WORKING PAPER 95

Current Policy and Status of DDT Use for Malaria Control in Ethiopia, Uganda, Kenya and South Africa

Melanie L. Biscoe, Clifford M. Mutero, and Randall A. Kramer

International Water Management Institute

FUTURE HARVEST
IWMI is a Future Harvest Center supported by the CGIAR

CGIAR SIMA
SYSTEMWIDE INITIATIVE ON MALARIA AND AGRICULTURE

NICHOLAS SCHOOL OF THE ENVIRONMENT AND EARTH SCIENCES
DUKE UNIVERSITY

Working Paper 95

Current Policy and Status of DDT Use for Malaria Control in Ethiopia, Uganda, Kenya and South Africa

Melanie L. Biscoe
Clifford M. Mutero
Randall A. Kramer

International Water Management Institute

IWMI receives its principal funding from 58 governments, private foundations and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Support is also given by the Governments of Ghana, Pakistan, South Africa, Sri Lanka and Thailand.

The authors: Melanie Biscoe is a Master's student in Environmental Management at the Nicholas School of the Environment and Earth Sciences of Duke University, USA. Randall Kramer is a Professor of Environmental Economics at the same institution. Clifford Mutero is the Coordinator of the CGIAR-Systemwide Initiative on Malaria and Agriculture (SIMA) whose host institution is the International Water Management Institute (IWMI).

Information for this paper was collected during a two and a half-month internship by Melanie Biscoe supported by SIMA, Duke University and the World Health Organization (WHO). The views expressed in this report are those of the authors only. Many thanks are extended to the individuals who arranged interviewee meetings, those individuals who consented to the interview process, as well as those who reviewed this paper. The list below contains the names of all those who generously gave their time to review parts of this paper. All remaining errors in this paper are the responsibility of the authors.

- Dr. Christiaan de Jager, School of Medicine, University of Pretoria, South Africa
- P.S. Kruger, Director of Malaria Control, Limpopo Province, South Africa
- Dr. Douglas Merrey, International Water Management Institute, South Africa
- Dr. Marie Lynn Miranda, Nicholas School of the Environment, Duke University, USA
- Dr. Joseph Okello-Onen, Livestock Health Research Institute, Uganda
- Dr. Kathryn Saterson, Duke Center for Environmental Solutions, Duke University, USA
- Dr. Barbara Van Koppen, International Water Management Institute, South Africa
- Dr. Jacob Williams, World Health Organization, Switzerland
- World Health Organization Kenya Country Office, Kenya

Biscoe, M. L.; Mutero, C. M.; Kramer, R. A. 2005. Current policy and status of DDT use for malaria control in Ethiopia, Uganda, Kenya and South Africa. Colombo, Sri Lanka: IWMI. 30p. (Working paper 95)

malaria / vectorborne diseases / disease vectors / policy / public health / legal aspects / case studies / pesticide residues / Ethiopia / Uganda / Kenya / South Africa/ Ddt

ISBN 92-9090-597-2

Please direct inquiries and comments to: *iwmi@cgiar.org*

Contents

Abstract

For most African countries, malaria has become an overwhelming public health problem, leading some governments to consider using DDT for malaria control in the midst of a heightened debate about its advantages and disadvantages. This report seeks to document the nature of the DDT debate in East and Southern Africa by describing current DDT policy plus malaria and insecticide control specialists' views on alternatives to DDT use, examining the factors that influence malaria control policy formation and assessing specialists' knowledge about the human health impacts of DDT. To obtain this information, malaria and insecticide control specialists were interviewed in Ethiopia, Uganda, Kenya, and South Africa and malaria control policy documents from each country were reviewed. Results indicate that DDT use for indoor residual spraying (IRS) continues to be viewed as a viable malaria control option, although most specialists are receptive to alternative control measures. Additionally, decentralization has had a profound impact on malaria control in East Africa and the POPs Treaty is used simultaneously as a rationale for a reintroduction of DDT and its continued prohibition in public health. Finally, research necessary to make informed decisions on malaria control policy is lacking in East Africa, and there is a need to educate malaria and insecticide control specialists on the human health impacts of insecticides used for vector control, including DDT.

1. Introduction and Objectives

Each year, the world experiences 300-500 million cases of malaria. Approximately 90 percent of those cases occur in Sub-Saharan Africa, where over one million children under the age of five die of malaria annually (WHO 2000). The malaria burden faced by African countries continues to be a challenge for national governments. Increasing resistance to drugs and pesticides, the lack of capacity to implement programs effectively and low public education about malaria are only a few of the many complications that African governments must address to effectively combat malaria.

In order to reduce malaria incidence, some African countries are moving back toward dichlorodiphenyltrichloroethane (DDT), a controversial insecticide once widely used throughout the world for agricultural and public health purposes (Hecht 2004). DDT has been widely banned as an agricultural pesticide because of its persistence and bioaccumulation in the food chain, causing negative environmental and human health effects. Thus, the use or reintroduction of DDT for malaria control in many African countries is of concern on both a national and international scale.

DDT's effectiveness on insects was discovered by Dr. Paul Müller just prior to World War II. His work received the Nobel Prize in Physiology or Medicine in 1948 (Carter 2004). DDT was initially used by the Allied forces during World War II to combat typhus and malaria vectors. After the war, it was used throughout the world as a vector control agent and agricultural pesticide helping to successfully eliminate malaria in the United States and Europe and reduce malaria incidence in the tropics.

In the United States, DDT usage reached a peak of 36 million kilograms in 1959 (USEPA 1972). Around that time, DDT resistance among insect populations became evident in many agricultural areas and comparable alternative pesticides emerged on the market. Serious concerns were also expressed about the potential negative environmental and human health impacts of DDT (Carson 1962). Environmental science research revealed that DDT and its metabolites bioaccumulated in food chains, causing eggshell thinning and a decline of numerous bird species, as well as reproductive defects and immune deficiencies in wildlife (Damstra 2004). Because of these environmental concerns and subsequent suspicions about DDT's negative human health impacts, most Western countries banned DDT in the 1970s. Many developing regions of the world, including Mexico, India, China and several countries in Africa, continued DDT production and use for both agriculture and malaria vector control. Currently most developing countries oppose the use of DDT in agriculture, but accept its use in malaria control. In 2001, the Stockholm Convention included DDT as one of 12 persistent organic pollutants to be banned worldwide. Parties to the Convention can only use DDT for "disease vector control" under strict guidelines for use and reporting (UNEP 2001).

This report focuses on DDT policy for malaria control in the East and Southern African context, seeking to:

- Describe the status of DDT policy for malaria control in East and South Africa
- Ascertain malaria and insecticide control specialists' views on alternatives to DDT use, including alternative pesticides and integrated vector management (IVM)
- Examine the factors that influence (or do not influence) malaria control policy formation and implementation, as well as DDT use/reintroduction
- Assess malaria and insecticide control specialists' knowledge about the human health effects of DDT

2. Methods

Research for this study was conducted from June 11 to August 17, 2004. During that time, twenty-six specialists on malaria control and DDT policy were interviewed in Ethiopia, Uganda, Kenya and South Africa. Additionally, each country has created strategic plans for malaria control, which detail the methods used and the challenges faced by the national government in implementing malaria control on the whole (and not just vector control). These strategic plans, as well as national legislation, vector control guidelines and other documents for each country were reviewed to supplement interviewee responses to obtain a more comprehensive understanding of malaria control policy and insecticide policy within the countries. Although this study provides several insights into DDT policy for malaria control in East Africa, the conclusions reached are necessarily limited because of the small number of interviewees in each country (6-7 for each).

The countries of Ethiopia, Uganda and Kenya were chosen because they are highly malarious countries, SIMA is currently conducting research within those countries and they have differing DDT policies for malaria vector control. South Africa was included because South Africa is seen as a leader in malaria control (and in many other arenas) on the African continent and because the SIMA secretariat is located in Pretoria, South Africa. Figure 1 illustrates the varying stability of malaria transmission in each of these countries. Table 1 summarizes the malaria prevalence in each country and whether DDT is used by the government for malaria vector control. Malaria prevalence data for the East African countries should be viewed with caution, as the data is of variable quality. This can be evidenced in the large differences between malaria prevalence data reported by the Roll Back Malaria initiative of the WHO and the country ministries of health.

TABLE 1. Summary of Malaria Incidence and DDT Use for Malaria Vector Control in East and South Africa

	Country Population (UN Data)	Annual Reported Malaria Cases from RBM (per 100,000)	RBM Malaria Risk times Population	Country-Reported Annual Malaria Prevalence	Currently Using DDT?
Ethiopia	65,590,000	621	407,314	5-10,000,000	Yes
Uganda	23,487,000	46	10,804	no data reported	No
Kenya	30,549,000	525	160,382	74-133,000[1]	No
South Africa	44,000,000	61	26,840	14-27,000	Yes

The research sought to obtain varied perspectives on DDT policy with respect to malaria vector control within each country; thus, interviewees were chosen from several government ministries as well as organizations outside of the national government (table 2). Specific interviewees were chosen according to their expertise in the issues of malaria vector control and insecticides policy, as well as their availability to be interviewed during the research time period.

[1]Data from a "few districts only."

TABLE 2. Summary of Interviewee Characteristics

	Ministry of Health	Environmental Protection Authority	Department of Agriculture	Research Institution	Non-Governmental Organization	Country Total
Ethiopia	1	0	2	0	4	7
Uganda	2	1	0	3	0	6
Kenya	2	2	1	0	2	7
South Africa	1	1	0	1	3	6

The interviewees were questioned regarding their country's vector control policy, insecticide use, views on vector control alternatives, and policy implementation and effectiveness. Interview questions and their corresponding categories are shown in table 3. Each structured interview was conducted in English and lasted approximately one hour.

