| BACKGROUND PAPER |

THE FIGHT AGAINST MALARIA

THE IMPERATIVE OF KEEPING DDT USE UNDER CONTROL

Umwelt Bundes Amt
for our Environment

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1. Introduction

On the occasion of the 3rd Conference of Signatory States to the Stockholm Convention on Persistent Organic Pollutants (POPs)[1], held from 30 April to 4 May 2007 in Dakar, Senegal, Maria Neira, Director of the Department of Health and the Environment at the World Health Organization (WHO), made a declaration on WHO's strategy on the use of DDT. The declaration restated WHO's continued commitment to the further reduction and eventual elimination of the use of DDT in accordance with the objectives of the Stockholm Convention. The aim of achieving a simultaneous reduction in the instance of diseases transmitted by animals (vectors) was also restated. This declaration was of special importance, as it clarified that both aims - fight against malaria and elimination of DDT - are still of the same high priority.

But this latter aim demands financial and technical assistance for the affected regions with the aim of implementing an integrated vector management program[2]. A joint companion action involving the WHO and the environmental programme of the United Nations (United Nations Environment Programme, UNEP) further underscored this position. In this way WHO went public with a necessary clarification on its approach to the question of DDT.

To cover the needs for financial and technical support a business plan was developed under the Stockholm Convention with the aim to prevent the use of DDT for deasease vector control by 2020. This business plan shall be decided by the forthcoming 4th Conference of the Parties of the Stockholm Convention held from 04 May to 08 May 2009 in Genf.

2. Background

In a press release dated 15 September 2006, the WHO seemed to be indicating a new focus in its strategy on the fight against malaria in respect of the use of DDT. Since the 1970s, which saw the implementation of a ban on the use of DDT as a pesticide in many industrialised nations, including the USA and European states, this agent has continued to be used in many developing countries as a means to tackle malaria[3]. Since the beginning of the 1980s attempts have been made also to restrict such exceptions. Thus for example WHO consistently made the recommendation over a long period of time that DDT use in the fight against malaria should be drastically reduced, following up this recommendation with concrete action in the form of specific projects[4]. In September 2006 the idea gained ground that WHO was again recommending the larger-scale use of DDT in the fight against malaria on the grounds that it was efficient and inexpensive, and that the ban was scientifically unjustifiable and had been originally motivated by political considerations. Numerous health and development experts fear a significant increase in the global use of DDT, which is currently at a level of around 6,000 to 7,000 tonnes per annum. This question is of particular interest to large sections of the mass media.

WHO considers the use of DDT to be appropriate in the context of the IRS procedure (Indoor Residual Spraying) in areas where malaria is epidemic[5]. The same is however not true for areas where it is endemic[6]. Further methods for the tackling of malaria which make no use of DDT, such as the distribution of mosquito nets impregnated with other agents - e.g. pyrethroidin or permethrin (ITN – Insecticide Treated Nets) - and the drug-based treatment of malaria are also widely available. As early as 2004, however, WHO established that it was correct to assert that DDT posed a realistic danger to the environment[7], and WHO stills holds to the aim of keeping the use of DDT to the absolute minimum possible. This position was further reinforced in the most recent WHO declaration of May 2007.

1998 saw the initiation of a WHO programme under the name "Rollback Malaria"[8] with the aim of reversing the spread of the disease. However, the project failed to achieve anything like the desired results, which can be attributed to

the inadequate funding made available to it. The goals of the project were defined in the Abuja Declaration of the year 2000 and included the aims of halving the number of deaths from malaria by 2010, providing bed nets by 2005 to 60% of those in need of them, and speeding up the treatment of under fives and pregnant women[9]. In 2005 the USA launched its own anti-malaria programme (PMI – President's Malaria Initiative), equipped with a significantly higher budget, which provides for an investment of 1.2 billion dollars within 5 years. This programme, in addition to propagating the previously highlighted ideas of technical and infrastructure assistance to the affected states, also supports the spraying of individual houses with DDT.

The discussion around DDT is generally difficult to conduct with restraint as it is emotionally highly charged due to malaria's position as the infection which causes the most deaths of any infectious disease in the world (according to WHO more than 1 million per annum[10]). Most of the mass media continue to report that DDT is a particularly dangerous agent, both in human health and environmental terms, and that a ban on its use remains justified. This means in turn that, as before, there is a high level of public awareness of this pesticide.

