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Item 5 (a) (ii) of the provisional agenda*

Matters related to the implementation of the Convention: measures to reduce or eliminate releases from intentional production and use: DDT

Information from the World Health Organization on the continued need for DDT for disease vector control

Note by the Secretariat

As referred to in the note by the Secretariat on the evaluation of the continued need for DDT for disease vector control and promotion of alternatives to DDT (UNEP/POPS/COP.7/5), the annex to the present note contains a letter from the World Health Organization (WHO), dated 30 January 2015, together with an attachment entitled WHO information on the use of DDT and DDT alternatives in disease vector control. The present note, including its annex, has not been formally edited.

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Annex

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Secretariat of the Basel, Rotterdam and Stockholm Conventions
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Geneva

30 January 2015

Dear Dr Payet,

Please find enclosed a submission by the World Health Organization, titled *World Health Organization information on the use of DDT and DDT alternatives in disease vector control.*

The submission includes the views of the World Health Organization on the continued need for DDT for disease vector control, and is provided in accordance with the Stockholm Convention, Annex B, Part II, paragraph 6.

We request that you kindly provide our submission to the 7th Conference of the Parties to the Stockholm Convention and the related regional preparatory meetings.

Yours sincerely,

Dr Maria Neira
Director
Department of Public Health, Environmental and Social Determinants of Health

ENCL: (1)

WORLD HEALTH ORGANIZATION INFORMATION ON THE USE OF DDT AND DDT ALTERNATIVES IN DISEASE VECTOR CONTROL

Prepared 28 January 2015 for the 7th Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants, 4 – 15 May 2015, Geneva, Switzerland. The present document is an updated version of a report on the same subject provided to COP6 (UNEP/POPS/COP.6/INF/10).

Contents:

Part 1: Current WHO policies and activities relevant to the use of DDT in malaria vector control
Part 2: Status report on DDT alternatives recommended and under consideration by WHO
Part 3: Human health aspects of the use DDT in indoor residual spraying
Part 4: Information on the use of DDT for leishmaniasis vector control

Part 1: Current WHO policies and activities relevant to the use of DDT in malaria vector control

Malaria control efforts over the past decade have shown remarkable success. The 2014 WHO World Malaria Report shows that malaria mortality rates decreased by 47% between 2000 and 2013 globally, and by 54% in the WHO Africa region; an estimated 4.3 million malaria deaths were averted, in large part due to the scale up of vector control, especially the deployment of insecticide treated mosquito nets and indoor residual spraying. These fragile gains are now seriously threatened by insecticide resistance in the mosquito vectors, outdoor (residual) malaria transmission, by diminishing financial support and by the capacity needs of national programs to implement entomological monitoring and optimize their scanty resources for vector control. This is a critical time for global malaria control efforts and for communities that are now at a greater risk for resurgence of malaria and death.

One of the challenges of insecticide resistance management is the availability of a few insecticides in only four classes with different mode of action that are suitable for vector control. This limitation in the availability of alternative insecticides is one of the factors necessitating the need for continued use of DDT for vector control in certain areas. As outlined below, WHO is engaged with the safe and judicious use of DDT and the development of alternatives across a broad spectrum of activities related to a) policy guidance; b) contribution to the DDT Expert Group; c) support to DDT reporting; d) capacity building; and e) facilitation for development of alternatives.

A) **Policy Guidance**

The World Health Organization issued a position statement on the use of DDT in malaria vector control in 2007. This was updated in 2011 to include the International Program on Chemical Safety review "DDT in Indoor Residual Spraying: Human Health Aspects" (WHO/HTM/GMP/2011[1]).

The conclusion of the 2011 Position Statement is essentially the same as the conclusion from 2007:

> *DDT is still needed and used for disease vector control simply because there is no alternative of both equivalent efficacy and operational feasibility, especially for high-transmission areas. The reduction and ultimate elimination of the use of DDT for public health must be supported technically and financially. It is essential that adequate resources and technical support are rapidly allocated to countries so that they can adopt appropriate measures for sound management of pesticides in general and of DDT in particular. There is also an urgent need to develop alternative products and methods, not only to reduce reliance on DDT and to achieve its ultimate elimination, but also to sustain effective malaria vector control.*

Since that time there have been a number of contextual changes related to the relative costs of malaria vector control, the production and availability of DDT and the extent of insecticide resistance, especially in Africa. In summary, while the contexts, the challenges and the needs for global malaria control efforts have evolved since the 2007 and 2011 Position Statements, DDT is still needed as an option for malaria vector control programs.

Cost and duration of effectiveness (residual efficacy) remain important considerations in the use of DDT. While the price of pyrethroids has declined, the new longer lasting formulations for indoor residual spraying have improved duration of effectiveness, but still do not match the duration of effectiveness of DDT, i.e. these alternative carbamate and organophosphate insecticides are still far more expensive and shorter-acting than DDT. The most important change over recent years has been a recognition of the extent of insecticide resistance in Africa to pyrethroids and in many other countries[2 3 4]. There are however, specific situations where the dominant mosquito vector is resistant to pyrethroids and carbamates but still susceptible to DDT, which on technical grounds, would be the insecticide of choice.

