

Global Insecticide Use for Vector-Borne Disease Control

Third Edition

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Vector Ecology and Management
WHO Pesticide Evaluation Scheme (WHOPES)

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GLOBAL INSECTICIDE USE FOR VECTOR-BORNE DISEASE CONTROL

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**DEPARTMENT OF CONTROL OF NEGLECTED TROPICAL DISEASES (NTD)
WHO PESTICIDE EVALUATION SCHEME (WHOPES)**

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INTRODUCTION

Vector control constitutes an important element in the current global strategy for the control of major vector-borne diseases, and chemical control remains an important element in an integrated approach to vector control. In order to support the development of products to control vectors, facilitate the judicious use of insecticides and effectively manage insecticide resistance, there is a need to develop pesticide management systems based on regular monitoring and reporting of insecticide use in different disease control programmes.

An attempt has been made to document the use of insecticides for vector control at the global level (WHO, 2002^{1,2}), which could form the basis for the following:

- development of guidelines on safe and effective use of insecticides;
- development of guidelines for management of insecticide resistance;
- agreements for international use of insecticides (e.g. DDT, re-registration of insecticides in certain countries and how that may affect their international use);
- investment for development of alternatives;
- review and formulation of policies for insecticide usage at different levels (national, regional and global levels).

This document is a continuation of such effort and contains information on the global use of insecticides for control of vector-borne diseases for the reporting period 2003–2005.

¹ Zaim M (2002). *Global insecticide use for vector-borne disease control*. Geneva, World Health Organization (WHO/CDS/WHOPES/GCDPP/2002.2).

² Zaim M, Jambulingam P (2004). *Global insecticide use for vector-borne disease control*, 2nd ed. Geneva, World Health Organization (WHO/CDS/WHOPES/GCDPP/2004.9).

COLLECTION OF INFORMATION

The data on the use of insecticides in vector-borne disease control programmes were collected and validated, with the assistance of WHO regional offices, from the national disease control programmes, using a standard questionnaire (Annex 1). Only Member States having vector-borne diseases as their major public health problem were approached for such information.

The WHO Pesticide Evaluation Scheme (WHOPES) invites national disease control programmes to report regularly on the use of insecticides for vector control, using the questionnaire provided in Annex 1. They are also invited to submit data on such use for the missing years, in order to obtain a clear understanding of insecticide use at national, regional and global levels.

DATA ANALYSIS AND OBSERVATIONS ON REPORTING

A total of 81 countries from the six WHO regions responded to the questionnaire as follows: African Region, (20); Region of the Americas, (25); Eastern Mediterranean Region (11); European Region (6); South-East Asia Region, (6); and Western Pacific Region (13).

While many countries provided information for the entire three-year reporting period (2003–2005), others provided information for either two years or just one year. A few countries provided data on insecticide use pooled with those for more than one vector-borne disease. Such data were not included in the analysis of insecticide use for specific diseases but used only to estimate the total use of insecticides for vector control.

While the data provided by most countries were on the use of the four major classes of insecticides (see below), some countries also reported on the use of bacterial larvicides and/or insect growth regulators. Such data are presented separately in this document.

The number of countries reporting to WHOPES on insecticide use for vector control remains almost the same as in the previous survey. In addition, some countries updated their information by providing data for the missing years. Comparison of data from the current survey with previous surveys was done using the updated information.

As in the previous survey, one of the reasons cited by countries for not providing complete data is that decentralized programmes have difficulty in collecting such information. This is a matter of major concern that could adversely affect the management of insecticides for vector control. It is therefore important that these countries take adequate steps to develop appropriate and effective monitoring and reporting systems for insecticide use in their vector-borne disease control programmes.

DATA ANALYSIS AND OBSERVATIONS ON REPORTING

The major vector-borne diseases reportedly controlled with insecticides were:

- malaria, caused by protozoan *Plasmodium* parasites transmitted by *Anopheles* mosquitoes;
- dengue, Japanese encephalitis, yellow fever and other arboviruses transmitted by certain mosquitoes;
- leishmaniasis, caused by protozoan *Leishmania* parasites transmitted by phlebotomine sandflies;
- Chagas disease, caused by protozoan *Trypanosoma cruzi* parasites transmitted by triatomine bugs.

The insecticides used against these disease vectors were mostly of the following classes, as detailed in other WHO documents:^{1,2}

- organochlorines, of which DDT is the main insecticide used in vector control;
- organophosphates such as fenitrothion, malathion and temephos;
- carbamates such as bendiocarb and propoxur;
- pyrethroids such as alpha-cypermethrin, cyfluthrin, cypermethrin, deltamethrin, etofenprox, lambda-cyhalothrin and permethrin;
- insect growth regulators such as diflubenzuron, methoprene and pyriproxyfen;
- bacterial larvicides such as *Bacillus thuringiensis israelensis*.

¹ *Pesticides and their application for the control of vectors and pests of public health importance* (2006). Geneva, World Health Organization (WHO/CDS/NTD/WHOPES/GCDPP/2006.1).

² Najera JA, Zaim M (2002). *Malaria vector control – Decision making criteria and procedures for judicious use of insecticides*. Geneva, World Health Organization (WHO/CDS/WHOPES/2002.5 Rev.1).

DATA ANALYSIS AND OBSERVATIONS ON REPORTING

The most common formulations of synthetic insecticides employed for particular applications were:

- larvicidal treatments with emulsifiable concentrate and granules;
- residual treatment with wettable powder, suspension concentrate and capsule suspension;
- treatment of mosquito nets with aqueous formulations such as suspension concentrate, capsule suspension and emulsion oil in water; use of emulsifiable concentrate is discouraged for treatment of mosquito nets, except for permethrin;¹
- space spraying with emulsifiable concentrate, emulsion oil in water or ultra-low-volume liquid.

¹ Zaim M, Aitio A, Nakashima N (2000). Safety of pyrethroid-treated mosquito nets. *Medical and Veterinary Entomology*, 14, 1–5.

ALL USES IN VECTOR CONTROL

Table 1 shows the reporting period of insecticide use for vector control by Member States.

A total of 81 countries from the six WHO regions reported on the use of insecticides for vector control in this survey; 60 countries provided data for the three-year reporting period (2003–2005); 7 for two years; and 14 for just one year. Compared with the previous survey (2000–2002), the number of countries reporting for the entire survey period has increased considerably.

In the African Region, 20 countries out of 46 Member States reported the use of insecticides; the remaining five regions, where the majority of the countries were requested to provide data and where major vector-borne diseases occur, responded to the questionnaire. In the African Region, 8 of the reporting countries were among those that had reported during the previous survey.

Region of the Americas (25 countries), Mediterranean Region (11 countries) and European Region (6 countries) – With a few exceptions, many of the countries reporting during the previous survey also reported this time. A few additions were also reported from the Region of the Americas and the Eastern Mediterranean Region.

South-East Asia Region (6 countries) – Except for Bangladesh, India and the Maldives, 3 countries continued to provide data on insecticide use for vector control.

Western Pacific Region – Of the 13 countries reporting from this region, 8 had reported previously.

ALL USES IN VECTOR CONTROL

Although some variations occurred in the number of countries reporting the use of insecticides in the three surveys, it is encouraging to note that among the 81 countries that reported insecticide use during this survey, 45 provided data on insecticide use continuously for the three surveys and 61 for the past two surveys. This trend is observed from countries in all WHO regions except the African Region.

Note: The 81 countries that reported on the use of insecticides have the important vector-borne diseases as their major public health problem and have a population of about 1.8 billion. Excluding China and India, this population constitutes a considerable proportion of the total population living in countries endemic for vector-borne diseases.

Table 1. Insecticide use for vector control: reporting period by countries in each WHO region

WHO region	Country	Total population 2004 ^a	2003	2004	2005
African	Angola	15 490 000	–	–	+
	Benin	8 177 000	+	+	+
	Botswana	1 769 000	+	+	+
	Eritrea	4 232 000	–	+	+
	Ethiopia	75 600 000	+	+ ^b	+ ^b
	Gambia	1 478 000	+	+	+
	Guinea	9 202 000	+	+	+
	Kenya	33 467 000	+	+	+
	Madagascar	18 113 000	+	+	+
	Mali	13 124 000	+	+	+
	Mauritius	1 233 000	+	+	+
	Mozambique	19 424 000	–	–	+ ^b
	Namibia	2 009 000	+	+	+
	Rwanda	8 882 000	+	+	+
	Seychelles	80 000	+	+	+
	South Africa	47 208 000	+	+	+
	Swaziland	1 034 000	–	–	+ ^b
	Togo	5 988 000	+	–	+
	Zambia	11 479 000	–	+	+
Zimbabwe	12 936 000	–	–	+ ^b	

^a Source: *The world health report 2006 – working together for health*. Geneva, World Health Organization, 2006.

^b DDT use only.

Table 1 (cont'd). **Insecticide use for vector control: reporting period by countries in each WHO region**

WHO region	Country	Total population 2004 ^a	2003	2004	2005
Americas	Argentina	38 372 000	+	+	+
	Bahamas	319 000	+	–	–
	Belize	264 000	+	–	–
	Bolivia	9 009 000	+	–	–
	Brazil	183 913 000	+	+	+
	Chile	16 124 000	+	+	+
	Colombia	44 915 000	+	+	+
	Cuba	11 245 000	+	+	+
	Dominica	79 000	+	+	+
	Dominican Republic	8 768 000	+	+	+
	Ecuador	13 040 000	+	+	+
	El Salvador	6 762 000	+	+	+
	Guatemala	12 295 000	+	+	+
	Guyana	750 000	+	+	+
	Haiti	8 407 000	–	–	+
	Jamaica	2 639 000	+	+	+
	Mexico	105 699 000	+	+	+
	Panama	3 175 000	+	+	+
	Paraguay	6 017 000	+	+	+
Peru	27 562 000	–	–	+	
Saint Lucia	159 000	+	–	–	

Table 1 (cont'd). **Insecticide use for vector control: reporting period by countries in each WHO region**

WHO region	Country	Total population 2004 ^a	2003	2004	2005
Americas	Saint Vincent and the Grenadines	118 000	+	–	–
	Trinidad and Tobago	1 301 000	+	+	+
	Uruguay	3 439 000	+	+	+
	Venezuela	26 282 000	+	+	+
Eastern Mediterranean	Bahrain	716 000	–	+	+
	Iran (Islamic Republic of)	68 803 000	+	+	+
	Iraq	28 057 000	–	+	+
	Jordan	5 561 000	+	+	+
	Morocco	31 020 000	+	+	+
	Oman	2 534 000	+	+	+
	Pakistan	154 794 000	+	+	+
	Saudi Arabia	23 950 000	–	+	+
	Sudan	35 523 000	+	+	+
	Syrian Arab Republic	18 582 000	+	+	+
Yemen	20 329 000	+	+	+	
European	Armenia	3 026 000	+	+	+
	Azerbaijan	8 355 000	+	+	+
	Georgia	4 518 000	+	+	+
	Kyrgyzstan	5 204 000	+	+	+
	Tajikistan	6 430 000	+	+	+
	Turkey	72 220 000	+	+	+

Table 1 (cont'd). **Insecticide use for vector control: reporting period by countries in each WHO region**

WHO region	Country	Total population 2004^a	2003	2004	2005
South-East Asia	Bhutan	2 116 000	+	+	+
	Indonesia	220 077 000	+	+	+
	Maldives	321 000	+	+	+
	Myanmar	50 004 000	+	+	+
	Sri Lanka	20 570 000	+	+	–
	Thailand	63 694 000	+	+	+
Western Pacific	Brunei Darussalam	366 000	+	+	+
	Cambodia	13 798 000	+	+	+
	Fiji	841 000	+	+	+
	Kiribati	97 000	+	+	+
	Malaysia	24 894 000	+	+	+
	New Zealand	3 989 000	+	+	+
	Palau	20 000	+	+	+
	Philippines	81 617 000	+	+	+
	Singapore	4 273 000	–	–	+
	Tonga	102 000	+	+	+
	Tuvalu	10 000	+	–	–
	Vanuatu	207 000	+	–	–
	Viet Nam	83 123 000	+	+	+
	All regions	81 countries	1 880 569 000	69	66

**ALL USES IN
VECTOR
CONTROL**

See Table 2 and Figures 1 and 2.