TABLE 3. Interview Questions

Vector Control Policy

What national laws or policies pertain to insecticidal control of malaria vectors?
Do these laws/policies allow for DDT use? If yes, how?

Which agencies are responsible for implementing these DDT laws/policies?

Do current national policies support the use of alternatives (to DDT) in malaria prevention?

What changes to national policy do you think would make the use of Integrated Vector Management more feasible and attractive as a practical option for minimizing pesticide use?
What changes would you like to see in national malaria prevention policies?

What are your views of other countries' DDT/malaria prevention policies? Would you adopt any policies from them?

Country Insecticide Use

What categories of pesticides or insecticides are commonly used in this country for vector control and agriculture? By whom? In what manner? When? Where? What times? When were they introduced? Of what quality are they?

Does the country have DDT stocks and/or stocks of other malaria prevention insecticides?

Does the country have agricultural pesticide stocks?

Are you aware of any illegal local production of pesticides or insecticides?

Views on Alternatives

DDT use is often considered one of many options for malaria prevention. Do you consider DDT to be the best option for malaria prevention?
If so, what are your views on alternatives?

If not, what do you consider to be the best alternative or combination of alternatives?

What are your views on Integrated Vector Management (IVM)?

Policy Implementation and Impact
What methods does the government use to predict malaria epidemics?
What methods does the government support/encourage to prevent malaria epidemics?
What measures are used to mitigate malaria transmission during an epidemic?
Do you believe that current malaria prevention policies in your country are effective in reducing malaria incidence? Why or why not? What would make them more effective?
Do you think the malaria prevention policies have any negative environmental or human health impacts? Why or why not?
Are other countries' DDT/malaria prevention policies implemented well?
Are other countries' DDT/malaria prevention policies effective?

3. Results and Discussion

3.1 LEGISLATIVE OVERVIEW OF DDT USE FOR MALARIA CONTROL: FINDINGS FROM POLICY DOCUMENTS AND INTERVIEWS

3.1.1 The POPs Treaty

During the last decade of the twentieth century, many countries became increasingly concerned about certain chemicals that were persistent in the environment and toxic to humans and wildlife. As a result, United Nations officials and national representatives developed an international treaty aimed at banning twelve "persistent organic pollutants" (POPs): DDT, Aldrin, Dieldrin, Endrin, Chlordane, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, Polychlorinated Biphenyls, Dioxins and Furans.

Although DDT was slated to be banned in the POPs Treaty, concerned groups from malarious nations successfully lobbied that the POPs Treaty allow for the use of DDT in public health. Parties to the Stockholm Convention are allowed to use DDT for "disease vector control," under conditions outlined in Part II of the Treaty, which can be found in Annex II.

151 nations signed the POPs Treaty between May 2001 and 2002, and 86 nations had become parties as of January 2005. Ethiopia, Uganda, Kenya and South Africa are all Parties to the Convention. The POPs Treaty went into force on May 17, 2004.

3.1.2 World Health Organization DDT Policy

The POPs Treaty identifies the World Health Organization (WHO) as the organization that establishes guidelines on the use of DDT for disease vector control. Parties to the Convention must abide by those WHO guidelines and recommendations, notify the WHO of the amount of DDT used, how it is used and defend its use in terms of the Party's disease management strategy. Parties to the Treaty are also required to consult the WHO in their evaluation of the need for DDT in disease vector control. However, the WHO cannot impose specific malaria control policies upon an individual country; it can only provide information and advice.

According to one interviewee, the WHO does not support DDT use in indoor residual spraying (IRS), only focusing on the use of insecticide treated bed nets (ITNs) for malaria control. Indeed, the WHO's *Africa Malaria Report 2003* includes an entire section on ITNs, but does not mention DDT and barely mentions IRS as a strategy for malaria vector control. According to this interviewee, malaria control decision makers in Southern African countries, such as South Africa and Swaziland, oppose the WHO's perceived over-emphasis on ITNs.

The official policy of the WHO, however, says that, "WHO proposed and supports the continued use of DDT for disease vector control, under the Stockholm Convention…" (WHO 2004b). Prior to the Stockholm Convention, a WHO Malaria Expert Committee meeting in 1998 concluded that

DDT use in IRS would continue to be an important malaria vector control strategy in several malarious countries. Currently, the WHO does not support a premature shift away from DDT, recognizing that such action will likely have drastic consequences for populations at risk of malaria (WHO 2004b). In contrast to their Southern African counterparts, a few interviewees in East Africa used WHO's DDT policy as a part of their rationale to promote the use of DDT for malaria vector control.

The WHO has also outlined an action plan to aid countries in: safe management of DDT stockpiles; conducting disease vector control and management needs assessments; monitoring DDT use, human exposure, public health impacts, efficacy, and the efficacy of alternatives; research "on the development of locally viable integrated pest and vector management strategies;" capacity building for vector control; and increasing the capacity of the health sector to make informed decisions (WHO 2004b; WHO 2003a).

The WHO states that, "the use of adulticides, including DDT, for indoor residual house spraying to control vectors is just one of several possible components of IVM" (WHO 2003a). Thus the WHO recognizes the potential for IRS in IVM strategies.

3.1.3 National Laws and Policies

In none of the four countries included in this report does national legislation specify how malaria control policy should be conducted. General health care legislation is typically the only legislation that impacts how malaria control programs create and implement policy. The only national laws that directly pertain to DDT use and reintroduction revolve around two aspects:

- Registration of DDT as an insecticide or hazardous chemical;
- Environmental law requiring an environmental impact assessment (EIA) prior to reintroduction.

The Department/Ministry of Agriculture is usually the entity that registers DDT for disease vector control, even though it is banned for agricultural use. The environmental departments within these countries are responsible for conducting the EIA before DDT reintroduction.

The particular vector control strategies of a country are typically more varied than the general malaria control strategies employed by the countries. The general characteristics of both general malaria control and vector control strategies are summarized in tables 4 and 5. National Malaria Control Strategic Plans typically target four general areas of concern: disease management, vector control, malaria prevention in pregnancy, and epidemic preparedness and response.[2] Vector control strategies may include IRS, ITN use, larviciding, and forms of environmental management (for instance. urban storm drainage, zooprophylaxis, etc.). The only vector control strategy actively adopted by all four countries in this study is IRS.

[2]Country strategic plans also include support strategies such as Human Resources Development and Information, Education, and Communication (IEC) development.

TABLE 4. Comparison of Malaria Control Strategies from Strategic Plans of Ethiopia, Uganda, Kenya and South Africa.

	Disease Management	Vector Control	Malaria Prevention in Pregnancy	Epidemic Preparedness and Response
Ethiopia	✓	✓	✓	✓
Uganda	✓	✓	✓	✓
Kenya	✓	✓	✓	✓
South Africa	✓	✓	-	✓

TABLE 5. Comparison of Vector Control Strategies from Strategic Plans of Ethiopia, Uganda, Kenya, and South Africa.

	Indoor Residual Spraying	Insecticide Treated Nets	Larval Control	Other Environmental Management
Ethiopia	✓	✓	✓	✓
Uganda	✓	✓	-	-
Kenya	✓	✓	-	-
South Africa	✓	-	✓	-

Malaria control divisions at the national level serve primarily as a policy-making body, rather than an implementing body. Typical functions of the malaria control programs include policy development, provision of technical advice, research coordination, setting standards, quality assurance, monitoring and evaluation, and resource mobilization. In Ethiopia, Uganda and Kenya, implementation of malaria control policies is solely the responsibility of the districts, due to decentralization of the health care sector. In South Africa, provinces create and implement malaria control policies through a vertical system, where malaria control policy is developed, pesticides are procured, and control actions are implemented at the province level.

3.2 GENERAL OBSERVATIONS AND TRENDS IN MALARIA CONTROL PROGRAMS

3.2.1 Overview

After conducting interviews with malaria control and insecticide control specialists, several trends emerged with respect to vector control and DDT policy. The *WHO Action Plan for the Reduction of Reliance on DDT in Disease Vector Control* promotes research on insecticide resistance management, as well as the cost-effectiveness of pyrethroids compared to DDT. However, none of the four governments in this study have implemented insecticide resistance management strategies or conducted cost-effectiveness studies. Additionally, government decentralization plays a key role in the effectiveness of vector control strategies. Malaria control and insecticide control specialists are ill informed on the human health impacts of DDT. These specialists also use the POPs Treaty either to criticize or legitimize DDT reintroduction. Finally, all malaria control decision makers view IVM positively.

3.2.2 Cost-effectiveness of DDT

Malaria control decision makers who use or want to use DDT to combat malaria say they want to use it because it is both effective and inexpensive, when compared to alternatives. With budgetary constraints faced by the Ministries of Health, these decision makers find it necessary to use the least expensive option for vector control. However, none of the malaria control or insecticide control specialists in Ethiopia, Uganda, Kenya or South Africa could cite a formal cost-effectiveness study to assess whether IRS using DDT was, in truth, the most effective and inexpensive method to be used.