There are however increasing numbers of dissenting voices which say that DDT does not cause any harm to man or to the environment, giving the impression that DDT has been withdrawn from the fight against malaria for environmental protection reasons, thus preventing effective protection from being afforded.

3. Need for action – strategy for reducing the use of DDT

The Federal Environment Agency believes that it is possible to suspend all DDT use without placing the health of people in malarial regions at risk. What is needed here is an effective strategy.

Important arguments in favour of reducing the use of DDT as far as is consistent with what is possible and acceptable, and ultimately ending its use completely, are its harmful impact on human health and the environment, its persistence[11], bioaccumulability[12], and its potential for being transported over large distances. With this in mind, the following points are to be taken into consideration in any further course of action:

- The availability of effective and affordable alternative agents for the fight against malaria using the IRS procedure[13], and their side-effects,
- The relative effectiveness of the IRS procedure in the individual regions in comparison with other measures for reducing the likelihood of transmission,
- The possibility of introducing an "integrated pest management/vector management (IPM/IVM)[14]" system of DDT use and alternatives in developing countries.
- Consequences of the continued use and possible non-use of DDT.

An investigation also needs to be carried out into the feasibility of using alternatives to DDT also to tackle leishmaniasis[15] carriers (sand flies), as this measure accounts for a significant proportion (1000 tonnes in 2005, around 20%[16]) of the DDT used.

4. Current state of affairs in the use of DDT

The production and use of DDT has been banned in Germany since 1972. The Stockholm Convention of 2001[17] prohibits the manufacture and use of DDT – with the exception of its use in the control of vectors in countries which lay claim to the necessity. DDT may be produced for the purpose of tackling malaria carriers, as long as effective and affordable alternatives are not available in sufficient amounts. The annual consumption of DDT for disease vector control is of 5.000 tonnes and have risen during last years. In 2007 India produced as main producer 6.300 tonnes. China and North Korea produced also DDT. China manufactured 4.500 tonnes between 2000 and 2004; 80 to 90 percent of that as intermediate for further production of the pesticide Dicofol. This substance is also a POP-candidate and currently

under assessment to be listed also as POP by the Stockholm Convention[18]. China announced to cease the production of DDT for 2009[19]. Users of DDT are India (3.188 tonnes in 2007) and Ethiopia (371 tonnes in 2007)[20]. It is estimated that 23 countries in the Asian, African, and Pacific regions use DDT for indoor spraying. Some countries – such as South Africa and Tanzania - have returned to DDT use or are planning to do so. Around 80 percent of the DDT is used in the control of malaria or of leishmaniasis[21]. Other uses of DDT, for example, in agriculture, which are not sanctioned under the Stockholm Convention, are the subject of sketchy, unconfirmed reports. Signatory states to the Stockholm Convention which continue to use DDT are obliged to register this use with the secretariat of the Stockholm Convention. A total of 163 states have ratified the Stockholm Convention, including all EU member states and the European Commission.

The EU remains committed to the non-use of DDT within Europe and is active in the promotion of the development of alternatives for malaria control in those states which still use DDT – the ultimate aim is the complete discontinuation of DDT use[22].

4.1 Strategy for the reduction of DDT use in accordance with the Stockholm Convention

According to the Stockholm Convention, the secretariat is obliged every three years to undertake an enquiry into the state of affairs in respect of the substitution of DDT. This is carried out on the basis of data submitted by the signatory states. The secretariat presented a procedural proposal on this matter to the second Signatory State Conference in May 2006. This proposal is based on background information derived from joint studies carried out by WHO and UNEP[23].

The Stockholm secretariat sent a very detailed questionnaire to all potential DDT user states, by means of which those states were to provide information on the actual use of the agent, any resistances arising as a result of its use, and any alternatives employed. This information was assessed by the secretariat at the third Signatory State Conference in May 2007. To provide specialist assistance a committee of experts met in Geneva between 21 and 23 November 2006. This group came to the conclusion that integrated strategies and procedures for vector control which did not include the use of DDT needed to be implemented as a matter of priority.

The third Signatory State Conference in May 2007 decided to reappraise the situation on the basis of this procedure by 2009 at the latest. In addition to this UNEP, WHO, and the secretariat of the Stockholm Convention are to prepare a global strategy in the context of a business plan for the substitution of DDT. By the next Signatory State Conference in 2009 the abovementioned organisations are to have drawn up a report on the status of use of integrated vector management (IVM).

