil > water.

Table 4. Insecticide residues concentration (mg kg<sup>-1</sup>) in rice in West Java, Central Java and East Java in 1999

Tabel 4. Konsentrasi residu insektisida (mg kg<sup>-1</sup>) pada padi di Jawa Barat, Jawa Tengah dan Jawa Timur pada tahun 1999

Insecticides	Location		
	West Java	Central Java	East Java
<i>Chlorpyrifos</i>	0.0002-0.0016	0.0028-0.0970	0.0002-0.0008
<i>Diazinon</i>	-	0.0142-0.0556	0.0002-0.0003
<i>Fenthion</i>	-	0.0246-0.0372	-
<i>Lindane</i>	0.0023-0.00024	0.0024-0.0466	-
<i>Aldrin</i>	-	0.0037-0.0199	-
<i>Endosulfan</i>	0.0002-0.0005	0.0157-0.0357	0.0003-0.0006
<i>Fenvalerate</i>	-	0.0163-0.0212	-
<i>Carbofuran</i>	0.0005-0.0013	-	0.0003-0.0008
<i>BPMC</i>	0.0004-0.0059	-	-

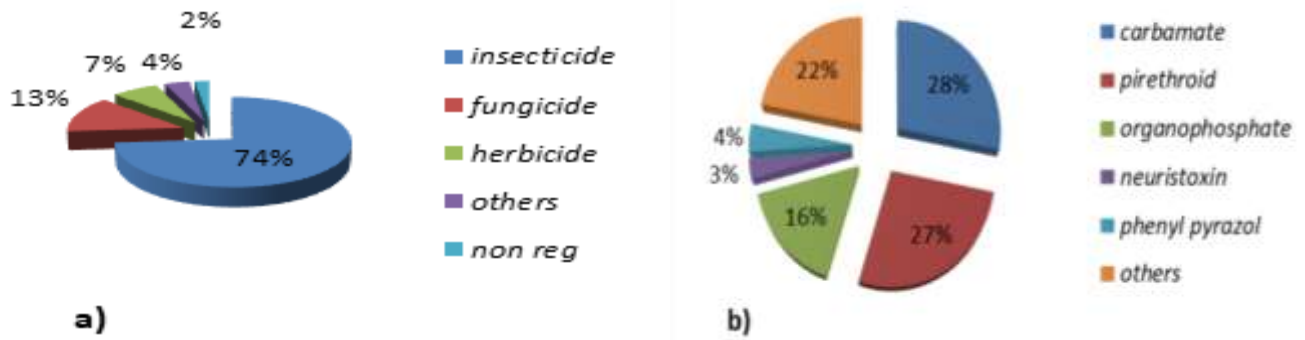
Source: Ardiwinata *et al.* (1999)

Table 5. Insecticide residues concentration (mg kg<sup>-1</sup>) in soybeans from several markets in West Java in 1992.

Tabel 5. Konsentrasi residu insektisida (mg kg<sup>-1</sup>) pada kedelai dari beberapa pasar di Jawa Barat pada tahun 1992.

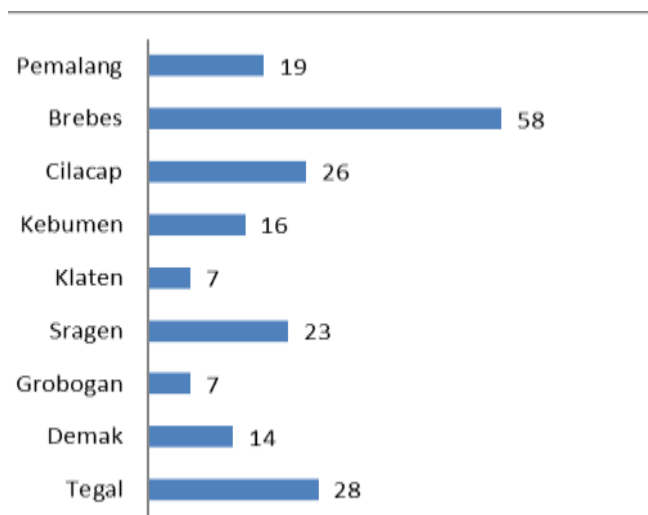
Location	Insecticides					
	<i>Lindane</i> *	<i>Dieldrin</i> *	<i>BPMC</i>	<i>MIPC</i>	<i>Chlorpyrifos</i>	<i>Fenthion</i>
Ciamis	0.0047	-	-	-	0.0557	0.0034
Cianjur	0.0094	-	-	-	0.0628	0.0031
Garut	0.0078	0.0049	-	-	0.0073	0.0019
Majalengka	0.0115	-	0.0019	-	0.0053	0.0053
Sumedang	0.0070	-	0.0015	-	0.0089	0.0026
Import	0.0052	-	-	-	0.0103	0.0025

Source: Ardiwinata *et al.* (1999)