DDT has several characteristics that are of particular relevance in malaria vector control. Among the 12 insecticides (in 15 formulations) currently recommended for this intervention, DDT has one of the longest residual efficacy when sprayed on walls and ceilings (6–12 months depending on dosage and nature of substrate). In similar conditions, other insecticides had much shorter residual efficacy (pyrethroids: 3–6 months; organophosphates and carbamates: 2–6 months). Since 2007, two new

[1] http://www.who.int/malaria/publications/atoz/who_htm_gmp_2011/en/index.html

[2] Mulamba C, Riveron JM, Ibrahim SS, Irving H, Barnes KG, et al. Widespread pyrethroid and DDT resistance in the major malaria vector Anopheles funestus in East Africa is driven by metabolic resistance mechanisms. PLoS ONE 2014, 9(10): e110058

[3] Toe KH, Jones CM, N'Fale S, Ismail HM, Dabire RK, Ranson H: Increased pyrethroid resistance in malaria vectors and decreased bed net effectiveness, Burkina Faso. Emerg Infect Dis 2014, 20(10).

[4] Temu EA, Maxwell C, Munyekenye G, Howard AFV, Munga S, et al. Pyrethroid resistance in Anopheles gambiae, in Bomi County, Liberia, compromises malaria vector control. PLoS ONE 2012, 7(9):e44986.

longer-lasting formulations of pyrethoids have become available, a deltamethrin water-dispersible granule and a lambda-cyhalothrin capsule suspension; at the same time their price has fallen below that of DDT. There is also a new capsule suspension formulation of the organophosphate insecticide primiphos-methyl that may provide similar results, but whose current price is more than four times that of DDT. The emusifiable concentrate formulation of primiphos-methyl was used for two annual spray rounds recently in Malawi, but because of its very short effectiveness of less than three months and very high price at the time, IRS was discontinued in those districts. There are no longer-lasting carbamate insecticides available in the near future. Depending on the duration of the transmission season, the use of carbamate or organophosphate alternatives might require more than two spray cycles per year, and the associated cost would be very difficult (if not impossible) to achieve and sustain in most settings.

Now, insecticide resistance management, more than cost and duration of effectiveness, has become the dominant driver for the continued use of DDT in specific circumstances.

Insecticide resistance, particularly pyrethroid resistance in Africa, is a major challenge to global malaria control efforts. In May 2012, WHO launched the "Global Plan for Insecticide Resistance Management" [5] (GPIRM) that laid out a comprehensive, five-part framework for meeting the challenge of insecticide resistance. The threat to pyrethroids is severe as this class of insecticide is widely used in agriculture, domestic pest control, and indoor residual spraying for malaria. Pyrethroids are also the only class of insecticide that can be used to treat mosquito nets; their loss of efficacy could be catastrophic to global malaria control efforts.

Over the past five years, DDT resistance in *An gambiae* and *An arabiensis* has been demonstrated in a number of countries, including Ethiopia, Uganda and Zambia, resulting in a discontinuation of DDT IRS in favour of delamethrin, with a subsequent switch to carbamate (bendiocarb) or organophosphate (primiphos-methyl) products. Other vectors, particularly *An. funestus,* do not exhibit the same type of "kdr" target-site cross resistance as in *An. gambiae* and *An. arabiensis*. Rather, when resistance develops in *An. funestus* it is the more specific "metabolic" type of resistance where one may find resistance to the other classes of insecticides, but continued susceptibility to DDT. This has been shown across a number of countries in southern Africa (such as Mozambique, Zambia and Malawi), most notably in KwaZulu Natal in South Africa.

There is a long history of DDT IRS in Southern Africa. In Namibia for example DDT IRS was used from 1960 to 1990 when it was discontinued and this led to a malaria epidemic which killed 7000 people. From 1998 onward Namibia adopted an integrated approach which includes LLIN, DDT- IRS for traditional houses, pyrethroid - IRS for modern houses and targeted larviciding. Using an integrated approach, the incidence of malaria cases dropped to 400 in the year 2000 and by 2013 only 4 malaria deaths were recorded.[6]

[5] http://www.who.int/malaria/vector_control/ivm/gpirm/en/

[6] Personal communication, Minister of Health, Namibia, WHO Vector Control Working Group meeting, 28 – 30 January 2015, Geneva.

South Africa used DDT – IRS until 1995 and during this time *An. funestus* was considered to have been eliminated. In 1996, there was a switch from DDT to pyrethroid - IRS and this resulted in a gradual increase in malaria morbidity until 2000 when the country experienced an epidemic which was mainly attributed to pyrethroid resistance in *An. funestus*. From 2001 onward, DDT – IRS was re-introduced and there was a more than 90% reduction in malaria morbidity.