On average, 547 tonnes of active ingredient of organochlorines, 437 of organophosphates, 25 of carbamates and 161 of pyrethroids were reportedly used annually for vector control at the global level during 2003–2005 (Table 2). The use of organochlorines, exclusively DDT, was reported to WHOPES only from the African Region (Figure 2 and Table 2). The use of organophosphates was reported from all regions; about 84% of their total use was in the Region of the Americas and 1–6% in countries from other regions. Compared with other classes of insecticides, the use of carbamates was limited, with 80% of their total use globally in the African Region; the remaining use was in the Region of the Americas (11%), the South-East Asia Region (8%) and the Eastern Mediterranean Region (1%). Carbamates were reportedly not used in the Western Pacific Region and in the European Region. The use of pyrethroids was higher in countries from the Region of the Americas (57% of total use) than in other regions. The European Region reported the lowest (1%) use of pyrethroids.

During 2003–2005, the annual use of organochlorines increased in the African Region. The use of organophosphates increased in the Region of the Americas, the South-East Asia Region and the Western Pacific Region; it was stable in the Eastern Mediterranean Region and drastically declined in the European Region. There was no reported use of organophosphates in the European Region during 2005. While an increase in the use of carbamates was reported in the South-East Asia Region and African Region, notably in 2005, a declining trend in their use was observed in the Region of the Americas and the Eastern Mediterranean Region. Globally, the quantity of pyrethroids used for vector control increased slightly during 2005, mainly as a result of their increased use in the African Region and the Western Pacific Region; however, their use in the Region of the Americas and the South-East Asia Region declined during this period. Overall, the quantity of insecticides reportedly used was lesser in 2004 compared with 2003 and 2005.

Table 2. **Global use of insecticides for vector control reported to WHOPES, in kg of active ingredient, by class of insecticide^a and WHO region, 2003–2005**

Year	Class	WHO region						
		African	Americas	Eastern Mediterranean	European	South-East Asia	Western Pacific	All regions
2003	OC	423 868	0	0	0	0	0	423 868
	OP	19 251	151 509	21 619	6 350	22 326	6 483	227 538
	C	3 900	3 835	1 000	0	1600	0	10 335
	PY	8 407	123 007	9 282	1 288	14992	14 957	171 933
2004	OC	389 210	0	0	0	0	0	389 210
	OP	327	401 508	19 594	3 600	6 691	3 816	435 536
	C	321	2 473	400	0	1 600	0	4 794
	PY	1 201	81 482	21 092	872	9 300	13 499	127 446
2005	OC	827 648	0	0	0	0	0	827 648
	OP	15 543	550 465	22 230	0	44 644	15 760	648 642
	C	56 701	1 735	465	0	2 560	0	61 461
	PY	31 211	71 355	15 752	2 072	5 645	60 203	186 238
Average	OC	546 909	0	0	0	0	0	546 909
	OP	11 707	367 827	21 148	3 317	24 554	8 686	437 239
	C	20 307	2 681	622	0	1 920	0	24 230
	PY	13 606	91 948	15 375	1 411	9 979	29 553	161 872

^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

ALL USES IN VECTOR CONTROL

See Table 3 and Figure 3.

About 60% of the insecticides reportedly used for vector control (all classes of insecticides) during 2003–2005 were for indoor residual spraying, followed by space spraying (30.7%), larviciding (7.6%) and treatment of mosquito nets (1.5%). While the same order of use was noted during 2000–2002, a significant decrease in the proportion of insecticides used in indoor residual spraying (from 85%) and a significant increase in the proportion of insecticides used in space spraying (from 9.3%) were noted.

The use of organochlorines and carbamates at global level was limited to indoor residual spraying. Of the total annual use of organophosphates, however, 66% was for space spraying, 20.2% for larviciding and 13.2% for indoor residual spraying.

While about 43% of the total use of pyrethroids was for indoor residual spraying and 45% for space spraying, the remaining 11% was used for treatment of mosquito nets. While the use of pyrethroids for space spraying and for treatment of mosquito nets increased over the three-year reporting period, it showed a decline for indoor residual spraying. The quantity of organochlorines, organophosphates and carbamates used for indoor residual spraying, however, increased considerably. Similarly the use of the two classes of insecticides for space spraying, i.e. organophosphates and pyrethroids, increased during this period.

Generally, the annual use of insecticides was higher in 2005 than in 2003 and 2004.

Table 3. Global use of insecticides for vector control reported to WHOPES, in kg of active ingredient, by type of application and class of insecticide, 2003–2005

Type of application	Class of insecticide	Amount of insecticide used (kg active ingredient)			
		2003	2004	2005	Average
Indoor residual spraying	Organochlorines	423 868	389 210	827 648	546 909
	Organophosphates	48 312	32 070	91 232	57 205
	Carbamates	6 242	4 417	61 235	23 965
	Pyrethroids	82 164	71 183	55 128	69 492
Treatment of mosquito nets	Pyrethroids	15 838	4 694	31 819	17 450
Larviciding	Organophosphates	90 725	89 426	83 136	87 762
Space spraying	Organophosphates	84 243	311 948	473 994	290 062
	Pyrethroids	49 675	50 336	98 021	66 011

ALL USES IN VECTOR CONTROL

See Table 4 and Figure 4.

DDT was the only organochlorine insecticide reportedly used for vector control in the countries that reported. Nearly 547 tonnes of active ingredient of DDT was used annually for vector control during 2003–2005.

Of the 437 tonnes of organophosphate insecticides used annually for vector control at the global level, malathion was the most abundantly used compound (58.8%), followed by temephos (19.4%) and fenitrothion (13.2%).

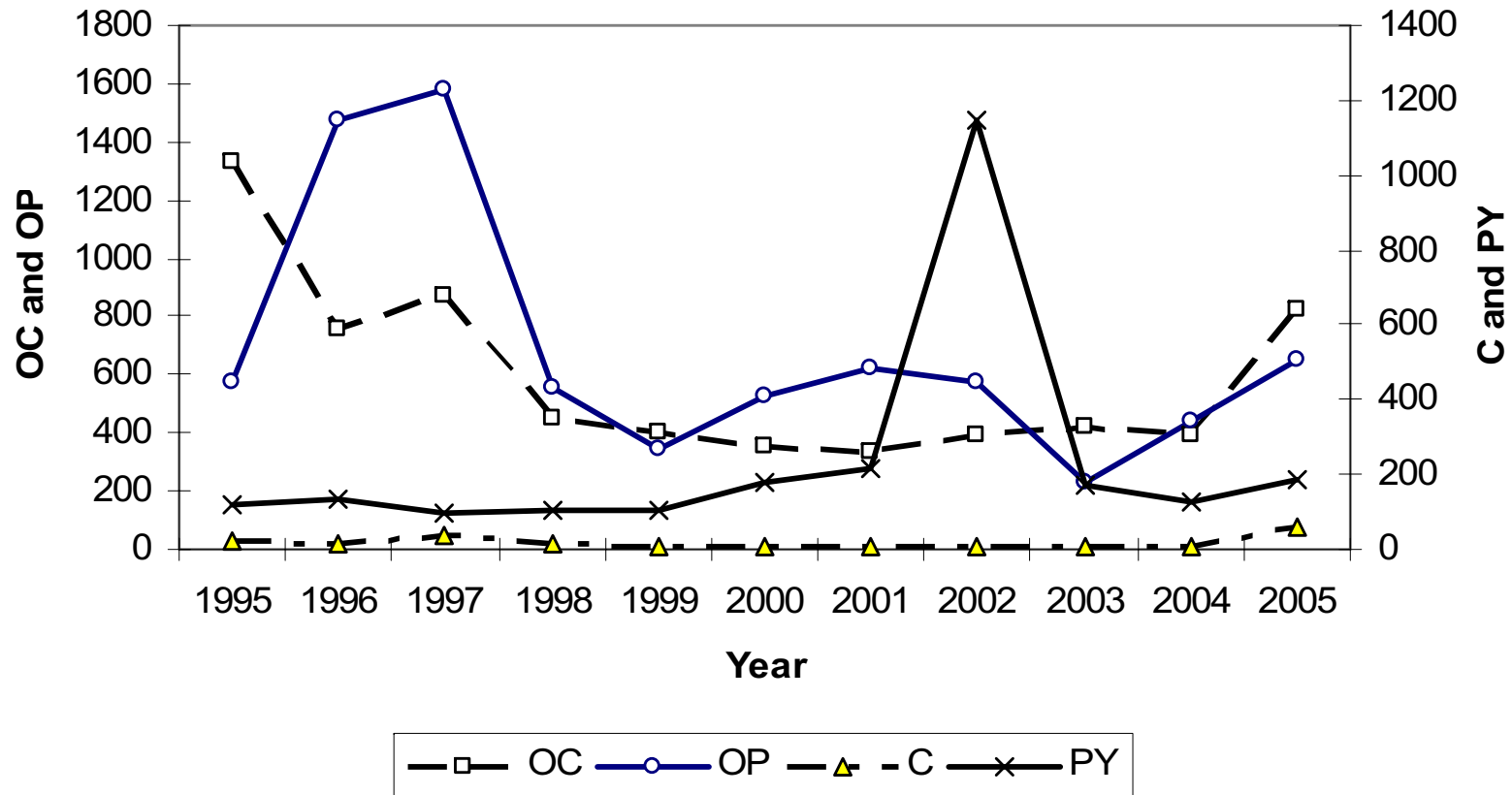
The estimated annual quantity of bendiocarb used was nearly five times more than that of propoxur. During the 2000–2002 survey, propoxur was the carbamate used in larger quantity.

Among the pyrethroids reportedly used for vector control at the global level, permethrin was the most commonly used compound (28.5%), followed by cypermethrin (26.8%), deltamethrin (17.4%) and alpha-cypermethrin (15.5%).

Table 4. Insecticides used most extensively for vector control reported to WHOPES, in kg of active ingredient, 2003–2005

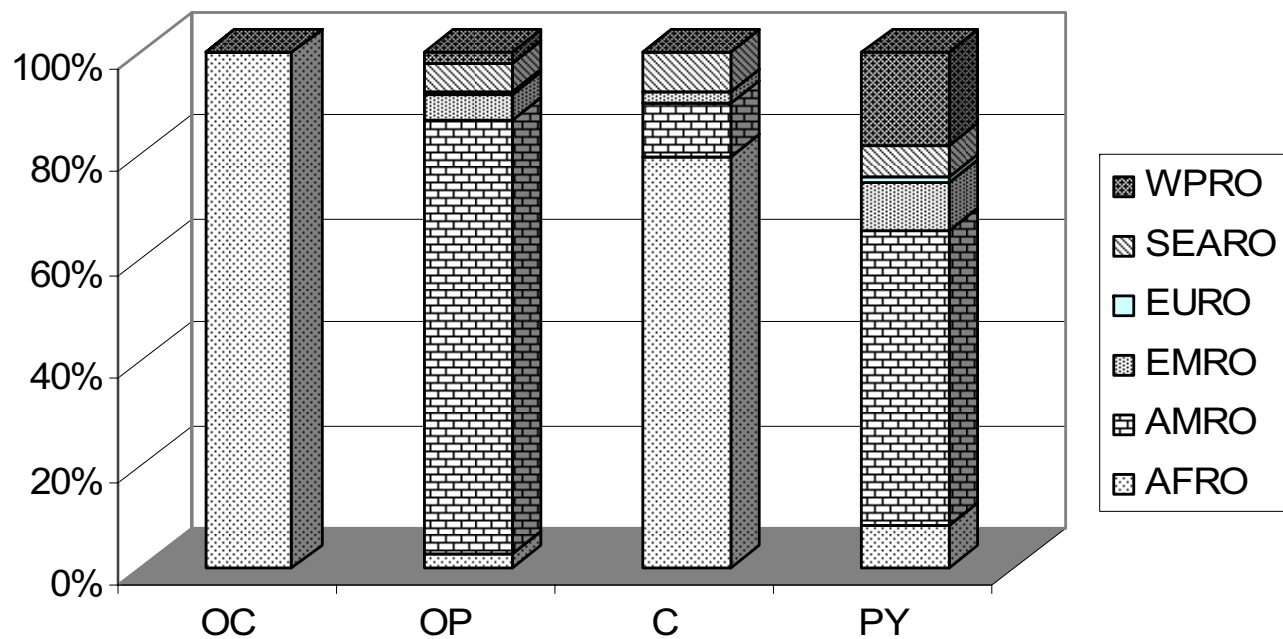
Class	Compound	2003	2004	2005	Total	Average
Organochlorines	DDT	423 868	389 210	827 648	1 640 726	546 909
Organophosphates	Chlorpyrifos	2 998	2 425	7 041	12 464	4 155
	Chlorpyrifos-methyl	9 048	2 931	6 460	18 439	6 146
	Fenthion	3 924	3 205	3 019	10 148	3 383
	Fenitrothion	19 515	56 565	97 084	173 164	57 721
	Malathion	97 741	243 714	428 955	770 410	256 803
	Pirimiphos-methyl	4 654	38 316	29 372	72 342	24 114
	Temephos	89 338	87 738	76 519	253 595	84 532
Carbamates	Bendiocarb	1 600	2 056	59 759	63 415	21 138
	Propoxur	8 735	2 738	1 702	13 175	4 392
Pyrethroids	Alpha-cypermethrin	19 394	29 436	26 102	74 932	24 977
	Bifenthrin	171	732	803	1 706	569
	Cyfluthrin	3 988	3 221	3 852	11 061	3 687
	Cypermethrin	80 548	26 581	21 293	128 422	42 807
	Deltamethrin	16 874	18 267	48 005	83 146	27 715
	Etofenprox	5 256	4 355	5 248	14 859	4 953
	Lambda-cyhalothrin	6 887	16 725	4 956	28 568	9 523
	Permethrin	38 582	25 236	72 708	136 526	45 509