To cover the needs for financial and technical support a business plan was developed under the Stockholm Convention with the aim to prevent the use of DDT for disease vector control by 2020. Core objectives are:

- Improve the knowledge on alternative procedures and methods;
- Support to use alternatives; guidance to take informed decisions for implementation of an integrated vector management (IVM);
- Make available new insecticides (new mixtures of already used pesticides as alternatives for DDT, research for new pesticides and their affect mechanisms),
- Development of non-chemicals alternatives.

The business plan will establish a global alliance as platform for information exchange to support existing initiatives. Need for action shall be identified for additional research and best-practice-methods shall be promoted. In future will be monitored, if these measures will result in reduced amounts of DDT. Existing organisations und funds shall work together and double work should be avoided.

4.2 Effects of DDT on human health and the environment

4.2.1 Effects on health

In an acute sense DDT is only poisonous to a very slight degree, which makes it admissible as a means of indoor malaria control. A working document from a consultation meeting in the context of the International Programme on Chemical Safety, IPCS[24], held in Brazzaville, Congo, from 20 to 22 June 2006 on the use of DDT in indoor spraying in the African region contains a current assessment of the effects of DDT on human health.

This document refers to the last international assessment carried out by WHO and the FAO in 2000. This assessment established by means of animal experiment studied a wide variety of toxic effects, including reproductive toxicity, developmental inhibitions, and neuronal effects. The assessment recommends a precautionary TDI value[25] of 0.01 mg/kg per day[26]. So far the effects highlighted in animal experiments[27] have not been found to be reproduced in human epidemiological studies.

IPCS is currently working on a CICAD report[28] on DDT (including the metabolites DDE/ Dichlordiphenyldichloroethene and DDD/ Dichlorodiphenyldichloroethane), which is intended to evaluate the scientific findings that were available at the end of 2005. The report is scheduled for publication in 2007.

4.2.2 Effects on the environment

DDT is highly toxic, especially to arthropods (animals with segmented bodies such as insects and small crustaceans), and was thus used in the 1950s and 60s as a "magic bullet" against anopheles mosquitoes, in the struggle to control the spread of malaria, and other insects, primarily as a means of crop protection. The consequences of its use only came to light later on and are still being felt. DDT is extremely persistent and bio-accumulative, and thus poses a major environmental problem. Due to its semi-volatility[29] DDT spreads very widely and occurs conjointly with its derived compounds (metabolites) - DDD and DDE - in especially high concentrations in the Polar Regions. Due to the prevailing low temperatures in these regions semi-volatile chemicals tend to condense.

DDT is the cause of significant harm in the food chain, especially to birds, as a consequence of its characteristic of accumulation. Thus in the 1970s a sharp decline in the numbers of eagles in Germany[30] and in the USA[31] was documented. The primary reasons are that DDT leads to eggshell fragility and to infertility. The ban on DDT use led directly to a decrease in concentrations throughout the food chain, which meant that wild bird populations were able to recover. Another indicator of the current state of pollution through DDT is the decline in concentrations in mothers' milk: the concentrations of chlorinated pesticides such as DDT, which are no longer permitted, are decreasing. In 1997, tests of mothers' milk yielded concentrations of around 5 – 15 percent of those recorded in similar tests in 1980[32].

4.3 WHO recommendations on the use of DDT

In line with WHO recommendations the use of DDT for the spraying of interior walls is permissible under fulfilment of the following conditions:

- Use must be restricted to the spraying of interior walls only. WHO offers comprehensive technical recommendations on how to conduct such spraying in a correct and proper manner;
- Manufacture in accordance with WHO specifications;
- The presence of a functioning set of rules and monitoring systems to ensure that DDT is used only for the purposes of combating malaria;
- Use by specifically trained personnel only.

At the same time, however, WHO established that

- There are significant problems associated with the recording and management of resi-

stances;
- The countries in which DDT is still used often do not have recourse to appropriate guidelines and monitoring systems for the use of DDT in malaria control;
- The reporting to WHO and the secretariat of the Stockholm Convention by states using DDT demonstrates serious inadequacies.