Several researchers have conducted cost-effectiveness analyses for DDT and its alternatives and found varying results. In KwaZulu-Natal, South Africa, IRS using pyrethroids was the most cost-effective vector control option when compared to insecticide treated bed nets (DDT was not considered in this study) (Goodman et al. 2001). In contrast, cost comparisons in western Thailand and the Solomon Islands indicated that ITNs were more cost-effective control measures than IRS using DDT (Kamolratanakul 2001; Kere 1992). Kathleen Walker concluded in her global cost comparison of DDT to its alternatives that although globally the cost of DDT was lower than its alternatives (as of 2000), "a global cost comparison may not realistically reflect local costs or effective application dosages at the country level": she goes on to say that "the most cost-effective insecticide in any given country or region must be determined on a case-by-case basis" (Walker 2000). In light of her conclusion and the diversity of results in cost-effectiveness studies, it is surprising that certain countries have assumed that DDT is the most cost-effective alternative.

Ideally, cost-effectiveness studies should aid malaria vector control decision-making. Unfortunately, many countries lack the capacity necessary to obtain and analyze data for such studies. Among other countries,[3] Ethiopia and South Africa are participating in a WHO/UNEP study funded by the Global Environment Facility (GEF) to "assess cost-effectiveness and sustainability of environmentally sound and locally appropriate alternatives to DDT" (UNEP/WHO Project Brief).

3.2.3 Prevention of Pesticide Resistance

One Ethiopian interviewee cited cost as a reason that the Ministry of Health was not implementing a rotation of IRS pesticides to prevent pesticide resistance. Ethiopia, Uganda and Kenya's malaria control strategies do not address resistance prevention in vector control. South Africa's Malaria Advisory Group (MAG) has stated that vector control measures should be reviewed annually to "remain ahead of changes in vector resistance, ecology, social aspects and technology" (2004); however, formal resistance prevention measures have not yet been implemented. Ideally, countries using IRS should rotate insecticides or use a mosaic approach to IRS to prolong the usefulness of

[3] Eritrea, Madagascar, Namibia and Swaziland are also participating in the study. All these countries use DDT for malaria vector control. Madagascar is a signatory to the Stockholm Convention. Eritrea, Namibia and Swaziland are neither signatories nor parties to the Stockholm Convention.

vector control insecticides (UNEP/WHO/FAO 2002). None of the countries in this study had completed a cost-benefit study to address the potential costs and benefits of pesticide rotation or using a mosaic approach. This will need further attention in the future, as the Stockholm Convention requires POPs Treaty signatories to implement "suitable alternative products, methods, and strategies, including resistance management strategies to ensure the continuing effectiveness of these alternatives [to DDT]."

3.2.4 Decentralization and Capacity for Vector Control

One commonality among African nations is the move toward health sector decentralization. Malaria control experts in Ethiopia, Uganda and Kenya cited decentralization as a complicating factor in implementing vector control strategies for malaria prevention—a reality that is readily expressed in these countries' strategic plans for malaria control. These experts believe that a strong central infrastructure is needed for effective vector control strategies, especially where DDT is concerned. In contrast, South Africa's decentralization has had a lesser impact on the country's capacity to conduct malaria research and implement malaria vector control strategies. Reasons for this difference will be explored at the end of the section.

Though still using DDT for IRS, Ethiopia is having difficulty providing effective implementation of its IRS strategies. From 1976 to 1993, Ethiopia had a vertical system of vector control, where the national government (rather than the districts) was responsible for creating and implementing all vector control policies. Vector control policy was implemented through the National Organization for the Control of Malaria and Other Vector-borne Diseases (NOCMVD). Ethiopia's Malaria Eradication Service Training Center trained malaria technicians in various fields. The Training Center ceased its operations in the 1970s and the vertical system for vector control was eliminated during the decentralization process that began in 1993, when responsibility for malaria control was transferred to regional health offices. There are currently no malaria training institutions in the country. Now vector control is implemented at the district level, which poses a considerable challenge to vector control policy effectiveness. There are few human resources at the district level to effectively implement vector control measures, and the role of the Federal Ministry of Health in vector control is limited to policy formation, provision of technical guidelines to the regions, assisting in training, and acquiring insecticides and equipment for the regions (Ethiopia Ministry of Health 2001).

Uganda's health sector has also undergone radical devolution within the past decade. From 1997 to 1999, the Ministry of Health underwent restructuring that limited its functions to "policy-making, planning and mobilization, setting of standards, quality assurance, capacity development and technical support and coordination of services rendered at national level" (Jeppsson 2003). With regard to malaria control, "planning, management and implementation of programme activities are functions of districts," and in many cases, district managers lack proper training to carry out these functions (Uganda Ministry of Health 2001). Thus, there is some concern that the districts do not have the human resources or expertise to conduct proper control, application, and disposal of DDT for IRS. (This concern accompanies worries about the impact that DDT misuse may have on the agricultural export market). Prior to the 1970s, when DDT was still used in Uganda, the Ugandan government had highly centralized and controlled application of DDT. Two Ugandan malaria control and insecticide experts stated that responsible DDT reintroduction requires a vertical program for application and disposal, good logistics, supervision and an adequate organizing structure**.** The WHO also takes this position (WHO 2004a).

Kenya's decentralization is slightly more limited compared to Ethiopia and Uganda. In 1999, Kenya's Health Sector Reform Secretariat issued The National Health Sector Strategic Plan: 1999-2004. Because of the reform agenda, says the National Malaria Strategy, "traditionally vertical programmes such as malaria control will need to change radically. The Division of Malaria Control (DOMC) will no longer direct, fund and provide staff for activities in districts. Districts will take on this role themselves, turning to higher levels for specialized advice and quality control" (Kenya Ministry of Health 2001c). Now, the DOMC provides a strictly policymaking, capacity building and advisory role in malaria control. This major transition has likely hindered the ability of the country to implement adequate malaria control measures. In the transition from a vertical to a decentralized program, Kenya's vector control strategy has recently been promoting the establishment of community spray teams to replace technical spray teams for IRS. WHO guidelines stipulate that technical teams should be utilized to conduct IRS using DDT. It is also important to note that, in the future, decentralization may also aid Kenya's capacity to enforce pesticide policies. The Chair of Kenya's Pesticide Control Products Board is currently establishing offices in several regions of the country to increase the enforcement capacity of the Board. In recent years, enforcement actions were taken directly from the PCPB office in Nairobi.

Post-Apartheid health sector decentralization in South Africa has not been viewed as a significant impediment to the implementation of malaria vector control strategies. One specialist cited several reasons for South Africa's smooth transition from centralized to decentralized malaria control. First, South Africa's decentralization did not diminish the malaria control expertise that was prevalent at both the national and provincial levels of government. Specific activities were conducted in the early stages of decentralization to strengthen the malaria control expertise already present in the health sector. Such activities included regular meetings of South Africa's National Malaria Advisory Group and its subcommittees, annual planning meetings focusing on operational issues, and annual training of malaria managers on operational issues and links between research and malaria control policies and procedures. Second, the National Malaria Advisory Group functioned as a stabilizing and motivating force through the decentralization process. Third, South Africa's capacity for malaria research is particularly strong. The activities of South Africa's malaria control programmes are supported by the Medical Research Council and the Entomology Unit at the National Institute for Communicable Diseases. These research entities have a particularly high level of expertise. Finally, the National Malaria Programme Manager acts primarily as a coordinator to support and strengthen the provincial programmes. Thus, strong links have been established between the national and provincial malaria control programmes. Additionally, responsibilities for attending national and international meetings are distributed amongst various managers at the provincial level, rather than being delegated exclusively to the National Malaria Programme Manager.

Decentralization of vector control within East Africa poses a challenge to effective implementation of vector control strategies, especially with regard to IRS and responsible DDT use. If done properly, however, it may provide unique opportunities to enhance malaria control actions in East Africa. Insights from the South African experience may prove helpful in discovering these opportunities.

3.2.5 DDT and Human Health

Within the scientific literature, the conclusions that can be drawn regarding the human health impacts of DDT and its metabolites, DDE and DDD, lack clarity.[4] In this study, many interviewees lacked a clear understanding of the human health effects of DDT, others cited effects that the scientific literature does not support and some dismissed the idea that DDT can negatively impact human health. Interviewee responses indicate that there is an opportunity to educate malaria control and insecticide control specialists on the human health impacts of the insecticides chosen and used to reduce the malaria burden. To that end, the remainder of this section provides a brief introduction to the human health impacts of DDT.

DDT and its metabolites are endocrine disrupting chemicals (EDCs); DDT is estrogenic and DDE is an anti-androgen (Damstra et al. 2004). Recently, the International Programme on Chemical Safety[5] issued a comprehensive report entitled *Global Assessment of the State of the Science of Endocrine Disruptors*. This report evaluates the science surrounding endocrine disruption in humans and other animals and makes conclusions, (when possible), based on broad bodies of scientific evidence.[6]

The *Global Assessment* identifies some specific human health impacts that can be attributed to DDT and similar substances (for instance. other organochlorine pesticides).[7] Exposure to DDT and its metabolites (as well as other environmental chemicals) can cause decreased fertility and fecundity in adults, although the mechanisms for this impact remain unknown (Damstra et al. 2004). Additionally, the reproductive health effects of DDT and its metabolites are transgenerational. Scientific evidence cited in the *Global Assessment* supports the hypothesis that *in utero* exposure can cause "reduced tests and epididymis weight, reduced sperm numbers and motility, increased prostate weight and delayed puberty" in males (Damstra et al. 2004). *In utero* exposure can also cause hypospadias (the opening of the meatus at a higher point on the penis) and cryptorchidism (undescended testes) in males (Damstra et al. 2004). There is scant information regarding the reproductive health impacts of EDCs on females, and thus far, scientific evidence has not confirmed any negative reproductive health impacts of DDT or its metabolites on females. DDD is well known to be cytotoxic to the outer cells of the adrenal gland, which causes high blood sugar and immune system suppression. A specific type of DDE, Methylsulfonyl-DDE, is also adrenotoxic (Damstra et al. 2004). However, the *Global Assessment* notes that evidence on other suspected human health effects of DDT and its metabolites (e.g. testicular, prostate and thyroid cancers) is lacking (Damstra et al. 2004).[8] It should also be noted that countries that are parties to the Stockholm Convention are required to inform the public about the human health risks posed by DDT use for public health.