Figure 1. Trend in the global use of insecticides for vector control reported to WHOPES, in tonnes of active ingredient and by class of insecticide, 1995–2005



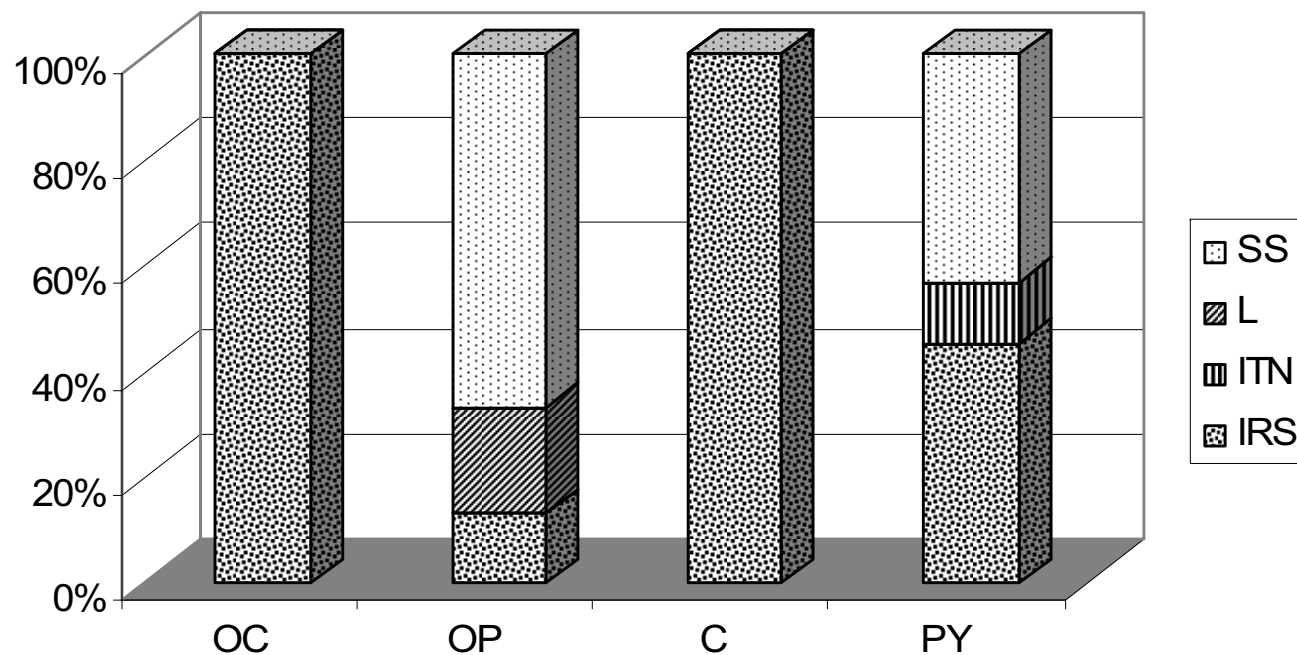
Note: data from India are not included
 C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

Figure 2. Proportion of regional use of insecticides for vector control reported to WHOPES, by class of insecticide, 2003–2005



OC = organochlorine; OP = organophosphate; C = carbamate; PY = pyrethroid

Figure 3. Global use of insecticides for vector control, by type of application, 2003–2005



IRS = indoor residual spraying; ITN = treatment of mosquito nets; L = larviciding; SS = space spraying

Figure 4. **Organophosphate (left) and pyrethroid (right) insecticides most extensively used for vector-borne disease control as reported to WHOPES, 2003–2005**



MALARIA VECTOR CONTROL

See Table 5.

A total of 64 countries provided data on insecticide use for malaria vector control in 2003–2005; 44 countries in the six WHO regions provided data for all three years (African, 12; Americas, 11; Eastern Mediterranean, 8; European, 5; South-East Asia, 4; and Western Pacific, 4) and 8 countries for two years.

A total of 9 countries reported, at least in part, on insecticide use for malaria pooled with that for dengue (Americas, 7; Eastern Mediterranean, 1; and South-East Asia, 1). One country in the Eastern Mediterranean Region reported on insecticide use for malaria pooled with that for leishmaniasis; and 4 countries in the Americas reported on pooled use with Chagas disease control (Table 20).

This report does not include the use of long-lasting insecticidal mosquito nets and the amount of pyrethroid insecticides used in making such nets.

Table 5. Insecticide use for malaria vector control: reporting period by countries in each WHO region

WHO region	Country	2003	2004	2005
African	Angola	–	–	+
	Benin	+	+	+
	Botswana	+	+	+
	Eritrea	–	+	+
	Ethiopia	+	+ ^a	+ ^a
	Gambia	+	+	+
	Guinea	+	+	+
	Kenya	+	+	+
	Madagascar	+	+	+
	Mali	+	+	+
	Mauritius	+	+	+
	Mozambique	–	–	+ ^a
	Namibia	+	+	+
	Rwanda	+	+	+
	South Africa	+	+	+
	Swaziland	–	–	+ ^a
	Togo	+	–	+
	Zambia	–	+	+
	Zimbabwe	–	–	+ ^a

^a Reported only on DDT use.

Table 5 (cont'd). **Insecticide use for malaria vector control: reporting period by countries in each WHO region**

WHO region	Country	2003	2004	2005
Americas	Bahamas ^a	+	–	–
	Belize	+	–	–
	Bolivia	+	–	–
	Brazil	+	+	+
	Chile ^a	+	+	+
	Colombia	+	+	+
	Dominican Republic ^a	+	+	+
	Ecuador ^a	+	+	+
	El Salvador ^a	+	+	+
	Guatemala ^a	+	+	+
	Guyana	+	–	–
	Haiti	–	–	+
	Mexico ^a	+	+	+
	Panama	+	+	+
	Paraguay ^a	+	+	+
	Peru	–	–	+
	Trinidad and Tobago ^a	+	+	+
Venezuela	–	+	+	

^a Provided partial data on insecticide use pooled with those for other vector-borne disease that are not included in this analysis (see Table 20).

Table 5 (cont'd). **Insecticide use for malaria vector control: reporting period by countries in each WHO region**

WHO region	Country	2003	2004	2005
Eastern Mediterranean	Bahrain	–	+	+
	Iran (Islamic Republic of)	+	+	+
	Iraq	–	+	+
	Jordan	+	+	+
	Morocco ^a	+	+	+
	Oman	+	+	+
	Pakistan	+	+	+
	Saudi Arabia	–	+	+
	Sudan	+	+	+
	Syrian Arab Republic	+	+	+
	Yemen ^a	+	+	+
	European	Armenia	+	–
Azerbaijan		+	+	+
Georgia		+	+	+
Kyrgyzstan		+	+	+
Tajikistan		+	+	+
Turkey		+	+	+

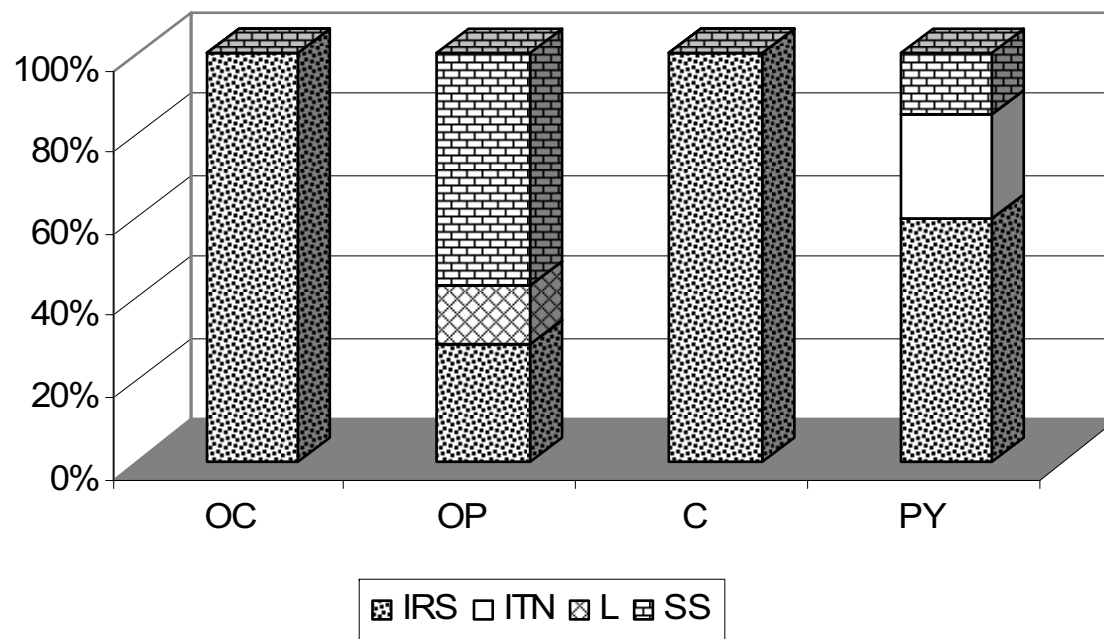
^a Provided partial data on insecticide use pooled with those for other vector-borne disease that are not included in this analysis (see Table 20).

Table 5 (cont'd). **Insecticide use for malaria vector control: reporting period by countries in each WHO region**

WHO region	Country	2003	2004	2005
South-East Asia	Bhutan	+	+	+
	Indonesia	+	+	+
	Myanmar	+	+	+
	Sri Lanka	+	+	–
	Thailand ^a	+	+	+
Western Pacific	Cambodia	+	+	+
	Malaysia	+	+	+
	Philippines	+	+	+
	Vanuatu	+	–	–
	Viet Nam	+	+	+

^a Provided partial data on insecticide use pooled with those for other vector-borne disease that are not included in this analysis (see Table 20).

Figure 5. Global use of insecticides for malaria vector control reported to WHOPES, by class of insecticide and type of application, 2003–2005



C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

MALARIA VECTOR CONTROL

See Table 6 and Figures 5 and 6.

On average, 547 tonnes of active ingredient of organochlorines (DDT), 39 of organophosphates, 23 of carbamates and 41 of pyrethroids were used annually for indoor residual spraying against malaria vectors at the global level.

An average of 19 tonnes of active ingredient of organophosphates were used for larviciding in malaria control programmes, which amounts to only 22% of the total organophosphates used for larviciding at the global level for all disease vectors. A significant number of countries reportedly use bacterial larvicides and insect growth regulators for larviciding for malaria vector control (see Tables 22 and 23).

On average, 76 tonnes of organophosphates and 10 tonnes of active ingredients of pyrethroids were reportedly used for space spraying against malaria vectors at the global level. This accounts for 26% and 16% of the total organophosphates and pyrethroids used for space spraying globally. An average of 17 tonnes of active ingredient of pyrethroids was reportedly used for treatment of mosquito nets for malaria vector control at the global level, constituting about 11% of total pyrethroids used for all vector control.

In malaria control, use of organochlorines and carbamates was limited to indoor residual spraying. While a major quantity of organophosphates was used for space spraying (57%), 29% were used for indoor residual spraying and 14% for larviciding. Of the total percentage of pyrethroids used, 60% were for indoor residual spraying, 25% for mosquito net treatment and 15% for space spraying.