4.4 Alternative methods of malaria control

Methods of malaria control without recourse to DDT include the following:

- Using insecticide (pyrethroids) impregnated bed nets; recent times have seen the development of special, long-term effective impregnated bed nets (LLIN =long lasting insecticidal nets), which obviate the necessity of continuous after-treatment;
- The spraying of interior walls with long-term insecticides such as carbamate pesticides, organophosphates, and pyrethroids;
- New combined malaria treatment therapies using drugs whose active ingredient is artemisin;
- Non-chemical methods of elimination of the breeding grounds of malarial mosquitoes, for example by drying out swampland, and covering over water reservoirs and waste water tanks.

In addition, several groups of researchers are working on vaccines either to prevent malaria or at least to alleviate its worst symptoms. A new vaccine, which offers roughly 50 percent protection, is currently being trialled, with the aim of introducing it onto the market in 2010. The Bernhard Nocht Institute (BNI) in Hamburg is working jointly on this project with the Ghanaian research station of the Hamburg tropical institute the "Kumasi Centre for Collaborative Research in Tropical Medicine" (KCCR).

WHO and UNEP experts are unambiguously in favour of an integrated strategy of malaria control – in other words, of the use of all the abovementioned methods as far as the various prevailing ecological and economic circumstances allow. That impregnated bed nets, especially the long-term effective ones, have a positive impact on the fight against malaria is beyond dispute. Global success, however, remains elusive for the simple reason that too few households have access to such nets. Infection epidemiologists predict an effective interruption of transmission of plasmodia – the causative organism of malaria – between humans once at least 80 percent of the population of malarial areas have access to the bed nets. There are currently no means of comparing the costs generated by indoor spraying with DDT with those arising from the use of bed nets. An impregnated bed net currently costs between 2 and 6 US dollars: targeted DDT spraying using trained personnel may well be even more expensive.

Resistances which develop to the agents used are important to varying degrees: during the 1950s and 60s the anopheles mosquitoes quickly developed resistance to DDT due to its large scale use in agriculture, including in their breeding areas, and the same could happen today in the case of pyrethroids. What could present an additional complication in the case of the use both of DDT and pyrethroids in the same area is the possibility of cross-resistances developing in the disease-carrying organisms, which would leave the options of only a few types of organophosphate and carbamate pesticides in the affected areas. Due to their highly acute toxicity, the use of such agents represents a significant risk to health for those people who have to apply them. The high costs relative to the use of DDT can partially be attributed to the necessity for expensive protective working equipment.

The focus in the fight against malaria in the affected areas has over the last 20 years been placed on the medical treatment of infected people. This is however closely connected to the development of resistance on a massive scale amongst the malaria-causing organisms (plasmodia) to the few available anti-malarial agents. Newly developed agents (e.g. artemisine) have since become available. WHO makes international recommendations for each affected region, depending in each case on the status of resistance.

Reference has also been made to the great strides in malaria control made in Mexico in recent years without the use of DDT[33]: Mexico banned the use of DDT in 2000. During the subsequent period the incidence of deaths due to malaria has decreased to zero. What brought about this success was an integrated system of measures, in which the breeding grounds of the carrier insects in rural areas were eliminated and the population systematically tested for existing infection to establish the need for medical treatment. Mexico, however, benefits in comparison with other states strongly affected by malaria from a significantly better healthcare infrastructure as well as much more ample financial resources.

5. Recommendations for a new strategic direction

The federal German ministries with interest in the topic at hand, that is, the Federal Ministries for the Environment, Nature Conservation, and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit – BMU), for Economic Cooperation and Development (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung - BMZ), and for Health (Bundesministerium für Gesundheit – BMG) support the resolutions passed at the 3rd Signatory State Conference on the Stockholm Convention held in Dakar, Senegal. The BMZ intends as a priority to enter into dialogue with the responsible authorities in those countries cooperating on the promotion of malaria control without DDT, with the aim of giving them technical and institutional support in the implementation of WHO requirements. To the extent possible, money for the use of alternative agents and approaches will be made available either directly or via third parties (e.g. the Global Fund for the Fight Against Tuberculosis, Aids, and Malaria (GFTAM), or the World Bank). Malaria control programmes which use DDT will only be sanctioned as an ultima ratio in individual cases where a timed exit strategy has been worked out in advance.