Rotation of insecticides among the four available classes is a key strategy in resistance management and the only way we know to preserve the effectiveness of long lasting insecticidal nets currently using pyrethroids. Also the population protected by IRS has been declining and this is mainly due the fact that most countries reporting pyrethroid resistance could not afford costly alternative insecticides for IRS such as carbamate and organophosphate available for vector control. It is therefore vital that DDT remain available for IRS in those areas where vectors are still susceptible to DDT, but metabolic resistance to the other classes of insecticides, particularly pyrethroids, has been demonstrated.

B) **Contribution to Stockholm Convention DDT Expert Group**

The "Expert Group on the Assessment of the Production and Use of DDT and its Alternatives for Disease Vector Control" met 10 – 12 November 2014, in Geneva. WHO participated in the meeting (as an observer) and provided an update on the current status of global malaria vector control and the technical challenges we face to maintain the fragile gains we have achieved over the past decade.

The expert group noted the marked decline in production of technical grade DDT material (98-99% a.i.) from 3,872.4 MT in 2012-13 to 2,786.0 MT in 2013-14, and global exports from 286.2 MT in 2012/13 to 76.5 MT in 2013-14, reflecting the discontinuation and a decline in DDT use for IRS in a number of large programmes. India is the only producer of DDT, consuming more than 97% of annual global production in the past two years. Overall the use of DDT for malaria control has been reduced from 2847 MT in 2009 to 1757 MT in 2014 but the amount used for visceral leishmaniasis control increased from 500 MT in 2009 to 1335 MT in 2014. Also a few countries use DDT for control of diseases transmitted by *Aedes* spp. without WHO recommendations. Given the production of DDT for public health use is now limited, countries using DDT are facing two challenges: 1) limited access to quality DDT for IRS and 2) high cost of available DDT product for IRS.

WHO supports the finding of the DDT Expert Group that while production and export of DDT has declined from 2012/13 to 2013/14 it is not an indication of a clear trend but likely to be part of a fluctuating production cycle, that management and the generation of an inventory of DDT stockpiles remains a global challenge (only five out of 24 countries reported on stockpiles of DDT during the period 2009-11), and disposal of obsolete DDT and used containers remains a priority.

Between 2011 and 2014, WHO and UNEP coordinated a project to establish efficient and effective data collection and reporting procedures for evaluating the continue need of DDT for disease vector control. The project involved 12 countries in WHO AFRO and two in the WHO EMRO region. Countries reported progress in various activities ranging from capacity building for improved reporting on DDT use, quality control/assurance of procured insecticides, review of training manual for IVM strategies, training in spray techniques and IR monitoring and investigation of DDT stockpile management. Overall

participating countries recognize investment in human resource, specifically training on sound management of pesticides, is crucial to minimize potential risk of DDT and other POPs of public health importance.

In the Region of the Americas and Eastern Mediterranean dealing with obsolete stocks of DDT is a high priority. There was a successful WHO implemented demonstration project in Central America and Mexico, where stockpiles of DDT were identified in all participant countries (Belize, Costa Rica, Guatemala, El Salvador, Honduras, Mexico, Nicaragua, and Panamá). Mexico incinerated all the DDT collected during the project, and the other countries have re-packed the pesticides and they were replaced in a safer storage space. The WHO Eastern Mediterranean Region reported destruction of the majority of DDT waste identified in the eight participating countries during the project. This includes 23.8 tonnes of DDT and other obsolete stocks in Jordan, 41.2 tonnes of concentrated DDT in Morocco and 28.7 tonnes of DDT in Iran have been repacked and destroyed in September 2014. The project was funded by the Global Environment Facility (GEF) (through UNEP). But the final disposal of the remaining DDT and other obsolete pesticides is still a problem. A Few countries, for example, Mozambique, Papua New Guinea and Vanuatu still maintain stocks of obsolete DDT which require disposal.

As noted by the Expert Group, there are currently a limited number of effective and affordable alternatives to DDT for vector control and to reverse this situation a sustained investment in research on new tools and strategies for vector control is needed.

The Expert Group noted the continued challenge of obsolete stocks of DDT, including in countries that are not reporting. For example Swaziland reported unspecified stocks of obsolete DDT in need of disposal, whereas Bangladesh has 602 MT of obsolete DDT in storage facilities that are inadequate leading to risk in environment contamination and health hazards.

WHO concurs with the recommendations of the DDT Expert Group (provided in a separate document) and also copied here below. WHO would especially like to emphasize recommendations 5, 6 and 7.

Recommendations of the Stockholm Convention DDT Expert Group:

1. The DDT Expert Group recognizes that there is a continued need for DDT for indoor residual spraying (IRS) in specific settings for disease vector control where locally safe, effective and affordable alternatives are still lacking.

2. Countries that use IRS for the control of vectors of leishmaniasis should use DDT only if locally available, safe, effective and affordable alternatives to DDT are not available.

3. WHO is encouraged to provide further clarification to countries considering DDT for the control of vectors of arboviruses.

4. Countries should endeavour to make targeted application of IRS a high priority to ensure the judicious use of resources, including DDT, and undertake comparative economic evaluations of various insecticides recommended for IRS and alternative means of vector control.