Table 6. Annual insecticide use for malaria vector control reported to WHOPES, by WHO region, average kg of active ingredient, type of application^a and class of insecticide,^b 2003–2005

WHO region	Number of reporting countries			Annual use (kg of active ingredient)							
	2003	2004	2005	IRS				ITN	L	SS	
				OC	OP	C	PY	PY	OP	OP	PY
African	13	14	19	546 909	11 324	18 878	1 267	12 202	274	103	0
Americas	14	11	13	0	18 652	2 497	17 690	956	1 555	76 118	3 996
Eastern Mediterranean	8	11	11	0	1 114	53	6 973	30	16 131	0	5 718
European	6	5	5	0	2 250	0	677	133	1 067	0	600
South-East Asia	5	5	4	0	5 549	1 920	7 065	1 984	244	10	6
Western Pacific	5	4	4	0	0	0	7 154	2 154	0	0	0
All regions	51	50	56	546 909	38 889	23 348	40 826	17 449	19 270	76 231	10 321

^a IRS = indoor residual spraying; ITN = insecticide treatment of mosquito nets; L = larviciding; SS = space spraying

^b C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

MALARIA VECTOR CONTROL

See Table 6 and Figures 5 and 6 (cont'd).

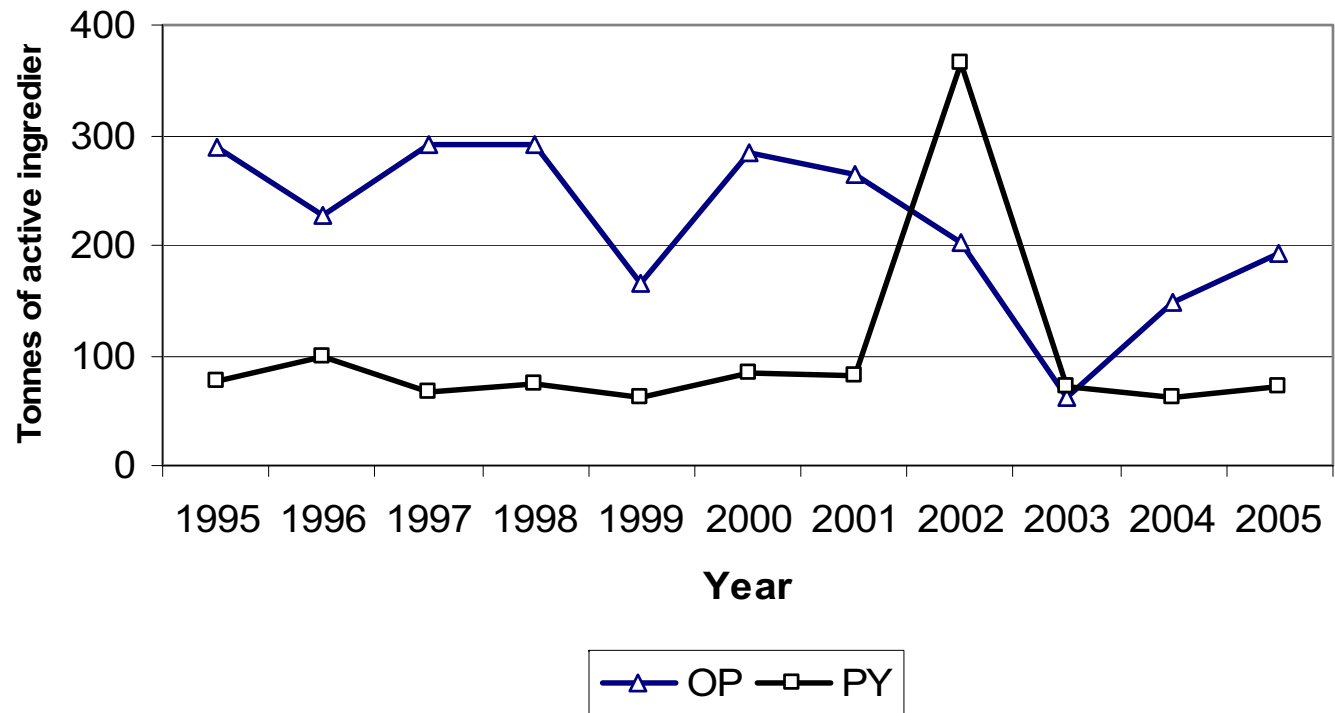
The use of organochlorines to control malaria was reported from the African Region only. About 81% of total carbamates used to control malaria was also from the African Region; the remaining 20% was from the Region of the Americas and the South-East Asia Region. The Eastern Mediterranean Region reported a small proportion of use. No use of carbamates was reported for indoor residual spraying in countries from the European Region and the Western Pacific Region.

Overall, about 71% of the total amount of organophosphates used for malaria vector control was in the countries from the Region of the Americas; the Western Pacific Region reported no use of organophosphates for malaria control. About 99.9% of organophosphate usage for space spraying against malaria vectors was from the Region of the Americas; 94% of pyrethroid use was from the Region of the Americas and the Eastern Mediterranean Region.

About 84% of the use of insecticides (organophosphates) in larviciding for malaria vector control was from the Eastern Mediterranean Region. About 70% of the pyrethroid use for conventional treatment of mosquito nets was reportedly from the African Region.

Over the years until 2003, the use of organophosphates for malaria control globally decreased; from 2004, there has been an increasing trend (Figure 6). The use of pyrethroids has remained almost stable over the years except for a sudden increase in 2002.

Figure 6. Global use of organophosphate (OP) and pyrethroid (PY) insecticides (tonnes of active ingredient) for malaria vector control reported to WHOPES, 1995–2005



Note: data from India are not included.

MALARIA VECTOR CONTROL

See Table 7.

DDT was the only organochlorine insecticide reportedly used for malaria vector control globally during 2003–2005. Among the organophosphates commonly used for malaria vector control, malathion was the highest reportedly used insecticide (48%), followed by fenitrothion (25%), temephos (13%) and pyrimiphos-methyl (11%).

Bendiocarb constituted about 89% of the total carbamates used for malaria control globally. Although propoxur was used in relatively larger quantities in 2003 and 2004, the use of bendiocarb increased in 2005.

Among the pyrethroids, deltamethrin was the major insecticide used for malaria control (35%), followed by cypermethrin (15%).

Table 7. **Insecticides used most extensively (in kg of active ingredient) for malaria vector control globally reported to WHOPES, by class of insecticide, 2003–2005**

Class	Compound	2003	2004	2005	Total	Average
Organochlorine	DDT	423 868	389 210	827 648	1 640 726	546 909
Organophosphate	Chlorpyrifos	314	121	369	804	268
	Chlorpyrifos-methyl	4 834	2 068	80	6 982	2 327
	Fenthion	944	1 373	1 314	3 631	1 210
	Fenitrothion	16 517	33 668	51 480	101 665	33 888
	Malathion	18 889	68 526	105 341	192 756	64 252
	Pirimiphos-methyl	20	22 358	20 752	43 130	14 377
	Temephos	20 013	19 717	14 191	53 921	17 974
Carbamate	Bendiocarb	1 600	1 600	59 294	62 494	20 831
	Propoxur	3 642	2 335	1 573	7 550	2 517
Pyrethroid	Alpha-cypermethrin	6 148	8 830	7 925	22 930	7 643
	Bifenthrin	171	732	803	1 706	569
	Cyfluthrin	3 766	2 995	3 609	10 370	3 457
	Cypermethrin	22 877	6 087	2 209	31 173	10 391
	Deltamethrin	14 592	13 034	42 962	70 600	23 533
	Etofenprox	3 404	4 355	4 938	12 697	4 232
	Lambda-cyhalothrin	5 730	15 990	4 150	25 870	8 623
	Permethrin	16 092	7 184	3 284	26 560	8 853

MALARIA VECTOR CONTROL

See Tables 8, 9 and 10 and Figure 7.

A total of 41 countries reported the use of insecticides for indoor residual spraying against malaria vectors, constituting 56–86% of the responding countries in the six WHO regions. Twenty countries reported the use of insecticides for conventional treatment of mosquito nets in malaria control programmes (this report does not include the use of insecticides in long-lasting insecticidal mosquito nets), constituting 0–26% of the responding countries in the European Region, the Eastern Mediterranean Region, the Region of the Americas and the African Region, and 80% of the responding countries in the South-East Asia Region and the Western Pacific Region.

Among the pyrethroids used for the treatment of mosquito nets for malaria prevention and control, deltamethrin was the most abundantly used compound, constituting about 60% of the global usage, followed by permethrin (22%).

For indoor residual spraying for malaria control, a total of 39 tonnes of pyrethroids was reportedly used. Deltamethrin constituted 33% of the total quantity of pyrethroids used. The use of lambda-cyhalothrin, cypermethrin and alphacypermethrin was almost in the same range (16–19%). Permethrin was the pyrethroid used in least quantity for indoor residual spraying (0.1%). Almost 99% of cypermethrin used in 2003 was from Brazil.

Table 8. Number of reporting countries using indoor residual spraying (IRS) and/or insecticide-treated nets (ITNs) for malaria prevention and control during 2003–2005. The data do not include the use of long-lasting insecticidal mosquito nets (LNs)

WHO region	2003		2004		2005	
	IRS	ITN	IRS	ITN	IRS	ITN
African	9	6	12	3	16	5
Americas	11	3	10	3	10	2
Eastern Mediterranean	7	1	9	2	9	1
European	6	1	5	0	5	0
South-East Asia	5	4	5	5	4	4
Western Pacific	3	5	3	4	3	4
Total	41	20	44	17	47	16

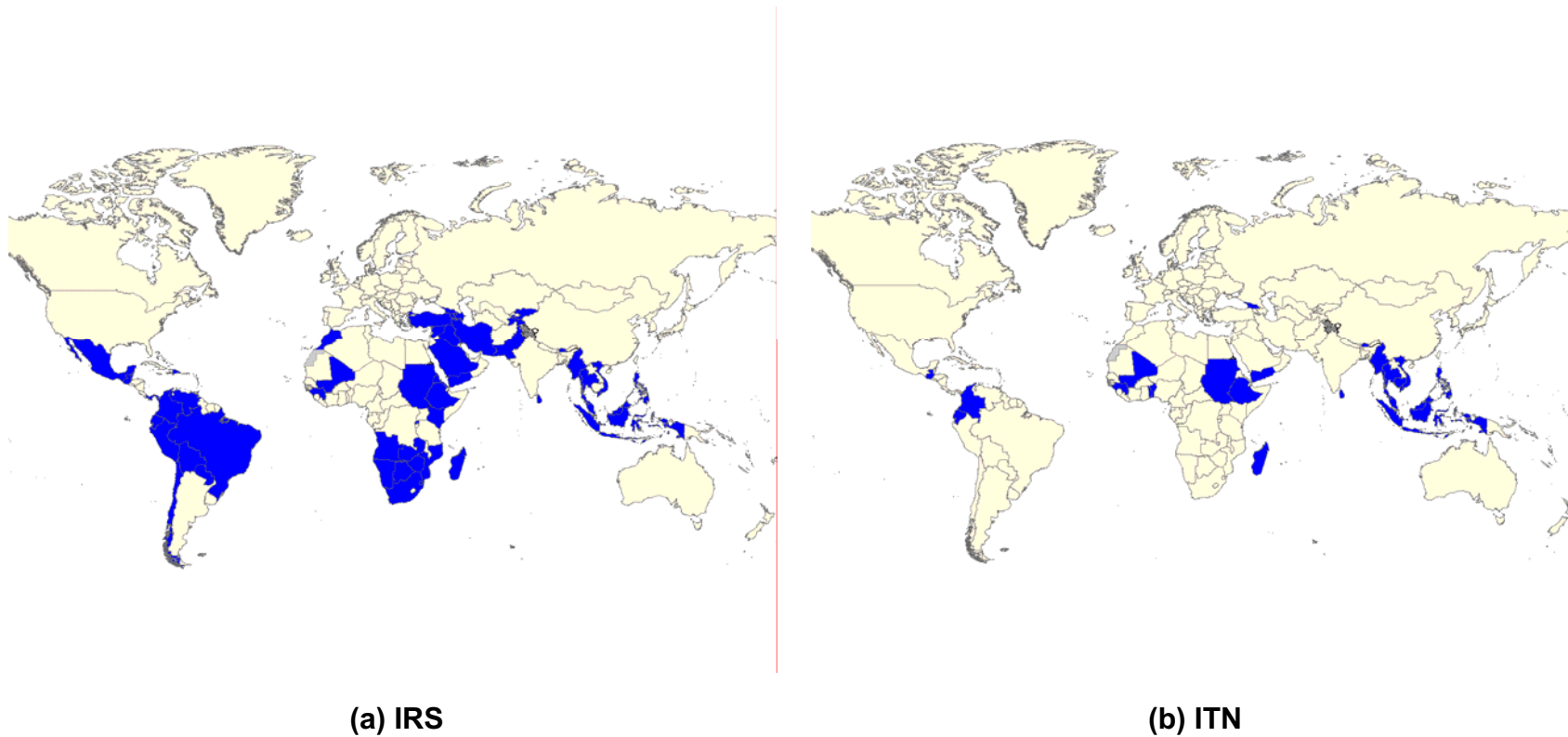
Table 9. Amount of pyrethroid insecticides, in kg of active ingredient, most extensively used for treatment of mosquito nets for malaria prevention and control, 2003–2005. The data do not include the use of pyrethroids in making long-lasting insecticidal mosquito nets

Compound	2003	2004	2005	Total	Average
Alpha-cypermethrin	2 739	85	35	2 859	953
Bifenthrin	22	44	48	114	38
Cyfluthrin	1 610	62	1 581	3 253	1 084
Deltamethrin	2 948	1 196	27 513	31 657	10 552
Etofenprox	6	7	32	45	15
Lambda-cyhalothrin	2	1 433	1 496	2 931	977
Permethrin	8 510	1 853	1 113	11 476	3 825

Table 10. Amount of pyrethroid insecticides, in kg of active ingredient, most extensively used for indoor residual spraying for malaria prevention and control, 2003–2005

Compound	2003	2004	2005	Total	Average
Alpha-cypermethrin	3 409	8 473	7 915	19 797	6 599
Cyfluthrin	2 156	2 932	2 028	7 116	2 372
Cypermethrin	17 947	769	486	19 202	6 401
Deltamethrin	11 202	11 846	15 446	38 494	12 831
Etofenprox	3 397	2 948	3 506	9 851	3 284
Lambda-cyhalothrin	5 272	14 531	2 635	22 438	7 479
Permethrin	3, 570	80	58	138	46

Figure 7. Countries reporting (a) use of insecticides in indoor residual spraying (IRS) and (b) conventional treatment of mosquito nets (ITNs) for malaria prevention and control, 2003–2005. The data do not include the use of long-lasting insecticidal mosquito nets



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**DENGUE
VECTOR
CONTROL**

See Table 11.