The following tasks will need to be accomplished:

- determination of the actual costs incurred by the comprehensive distribution of mosquito nets and other alternatives in comparison with those arising from DDT spraying measures carried out by trained personnel,
- establishment of the criteria for those situations in which it will actually be necessary to use DDT;
- Promotion of integrated control measures[34] in preference to the one-sided prioritisation of DDT use.

To assure long-term success additional financial commitments need to be made to:

- The development of new environmentally friendly insecticides which do not impact negatively on human health for use against malaria and leishmaniasis carriers,
- The development and promotion of integrated control strategies without DDT,
- The promotion of the development and general availability of drugs for malaria control (vaccines and other medicines).

The Federal Environment Agency is of the opinion that a significant financial contribution, comparable in scale to the President's Malaria Initiative (PMI) to the tune of 1.2 billion dollars within 5 years, needs to be made by the European Union.

[1]Stockholm Convention signed in 2001, ratified by Germany in 2004, came into effect in 2004, www.pops.int.

[2]Earth Negotiation Bulletin, Vol. 15, No. 151, Wednesday 2 May 2007 http://www.iisd.ca/download/pdf/enb15151e.pdf

[3]Malaria (from the Italian mal'aria – "bad air") – also known as ague – is a tropical disease brought about by single-celled parasites of the Plasmodium genus. The disease is transmitted via the bite of the female mosquito of the genus anopheles. Outside these regions mosquitoes inadvertently carried by air passengers can give rise to the so-called "airport malaria". In such cases all those in the immediate surroundings of airports are at risk, including employees and local residents. Human to human transmission, accidental means such as via blood transfusions or laboratory accidents aside, is practically restricted to occasional transmission from mother to unborn child if the placenta is damaged, especially during the birth. Humans and anopheles mosquitoes represent the only significant reservoirs of humanopathogenic plasmodia.

[4]WHO: Global Malaria Programme (GMP), http://www.who.int/malaria/ddtandmalariavectorcontrol.html

[5]epidemic – the disease occurs in temporal and geographical clusters within a given population

[6]endemic – the disease occurs regularly within a population group and the cause of the disease is continuously present.

[7]WHO: WHO Position on DDT Use in Disease Vector Control under the Stockholm Convention POPs http://www.who.int/malaria/docs/WHOpositiononDDT.pdf

[8]Position of WHO's Roll Back Malaria Department on malaria treatment policy", http://www.who.int/malaria/docs/who _apt_position.htm

[9]WHO (2003): The Abuja Declaration and the Plan of Action. An extract from The African Summit on Roll Back Malaria, Abuja, 25 April 2000 (WHO/CDS/RBM/2000.17) WHO/CDS/RBM/2003.46 http://www.rbm.who.int/docs/abuja_declaration.pdf

[10]WHO: World Malaria Report 2005, http://rbm.who.int/wmr2005/

[11]Persistence is the term used in biology and environmental chemistry to describe the ability of substances to survive for long periods of time in the environment without being subject to changes caused by physical, chemical, or biological processes.

[12]Bio-accumulability is the accumulation in an organism of substances ingested from the animate or inanimate environment

[13]see page 2

[14]An integrated vector management system takes into account local conditions (vector biology, climate, resources) and makes use of an optimised combination of various alternative methods with the active participation of the local population. The characteristics of an IVM are:

- Selection of measures appropriate to local vector biology, disease transmission, and morbidity,
- Application of more than one method in combination, making use of synergistic effects,
- Cooperation between state health systems and public/private organisations, involving the local population and other interested parties,
- Sparing use of insecticides,
- Good management practices.

[15]Leishmaniasis is a globally occurring infectious disease of people and animals caused by obli-

gatory intracellular protozoan parasites of the genus Leishmania. It is most commonly found in the tropics, especially in eastern Africa, but also occurs in the Mediterranean region. It is transmitted by sand flies or moth flies. In the 1950s, the use of insecticides (principally DDT) against malaria-carrying anopheles mosquitoes also led to the decimation of sand flies (Phlebotominae). Today, however, the sand fly population has recovered to pre-war levels, leading to a renewed increase in cases of leishmaniasis in people and animals in the Mediterranean area.