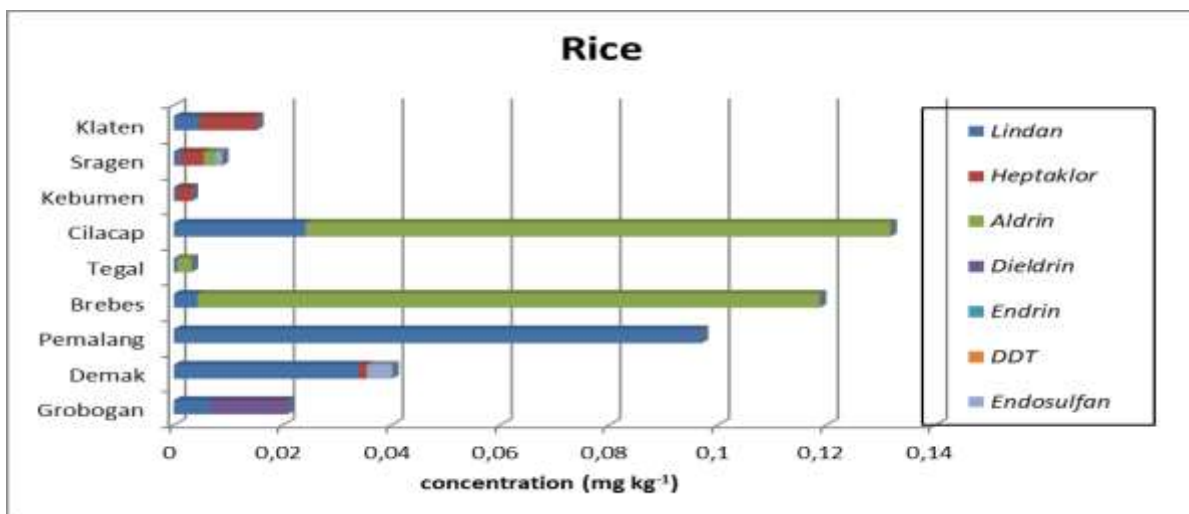
Source: Ardiwinata et al. (2007)

Figure 1. The use of pesticide in Central Java: a). Type of pesticide and b) Type of insecticide  
 Gambar 1. Penggunaan pestisida di Jawa Tengah: a) Jenis pestisida dan b) Jenis insektisida



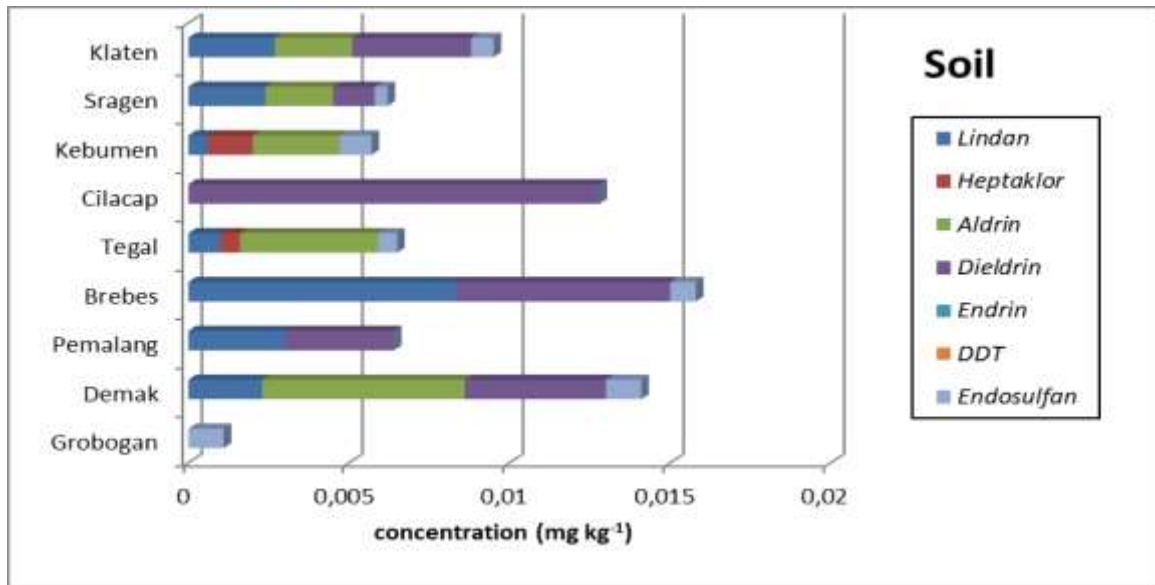
Source: Ardiwinata et al. (2007)

Figure 2. The use of pesticides in Central Java's rice-producing areas  
 Gambar 2. Penggunaan pestisida di daerah penghasil beras di Jawa Tengah



Source: Ardiwinata and Dedi Nursyamsi (2012)