A total of 40 countries reported the use of insecticides for control of dengue during 2003–2005. While 25 countries reported for the entire three-year period (African Region, 1; Region of the Americas, 14; Eastern Mediterranean Region, 1; South-East Asia Region, 3; Western Pacific Region, 6), 6 countries provided data for two years and the remaining 9 countries for just one year.

Nine countries (Region of the Americas, 8; Eastern Mediterranean Region, 1; South-East Asia Region, 1) provided data on insecticide use for dengue vector control, at least in part, pooled with data for malaria control; two countries from the Western Pacific Region provided data pooled with those for vector control of filariasis (see Table 20).

Table 11. Insecticide use for dengue vector control: reporting period by countries in each WHO region

WHO region	Country	2003	2004	2005
African	Seychelles	+	+	+
Americas	Bahamas ^a	+	–	–
	Argentina	+	+	+
	Belize	+	–	–
	Brazil	+	+	+
	Chile ^a	+	+	+
	Colombia	+	+	+
	Cuba	+	+	+
	Dominica	+	+	+
	Dominican Republic ^a	+	+	+
	Ecuador	+	+	+
	El Salvador ^a	+	+	+
	Guatemala ^a	+	+	+
	Jamaica	+	+	+
	Mexico ^a	+	+	+
	Panama	+	+	+
	Paraguay ^a	+	+	+
	Peru	–	–	+
	Saint Lucia	+	–	–
	Saint Vincent and the Grenadines	+	–	–
	Trinidad and Tobago ^a	+	–	+
Uruguay	+	–	+	
Venezuela	–	+	+	

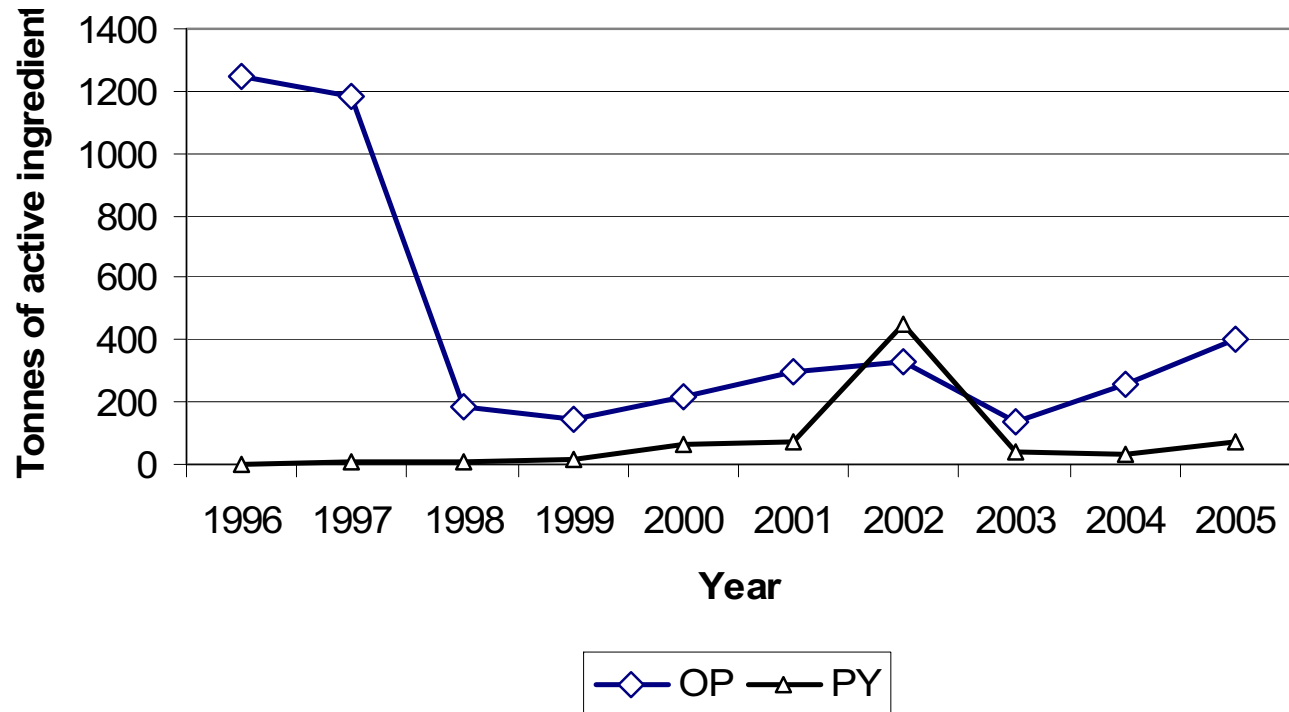
^a Provided data, at least in part, on insecticide use pooled with those for other vector-borne disease that are not included in this analysis (see Table 20).

Table 11 (cont'd). **Insecticide use for dengue vector control: reporting period by countries in each WHO region**

WHO region	Country	2003	2004	2005
Eastern Mediterranean	Yemen ^a	+	+	+
South-East Asia	Bhutan	–	–	+
	Indonesia	+	+	+
	Maldives	–	+	+
	Myanmar	+	+	+
	Sri Lanka	–	+	–
	Thailand ^a	+	+	+
Western Pacific	Brunei Darussalam	+	+	+
	Cambodia	+	+	+
	Fiji	+	+	+
	Kiribati	+	+	+
	Malaysia	+	+	+
	Palau	+	+	–
	Philippines	+	+	+
	Singapore	–	–	+
	Tonga	–	+	+
	Vanuatu	+	–	–

^a Provided partial data on insecticide use pooled with those for other vector-borne disease that are not included in this analysis (see Table 20).

Figure 8. Global use of organophosphate (OP) and pyrethroid (PY) insecticides (by tonnes of active ingredient) for dengue vector control, 1996–2005



DENGUE VECTOR CONTROL

See Table 12 and Figures 8, 9 and 10.

On average, 262 tonnes of organophosphate (OP) insecticides and 39 tonnes of pyrethroids were used annually for dengue vector control globally. Of the OPs used, 76% (199 tonnes of active ingredient) was for space spraying, 23% for larviciding and 1% for peri-focal spraying. OPs were used for peri-focal spraying in the Region of the Americas only. Of the total amount of pyrethroids used for dengue vector control, 78% (31 tonnes) was for space spraying and the remaining for peri-focal spraying. Pyrethroids were used for peri-focal spraying mainly in countries from the Region of the Americas and a very small quantity in the Western Pacific Region. About 50% of the total global usage of pyrethroid insecticides was in countries from the Western Pacific Region and about 47% from the Region of the Americas.

About 90% of the total use of OPs for dengue vector control globally was in countries from the Region of the Americas. The amount of OPs and pyrethroids used for dengue vector control constituted 60% and 24% of the total annual use of insecticides of these classes globally for all vector control, respectively.

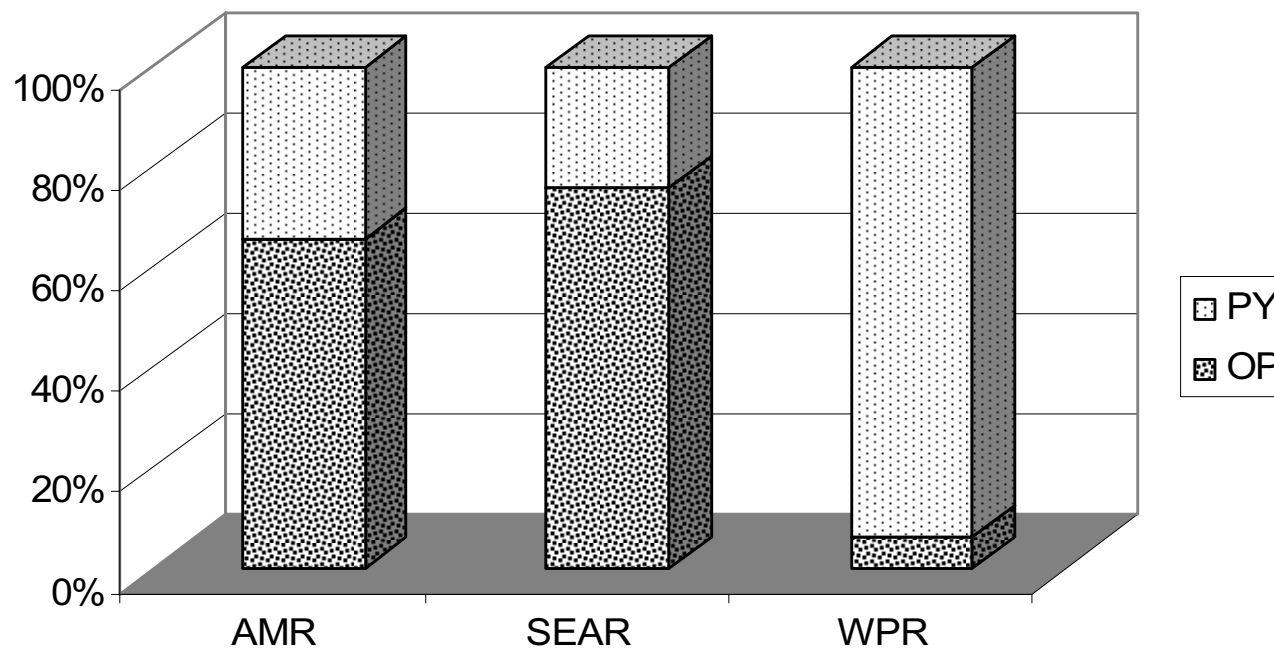
Analysis of the data for the past 10 years shows that OP use was high during 1996–1997 (about 1400 tonnes), drastically reduced in 1998–1999 (<200 tonnes) and fluctuated during subsequent years (between 200 and 400 tonnes). The use of pyrethroids for dengue vector control was at a very low level up to 1999 and thereafter relatively increased and maintained at the same level. Exceptionally, a large quantity of pyrethroids (about 400 tonnes) was reportedly used in 2002. Since 1995, the use of OPs for larviciding has increased, with nearly 500 tonnes of active ingredient reportedly used in 1998. Thereafter, usage remained at the same level except for an increase in 2002. The use of OPs increased from about 300 tonnes in 1995 to 700 tonnes in 1997, followed by a sharp decline in 1998 (about 100 tonnes). Since then, it has fluctuated between 100 and 200 tonnes. After an initial increase in 1999–2000, the use of pyrethroids has stabilized at the same level.