5. Funding should be made available to increase the national policy and management capacity for translating international best practices on disease vector control including the implementation of the WHO Global Plan for Insecticide Resistance Management (GPIRM) and quality assurance systems for vector borne diseases.

6. Identifying and disposing of obsolete DDT stockpiles should continue towards complete removal of the stocks.

7. Capacity should be increased for the development and evaluation of novel vector control products and for expeditious reviewing of such products by relevant national and international bodies within the framework of the UNEP Roadmap for the Development of alternatives to DDT.

8. The Secretariat of the Stockholm Convention should continue to facilitate activities on strengthening capacity to transition away from the reliance on DDT for disease vector control.

C) **Support for DDT reporting in 14 African Countries**

WHO, in collaboration with UNEP and with funding from the GEF is currently working with the relevant national stakeholders to strengthen the DDT reporting system in 12 countries in the WHO African region and 2 in the WHO Eastern Mediterranean region. Overall there has been remarkable decline in DDT use on the African continent. The following table shows 2006 – 2011 data from a WHO consultant report[7] and updates for 2012 to 2013 provided by WHO AFRO. Note the data from Senegal was missing at the time of the initial report, but should read "zero". However, due to widespread resistance to pyrethroids and high cost of pyrethroid alternatives, DDT may be re-introduced if effective, in rotation with other classes of insecticides, as a resistance management tool.

[7] Henk van den Berg, Consultant ASSESSMENT OF REPORTING SYSTEMS FOR VECTOR CONTROL PESTICIDES Project GFL/3349: Establishment of efficient and effective data collection and reporting procedures for evaluating the continued need of DDT for disease vector control. Global Malaria Programme, World Health Organization

Table 1: Annual use of amounts of DDT per countgry (in tons of product), as reported in the DDT questionare. (m = missing)

Country	2006	2007	2008	2009	2010	2011	2012	2013
Eritrea	m	m	m	13	18	23	0	0
Ethiopia	m	1600	1600	1800	0	0	0	0
Gambia	0	0	m	21	15	15	19	20
Madagascar	0	0	0	0	0	0	0	0
Mauritius	2	3	3	0	1	0	0	0
Morocco	0	0	0	0	0	0	m	m
Mozambique	m	m	m	400	200	130	31	21
Namibia	m	m	m	m	m	m	m	63
Senegal	m	m	m	m	m	m	0	0
South Africa	m	101	98	85	21	62	45	45
Swaziland	m	m	m	5	5	5	4	4
Uganda	0	0	32	0	0	0	0	0
Yemen	0	0	0	0	0	0	m	m
Zambia	m	30	44	32	25	0	20	20
Total	**2**	**1734**	**1777**	**2356**	**285**	**235**	**119**	**173**

D) **Support for Capacity building**

Demonstrating and Scaling Up Sustainable Alternatives to DDT, and Strengthening National Vector Control Capabilities in the AFRO, EMRO and PAHO regions

Through support from the GEF, three WHO regional offices support capacity building for demonstrating and scaling up sustainable alternatives to DDT in their respective regions.

- **Africa Region:** The WHO Regional Office for Africa works in collaboration with UNEP through funding from the GEF supports projects in Ethiopia and Madagascar The long-term developmental objective of the project is to reduce the reliance on DDT without increasing the occurrence of vector borne diseases, and to promote appropriate vector control management practices through strengthened capacities of countries to sustain scaled-up implementation of environmentally sound alternatives. In two countries the project supported 1) initial entomological, parasitological and community surveys to document information on vector and parasite profiles; 2) Capacity building in including training in entomology and parasitology, provision of basic equipment and suppliers for diagnostic parasitology and entomological labs, and IRS (spray pumps etc) supplies; 3) a trial on alternative insecticides (OP and carbamate) to DDT; 4) mapping of insecticide resistance status of major vectors to include four classes of insecticides available for public health use. In Madagascar the project supported an anthropological study and the outcome guided development of a communication (IEC-BBC) strategy for malaria which has potential for expansion for other disease control.

- **Eastern Mediterranean Region.** This regional project (2009–2014) covers the following countries of the WHO Eastern Mediterranean Region: Djibouti, Egypt, Jordan, Islamic Republic of Iran, Morocco, Sudan, Syrian Arab Republic and Yemen. The regional project aim to reduce reliance on, and minimize the potential to revert to DDT for the prevention and control of vector-borne diseases in seven countries, through the use of sustainable, cost-effective and environmentally friendly alternative interventions. A total of US$3.9 million has been made available to support the five components of the project at national and regional level. The five components of the project are: (i) demonstration of DDT alternatives; (ii) capacity building on Integrated Vector Management (IVM); (iii) disposal of Persistent Organic Pollutant (POPs) pesticides; (iv) information sharing on good practices; and (v) coordination, monitoring and evaluation. The first component has focused on exploring viable alternatives to DDT in 4 countries (Iran, Morocco, Sudan and Yemen) through on site implementation of research studies and has so far demonstrated tangible results: in Sudan combined interventions (IRS and LLINs) offered additional protection but with no evidence of any relationship between malaria incidence or prevalence and phenotypic resistance. In Morocco, IRS using alpha-cypermethrin was effective in significantly reducing leishmaniasis transmission but no significant benefit was identified with the use of LLINs. Iran has successfully explored environmental management measures (concrete and straw mat coverings) to support its malaria elimination strategies and data analysis for study in Yemen is currently ongoing. This experience showed the feasibility of planning, conducting and evaluating research studies within the context of operational programmes, through effective partnering with research. This is expected to benefit the utilization of research results and adoption of best practices by the programmes.