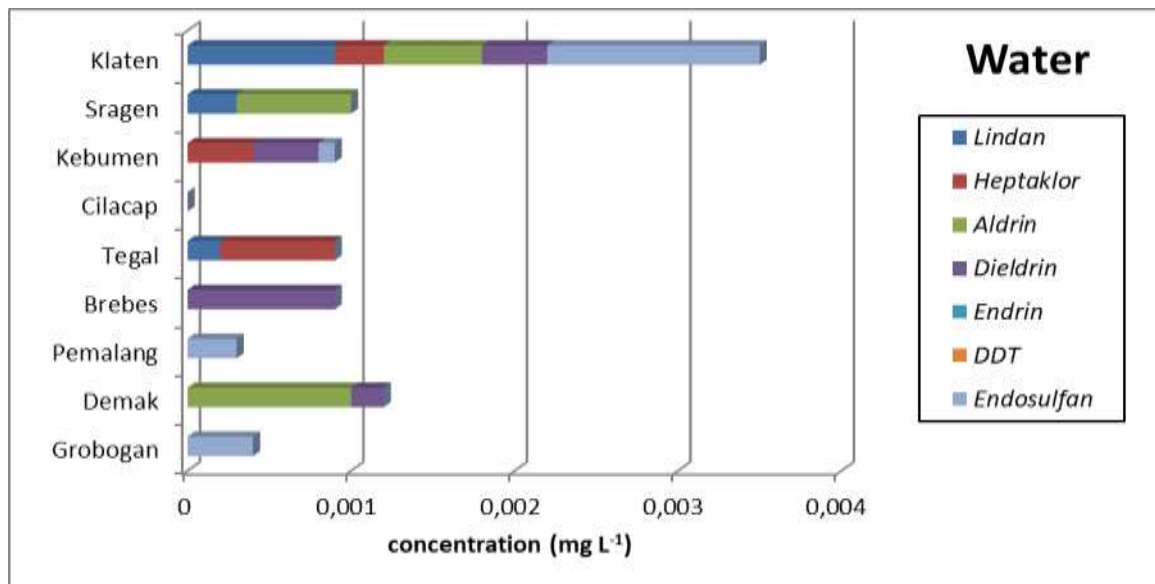
Figure 3. Insecticide residue concentration in rice, in Central Java, 2007.  
 Gambar 3. Konsentrasi residu insektisida dalam beras, di Jawa Tengah, 2007.



Source: Ardiwinata and Dedi Nursyamsi (2012)

Figure 4. Insecticide residue concentration in soil, in Central Java, 2007

Gambar 4. Konsentrasi residu insektisida dalam tanah, di Jawa Tengah, 2007



Source: Ardiwinata and Dedi Nursyamsi (2012)

Figure 5. Insecticide residue concentration in water, in Central Java, 2007.

Gambar 5. Konsentrasi residu insektisida dalam air, di Jawa Tengah, 2007.

### IMPLICATIONS OF POLICIES-RELATED OF PESTICIDE IN INDONESIA

The use of pesticides is a policy mandated by Indonesia's Ministry of Agriculture, while assessing the impact of pesticides on the environment is the responsibility of the Ministry of Environment and

Forestry. Policies or regulations relating to pesticides already exist, including :

1. Government Regulation Number 7 of 1973 concerning Supervision of Circulation, Storage and Use of Pesticides
2. Government Regulation Number 6 of 1995 concerning Plant Protection

3. Government Regulation Number 74 of 2001 concerning Management of Hazardous and Toxic Materials
4. Government Regulation Number 101 of 2014 concerning Management of Hazardous and Toxic Waste
5. Regulation of the Minister of Health Number 472 / Menkes/ PER / XI / 1992 concerning Hazardous Materials
6. Regulation of the Minister of Agriculture Number 107 / Permentan / SR.140 / 9/2014 concerning Supervision of Pesticides; and
7. Minister of Agriculture Regulation Number 39 / permentan / SR.140 / 7 / 2015 concerning registration of pesticides.

Despite these rules and regulations which are in place, their implementation to date has not been thorough. For this reason, strategies must be put in place at the government and local level to improve the use, measurement and management of pollution caused by pesticides. In fact, there needs to be continuous improvement for such laws and regulations to be effective.

### CONCLUSIONS

The following conclusions can be made on the use of pesticides to prevent pests and increase yield and quality of produce in Indonesia. *Organochlorine* pesticides that have been banned from use, have still resulted in their residues being found in soil, water, and foodstuffs, particularly vegetables. *Organochlorine* residues do exert adverse impacts on human health and also endanger the environment so that water, air and soils are polluted. The residue has the potential to cause bioaccumulation and biomagnification. Proper and detailed management of pesticides will increase our knowledge and improve our practices regarding the use of pesticides. In particular, being diligent about what pesticides can do to people and the environment will curtail the negative effects or dangers posed by them.

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