---

[4]One of the most controversial aspects of the DDT issue is whether human health impacts are "real". During the interviews, proponents of DDT use for malaria control believed that scientific evidence revealed negligible human health impacts, while critics of DDT use for malaria control believed that scientific evidence indicated that DDT caused serious human health effects.

[5]The International Program on Chemical Safety (IPCS) was established in 1980 as a cooperative program between the WHO, UNEP and the International Labour Organization (ILO).

[6]The authors rely primarily on the Global Assessment for their conclusions about the human health impacts of DDT and its metabolites to avoid argumentation over the scientific value of specific studies. The Global Assessment provides a balanced and thorough analysis of the body of scientific work surrounding human health and environmental impacts of DDT.

[7]It is important to note that the human health impacts of DDT cannot be viewed in isolation. Communities are exposed to various mixtures of endocrine disrupting chemicals, which may act additively, synergistically, or antagonistically (Damstra et al. 2004).

[8]Current scientific evidence indicates that DDT's neurologic effects occur exclusively as a result of DDT poisoning, not of bioaccumulation. Neurologic effects of DDT poisoning include "perioral and lingual paresthesia, apprehension, hypersensitivity to stimuli, irritability, dizziness, vertigo, tremor and convulsions" (Longnecker 1997).

Because dose-response functions have not been established for most EDCs, including DDT and its alternatives, it is difficult to precisely conclude what constitutes "harmless" versus "harmful" levels of exposure for both wildlife and humans (Damstra 2004).[9] The lack of information on dose-response functions provides an immense hurdle in concluding the extent to which IRS using DDT or its alternatives may be harmful to human health and the environment. It should be noted, however, that regardless of the dose-response function, DDT's persistence bioaccumulation extends its negative human health impacts into subsequent generations, unlike its WHO-recommended alternatives.

Regardless of DDT's human health effects, thousands of Africans suffer or die from malaria each year. In this light, it is easy to understand why many believe that the malaria burden outweighs the negative human health burden posed by DDT. However, it is important to recognize that DDT will have human health implications and associated socio-economic impacts on African communities where it is used. This fact needs to be understood by all malaria control specialists, whether DDT reintroduction is supported or not.

3.2.6 Policymaking Effects of the POPs Treaty

Under the Stockholm Convention, parties are allowed to use DDT for "disease vector control," and are encouraged to use alternative disease vector control measures. At the time of the interviews, Ethiopia, Uganda and South Africa were parties to the Stockholm Convention and Kenya was not. Of these four countries, Ethiopia and South Africa were widely using DDT for malaria vector control, Uganda's Ministry of Health had decided to reintroduce DDT and Kenya was refusing to reintroduce DDT.

Throughout the interviews, the POPs Treaty was often regarded as an agreement that legitimized DDT use for malaria vector control. A few interviewees indicated that use/reintroduction of DDT is appropriate because the POPs Treaty allows its use. Interviewees who were opposed to DDT use/reintroduction cited the country's signatory or party status as a reason to avoid DDT use as long as alternative insecticides are effective.

Though the spirit of the Stockholm Convention is clearly in line with the goal of DDT reduction, DDT use and reintroduction is a trend on the African continent that may likely continue. Thus, at least in the short term, the Stockholm Convention may not be effective in reducing DDT use because it validates governments' decisions to use it.

[9] Many endocrinologists believe that endocrine disrupting chemicals sometimes have greater human health effects at low concentrations than high concentrations. However, this issue is still being hotly debated in the scientific community; "reports of low-dose effects of EDCs are highly controversial and the subject of intense research" (Damstra 2004).

3.2.7 Integrated Vector Management: Flexible and Acceptable

The general view of malaria control and insecticide control specialists interviewed in East Africa is that malaria control cannot be accomplished using one method exclusively. Most interviewees believe that a combination of strategies is necessary to combat malaria. Additionally, these interviewees are familiar with and receptive to the concept of IVM.[10] Indeed, it is difficult to think of a reason why IVM would be explicitly opposed, as it is a management strategy that can incorporate many different control options. Within IVM strategies, a malaria control decision maker can choose to use pesticides for IRS, including DDT.

3.3 CASE STUDIES ON DDT POLICY IN AFRICA: ETHIOPIA, UGANDA, KENYA AND SOUTH AFRICA

3.3.1 Vector Control and DDT in Ethiopia

In a population of approximately 67 million, 68 percent of Ethiopians are at risk of contracting malaria (Ethiopia Ministry of Health 2001). About 40 percent of the population lives in epidemic areas, while another 24 percent resides in endemic areas (WHO/RBM 2004). The average number of malaria cases is estimated to be 4 to 5 million; however, in years when severe epidemics occur, malaria prevalence can reach 10 million. Malaria accounts for 13 to 26 percent of all inpatient admissions, and accounts for 13 to 35 percent of mortality in health facilities (Ethiopia Ministry of Health 2001).

The capacity for vector control for malaria prevention in Ethiopia is extremely limited, primarily for four inter-connected reasons: a decentralized health care system; the lack of human resources (trained, professional staff) to implement vector control policies; a lack of Ethiopia-specific malaria control research; and a lack of well-established communication networks within the Ministry of Health and with other ministries and outside research organizations. Budgetary issues also hinder the Ministry of Health in combating these problems. Integrated Vector Management (IVM) as a strategy to reduce malaria within the country has been received quite well by the Ministry of Health, but not without a bit of skepticism.

In the 1960s, Ethiopia trained malaria and vector control specialists at its Malaria Eradication Service Training Center. This center was closed in the 1970s, but the functions it held were not replaced by any other entity. Little training was conducted between the 1970s and 1990s, and when the government decentralized its health care system in 1993, the capacity for centralized training of human resources was reduced substantially. To compound this problem, most of the trained malaria prevention staff are retiring or leaving the sector. Ethiopia's *National Five Years Strategic Plan for Malaria Control: 2001-2005* recognizes these limitations and attempts to address them.

---

[10]There may be some confusion about the definition of IVM. While most of our respondents were aware of IVM, their perception of what constitutes IVM may vary because the literature is somewhat ambiguous in its definitions and descriptions of IVM. In the international arena, IVM for malaria control is sometimes considered an alternative to DDT use, and sometimes DDT is considered a potential strategy within IVM (WHO 2003b; WHO 2003c). The World Health Organization's Global Strategic Framework for Integrated Vector Management treats IVM as a "management framework" in which shifts away from persistent organic pollutants "can be effected" (WHO 2004b). According to the WHO, key elements of an IVM strategy include inter-sectoral collaboration, multi-stakeholder involvement, integration of non-chemical and chemical vector control methods for a multi-disease control approach, evidence-based decision-making, and capacity building.

However, interviewees working with the Ministry of Health still cited decentralization of the health care sector as a major hindrance to vector control efforts within the country.

Decentralization has also substantially impacted the Ministry of Health's ability to conduct IRS activities. Prior to 1993, a vertical program coordinated and conducted IRS throughout the country. Now, the National Health Sector Strategy has obstructed the use of any vertical program for IRS purposes, saying that, "no specialized program will function in a vertical manner" (Ethiopia Ministry of Health 2001). Currently, the Ministry of Health procures insecticides and Regional Health Boards implement IRS programs. Substantial problems in Ethiopia's IRS programs include: inadequate equipment (pumps, sprayers, nozzles), lack of trained spray personnel, lack of supervision during IRS, illegal diversion of DDT for agricultural use and poor quality of the insecticides (Ethiopia Ministry of Health 2001). Thus conducting IRS in a responsible manner has been and will continue to be a challenge for Ethiopia.

An additional challenge to its IRS programs is that research on *Anopheles arabiensis* resistance to insecticides is old and incomplete. A formal investigation of *An. arabiensis* resistance to DDT was conducted from 1986 to 1995. While *An. arabiensis* is susceptible to DDT in most areas of the country, the studies revealed that resistance was extremely high in areas surrounding Arba Minch and Gambella. Resistance is now believed to be present in selected areas of Amhara, Gambella, Tigray and SNNP Regional States. Thus DDT resistance is an issue that vector control staff at the Ministry of Health will have to address. Unfortunately, there have been no recent studies carried out on DDT resistance, and no studies have been carried out on resistance to malathion, deltamethrin (used for ITNs), permethrin (used for ITNs), or temophos (used for larviciding). There is suspicion, however, that malathion and deltamethrin resistance rates are high. Thus insecticide resistance within the country is unknown, with the exception of some areas where resistance to DDT has been noted.

One interviewee expressed the concern that there are few interactions between decision makers and staff that enable staff to express their concerns or views on policy. This interviewee believes that this disconnect was likely exacerbated by the closure of the Malaria Control and Prevention Office in the 1990s. One concern at the staff level is the need to train or hire an entomologist at the federal level of the Ministry of Health to conduct research, as efforts to work with outside researchers have not succeeded. The Strategic Plan gives credence to this particular concern, citing weak links between the Ministry of Health, "research institutions, universities, and overseas institutions" (Ethiopia Ministry of Health 2001). There also seems to be weak connections between the Ministry of Health and other federal ministries. The implementation of sound DDT policy requires that staff in one department know the role of other departments in control of insecticides for public health use. In talking with staff from various departments as well as external stakeholders, one ministry is often unaware of the insecticide control activities (or lack thereof) conducted by other ministries.