  Regarding the second component and capacity building, all participating countries have reviewed their policy and legal frameworks, and institutional arrangements on vector control, and subsequently developed an IVM policy framework, national policy on pesticide management. IVM steering committees have been constituted to review existing policies and regulations, and clear standards for professions and careers in vector control and public health entomology have been established for over 6000 personnel. Five out of seven countries have developed a national strategic and implementation plan to harmonize separate vector borne disease control programmes. Epidemiological and entomological surveillance (144 sites) have been introduced in seven countries. Seven hundred and forty five staff have undergone certified training courses on IVM and judicious use of pesticides. Lastly community participation in vector control has been emphasized through partnership for change among all stakeholders through advocacy meetings, multiple behavioral change campaigns and community wide communications.

  Under component three, a detailed inventory data of the quantities, locations and conditions of the public health pesticides and other POPs pesticide stocks has been conducted in three Countries: Islamic Republic of Iran, Jordan and Morocco. Approximatley120,000 tons of pesticides used in public health and agriculture have been successfully safely collected, packaged and incinerated.

  Information on good practices on cost effective and sustainable alternatives have been documented with a tri-lingual (French, Arabic and English) webpage, and trans-boundary coordination has

improved information sharing and monitoring and evaluation. The shortage of medical entomologists in the Region has been identified as a major challenge to IVM. EMRO has developed a robust curriculum for a MSc degree programme in medical entomology and vector control with the Blue Nile River Institute, Gezira State, Sudan, in 2008. Particular attention has been given to capacity building on insecticide resistance management. At Regional level, a framework for action on sound management of public health pesticides in the East Mediterranean Region (2012-2016) was developed and adopted. Overall this project has enabled countries to strengthen IVM on several fronts: to develop their policy and legal framework, and capacity on IVM, to demonstrate new vector control strategies, to dispose POPs pesticides, and to advocate on IVM and/or pesticide management. All of these activities will reduce reliance on DDT in case of outbreaks of vector borne diseases and minimize the potential to revert to DDT use.

- **American Region.** The project had three main goals: to implement demonstration projects of malaria vector control without DDT or other persistent pesticides that can be replicable in other parts of the world; to strengthen national and local institutional capacity to control malaria without the use of DDT; and to eliminate DDT stockpiles in the eight participating countries. The project involved eight countries: Mexico, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama and nine sites for demonstration projects were selected in each country. The project begun in August 2003 and was finished by July 2008 (except for the POPs Disposal component). The project was extended twice beyond its initial duration of three years. A final evaluation was conducted from September 2008 to January 2009 as an in-depth evaluation using a participatory approach. It was a descriptive multi-case study, using several sources of information. The project evaluation was conducted at the regional level and at three levels; national, demonstrative areas and localities, in four countries, namely Costa Rica, Guatemala, Mexico and Panama.

The Malaria Decision Analysis Support Tool (MDAST): Evaluating Health, Social and Environmental Impact and Policy Trade-offs

The WHO-AFRO in collaboration with UNEP, Duke University, University of Pretoria and three National Institutes, one each in Kenya, Tanzania and Uganda conducted a three year study to develop a MDAST that incorporates health, social and environmental priorities for malaria control and increase capacity of programs for evidence-based malaria control policy making through the regular use of MDAST. The aim of the project was to promote evidence-based, multi-sectoral malaria control policymaking through the use of a comprehensive framework for assessing the full range of health, social, and environmental risks and benefits associated with alternative malaria control strategies. The project developed a decision support tool for malaria control in Kenya, Tanzania, and Uganda and building capacity for evidence-based policy making , serving as a pilot for other countries facing the burden of malaria.[8] The extension of MDAST to include additional

[8] Malaria Decision Analysis Support Tool (MDAST): Evaluating Health, Social and Environmental Impacts and Policy Tradeoffs, Project Implementation Report, June 2013 http://sites.duke.edu/mdast/files/2013/12/Final-Report.pdf

countries would require financial resource, the commitment of certain human resources, including a core group of stakeholders headed by an in-country lead with the interest and authority to engage with MDAST, and of technical staff to support the dissemination, training, and implementation of activities. The project was funded by the Global Environmental Facility.