Table 12. Annual insecticide use for dengue vector control as reported to WHOPES, in average kg of active ingredient, by WHO region, type of application and class of insecticide,^a 2003–2005

WHO region	Number of reporting countries			Annual use (kg active ingredient)					
				Peri-focal residual		Larviciding		Space spraying	
	2003	2004	2005	OP	PY	OP	PY	OP	PY
African	1	1	1	0	0	0	0	7	15
Americas	19	16	18	2 210	8 752	55 796	0	177 732	10 124
South-East Asia	3	5	5	0	0	520	0	17 889	875
Western Pacific	8	8	8	0	1	4 614	54	4 073	19 993
All regions	31	30	32	2 210	8 753	60 930	54	199 701	31 007

^a OP = organophosphate; PY = pyrethroid

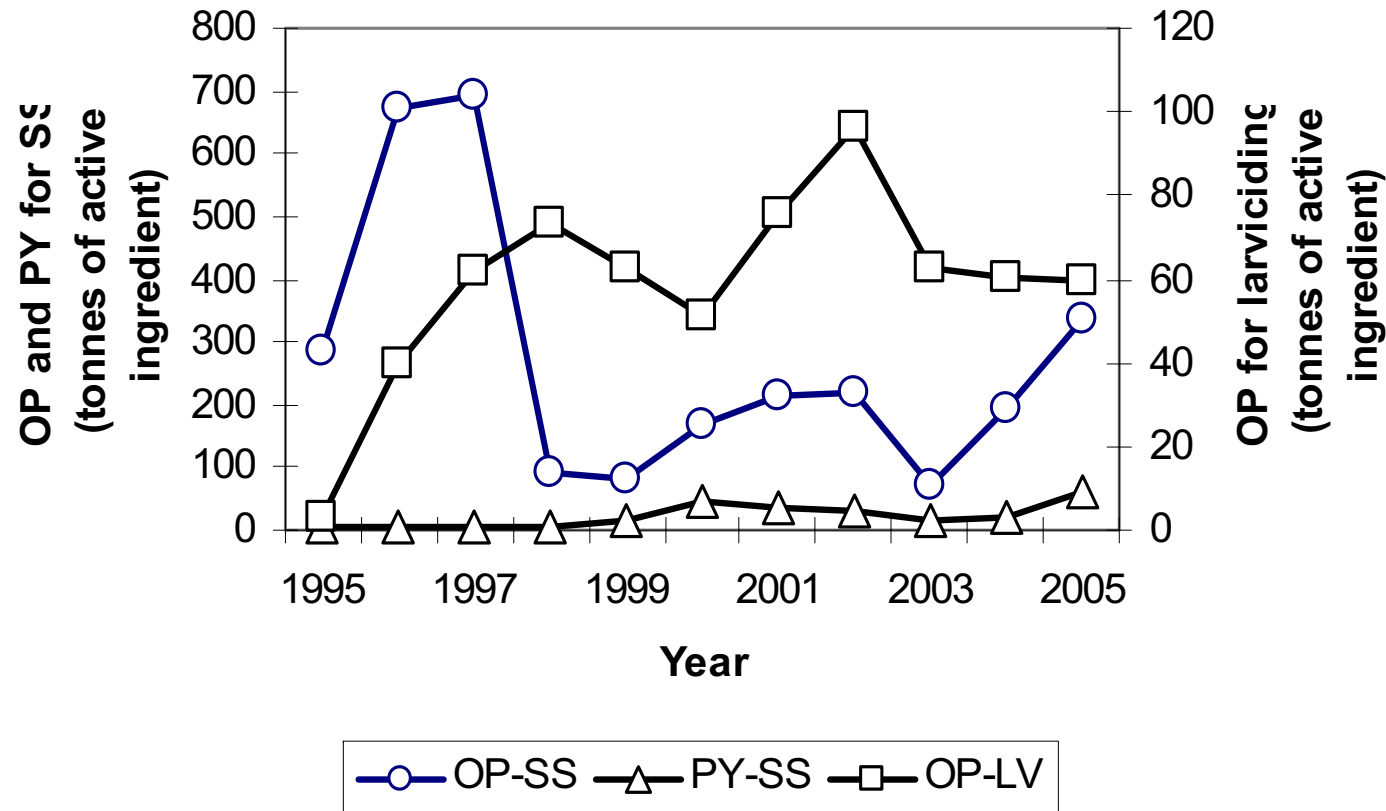
Figure 9. Global use of insecticides for dengue vector control, by WHO region^a and class of insecticide,^b 2002–2005



^a AMR = Region of the Americas; SEAR = South-East Asia Region; WPR = Western Pacific Region

^b OP = organophosphate; PY = pyrethroid

Figure 10. Trend in the global use of insecticides for larviciding and space spraying for dengue vector control as reported to WHOPES, in tonnes of active ingredient, by class of insecticide, 1995–2005



LV = larviciding; OP = organophosphate; PY = pyrethroid; SS = space spraying

DENGUE VECTOR CONTROL

See Table 13.

Among the organophosphates used for dengue vector control globally, malathion was the most abundantly used compound, constituting 67% of average annual use, followed by temephos (22%). A similar trend was observed during the survey period 2000–2003.

Among the pyrethroids, cypermethrin (37%) and permethrin (45%) were the main insecticides used, followed by alpha-cypermethrin (14%). In 2003, the pyrethroid used most abundantly for dengue vector control was cypermethrin (84% of the total pyrethroid used); in 2005, it was permethrin (70%).

Compared with 2003 and 2004, the use of permethrin and malathion greatly increased in 2005.

Table 13. Insecticides (by class) used (in kg active ingredient) most extensively for dengue vector control globally reported to WHOPES, 2000–2002

Class	Compound	2003	2004	2005	Total	Average
Organophosphates	Fenitrothion	2 998	19 914	26 018	48 930	16 310
	Fenthion	2 980	1 832	1 705	6 517	2 172
	Malathion	63 133	162 056	308 236	533 425	177 808
	Pirimiphos-methyl	4 634	15 958	8 620	29 212	9 737
	Temephos	62 488	60 443	54 300	177 231	59 077
Pyrethroids	Alpha-cypermethrin	0	9 804	9 528	19 332	6 444
	Cyfluthrin	44	14	21	79	26
	Cypermethrin	31 953	10 510	9 297	51 760	17 253
	Deltamethrin	1 071	968	1 581	3 620	1 207
	Etofenprox	0	0	310	310	103
	Lambda-cyhalothrin	61	204	84	349	116
	Permethrin	4 908	7 961	50 416	63 285	21 095
	Mixture	84	81	223	388	129

**CHAGAS
DISEASE
VECTOR
CONTROL**

See Table 14.

A total of 12 countries from the Region of the Americas reported the use of insecticides for vector control of Chagas disease for the period 2003–2005; the list includes nine countries that reported in the previous survey (2000–2002).

Six countries reported for the three-year period (2003–2005), three countries for two years and three countries for just one year. Ecuador, El Salvador, Guatemala and Paraguay provided partial data that were also pooled with those for insecticide use for control of other vector-borne diseases. Such data were not included in the specific analysis related to insecticide use for Chagas vector control.

Table 14. Insecticide use for Chagas disease vector control: reporting period by country, WHO Region of the Americas

WHO region	Country	2003	2004	2005
Americas	Argentina	+	+	+
	Bolivia	+	—	—
	Brazil	+	+	+
	Chile	+	+	+
	Colombia	—	+	+
	Ecuador ^a	+	+	+
	El Salvador ^a	—	—	+
	Guatemala ^a	—	+	+
	Paraguay ^a	+	+	+
	Peru	—	—	+
	Uruguay	+	+	+
	Venezuela	—	+	+

^a Provided partial data on insecticide use pooled with those for other vector-borne disease that are not included in this analysis (see Table 20).

CHAGAS DISEASE VECTOR CONTROL

See Tables 15 and 16.

In the Region of the Americas, only pyrethroids were used during the reporting period for indoor residual spraying for Chagas disease vector control. This is in contrast to the previous survey in which a significant amount of fenitrothion, an organophosphate insecticide, was reportedly used. On average, 15 tonnes of active ingredient of pyrethroids were used annually for Chagas disease vector control (Table 16).

Among the pyrethroids used, alpha-cypermethrin was the most abundantly used insecticide (57%), followed by cypermethrin (29%) and deltamethrin (10%). Annually, 8 tonnes of active ingredient of alpha-cypermethrin, 4 tonnes of cypermethrin and 1.5 tonnes of deltamethrin were reportedly used (Table 16). A relatively larger quantity of alphacyperpethrin and cypermethrin was used in 2003 compared with 2004 and 2005.

Table 15. **Annual insecticide use for indoor residual spraying for Chagas disease vector control in the WHO Region of the Americas reported to WHOPES, in average kg of active ingredient and by class of insecticide,^a 2003–2005**

WHO region	Number of countries reporting			Annual use (kg active ingredient)			
	2003	2004	2005	OC	OP	C	PY
Americas	6	7	9	0	0	0	14 865

^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

Table 16. **Pyrethroid insecticides used most extensively for Chagas disease vector control reported to WHOPES, 2003–2005**

Compound	2003	2004	2005	Total	Average
Alpha-cypermethrin	13 245	6 127	5 954	25 326	8 442
Beta-cypermethrin	53	718	630	1 401	467
Cypermethrin	11 904	765	250	12 919	4 306
Deltamethrin	112	2 775	1 709	4 596	1 532
Lambda-cyhalothrin	55	22	35	112	37

**LEISHMANIASIS
VECTOR
CONTROL**

See Table 17.

Only two countries from the Region of the Americas and three countries from the Eastern Mediterranean Region reported insecticide usage for leishmaniasis vector control, mainly for indoor residual spraying. Brazil, Morocco and the Syrian Arab Republic reported for the three-year period. Morocco provided partial data pooled with those for insecticide use for malaria vector control. Paraguay provided partial data pooled with those for malaria and Chagas disease vector control. These pooled data are not included in the specific data analysis for leishmaniasis.

Table 17. **Insecticide use for leishmaniasis vector control: reporting period by countries in each WHO region**

WHO region	Country	2003	2004	2005
Americas	Brazil	+	+	+
	Paraguay ^a	—	+	+
Eastern Mediterranean	Iran (Islamic Republic of)	+	—	—
	Morocco ^a	+	+	+
	Syrian Arab Republic	+	+	+

^a Provided partial data on insecticide use pooled with those for other vector-borne disease that are not included in this analysis (see Table 20).

LEISHMANIASIS VECTOR CONTROL

See Tables 18 and 19.

On average, 3.8 tonnes of organophosphates, 0.3 tonnes of carbamates and 6 tonnes of pyrethroids were reportedly used annually for leishmaniasis vector control (Table 18) in the reporting countries of the Region of the Americas and the Eastern Mediterranean Region. In the Region of the Americas, pyrethroids only were used.

Cypermethrin and alpha-cypermethrin were the two main pyrethroids used (95% of the total pyrethroids used) for the control of leishmaniasis vectors globally (Table 19). Chlorpyrifos-methyl was the only organophosphate insecticide used for leishmaniasis vector control in the countries that reported during this period. The use of propoxur was reported only in 2003.

Table 18. Annual insecticide use for leishmaniasis vector control reported to WHOPES, in average kg of active ingredient, by WHO region and class of insecticide, 2003–2005

WHO region	Number of reporting countries			Annual use (kg active ingredient) and class of insecticide ^a		
	2003	2004	2005	OP	C	PY
Americas	1	2	2	0	0	3 638
Eastern Mediterranean	2	1	1	3 819	334	2 158
All regions	3	3	3	3 819	334	5 796

^a C = carbamate; OP = organophosphate; PY = pyrethroid

Table 19. Insecticides most extensively used for leishmaniasis vector control reported to WHOPES, by class of insecticide, 2003–2005

Class ^a	Compound	2003	2004	2005	Total	Average
OP	Chlorpyrifos-methyl	4 214	863	6 380	11 457	3 819
C	Propoxur	1 000	0	0	1 000	334
PY	Alpha-cypermethrin	0	4 660	2 571	7 231	2 410
	Cypermethrin	7 268	1 894	157	9 319	3 106
	Deltamethrin	222	130	197	549	183
	Lambda-cyhalothrin	65	190	35	290	97

^a C = carbamate; OP = organophosphate; PY = pyrethroid

OTHER VECTOR- BORNE DISEASE CONTROL

See Table 20.

A total of 16 countries from the Region of the Americas, the Eastern Mediterranean Region, the South-East Asia Region and the Western Pacific Region reported the total use of insecticides for any two of the diseases borne by mosquito vectors, as well as for other vector-borne diseases.

On average, 9 tonnes of organophosphates and 26 tonnes of pyrethroids were used annually for the control of two or more mosquito vectors. Pyrethroids were used in the majority of the reporting countries for the control of various disease vectors. Organophosphates were reportedly used for the control of Bartenollosis in Peru, dengue and filariasis vectors in the Maldives, diarrhoea vectors in Sudan, malaria and dengue vectors in the Dominican Republic and malaria and leishmaniasis in Ecuador. Mexico (57%) and Trinidad and Tobago (32%) were the main users of pyrethroids for the control of vectors.