Ethiopia has primarily used DDT for its IRS operations for the past 40 years. It obtains its DDT from a factory located approximately 200 km outside the capital, Addis Ababa. In areas where DDT resistance is prevalent, the government uses malathion produced by the same factory. Ethiopia uses approximately 400 tons of active-ingredient DDT and anywhere from 22 to 95 tons active-ingredient malathion for IRS per year. Although DDT is produced within Ethiopia, to the knowledge of government officials, it is not exported to other countries. Ethiopia's Strategic Plan for Malaria Control 2001-2005 says that, "DDT will be phased out sometime in the future and replaced by some other environmentally friendly and cost effective insecticide" (Ethiopia Ministry of Health 2001).

Despite its overwhelming challenges, Ethiopia has successfully increased IRS coverage within the country. About 75 percent of the country (land area) experiences malaria epidemics. About 50 percent of those areas are slated for IRS. Prior to 2001, about 7-15 percent of those areas were sprayed. Currently, about 20-30 percent of these areas are now sprayed prior to the rainy seasons. Epidemic areas are reprioritized each year; thus, the same areas may not be sprayed every year. However, Ethiopia is still struggling to ensure that application of DDT is conducted "safely" and "correctly" (Ethiopia Ministry of Health 2001).

Finally, Ethiopia's Malaria and Other Vector-borne Diseases Prevention and Control Team (MOVBDPCT) also suffers from budgetary allocation issues. One interviewee claims that funds received from international aid organizations have not been used in an optimal manner. In terms of its approved national budget, the end of the budget year coincides with spraying time, resulting in a shortage of funds when insecticides need to be purchased and IRS needs to be operationalized. In addition, the MOVBDPCT's activities are hampered due to a delay of released funds at beginning of the budget year (Ethiopia Ministry of Health 2001).

i. Other vector control methods. ITNs and environmental control are the other vector control methods used to prevent malaria by the Ministry of Health. ITN coverage is unfortunately low, and ITNs are present in less than 10 percent of malaria prone areas. UNICEF recently distributed one million ITNs. Environmental control is primarily conducted in urban and settlement areas and consists of filling ditches and larviciding. (Temophos and used motor oil are used for larviciding). The government also promotes the use of aerosols, house screening and zooprophylaxis to reduce malaria transmission (Ethiopia Ministry of Health 2002).

ii. Integrated vector management. Interviewees from within the government and those who work with the government are extremely receptive to the concept of Integrated Vector Management, although there is some skepticism about the extent of its impact. At the time of the interviews, Ethiopia was in the process of developing its national guidelines for IVM. The agro-chemical industry within Ethiopia is also highly supportive of IVM; there is no political resistance to IVM as a malaria control strategy.

3.3.2 Vector Control and DDT in Uganda

According to Uganda's Malaria Control Strategic Plan, "malaria causes more illness and death in Uganda than any other single disease" (Uganda Ministry of Health 2001). In a population of 25 million, the average number of malaria deaths is approximately 80,000 per annum (Uganda Ministry of Health 2002). Malaria accounts for 9 to14 percent of all inpatient deaths and 78 deaths per 1000 children below 5 years of age.

Compared to Ethiopia, Uganda has several advantages in its efforts to control malaria using IRS. Only 5 percent (land area) of Uganda suffers from seasonal epidemics, while almost 70 percent of Ethiopia experiences this form of malaria transmission that is usually associated with a high human mortality. Thus, most of Uganda has a more predictable and stable transmission pattern for which the allocation of the available resources can be better planned. Additionally, communication networks within Uganda are well established, making education of the public easier. This provides Uganda with greater opportunity to use alternatives to DDT than Ethiopia. However, like Ethiopia's MOVBDPCT, Uganda's Malaria Control Programme also suffers from a lack of communication and coordination with ministries outside the Ministry of Health (Uganda Ministry of Health 2001). The differing environmental and capacity situations of the two countries will likely influence the extent to which DDT use can be beneficial to their populations.

Compared to other countries, the issue of DDT reintroduction is extremely controversial in Uganda. The Ministry of Health's plans to reintroduce DDT is raising concerns in the country's scientific community. In the early part of 2004, there was much internal turmoil at the Ugandan Ministry of Health regarding its policies on DDT. After its recent ratification of the POPs Treaty on July 20, 2004, the Ugandan Parliament requested that the Ministry of Health "come up with a policy on DDT as soon as possible and to source for funding to implement the spraying of DDT" (Nalugo 2004). Most Members of Parliament support the move to reintroduce DDT for malaria control, although there are some strong dissenters (Mubiru 2004). The Ministry's initiative is driven by government elites, rather than malarious communities themselves; the general population of Uganda is not particularly adamant about the DDT issue. In fact, the State Minister for Health, Alex Kamugisha, said, "We shall continue to sensitise people on the Ministry's decision to use DDT" (Mubiru 2004). Debates about DDT reintroduction have thus primarily occurred among politicians and specialists in the health sector and academia.

The controversy surrounding DDT reintroduction has been prevalent in Ugandan newspapers, as well as in conferences and workshops. In April 2004, the African Network for Chemical Analysis of Pesticides (ANCAP) held a workshop in Kampala, Uganda on the appropriateness of DDT, considering the malaria crisis and Uganda's capacity to control hazardous chemicals. According to one workshop attendee, the keynote address, given by the Minister of Health, indicated that DDT would be reintroduced into Uganda regardless of the outcome of the workshop. Another attendee believes that many misinterpreted the statements of the Minister of Health, who also said that the Ministry would conduct research on various insecticides to make the best decisions about which insecticides should be used. Ministry of Health staff did not attend the workshop. Much of the discussion at the workshop indicated that DDT use for malaria control is not desirable, and that alternatives should be used.

IRS is typically used to prevent epidemics; however, Uganda's Malaria Control Programme has recently promoted IRS in structures where ITNs are not used, "regardless of level of endemicity" (Uganda Ministry of Health 2001). The Malaria Control Programme is currently developing a new strategic plan to reflect its support for DDT reintroduction. It is unclear whether this plan will encourage the use of DDT in IRS exclusively in epidemic-prone highland areas of Southwestern Uganda or in highly endemic areas in other parts of the country. One malaria control specialist raised concerns that reintroduction could negatively impact the horticultural and fisheries export markets. One South African malaria control specialist (and proponent of DDT use) disagrees with the claim that DDT reintroduction would harm the horticultural industry, but does believe that Ugandan fisheries exports may be compromised by DDT reintroduction. Two Ugandan scientists raised concerns that food within homes will be contaminated with DDT if it is used for IRS.

Although the Ministry of Health seeks DDT reintroduction on the grounds that it is cheap both as a product and to apply, the National Environmental Management Authority (NEMA) has several concerns. There is concern that there is not enough internal capacity to monitor how and where pesticides are used, and where they are disposed. Currently, the quantities and types of pesticides used in the country are not entirely known, so there is concern that Uganda does not have the capacity to track DDT from its import to the end use. One NEMA staff member indicated that pesticides regulation has declined since Uganda liberalized its economy.

By law, Uganda's National Environmental Management Authority is required to conduct an Environmental Impact Assessment (EIA) prior to DDT reintroduction. Issues of special concern include occupational exposure and management of contaminated containers. Additionally, NEMA wants to investigate whether IRS in mud huts—the typical rural Ugandan dwelling—will exacerbate the environmental impact of DDT reintroduction. (When mud walls crumble, DDT falls to the floor and is swept outside of the home). The EIA will take approximately one year to complete.

Uganda currently uses pyrethroids (deltamethrin, lambdacyhalothrin (Icon), alphacypermethrin (Fendona)) and organophosphorous insecticides (pirimiphosmethyl) for IRS in epidemic-prone areas as well as endemic areas where ITN use is difficult. The government is currently researching whether the use of DDT will increase pyrethroid resistance (this is called cross-resistance). Pyrethroid formulations are prepared in Uganda, but the active ingredient is not manufuctured within the country and must be imported for use in IRS. IRS sprays are procured by the Ministry of Health and delivered to individual districts. The Ministry of Health has developed guidelines for districts and its spray teams on how to conduct IRS, and the Ministry has also trained districts in epidemic-prone areas on proper IRS implementation.

i. Other vector control methods. The key vector control methods in Uganda are IRS and ITNs. Of the two methods, ITNs are considered the more cost-effective means of malaria prevention in endemic areas. ITN coverage is extremely low due to a lack of availability and affordability, primarily in rural areas. Much of the public also does not view ITNs as being capable of subsequently reducing household health care expenditures. ITN coverage varies from 15-45 percent in urban areas and 2-15 percent in rural areas. Uganda has an active ITN commercial sector that the government is actively supporting in three ways: eliminating taxes on ITNs, eliminating tariffs on ITN imports and restricting free donations of ITNs to emergency situations. In addition, the government subsidizes ITNs for children less than five years of age, pregnant women and those living below the poverty line (Uganda Ministry of Health 2001).

Environmental management for malaria control has not been widely implemented by the government. There is a lack of funds at the local level and weak local government implementation of environmental management strategies. Larviciding, introduction of larvivorous fish and use of *Bacillus thuringiensis israelensis (Bti)* are being conducted in small pilot projects.

ii. Integrated vector management. The Ministry of Health believes that the best options for vector control are ITN usage and IRS. Uganda does not have a policy or guidelines for IVM at this time. Uganda's Malaria Control Strategic Plan states that, "other vector control approaches will be encouraged where appropriate," but does not specify what these approaches are (Uganda Ministry of Health 2001).