E) **Facilitation for the development of alternatives to DDT**

- *Integrated Vector Management.* The foundation for improved vector control operations is the Global Framework for Integrated Vector Management which includes malaria as well as other vector-borne diseases. IVM is defined as "A rational decision-making process for optimal use of resources for vector control" and includes five basic elements: Advocacy, social mobilization and legislation; Cross sector collaboration; Integrated approaches; Evidence-based decision-making; and Capacity-building. IVM has been embraced as a fundamental strategy to meet the major challenges currently facing vector borne disease control programmes, including insecticide resistance management; maintaining prevention coverage (largely through insecticide treated mosquito nets and indoor residual spraying) in constrained financial times; developing tools and strategies for outdoor transmission; as well as developing alternatives to DDT. WHO has issued numerous handbooks and training documents, and leads a number of working groups with Roll Back Malaria and the Global Alliance for Alternatives for DDT to build capacity and facilitate the introduction of IVM principles into vector borne disease control programs. Although IVM is considered important for control of vector borne diseases, there is still a need for evidence from projects or systematic studies, such as cluster randomised trial, to show the impact on diseases.

- *Roll Back Malaria Vector Control Working Group.* WHO co-chairs certain work streams in this large and diverse working forum, with more than 450 members and more than 160 participants attending annual meetings organized each year in January. The VCWG has broad participation across national programmes, industry, academia, foundations, and bi-lateral, international and non-government organizations to build a common vision and collective action to meet current challenges. Many of the activities of the VCWG and its members include rationalization and optimization of vector control tools, including alternatives to DDT.

- *Innovative Vector Control Consortium.* WHO participates in a number of committees of this project, funded by the Bill and Melinda Gates Foundation, that works across industry and academia to develop new pesticide active ingredients, new formulations and new paradigms and strategies for vector control.

- *WHO Vector Control Advisory Group* and the *WHO Technical Expert Group for Vector Control.* These two new policy committees have been constituted by WHO in the first quarter of 2013. The first, VCAG, is to guide and facilitate development and approval process for new vector control tools under new paradigms, for control of vectors of malaria as well as other vector borne diseases, such as dengue, leishmaniasis and lymphatic filariasis. The VCAG review will shortens the process to get a product to the market. In 2014, VCAG reviewed nine paradigms

with 10 prototypes product under different steps (VCAG steps from 1 up to 4) of evaluation. Of the 9 paradigms reviewed todate, vector control products for use in areas of high insecticide resistance is much advanced. VCAG identifies this paradigm as having significant public health value and a recommendation on the paradigm will be submitted for policy issuing bodies of WHO. The second, GMP-TEG, advises advises on vector control strategy, such as optimizing coverage for treated mosquito nets, the role of larviciding and outdoor (residual transmission). Both these committees, for new forms of tools and for new strategies respectively, will play a significant role in the future development of alternatives to DDT.

- *The Global Alliance for the Development and Deployment of Alternatives to DDT for Disease Vector Control.* WHO participates in the Steering Committee for the Global Alliance and helps provide strategic and technical direction to the five thematic groups, for Integrated Vector Management; cost effectiveness of alternatives to DDT; reducing barriers to bring new chemicals and products to market; reducing barriers to bringing non chemical products to market; and insecticide resistance. In addition, WHO, through the WHO Pesticide Evaluation Scheme is centrally involved in testing and evaluation of the safe and judicious use of pesticides including the development of alternative to DDT, and work on sound management of pesticides. These WHOPES supported activities are described in more detail in the next section.

- *Update on implementation of Global Plan for Insecticide Resistance Management in malaria vectors* (GPIRM). Update was discussed at MPAC meeting held in November 2014. GPIRM was launched in May 2012 in response to widespread insecticide resistance. Some progress has been made in implementing GPIRM technical recommendations, but adoption to policy and operational implementation at country level have been poor due to a lack of political will coupled with major financial, human and infrastructural resource deficiencies. Therefore urgent efforts are needed to ensure correct use of existing interventions and availability of new tools in order to maintain the effectiveness of malaria vector control. As a consequence WHO and partners will conduct comprehensive situation analysis and develop a global response plan.

Part 2: Status report on DDT alternatives recommended and under consideration by WHO

Insecticide products to be used in control of malaria and other vector-borne diseases should be effective, of low risk and operationally acceptable.

WHO, in 1960, established the WHO Pesticide Evaluation Scheme (WHOPES) – an independent programme which promotes and coordinates the testing and evaluation of pesticides for use in public health in collaboration with industry and a network of research institutions, analytical laboratories and national programmes [9].

[9] http://www.who.int/whopes/en/

WHOPES is a four-phase testing and evaluation programme, assessing the safety, efficacy and operational acceptability of public health pesticides (PHPs), developing their specifications for quality control and international trade following the peer-reviewed standard guidelines for risk assessment, efficacy testing and development of pesticide specifications[10,11]. WHOPES also collects, consolidates, evaluates and disseminates information on the use of these chemicals. The International code of conduct on pesticide management[12] provides the framework for promoting life-cycle management of pesticides and minimizing human, animal and environmental risks associated with the use of these chemicals. Guidance documents to support life-cycle management of pesticides are developed in collaboration with FAO through the work of FAO/WHO Joint Meeting on Pesticide Management[13].