Table 20. Total insecticide use by countries for control of different vector-borne diseases, in kg active of ingredient and class of insecticide, by WHO region, 2000–2002

Disease	WHO region	Country	2003		2004		2005	
			Class of insecticide ^a					
			OP	PY	OP	PY	OP	PY
Bartenollosis	Americas	Peru	0	0	0	0	7 206	138
Dengue & filariasis	Western Pacific	Brunei Darussalam	0	179	0	213	0	122
		Maldives	350	0	340	0	337	0
Diarrhea	Eastern Mediterranean	Sudan	53	0	206	0	0	0
Malaria & dengue	Americas	Bahamas	116	0	0	0	0	0
		Dominican Republic	1 274	0	3 125	0	1001	0
		El Salvador	0	632	0	380	0	472
		Guatemala	0	120	0	117	0	145
		Mexico	0	17 484	0	9 994	0	16 938
		Paraguay	0	153	0	282	0	695
		Trinidad & Tobago	0	10 176	0	8 944	0	5 644
	Eastern Mediterranean	Yemen	0	23	0	31	0	49
South-East Asia	Thailand	0	38	0	81	0	33	
Malaria & leishmaniasis	Eastern Mediterranean	Morocco	0	7	0	4	0	3
Malaria & Chagas	Americas	Ecuador	3 970	0	970	0	8 572	0
		El Salvador	0	1 582	0	465	0	467
		Guatemala	0	0	0	339	0	360
		Paraguay	0	191	0	0	0	0
Malaria, Chagas & Leishmaniasis	Americas	Paraguay	0	0	0	0	0	235
Typhoid	Western Pacific	Tonga	0	8	0	4	0	0
Yellow fever	Eastern Mediterranean	Sudan	0	0	0	0	0	1 375
All regions	5	16 countries	5 763	30 593	4 641	20 854	17 116	26 673

^a OP = organophosphate; PY = pyrethroid

SELECTED INSECTICIDES – DDT

See Table 21.

A total of 10 countries from the African Region reported the use of DDT to control malaria vectors. Ethiopia, Madagascar, Mauritius, Namibia and South Africa provided data for three years. Eritrea and Zambia provided data for any two years and the remaining three countries for just one year. All the reporting countries provided data for 2005. An estimated annual average of 547 tonnes of DDT was used to control malaria in the reporting countries. A significant increase in use was noted between 2004 and 2005.

About 37% of the total reported use of DDT in the African Region was in Mozambique and 32% was in Ethiopia. Zimbabwe (13%) and South Africa (7%) also used considerable amounts of DDT during this period.

The following countries have registered for DDT use in the DDT registry of the Stockholm Convention (<http://www.pops.int/documents/registers/ddt.htm>): Botswana, China, Ethiopia, India, Marshall Islands, Mauritius, Morocco, Myanmar, Senegal, South Africa, Swaziland and Yemen. No data on insecticide use for vector control are available to WHOPES for the reporting period (2003–2005) from China, India, the Marshall Islands and Senegal. Botswana, Morocco, Myanmar and Yemen reported the use of insecticides for vector control during 2003–2005 but did not use DDT.

Table 21. Global use of DDT for vector control reported to WHOPES, in kg of active ingredient, WHO African Region, 2003–2005

WHO region	Country	2003	2004	2005
African	Eritrea	NA	6 552	10 109
	Ethiopia	272 243	255 163	275 195
	Madagascar	45 000	30 000	0
	Mauritius	872	899	625
	Mozambique	NA	NA	307 688
	Namibia	52 143	25 837	39 611
	South Africa	53 610	62 112	65 575
	Swaziland	NA	NA	7 538
	Zambia	NA	8 648	13 308
	Zimbabwe	NA	NA	108 000
Total	10 countries	423 868	389 210	827 649

NA, not available

**SELECTED
INSECTICIDES –
INSECT GROWTH
REGULATORS**

Table 22

A total of nine countries from five WHO regions (except the African Region) reported the use of different insect growth regulators (IGRs) for vector control.

On average, 4.6 tonnes of active ingredient of IGRs were reportedly used globally to control the vectors of malaria, dengue and Ross River virus. Of the total quantity, 68% was used to control malaria and dengue vectors and the remaining for the control of Ross River Virus vectors.

Methoprene constituted 76% of the total quantity of IGRs reportedly used for vector control globally, followed by diflubenzuron (23%), pyriproxifen (1.2%) and triflumuron (0.3%). Indonesia, New Zealand and Turkey were the main users of IGRs among the countries reporting data.

Table 22. **Global use of insect growth regulators for control of vector-borne diseases reported to WHOPES, in kg of active ingredient, 2003–2005**

Region	Country	Disease	Compound	Amount of active ingredient (kg)		
				2003	2004	2005
Americas	Argentina	Dengue	Triflumuron	15	NR	NR
	Brazil	Dengue	Diflubenzuron	NR	5	0
			Triflumuron	NR	<1	<1
			Methoprene	NR	2	<1
	Colombia	Dengue	Pyriproxyfen	NR	NR	4
Eastern Mediterranean	Saudi Arabia	Malaria	Pyriproxyfen	NR	45	45
	Yemen	Malaria	Pyriproxyfen	NR	NR	1
European	Turkey	Malaria	Diflubenzuron	950	966	1250
South-East Asia	Indonesia	Malaria & Dengue	Methoprene	6043	7.5	0
			Pyriproxyfen	0	5	9
Western Pacific	New Zealand	Ross River Virus	Methoprene	1765	837	1766
	Singapore	Dengue	Pyriproxyfen	NR	NR	<1

NR = not reported

**SELECTED
INSECTICIDES –
BACTERIAL
LARVICIDES**

See Table 23.

The following 18 countries from the six WHO regions reported the use of bacterial larvicides for vector control: African Region (2); Region of the Americas (8), Eastern Mediterranean Region (2), European Region (1), South-East Asia Region (2); Western Pacific Region (3).

Most of the countries (12 countries) reported the use of biolarvicides to control either malaria or malaria and dengue vectors. Four countries reported use against dengue vectors only. New Zealand reported the use of bacterial larvicides to control Ross River virus, a mosquito-borne disease.

The actual quantity of the bacterial larvicides used could not be estimated as the information on the potency of the products used by different countries in terms of International Toxic Units was not provided.

Table 23. **Countries reporting use of bacterial larvicides for control of vector-borne diseases, by WHO region, 2003–2005**

WHO region	Country	Disease
African	Gambia	Malaria
	Seychelles	Dengue
Americas	Argentina	Dengue
	Bahamas	Malaria and dengue
	Brazil	Malaria and dengue
	Colombia	Malaria
	Dominican Republic	Malaria
	Guatemala	Malaria and dengue
	Saint Lucia	Dengue
	Venezuela	Malaria
Eastern Mediterranean	Bahrain	Malaria
	Saudi Arabia	Malaria
European	Turkey	Malaria
South-East Asia	Bhutan	Malaria
	Indonesia	Malaria
Western Pacific	Fiji	Dengue
	New Zealand	Ross River Virus
	Singapore	Dengue

COUNTRY EXAMPLES

See Tables 24–36.

The following country examples from five WHO regions provide data on insecticide use for an extended period of time. These data may be used to analyse trends in a particular country and also to analyse control activities in relation to different vector-borne diseases.

African Region – Madagascar

Region of the Americas – Brazil, Guatemala, Mexico, Trinidad and Tobago, Venezuela

Eastern Mediterranean Region – Islamic Republic of Iran, Oman, Pakistan, Sudan

South-East Asia Region – Indonesia, Myanmar, Sri Lanka, Thailand

Western Pacific Region – Malaysia, Philippines, Viet Nam

WHO AFRICAN REGION – MADAGASCAR

Table 24. Insecticides used for malaria vector control in Madagascar, in kg of active ingredient and by class of insecticide,^a 1993–2005

Year	Madagascar	
	OC	PY
1993	156 635	0
1994	165 359	0
1995	99 260	0
1996	160 849	0
1997	162 521	2
1998	0	3
1999	40 579	3 121
2000	18 971	18
2001	0	0
2002	45 113	31
2003	45 000	0
2004	30 000	27
2005	0	663

^a OC = organochlorine; PY = pyrethroid

WHO REGION OF THE AMERICAS – BRAZIL

Table 25. Insecticides used for malaria, dengue, Chagas disease and leishmaniasis vector control in Brazil, in kg of active of ingredient and by class of insecticide,^a 1989–2005

Year	Malaria			Dengue		Chagas disease	Leishmaniasis
	OC	OP	PY	OP	PY	PY	PY
1989	NA	NA	NA	NA	NA	3 690	NA
1990	NA	NA	NA	NA	NA	3 060	NA
1991	NA	NA	NA	NA	NA	3 095	NA
1992	NA	NA	NA	NA	NA	5 030	NA
1993	362 380	0	617	NA	NA	5 820	625
1994	0	15 970	1 039	NA	NA	8 188	4 781
1995	369 138	0	43 200	NA	NA	22 875	9 719
1996	0	0	65 592	0	915 451	14 250	14 679
1997	0	9 680	16 405	0	980 221	7 774	8 228
1998	0	0	14 372	89 253	4 354	11 572	8 266
1999	0	0	15 441	56 166	10 242	9 764	8 136
2000	0	0	20 498	35 822	578	14 853	5 941
2001	0	0	32 185	60 000	67 150	25 662	10 265
2002	0	0	325 787	104 595	434 818	210 475	105 238
2003	0	0	22 273	45 176	32 294	11 896	5 948
2004	0	0	11 190	52 100	20 747	6 372	2 549
2005	0	0	7 653	44 370	17 716	5 954	2 381

^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid
NA, not available

WHO REGION OF THE AMERICAS – MEXICO

Table 26. Insecticides used for malaria and dengue vector control in Mexico, in kg of active ingredient and by class of insecticide,^a 1993–2005

Year	Malaria			Dengue		Malaria & dengue ^b	
	OC	OP	PY	OP	PY	OP	PY
1993	684 750	0	0	104 215	0	0	0
1994	515 250	0	0	142 643	0	0	0
1995	417 000	0	0	114 570	0	0	0
1996	297 000	0	0	167 609	0	0	0
1997	329 225	2 200	10	54 711	217	0	0
1998	215 083	325	723	315	0	62 528	2 174
1999	128 624	0	2 736	0	0	26 568	1 830
2000	0	616	1 925	19	0	0	594
2001	0	498	847	126	0	0	13 116
2002	0	463	762	7 570	0	0	13 074
2003	0	985	577	9 963	0	0	17 484
2004	0	189	1 003	9 923	0	0	9 994
2005	0	0	252	11 805	0	0	16 938

^a OC = organochlorine; OP = organophosphate; PY = pyrethroid

^b Space spray applications reportedly aimed at malaria and dengue vector control.