3.3.3 Vector Control and DDT in Kenya

Approximately 70 percent of Kenya's land is prone to malaria epidemics. The regular epidemics occur in the western highlands. The semi-arid regions in the northeastern and eastern parts of the country experience epidemics only during heavy flooding. Endemic areas are limited to areas primarily in the areas surrounding Lake Victoria, the floor of the Rift Valley, the central parts of the Eastern and Central provinces and Kenya's coastal regions.

Of approximately 31 million Kenyans, over 20 million are "at constant risk of malaria" (Kenya Ministry of Health 2001c). Malaria kills approximately 26,000 children per year in Kenya, and about 170 million working days are lost to malaria per year. Malaria accounts for 30 percent of all outpatient attendance and 19 percent of all admissions to Kenyan health facilities (Kenya Ministry of Health 2001c).

IRS is usually conducted in 16 highland epidemic-prone districts within the country. District Outbreak Management Teams (DOMTs) and Provincial Outbreak Management Teams (POMTs) are responsible for epidemic control and the Divisions of Malaria Control, Environmental Health, and Vector Borne Diseases are responsible for training spray teams and mobilizing resources for the districts. Districts are required to use insecticides recommended by the Ministry of Health that are registered for household use by the Pest Control Products Board (PCPB) (Kenya Ministry of Health 2001c). Districts typically use synthetic pyrethroids like lambdacyhalothrin (Icon) for IRS. The Division of Malaria Control encourages districts to acquire outside funding to purchase insecticides, sprayers and training materials. In recent years, however, districts have requested funds from the Division for the purchase of these items (Kenya Ministry of Health 2001d).

Surprisingly, IRS is barely mentioned as a vector control method in the National Malaria Strategy 2001-2010; rather, ITNs are the major focus for malaria vector control. DDT is not mentioned at all and the Ministry of Health has announced that DDT will not be used for malaria vector control in Kenya (Bosire 2004). The Ministry of Health has not chosen to use DDT for malaria control since DDT was banned as an agricultural product in1986. The National Environmental Management Authority (NEMA) is vehemently opposed to DDT reintroduction, as is the Chief Executive of the Pest Control Products Board (PCPB). They take the position that, so long as there are alternatives, DDT should not be used for malaria control. The Chief of the PCPB has expressed concerns that DDT reintroduction would compromise Kenya's $300 million horticultural industry. Stakeholders such as the Fresh Produce Exporters' Association of Kenya (FPEAK) and the Kenya Flower Council (KFC) feel threatened by the prospect of losing their export markets if DDT is reintroduced. The European Union constitutes approximately 90 percent of Kenya's horticultural export market (Kenya High Commission 2004).

Additionally, Kenya is the world's leading producer of natural pyrethrum, producing 80 percent of the global supply. The Pyrethrum Board of Kenya produces three vector control chemicals: Pylarvec (larviciding), Pymos (IRS) and Pynet (for ITNs). Some government officials believe that national malaria control strategies should support Kenya's own pyrethrum industry instead of DDT imports (Songa 2004). Two malaria control and insecticide control specialists, who were interviewed for this study, believe that Kenya has the capacity to control DDT from its import to its end use. Four other interviewed specialists, however, believe that Kenya does not have this capacity. A survey conducted by Egerton University supports the latter interviewees' conclusions, revealing that seven percent of households in the Nakuru district use DDT on their farms, despite Kenya's 18-year ban on agricultural use of DDT (Ramas 2004). As Kenya is currently not able to enforce its complete ban on DDT, questions should be raised about Kenya's capacity to regulate DDT use if it is reintroduced for malaria vector control.

Individuals in the Division of Vector-Borne Diseases (DVBD) in the Ministry of Health support the reintroduction of DDT; however, the DVBD is unable to implement any plans for DDT reintroduction without approval from the Ministry of Health and the Division of Malaria Control. In spite of opposition in NEMA, the PCPB and the Ministry of Health, the DVBD is developing a proposal that includes DDT use as an epidemic stopgap measure during a 7-year timeframe, an assessment of the knowledge that Kenyans have about integrated vector management and consequent training of community members in methods of integrated vector management. This proposal will be in the form of a cabinet memo, which will then be proposed in parliament. One interviewee indicated that DVBD officials are most likely unclear of their mandate, as the DVBD cannot develop malaria control strategies for the Division of Malaria Control. If the Ministry of Health were to approve the DDT use for malaria vector control, an environmental impact assessment would have to be conducted prior to DDT reintroduction.

i. Other vector control methods. Bed nets are the primary method of vector control for malaria prevention in Kenya; however, their use by the public is extremely low, and in some areas can range from 5-10 percent. Private firms and NGOs are currently using marketing strategies to create demand for bed nets. Kenya has a strong commercial sector that sells bed nets, as well as the insecticides to treat them. These firms and organizations sell hundreds of thousands of bed nets per year; nevertheless, approximately 10 million ITNs are required to protect the population, and would require re-impregnation every year. The Ministry of Health seeks to "scale up" the use of ITNs along with mass net retreatments at the community level. Like Uganda, Kenya's Division of Malaria Control seeks to drastically reduce taxes and tariffs on ITNs (Kenya Ministry of Health 2001b). The Ministry of Finance has implemented a policy where the value-added tax on mosquito nets is zero; however, the insecticides with which to treat them still have a value-added tax of 15 percent (Kenya Ministry of Health 2001d).

The Pest Control Products Act prohibits the sale of pre-treated bed nets; thus, individuals must purchase bed nets and insecticides separately, and impregnate the bed nets themselves. This particular measure in the Pest Control Products Act was intended as a quality-control measure to avoid treatment of ordinary nets, which are not meant to be impregnated, that would be sold in the market. This legislation will likely be changed in the near future, as long-lasting insecticidal mosquito nets (LLINs) provide an alternative to ITNs. (While ITNs are nets treated by dipping them in insecticide, LLINs have insecticides impregnated in the resin coating of the net that provides a time-release of the insecticide). The Kenyan Ministry of Health has temporarily registered LLINs until the law is changed.

The Kenyan government also encourages the sale of non-treated bed nets that consumers dip into an insecticide themselves. Knowledge regarding the safe use of these insecticides for impregnating and re-impregnating is unknown (Kenya Ministry of Health 2001b).

ii. Integrated vector management. The Division of Malaria Control does not conduct, but recommends that the public pursue, alternative vector control methods apart from ITNs. These include use of larvivorous fish, larviciding, filling in/draining breeding sites, tethering cattle for zooprophylaxis, aerial space spraying in urban areas and using mosquito coils, repellents and household screens. The Division of Malaria Control will "provide technical advice to employers, municipal councils, [District Health Management Teams] and community groups on alternative methods of local vector control and will ensure supporting reference material" (Kenya Ministry of Health 2001c). Overall, the government is generally receptive to IVM, although one interviewee believes that science surrounding IVM is lacking. The National Environmental Management Authority (NEMA) supports the use of alternative pesticides and integrated vector management rather than DDT reintroduction.

3.3.4 Vector Control and DDT in South Africa

Of a population of approximately 45 million people, ten percent of South Africans (4.5 million) reside in malaria risk areas. Malaria is commonest in the eastern part of the country and most prevalent in low altitude areas in the Limpopo province, the Mpumalanga province and in the north-eastern parts of KwaZulu-Natal. Low-lying areas are subjected to endemic malaria, while fringe and higher altitude regions are prone to epidemic malaria (South Africa Malaria Advisory Group 2004).

Malaria incidence in South Africa is extremely low compared to other African countries. In the past few years, the total annual number of South African cases has ranged from approximately 14,000 to 27,000. Total deaths have ranged from 96 to 142 (South Africa Department of Health 2004).

IRS is the "backbone" of South Africa's malaria control program (South Africa Malaria Advisory Group 2004). Spraying is conducted once per year, before the rainy season begins towards the end of the year. The provinces are responsible for procuring insecticides and implementing malaria control policies. Vector control programs in Limpopo, Mpumalanga and KwaZulu-Natal are administratively vertical (within the province). Provincial malaria control personnel work closely with district and sub-district personnel. The districts and sub-districts are responsible for the actual implementation of malaria control policies. DDT is used for 50 percent of IRS conducted and synthetic pyrethroids are used for the other 50 percent. Within these provinces, there is a mixture of traditional and western-style houses. DDT is used on the traditional houses, which are made of mud and readily absorb DDT. Synthetic pyrethroids are used in the western-style houses, because DDT does not readily absorb into plastered surfaces painted with PVC-based paints. Additionally, many homeowners do not like the white residue that DDT leaves on plastered walls, so synthetic pyrethroids are, in some instances, considered more desirable from an aesthetic point of view. There are about 60-70 spray teams that conduct IRS in the country, which move from high to low risk areas. The synthetic pyrethroids used in South Africa include deltamethrin, cyfluthrin and alpha cypermethrin. Research is ongoing in South Africa to evaluate existing and new insecticides as well as different groups of insecticides in order to determine their usefulness for IRS. The ultimate aim is to use insecticides out of the different insecticide groups as part of a resistance management program.

DDT was used widely in South Africa from the 1940s through 1995. Research by the South African Medical Research Council (MRC) indicated that pyrethroids were a suitable alternative to replace DDT. This was based on their assessment that pyrethroids would effectively eliminate malaria vector mosquitoes, that they would need to be sprayed only once per year and that they were acceptable to spray team personnel. DDT was then phased out and synthetic pyrethroids were used exclusively for IRS. From 1996 to 2000, malaria cases increased, culminating in epidemics in 1999 and 2000 where the Department of Health saw approximately 63,000 malaria cases. In 1999, scientists had discovered that South Africa had a pyrethroid-resistant strain of mosquito that had originated from Mozambique. The Department of Health thus decided to reintroduce DDT in 2000. As a result, malaria incidence decreased to 13,000 cases only two years later. South Africa was not required to conduct an Environmental Impact Assessment prior to DDT reintroduction.