WHO has also recently published Guidelines for procuring public health pesticides to ensure that appropriate high-quality pesticide products are procured rapidly, efficiently, economically and in a fair and transparent manner.[14] In addition and recognizing that the use of substandard products can have serious adverse effects on human health and the environment as well as waste of scarce resources, guidelines for quality control of pesticides were published to assist monitoring quality of products to prevent any unacceptable effects when these are used as recommended.[15]

Currently 12 pesticide compounds with a total of 19 formulations representing compounds in four class groups of insecticides have been recommended by WHO for indoor residual spraying for malaria vector control[16]. Characteristics of the insecticide and its formulation, the ecology and climate of the area to be sprayed, susceptibility and behaviour of the target vectors, and cost and availability of quality products are some important factors that should be considered in selecting alternative insecticides.

WHO promotes judicious and low-risk use of insecticides within the context of integrated vector management approach. This approach calls for, where possible, integration of different vector control interventions (e.g. larviciding, use of insecticide treated nets, space spraying) for a single or multiple disease control. As of January 2015, WHOPES has recommend 6 pyrethroids for conventional treatment and a formulation of one of them for long-lasting treatment of mosquito nets, 11 long-lasting insecticidal net (LNs) products, 6 insecticides for space spraying, and 12 larvicides.[17] As of November 2014, 12 products (11 LNs and 1 larvicide) are under evaluation of WHOPES.[18]

WHOPES monitors trends in global use of insecticides in public health. A WHO global survey collected and analyzed 10-year data (2000–2009) which showed that 4429 metric tonnes of active ingredient of organochlorine (DDT), 1375 tonnes of organophosphates, 30 tonnes of carbamates and 414 tonnes of pyrethroids were used annually for global vector control.[19] Analysis of the trend showed that the use of vector control insecticides was dominated by DDT in terms of quantity applied (71% of total global use)

[10] http://www.who.int/whopes/guidelines/en/
[11] http://www.who.int/whopes/quality/en/
[12] http://who.int/whopes/recommendations/International_Code_of_Conduct_on_Pesticide_Management_Y2014.pdf
[13] http://www.who.int/whopes/recommendations/who_fao_meetings/en/index.html
[14] http://whqlibdoc.who.int/publications/2012/9789241503426_eng.pdf
[15] http://whqlibdoc.who.int/hq/2011/WHO_HTM_NTD_WHOPES_2011.4_eng.pdf
[16] http://who.int/entity/whopes/Insecticides_IRS_17_Nov_2014.pdf
[17] http://www.who.int/whopes/en/
[18] http://who.int/entity/whopes/Products_Under_WHOPES_Evaluation_Nov_2014.pdf?ua=1
[19] http://whqlibdoc.who.int/publications/2011/9789241502153_eng.pdf

and by pyrethroids (excluding treated nets) in terms of the surface or area covered (81% of total).[20] Significantly high coverage of mosquito resting surfaces with pyrethroids and growing concern for resistance of malaria vectors call for appropriate use of these chemicals to manage resistance as outlined in the WHO's Global plan for insecticide resistance management.[21]

Use of DDT and its alternatives in vector-borne disease control requires adequate capacity for their sound management. The WHO survey has revealed critical deficiencies in the legislative and regulatory framework for PHPs across regions,[22] while major gaps were evident in pesticide procurement practices, training on vector control decision making, certification and quality control of pesticide application, monitoring of worker safety, public awareness programmes, and safe disposal of pesticide-related waste.[23]

To mitigate these deficiencies, during 2007-2013, WHOPES implemented a project on reduction of health risks through sound management of pesticides.[24] The project aimed and successfully raised political awareness and promoted inter- and intra-sectoral collaboration for sound management of public health pesticides (PHPs). It supported five WHO Regions in development of policy guidelines and or Regional framework for life-cycle management of PHPs, i.e. in the Americas[25], Africa[26], Western Pacific[27], South East Asia[28], and the Eastern Mediterranean where the Regional Committee passed a resolution to properly manage PHPs in the face of increasing burden of vector-borne diseases [29, 30].

Support was also provided to 13 participating countries in five WHO Regions to identify gaps, opportunities and needs as well as in development of national action plans for sound management of public health pesticides, including establishment of national standards for quality control of pesticides and for capacity building of national pesticide quality control laboratories. Seven additional countries in

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[20] van den Berg, H., M. Zaim, R. S. Yadav, A. Soares, B. Ameneshewa, A. Mnzava, J. Hii, A. P. Dash, M. Ejov (2012). Global trends in the use of insecticides to control vector-borne diseases. *Environmental Health Perspectives*, 120(4): doi:10.1289/ehp.1104340 or http://dx.doi.org/10.1289/ehp.1104340.

[21] http://www.who.int/malaria/vector_control/ivm/gpirm/en/index.html

[22] Matthews, G. M. Zaim, R.S. Yadav, A. Soares, J. Hii, B. Ameneshewa, A. Mnzava, A.P. Dash, M. Ejov, S.H. Tan, H. van den Berg (2011). Status of legislation and regulatory control of public health pesticides in countries endemic with or at risk of major vector-borne diseases. *Environmental Health Perspectives*, 119 (11): doi:10.1289/ehp.1103637.