WHO REGION OF THE AMERICAS – VENEZUELA

Table 27. Insecticides used for malaria, dengue and Chagas disease vector control in Venezuela, in kg of active ingredient and by class of insecticide,^a 1992–2005

Year	Malaria				Dengue		Chagas disease			
	OC	OP	C	PY	OP	PY	OC	OP	C	PY
1992	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1993	44 250	23 335	0	1 181	NR	NR	NR	NR	NR	NR
1994	4 500	0	2 288	0	NR	NR	NR	NR	NR	NR
1995	18 000	66 301	0	0	NR	NR	NR	NR	NR	NR
1996	24 559	61 178	0	788	39 493	53	54	4 244	0	0
1997	25 570	100 570	0	469	40 251	88	0	4 324	0	0
1998	23 271	90 748	0	276	63 577	80	0	11 114	164	0
1999	1 878	80 765	0	368	60 064	83	0	2 241	0	0
2000	476	76 129	0	336	53 479	64	0	6 453	80	0
2001	0	55 074	0	367	78 510	0	0	3 291	13	2
2002	0	117 092	0	357	67 735	0	0	3 411	25	5
2003	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2004	0	120 368	0	1 399	48 943	0	0	2 983	0	0
2005	0	140 396	0	1 109	57 432	0	0	12 380	0	1074

NR, not reported

^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

WHO REGION OF THE AMERICAS – GUATEMALA, AND TRINIDAD AND TOBAGO

Table 28. Insecticides used for vector-borne disease control in Guatemala and Trinidad and Tobago, in kg of active ingredient and by class of insecticide,^a 1995–2005

Year	Guatemala						Trinidad and Tobago	
	Malaria			Dengue		Chagas disease	Dengue	
	OP	C	PY	OP	PY	PY	OP	C
1995	273	650	543	257	58	NA	NR	NR
1996	266	11 620	454	197	22	NA	2 279	280
1997	3 547	12 000	3 968	0	0	NA	4 278	355
1998	1 108	4 592	66	1 622	765	94	6 685	96
1999	539	494	194	169	718	124	2 846	343
2000	532	3 420	640	416	142	23	6 088	197
2001	10 872	355	0	420	70	201	6 814	197
2002	494	959	704	492	43	89	11 574	188
2003	492	3 642	454	716	0	NR	957	193
2004	582	2 254	24	860	0	NR	668	0
2005	909	1 512	0	1 030	0	NR	399	0

NR, not reported

^a C = carbamate; OP = organophosphate; PY = pyrethroid

WHO EASTERN MEDITERRANEAN REGION – ISLAMIC REPUBLIC OF IRAN, PAKISTAN AND SUDAN

Table 29. Insecticides used for vector-borne disease control in the Islamic Republic of Iran, Pakistan and Sudan, in kg of active ingredient and by class of insecticide,^a 1997–2005

Year	Islamic Republic of Iran					Pakistan		Sudan		
	Malaria			Leishmaniasis		Malaria		Malaria		
	OP	C	PY	C	PY	OP	PY	OC	OP	PY
1997	4 304	8 858	3 686	10 000	0	2 587	1 452	4 800	13 825	152
1998	501	2 366	2 954	1 547	3	0	900	2 500	25 650	0
1999	528	1 649	1 744	1 826	22	0	1 000	0	29 300	0
2000	42	5	1 551	2 451	86	428	964	0	61 550	0
2001	43	313	1 319	1 725	0	4 515	815	0	15 683	3 696
2002	13	453	802	2 450	184	1 729	798	0	3 363	1 034
2003	0	0	571	1 000	98	1 332	1 010	0	10 117	5 920
2004	24	0	211	NR	NR	2 191	1 006	0	9 067	7 435
2005	19	0	542	NR	NR	1 789	1 132	0	7 333	3 295

^a C = carbamate; OP = organophosphate; PY = pyrethroid

WHO EASTERN MEDITERRANEAN REGION – OMAN

Table 30. Insecticides used for malaria vector control in Oman, in kg of active ingredient and by class of insecticide,^a 1984–2005

Year	OC	OP	PY
1984	24 566	301	0
1985	15 470	343	0
1986	6 459	433	0
1987	3 544	649	0
1988	3 929	733	0
1989	5 320	850	0
1990	2 715	228	0
1991	4 003	1 184	0
1992	1 008	1 266	125
1993	0	2 134	0
1994	0	4 131	5
1995	0	5 842	12
1996	0	9 289	12
1997	0	6 864	59
1998	0	5 756	75
1999	0	5 621	67
2000	0	4 365	47
2001	0	4 042	49
2002	0	3 426	0
2003	NR	NR	NR
2004	0	2425	109
2005	0	2466	5

NR, not reported ^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

WHO SOUTH-EAST ASIA REGION – INDONESIA

Table 31. Insecticides used for malaria and dengue vector control in Indonesia, in kg of active ingredient and by class of insecticide,^a 1987–2005

Year	Malaria				Dengue	
	OC	OP	C	PY	OP	PY
1987	244 275	24 320	0	0	11 570	0
1988	238 650	25 560	0	0	24 150	0
1989	571 950	85 680	0	0	28 950	0
1990	422 400	143 760	0	0	15 430	0
1991	408 023	61 480	1 704	1 024	19 252	0
1992	21 113	71 320	15 120	672	108 360	90
1993	0	77 920	17 840	2 380	142 740	100
1994	0	30 600	24 160	5 906	199 511	225
1995	0	31 598	22 000	5 949	167 138	798
1996	0	15 920	5 200	4 116	114 501	1456
1997	0	8 000	5 840	3 950	91 096	2082
1998	0	8 800	3 720	10 265	16 126	767
1999	0	0	1 168	2 156	11 870	200
2000	0	0	720	968	5 536	338
2001	0	0	1 600	678	11 344	210
2002	0	0	1 390	602	10 000	575
2003	0	0	1 600	4 513	5 214	668
2004	0	0	1 600	1 022	5 152	521
2005	0	0	2 560	1 633	43 197	1 356

^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

WHO SOUTH-EAST ASIA REGION – MYANMAR

Table 32. Insecticides used for malaria and dengue vector control in Myanmar, in kg of active ingredient and by class of insecticide,^a 1988–2005

Year	Malaria			Dengue
	OC	OP	PY	OP
1988	110 100	0	0	NR
1989	150 450	0	0	NR
1990	51 075	0	0	NR
1991	66 675	0	0	703
1992	26 475	0	144	1 102
1993	4 350	0	1 894	741
1994	7 500	0	143	1 968
1995	30 300	0	151	882
1996	20 025	0	233	550
1997	10 875	0	2 463	247
1998	6 975	0	24	3 762
1999	9 759	0	100	154
2000	8 587	0	250	70
2001	6 670	0	220	205
2002	578	25	296	499
2003	0	255	974	98
2004	0	45	802	267
2005	0	35	563	687

NR, not reported

^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

WHO SOUTH-EAST ASIA REGION – SRI LANKA

Table 33. Insecticides used for malaria vector control in Sri Lanka, in kg of active ingredient and by class of insecticide,^a 1986–2004

Year	OP	PY
1986	5 761 800	0
1987	1 080 200	0
1988	1 059 700	0
1989	1 369 700	0
1990	1 077 491	0
1991	1 098 419	40
1992	1 062 532	60
1993	809 159	48
1994	226 021	2 013
1995	168 691	1 352
1996	124 112	1 111
1997	110 214	752
1998	112 623	313
1999	23 399	723
2000	69 379	2 901
2001	83 937	8 384
2002	23 947	7 273
2003	16 021	5 691
2004	549	3 931

^a OP = organophosphate; PY = pyrethroid

WHO SOUTH-EAST ASIA REGION – THAILAND

Table 34. Insecticides used for malaria and dengue vector control in Thailand, in kg of active ingredient and by class of insecticide,^a 1988–2002

Year	Malaria			Dengue	
	OC	OP	PY	OP	PY
1988	390 300	25 110	0	NA	NA
1989	414 221	43 825	0	NA	NA
1990	492 375	20 350	0	NA	NA
1991	446 400	5 405	0	NA	NA
1992	418 875	382	380	NA	NA
1993	346 425	285	510	NA	NA
1994	254 175	675	1 078	NA	NA
1995	162 000	275	1 838	1 695	37
1996	140 175	410	2 742	1 924	19
1997	126 450	0	4 396	4 304	36
1998	113 400	46	2 777	1 307	12
1999	79 871	54	3 607	1 264	14
2000	22 044	100	3 994	3 681	11
2001	3622	53	4 305	3 288	12
2002	0	5	5 007	6 676	379
2003	0	13	2 989	200	12
2004	0	6	2 815	207	15
2005	0	12	1 909	201	21

Note: Space spray application of 38, 81 and 33 kg of active ingredient of pyrethroids against malaria and dengue vectors, during 2003, 2004 and 2005 were reported, respectively, which are not included in the above table.

NA, not available

^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

WHO WESTERN PACIFIC REGION – MALAYSIA

Table 35. Insecticides used for malaria and dengue vector control in Malaysia, in kg of active ingredient and by class of insecticide,^a 1993–2005

Year	Malaria			Dengue	
	OC	OP	PY	OP	PY
1993	47 500	223	908	9 609	0
1994	47 500	223	908	9 609	0
1995	18 750	223	908	400	1 729
1996	23 750	0	908	409	1 729
1997	0	223	2 408	409	3 412
1998	0	223	6 596	409	2 118
1999	0	0	3 963	0	3 412
2000	0	669	4 178	2 050	5 368
2001	0	0	5 070	2 719	3 740
2002	0	0	5 070	4 244	4 751
2003	0	0	5 070	4 239	4 448
2004	0	0	3 113	2 048	5 736
2005	0	0	7 617	60	47 811

^a OC = organochlorine; OP = organophosphate; PY = pyrethroid

WHO WESTERN PACIFIC REGION – PHILIPPINES, VIET NAM

Table 36. Insecticides used for malaria and dengue vector control in Philippines and Viet Nam, in kg of active ingredient and by class of insecticide,^a 1993–2005

Year	Philippines					Viet Nam	
	Malaria			Dengue		Malaria	
	OP	C	PY	OP	PY	OC	PY
1993	20 000	8 400	991	0	0	21 923	6 865
1994	14 091	7 040	939	0	0	2 918	6 377
1995	14	310	733	0	70	0	16 376
1996	0	28	445	0	90	0	16 678
1997	0	0	682	0	1 227	0	18 804
1998	0	4	1 435	0	316	0	25 944
1999	0	9	152	2	202	0	16 809
2000	0	0	364	8	137	0	37 519
2001	0	0	699	12	464	0	13 632
2002	0	0	1 028	0	29	0	3 517
2003	0	0	129	0	3	0	4 876
2004	0	0	216	0	225	0	3 908
2005	0	0	175	73	69	0	2 537

^a C = carbamate; OC = organochlorine; OP = organophosphate; PY = pyrethroid

ANNEX 1.

DATA REPORTING FORM AND INSTRUCTIONS FOR COMPLETION

DATA ON PESTICIDE USAGE BY MEMBER STATES

Please follow the instructions below when completing the attached form.

Each row is for a single application of a pesticide:

Example:

YEAR	COMPOUND ^a	CLASS ^b	FORMULATION ^c	CONCENTRATION ^d	TYPE OF APPLICATION ^e	FOR CONTROL OF ^f	AMOUNT OF FORMULATION USED (kg or L) ^g	AMOUNT OF ACTIVE INGRED ^h .
1997	malathion	organophosphate	WP	50%	Indoor residual spraying	malaria	1000 kg	500
1997	permethrin	pyrethroid	EC	10%	Treatment of mosquito nets	malaria	200 L	20
1998	temephos	organophosphate	GR	1%	Larviciding	dengue	1500 kg	15

^a COMPOUND – List only the *chemical* name of the pesticide (e.g. malathion, deltamethrin). The use of a trade name is not appropriate since a product may be registered under different trade names in different countries.

^b CLASS – The use of class of pesticides is *optional*. The following table may be used to identify the class of common pesticides.

Class	Organochlorine	Organophosphate	Carbamate	Pyrethroid
Compounds	DDT Lindane, gamma HCH	Diazinon Fenthion Fenitrothion Malathion Pirimiphos-methyl Temephos	Bendiocarb Propoxur	Alphacypermethrin Cyfluthrin Deltametrin Etofenprox Lambdacyhalothrin Permethrin

^c FORMULATION – Indicate the formulation according to the product label, e.g.:

WP = wettable powder

SC = suspension concentrate (= flowable concentrate)

EW = emulsion, oil in water

EC = emulsifiable concentrate

GR = granule

WT = water dispersible tablet

^d CONCENTRATION – Indicate the concentration of the active ingredient of the pesticide in the formulation as a percentage (e.g. 5%).

^e TYPE OF APPLICATION – Indicate the type of application, e.g.:

Indoor residual spraying

Treatment of mosquito nets

Space spraying

Larviciding

^f FOR CONTROL OF – Name the disease for which the pesticide is used, e.g. malaria, dengue, Chagas disease, onchocerciasis.

^g AMOUNT OF FORMULATION USED – Indicate the amount of *formulation* used in *kg* or *L*.

^h AMOUNT OF ACTIVE INGREDIENT – *Optional* – The amount of active ingredient used is equal to (concentration of the formulation x amount of formulation used), e.g. where 1000 kg of malathion 50% WP was used, the total amount of active ingredient used is $1000 \times 0.50 = 500$.

Please include your name and complete postal address, fax number and e-mail at the bottom of the last page for future contacts and for verification of the information, if necessary.

For more detailed information, contact the Regional Adviser for Vector Control, WHO Regional Office, or write to the WHO Pesticide Evaluation Scheme (WHOPES), Department of Control of Neglected Tropical Diseases, World Health Organization, Avenue Appia 20, CH-1211 Geneva 27, Switzerland; Fax: +41 22 791 4869; e-mail: zaimm@who.int

Region:

Country:

YEAR	COMPOUND	CLASS	FORMULATION	CONCENTRATION	TYPE OF APPLICATION	FOR CONTROL OF	AMOUNT OF FORMULATION USED (kg or L)	AMOUNT OF ACTIVE INGRED.

Completed by:

Name:

Postal address

.....

.....

Tel:; Fax:; e-mail:



**World Health
Organization**

**Vector Ecology and Management
WHO Pesticide Evaluation Scheme (WHOPES)**