Malaria control specialists in South Africa are extremely confident about the efficacy of malaria control programs, as well as the Department of Health's control over DDT from its procurement to its end use. They believe that, at this time, DDT is the ideal choice for malaria vector control in South Africa. Their views are backed by strong evidence that DDT has reduced malaria incidence in South Africa. And unlike East Africa, a cost-effectiveness study conducted comparing IRS and ITN use in KwaZulu-Natal, found that IRS using synthetic pyrethroids is more cost-effective than the use of bed nets impregnated with synthetic pyrethroids (Goodman et al. 2001).

Even though the majority of South African interviewees have a high regard for DDT use in vector control, they are also open to new scientific information on alternatives. The malaria control programs work closely with researchers in South Africa's Medical Research Council (MRC) to identify new vector control methods. Some potential insecticidal alternatives are in the process of being registered by the Department of Agriculture. All interviewees believe that malaria control policy in South Africa does not discourage the use of alternatives to DDT.

The Department of Health is typically the only end-user of DDT in South Africa. DDT is registered as an insecticide by the Department of Agriculture and restricted to malaria vector control. However, some interviewees mistakenly believe that the Department of Environmental Affairs and Tourism registers DDT. In 2000, approximately 8 tons of DDT were used for malaria control. The Department of Health increased the amount of DDT used to 15 tons in 2001. The majority of interviewees believe that human health and the environment are not adversely impacted by DDT because of its very controlled use in IRS. IRS using DDT is not conducted in national parks, although park buildings are sprayed twice per year with pyrethroids. Only occasionally are small amounts of DDT illegally imported or misused.

Malaria control specialists in East African countries are typically not extremely knowledgeable about the malaria control policies of other countries. In contrast, South African specialists are quite aware of the malaria control regimes in other southern African countries. Department of Health officials recognize that bordering nations' malaria programs can positively or negatively impact malaria prevalence in South Africa; thus, the South African government actively communicates with and advises other countries on their malaria control programs.

i. Other vector control methods. Provincial malaria control programs use larviciding where "larval breeding sites are well defined" (South Africa Malaria Advisory Group 2004). In national parks (such as Kruger National Park), *Bacillus thuringiensis* is used to kill mosquito larvae. Although ITNs are not mentioned in the Malaria Advisory Group draft malaria control strategy, ITNs are used by many at-risk South Africans. Two interviewees believe that a culture of ITN use is emerging in South Africa, and three consider ITNs a viable strategy for vector control. Another interviewee disagrees, saying that such a culture has not developed. There is currently a program to educate South Africans on ITN use, which is funded by NGOs and the ITN industry.

ii.Integrated vector management. During the 1960s, South Africa conducted environmental manipulation through a vertical program aimed at malaria vector control. Provincial teams, similar to IRS teams, would fill pits and clear stream banks. When the government found that mosquitoes were breeding in temporary pools and hoof-prints, teams had difficulty eliminating all mosquito-breeding sites. The environmental manipulation venture was found to be extremely costly, and consequently abandoned.

The South African government is slowly moving in the direction of integrated vector management.The MRC is currently conducting research in IVM, and the Provinces are looking toward use of IVM in the future. Two interviewees expressed the view that IVM cannot replace the use of DDT in IRS for malaria control, and two interviewees believe that DDT use in IRS should be a strategy within an IVM framework.

4. Conclusions

As previously discussed, Ethiopia and South Africa have been using and will continue to use DDT in the future. The Ugandan Ministry of Health will soon seek reintroduction of DDT, and Kenya's government will resist DDT for some time to come. Government specialists in those countries using DDT tend to view it in a positive light, while in Kenya they are often quite opposed to the use of DDT, preferring to emphasize its alternatives. Integrated vector management is rarely viewed as a substitute for indoor residual spraying; rather, specialists tend to believe that integrated management strategies should incorporate indoor residual spraying as a vector control method. On the whole, IVM is seen as a flexible and acceptable approach to vector control. Ethiopia and South Africa will likely diversify their vector control methods in the coming years.

Government decentralization has been extremely influential in the formation of vector control policy and its implementation, primarily hindering vector control effectiveness. Often, research is either lacking or ill incorporated into vector control policies. In East Africa in particular, better links to research organizations, as well as development of government research capacities, should be pursued to increase the robustness of future vector control policy decisions. Interestingly, the immediate impact of the POPs Treaty has been to legitimize government policies to use or reintroduce DDT for malaria vector control. Concerns about the national economy and budget constraints are often factors that influence the development of vector control policy.

Finally, there is a great opportunity to improve malaria control and insecticide control specialists' knowledge about the human health impacts of DDT and alternative pesticides. Unfortunately, scientific ambiguity surrounding DDT's human health effects is often exploited to defend policy positions on both sides of the DDT debate.

LITERATURE CITED

Bosire, Julius. 2004. *MP Thanks Minister for 'Useless' Reply*. Daily Nation (Nairobi).

Carson, Rachel L. 1962. *Silent Spring*. New York: Houghton Mifflin Company.

Carter, T. 2004. DDT: *Malaria's Answer in Africa? 2 Million Die Each Year From Disease.* The Washington Times.

Damstra, T.; Barlow, S.; Bergman, A.; Kavlock; and Van Der Kraak, G.; (eds.) 2004. *Global Assessment of the State of the Science of Endocrine Disruptors.* International Programme on Chemical Safety. Geneva, Switzerland: World Health Organization. http://www.who.int/ipcs/publications/new_issues/endocrine_disruptors/en/

Ethiopia Ministry of Health. 2001. Malaria and Other Vector-borne Diseases Prevention and Control Team, Diseases Prevention and Control Department. National Five Years Strategic Plan for Malaria Control in Ethiopia: 2001-2005.

Ethiopia Ministry of Health. 2002. Malaria and Other Vector-Borne Diseases Prevention and Control Team, Diseases Prevention and Control Department. Guideline for Malaria Vector Control in Ethiopia.

Goodman, C.A., et al. 2001. Comparison of the Cost and Cost-Effectiveness of Insecticide-Treated Bednets and Residual House-Spraying in KwaZulu-Natal, South Africa. *Tropical Medicine and International Health*. 6:280-295.

Hecht, M.M. 2004. Africa, DDT Makes A Comeback To Save Lives. *Executive Intelligence Review*.

Jeppsson, A.; Ostergren, P.O.; and Hagstrom, B. 2003. Restructuring a Ministry of Health- - An Issue of Structure and Process: A Case Study From Uganda. *Health Policy and Planning.* 18:68-73.

Kamolratanakul, P. et al. 2001. Cost-Effectiveness and Sustainability of Lambdacyhalothrin-Treated Mosquito Nets in Comparison to DDT Spraying for Malaria Control in Western Thailand. *American Journal of Tropical Medicine and Hygiene*. 65:279-284.

Kenya High Commission. 2004. *Horticulture*. http://www.kenyahighcommission.com/Agriculture/horticulture.htm

Kenya Ministry of Health. 2001a. Division of Malaria Control. Biennial Plan of Action, January 2002 to December 2003.

Kenya Ministry of Health. 2001b. Division of Malaria Control. Insecticide Treated Nets Strategy 2001-2006.

Kenya Ministry of Health. 2001c. Division of Malaria Control. National Malaria Strategy 2001-2010.

Kenya Ministry of Health. 2001d. Strategic Development and Activity for Roll Back Malaria in Kenya 1998-2000.

Kere, J.F.; and Kere, N.K. 1992. Bed-Nets or Spraying – Cost Analyses of Malaria Control in the Solomon Islands. *Health Policy and Planning*. 7:382-386.

Longnecker, M.P, et al. 1997. The Human Health Effects of DDT (Dichlorodiphenyl-trichloroethane) and PCBS (Polychlorinated Biphenyls) and an Overview of Organochlorines in Public Health. *Annual Review of Public Health*. 18:211-44.

Mubiru, A. 2004. *Lukyamuzi Blasts MPs Over DDT*. New Vision (Kampala).

Nalugo, M. 2004. *MPs Back Govt On DDT*. The Monitor (Kampala).

Ramas, I.; and Maskio, P. 2003. Sharp Division Over Use of DDT. *Biosafety News*. No. 52.

Songa, W. 2004. Forget DDT. *Biosafety News*. No. 52. Nairobi.

South Africa Malaria Advisory Group. 2004. *Policy Review 2004 Draft 1*.

South Africa Department of Health. 2004. *Document on Malaria Cases and Deaths.*

Uganda Ministry of Health. 2001. Malaria Control Programme. *Malaria Control Strategic Plan: 2001/2-2004/5.*

Uganda Ministry of Health. 2002. *Malaria: We Need Your Help To Fight It.* Brochure. Produced by Ugandan Ministry of Health in collaboration with the Malaria Consortium East Africa, John Hopkins Bloomberg School of Public Health Center for Communication Programs, funded by the Embassy of Ireland.

United Nations Environment Programme (UNEP). 2001. *Stockholm Convention on Persistent Organic Pollutants.*

United Nations Environmental Programme (UNEP) Secretariat for the Stockholm Convention on Persistent Organic Pollutants. 2004. Stockholm Convention on Persistent Organic Pollutants (POPs): Signatures and Ratifications. http://www.pops.int/documents/signature/

United Nations Environment Programme (UNEP)/World Health Organization (WHO). *Demonstrating Cost-effectiveness and Sustainability of Environmentally Sound and Locally Appropriate Alternatives to DDT for Malaria Vector Control in Africa.* Project Brief.