[23] van den Berg, H., J. Hii, A. Soares, A. Mnzava, B. Ameneshewa, A.P. Dash, M. Ejov, S. H. Tan, G. Matthews, R. S. Yadav, M. Zaim (2011). Status of pesticide management in the practice of vector control: a global survey in countries at risk of malaria or other major vector-borne diseases. *Malaria Journal*, 10:125. [doi:10.1186/1475-2875-10-125]

[24] http://who.int/iris/bitstream/10665/90546/1/9789241506106_eng.pdf

[25] *The Antigua Charter on pesticide management.* Regional consultation on sound management of public health pesticides in Latin America and Caribbean countries, Antigua, Guatemala, 23-26 August 2011.

[26] http://whqlibdoc.who.int/publications/2011/9789241501231_eng.pdf

[27] WHO (2011). Report of the Regional consultation on sound management of public health pesticides in the Western Pacific. Kuala Lumpur, Malaysia, 12–14 September 2011.

[28] http://www.who.int/whopes/resources/SEA_CD_214.pdf

[29] Mnzava, A., M. Zaim, R. S. Yadav, S. Elkhalifa, J. Mahjour (2012). Management of the use of public health pesticides in the face of the increasing burden of vector-borne diseases in the Eastern Mediterranean. *Eastern Mediterranean Health Journal*, 18(1): 70–76.

[30] WHO (2011). Regional Committee for the Eastern Mediterranean, 58th Session. *Managing public health pesticides in the face of increasing burden of vector-borne diseases*. Document no. EM/RC58.10(D).

Africa have used the guidance to develop national policies for pesticide management. WHO will continue spearheading its policies and activities for sound management of PHPs.

Part 3: Human health aspects of the use DDT in indoor residual spraying

In 2011, WHO published Environmental Health Criteria Document No. 241 *DDT in Indoor Residual Spraying: Human Health Aspects*[31]. This report was the result of deliberations of three WHO expert consultations, culminating in the final risk assessment consultation in November 2010. The findings of this work were provided to the 5th Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants.

Annually, since the publication of EHC241, WHO has reviewed the literature published in the previous year (ie to November 2011, November 2012, November 2013 and November 2014), to consider whether the literature suggests that the 2010 assessment should be revisited. To date, a re-evaluation has not been triggered. WHO will continue to monitor the situation, subject to availability of resources from voluntary donor contributions. As part of ongoing work to maintain the WHO International Agency for Research on Cancer (IARC) classification of carcinogens, the classification for DDT is scheduled to be reviewed in a meeting to be held 2 – 9 June 2015.

Part 4: Information on the use of DDT for leishmaniasis vector control

WHO has published its position on the use of DDT in malaria control. There is no such explicit position on the use of DDT for leishmaniasis control. It has been a long standing practice to use the same insecticide/doses for control of both malaria and leishmaniasis where the two diseases are co-endemic.

The 10-year average data for the period 2000-2009 showed that 4429 metric tonnes of active ingredient of DDT was used annually for indoor residual spraying for vector control[32]. During this period, use of DDT for leishmaniasis control accounted for 825 metric tonnes of active ingredient. In most recent years, use of DDT for leishmaniasis control has remained mostly in India. In some areas of Muzaffarpur, Vaishali and Samastipur in India, resistance of the sandfly to DDT has been observed [33,34]. Bangladesh and Nepal are now using pyrethroids for leishmaniasis vector control.

A few studies have evaluated efficacy of long-lasting insecticidal nets for leishmaniasis control, albeit with limited successes. These studies have focused only on impact of use of treated nets on sand fly densities and human-biting rates or on proxy indicators for disease transmission (KALANET project in India and Nepal measured reduction of transmission through sero-surveys). Presently, three tools are considered to be useful for vector control in leishmaniasis transmission control in South-East Asia:

[31] WHO (2011) Environmental Health Criteria Document 241 DDT in indoor residual spraying: Human health aspects, at: http://whqlibdoc.who.int/publications/2011/9789241572415_eng.pdf

[32] WHO (2011). Global insecticide use for vector-borne disease control – 5th edition. A 10–Year assessment (2000–2009). Available at: http://whqlibdoc.who.int/publications/2011/9789241502153_eng.pdf

[33] WHO (2012). Elimination of Kala-zar: Report of the fourth meeting of the Regional Technical Advisory Group (RTAG). 12-14 July 2011, Kathmandu, Nepal. http://203.90.70.117/PDS_DOCS/B4811.pdf

[34] Huda et al Toolkit for monitoring and Evaluation of IRS…J.Trop.Meds. 2011

indoor residual spraying of insecticides; long-lasting insecticidal nets; and environmental control. Limited entomological capacity in South-East Asia Region, which contributes largely to the global burden of visceral leishmaniasis, is a major impediment to guiding the decision making for vector control and monitoring and evaluation of impact of interventions.