[16]Meeting document for COP 4 of the Stockholm Convention UNEP/POPS/COP.4/INF/28 "Global status of DDT and its alternatives for use in vector control to prevent disease", page 6.;

WHO: Dr. M. Zaim, WHO Pesticide Evaluation Scheme-WHOPES), Zaim, Jambuligam (2004) Global Insecticide use for vector-borne disease control 2nd Ed.:

- K. Kishore, V. Kumar, S. Kesari, D.S. Dinesh, A.J. Kumar, P. Das* & S.K. Bhattacharya (2006): Vector control in leishmaniasis. Indian J Med Res 123, March 2006, pp 467-472

http://www.icmr.nic.in/ijmr/2006/march/0323.pdf

[17]Stockholm Convention signed in 2001, ratified in Germany in 2004, came into force in 2004. www.pops.int

[18]Meeting document for COP 4 of the Stockholm Convention UNEP/POPS/COP.4/INF/28 "Global status of DDT and its alternatives for use in vector control to prevent disease", page 6 f..

[19]Meeting document for COP 4 of the Stockholm Convention UNEP/POPS/COP.4/INF/4 „Information provided by the Government of China on the specific exemptions that it has in accordance with Article 4, Annex A and Annex B of the Stockholm Convention"

[20]Meeting document for COP 4 of the Stockholm Convention UNEP/POPS/COP.4/INF/28 "Global status of DDT and its alternatives for use in vector control to prevent disease", page 6 f..

Additional Source: Data presented by WHO on the occasion of the second expert meeting on the assessment of production and use of DDT and its alternatives (Geneva 21 – 23 November 2006)

[21]WHO: Dr. M. Zaim, WHO Pesticide Evaluation Scheme-WHOPES), Zaim, Jambuligam (2004) Global Insecticide use for vector-borne disease control 2nd Ed.:

[22]European Union statement at the second Signatory State Conference on the Stockholm Convention

[23]UNEP/POPS/EGDDT.2/4 – Review of the adequacy of the process for the reporting, assessment and the evaluation of the continued use of DDT for disease vector control, http://www.pops.int/documents/meetings/egddt/meetingdocs/meeting_docs.htm

[24]International Programme on Chemical Safety, IPCS, carried by several international organisations – WHO (World Health Organization), ILO (International Labour Organisation) and UNEP (United Nations Environment Programme)

[25]The TDI value represents the maximum tolerable concentration of a substance which is deemed not to have noticeable effects on human health if ingested on a daily basis. The threshold value is given g/kg/d, i.e. in micrograms of substance per kilogram bodyweight per day. TDI stands for "tolerable daily intake".

[26]The Codex Alimentarius for pesticides (WHO/FAO, 2002) still quotes the previously established PTDI value of 0.02 mg/kg per day, which was reduced in 2002 to 0.01 mg/kg per day

[27]Federal Institute for Health Protection of Consumers and Veterinary Medicine (Bundesinstitut für gesundheitlichen Verbraucherschutz und Veterinärmedizin - BgVV): "DDT, lindane, mexoxychlo-

ric, and simazine residues in animal feeds – position of the BgVV as of 6 June 2002".

[28]Concise International Chemical Assessment Documents (CICADS) are the latest in a family of publications from the International Programme on Chemical Safety (IPCS) - a cooperative programme of the World Health Organization (WHO), the International Labour Organisation (ILO), and the United Nations Environment Programme (UNEP). CICADs join the Environmental Health Criteria documents (EHCs) as authoritative documents on the risk assessment of chemicals

[29]Volatility of a chemical in the middle of the range between high and low volatility

[30]WWF: "Adler im Aufwind" 18.11.2004, WWF: http://www.wwf.de/presse/details/news/adler_im_aufwind/3032/nb/7/cHash/dc29a4c43c/

[31]http://www.wwf.ch/de/tun/unterstutzen/schenken_2006/dezember.cfm

[32]Federal institute for consumer health protection and veterinary medicine (BGVV) 15/2000, 10.8.2000: "Population burden with dioxins and other undesirable substances in Germany has fallen considerably" data from mothers' milk http://www.bfr.bund.de/cms5w/sixcms/detail.php/888

[33]Guerrero Cázare, Hernando (2006): Elimination of DDT use – the Mexico experience. Talk given at the second meeting of the group of experts on the assessment of the production and use of DDT and its alternatives (Geneva 21 – 23 November 2006). Stockholm Convention on persistent organic pollutants http://www.idrc.ca/en/ev-63715-201-1-DO_TOPIC.html

[34]see note [14]