United Nations Environment Programme (UNEP)/World Health Organization (WHO)/Food and Agriculture Organization (FAO). 2002. *Reducing and Eliminating the Use of Persistent Organic Pesticides - Guidance on Alternative Strategies for Sustainable Pest and Vector Management.* http://www.who.int/docstore/water_sanitation_health/pesticides/ch1.htm

United States Environmental Protection Agency (USEPA). 1972. *DDT Ban Takes Effect*. http://www.epa.gov/history/topics/ddt/01.htm

Walker, K. 2000. Cost-Comparison of DDT and Alternative Insecticides for Malaria Control. *Medical and Veterinary Entomology*. 14:345-354.

World Health Organization (WHO). 2000. WHO Expert Committee on Malaria, Technical Report Series No. 892. http://mosquito.who.int/docs/ecr20_toc.htm

World Health Organization (WHO). 2003a. Action plan for the reduction of reliance on DDT. http://www.who.int/docstore/water_sanitation_health/vector/ddt3.htm#Components

World Health Organization (WHO). 2003b. Regional Office for Africa, Division of Prevention and Control of Communicable Diseases, Vector Biology and Control Unit. *Annual Report 2003*.

World Health Organization (WHO). 2003c. Regional Office for Africa, Division of Prevention and Control of Communicable Diseases, Vector Biology and Control Unit. *Guidelines for Integrated Vector Management*. Trial Edition.

World Health Organization (WHO). 2004a. *Frequently Asked Questions on DDT Use for Vector Control*. http://mosquito.who.int/docs/FAQonDDT.pdf

World Health Organization (WHO). 2004c. *Global Strategic Framework for Integrated Vector Management*.

World Health Organization (WHO). 2004b. *WHO position on DDT use in disease vector control under the Stockholm Convention on Persistent Organic Pollutants.* http://whqlibdoc.who.int/hq/2004/WHO_HTM_RBM_2004.53.pdf

World Health Organization/Roll Back Malaria (WHO/RBM). 2004. Country Profile: Ethiopia. http://mosquito.who.int/malariacontrol

World Health Organization (WHO)/ United Nations International Children's Emergency Fund (UNICEF). 2003. *WHO Africa Malaria Report 2003*. http://www.rbm.who.int/amd2003/amr2003/amr_toc.htm

Annex I

TERMS OF REFERENCE.

Systemwide Initiative on Malaria and Agriculture (SIMA):
Scope and purpose of internship for Melanie Biscoe – June -August 2004

Background:

The Systemwide Initiative on Malaria and Agriculture (SIMA) seeks to expand knowledge on the links between malaria and agriculture and test innovative interventions in order to strengthen and complement existing malaria control strategies in different agricultural systems. The initiative facilitates both research and capacity-building and brings together researchers in health and agriculture to fight malaria jointly with the affected communities. SIMA is hosted by the International Water Management Institute (IWMI), which is one of the fifteen research centres supported by the Consultative Group on International Agricultural Research (CGIAR).SIMA currently has projects applying an ecosystem approach to malaria research and control in seven African countries. Among the countries, Ethiopia still uses DDT for malaria control; Uganda is seriously consideringreintroducing DDT; Kenya has been debating the pros and cons re DDT. Additionally, South Africa has reintroduced DDT for public health use.

Objective:

The specific objectives of the two and a half-month internship will be:

i) To review recent scientific literature on DDT and compile an up-to-date report on its health and environmental impacts;

ii) To collect information and compile a report on the current policy and status of DDT use for malaria vector control in Uganda, Ethiopia, Kenya and South Africa.

Data and information gathered during the internship will strengthen SIMA's data base and rationale for the development of alternative methods for malaria vector control. This work will ultimately assist countries still using DDT to reduce reliance on the chemical by developing appropriate alternatives, including the elimination of mosquito breeding through improved agroecosystem management.

Methods:

1) A key component of the internship will be to interview senior officials in the ministries of health and environment of the three countries on their current views and policies regarding DDT and malaria control. Specifically the intern will investigate and document the reasons behind renewed interest in DDT.

2) Additionally the intern will assess: the current status of alternative methods for malaria-vector control in the countries; barriers to the development and wide application of such alternatives; prospects of SIMA ecohealth-type research in enhancing the development and sustainable application of the alternatives. A visit to SIMA field sites will be included in the itinerary for at least Kenya and Uganda.

3) The third aspect of the internship will be to collate the latest research information/literature on the environmental and human health impacts of DDT, from the School of Public Health of the University of Pretoria.

Annex II

PART II OF THE STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS.

Part II

DDT (1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane)

1. The production and use of DDT shall be eliminated except for Parties that have notified the Secretariat of their intention to produce and/or use it. A DDT Register is hereby established and shall be available to the public. The Secretariat shall maintain the DDT Register.

2. Each Party that produces and/or uses DDT shall restrict such production and/or use for disease vector control in accordance with the World Health Organization recommendations and guidelines on the use of DDT and when locally safe, effective and affordable alternatives are not available to the Party in question.

3. In the event that a Party not listed in the DDT Register determines that it requires DDT for disease vector control, it shall notify the Secretariat as soon as possible in order to have its name added forthwith to the DDT Register. It shall at the same time notify the World Health Organization.

4. Every three years, each Party that uses DDT shall provide to the Secretariat and the World Health Organization information on the amount used, the conditions of such use and its relevance to that Party's disease management strategy, in a format to be decided by the Conference of the Parties in consultation with the World Health Organization.

5. With the goal of reducing and ultimately eliminating the use of DDT, the Conference of the Parties shall encourage:

    a. Each Party using DDT to develop and implement an action plan as part of the implementation plan specified in Article 7. That action plan shall include:

        i. Development of regulatory and other mechanisms to ensure that DDT use is restricted to disease vector control;

        ii. Implementation of suitable alternative products, methods and strategies, including resistance management strategies to ensure the continuing effectiveness of these alternatives;

        iii. Measures to strengthen health care and to reduce the incidence of the disease.

b. The Parties, within their capabilities, to promote research and development of safe alternative chemical and non-chemical products, methods and strategies for Parties using DDT, relevant to the conditions of those countries and with the goal of decreasing the human and economic burden of disease. Factors to be promoted when considering alternatives or combinations of alternatives shall include the human health risks and environmental implications of such alternatives. Viable alternatives to DDT shall pose less risk to human health and the environment, be suitable for disease control based on conditions in the Parties in question and be supported with monitoring data.

6. Commencing at its first meeting, and at least every three years thereafter, the Conference of the Parties shall, in consultation with the World Health Organization, evaluate the continued need for DDT for disease vector control on the basis of available scientific, technical, environmental and economic information, including:

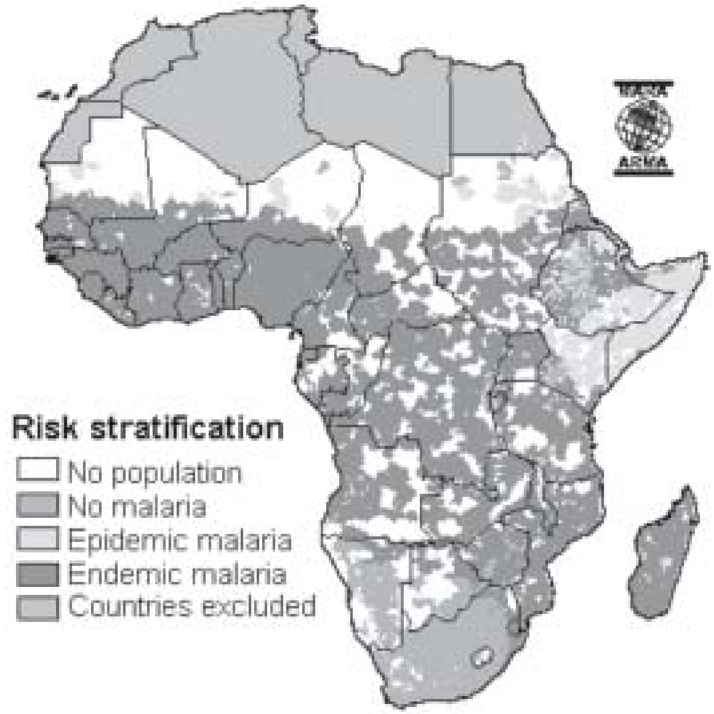
    a. The production and use of DDT and the conditions set out in paragraph 2;

    b. The availability, suitability and implementation of the alternatives to DDT; and

    c. Progress in strengthening the capacity of countries to transfer safely to reliance on such alternatives.

7. A Party may, at any time, withdraw its name from the DDT Registry upon written notification to the Secretariat. The withdrawal shall take effect on the date specified in the notification.

Figure 1: Malaria endemic/epidemic areas in Africa



Notes on risk stratification: Endemic areas are defined as areas with significant annual transmission, be it seasonal or perennial. Epidemic areas are defined as “areas prone to distinct inter-annual variation, in some years with no transmission taking place at all”.

Postal Address
P O Box 2075
Colombo
Sri Lanka

Location
127, Sunil Mawatha
Pelawatta
Battaramulla
Sri Lanka

Tel.
+94-11 2787404

Fax.
+94-11 2786854

E-mail
iwmi@cgiar.org

Website
http://www.iwmi.org

International Water Management Institute

FUTURE HARVEST
IWMI is a Future Harvest Center supported by the CGIAR

ISBN: 92-9090-597-2