The International POPs Elimination Project (IPEP)

Fostering Active and Effective Civil Society Participation in Preparations for Implementation of the Stockholm Convention

DDT Contamination in South Africa

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May 2006

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ABOUT THE INTERNATIONAL POPs ELIMINATION PROJECT

On May 1, 2004, the International POPs Elimination Network (IPEN http://www.ipen.org) began a global NGO project called the International POPs Elimination Project (IPEP) in partnership with the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Program (UNEP). The Global Environment Facility (GEF) provided core funding for the project.

IPEP has three principal objectives:

- Encourage and enable NGOs in 40 developing and transitional countries to engage in activities that provide concrete and immediate contributions to country efforts in preparing for the implementation of the Stockholm Convention;
- Enhance the skills and knowledge of NGOs to help build their capacity as effective stakeholders in the Convention implementation process;
- Help establish regional and national NGO coordination and capacity in all regions of the world in support of longer term efforts to achieve chemical safety.

IPEP will support preparation of reports on country situation, hotspots, policy briefs, and regional activities. Three principal types of activities will be supported by IPEP: participation in the National Implementation Plan, training and awareness workshops, and public information and awareness campaigns.

For more information, please see http://www.ipen.org

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PEN gratefully acknowledges the financial support of the Global Environment Facility, Swiss Agency for Development and Cooperation, Swiss Agency for the Environment Forests and Landscape, the Canada POPs Fund, the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM), Mitchell Kapor Foundation, Sigrid Rausing Trust, New York Community Trust and others.

This report is available in the following languages: English

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASP	Africa Stockpiles Programme
BTI	Bacillus thuringiensis israelensis
COP	Conference of the Parties
CSIR	Council of Scientific and Industrial Research
DAEA	Department of Agriculture and Environmental Affairs
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DEAT	Department of Environmental Affairs and Tourism
DOH	Department of Health
EDC	Endocrine Disruptive Chemical
IPEN	International POPs Elimination Network
IPEP	International POPs Elimination Project
IPM	Integrated Pest Management
IRS	Indoor Residual Spraying
NIP	National Implementation Plan
PCB	Polychlorinated biphenyl
POPs	Persistent Organic Pollutants
SA	South Africa
SABS	South African Bureau of Standards
SAICM	Strategic Approach to International Chemicals Management
TWIG	Third Work Investment Gateway
UN	United Nation
UNEP	United Nations Environment Programme
WB	World Bank
WFPHA	World Federation of Public Health Associations
WHO	World Health Organization
WSSD	World Summit on Sustainable Development

EXECUTIVE SUMMARY

This report provides a contextual overview of DDT usage in South Africa. It specifically highlights the fact that the present use of DDT in South Africa is unnecessary in the Mphumalanga and Limpopo provinces where the only malaria vector is the *Anopheles arabiensis* which can be effectively controlled with pyrethroids and other less toxic technologies.

The report also questions the use of DDT in the KwaZulu Natal Province without proper monitoring of the pyrethroid resistant *Anopheles phenestus* population following its re-emergence during the 1999-2000 malaria epidemic. It is likely that this specific malaria vector has once again been eradicated as it was when the DDT indoor residual spraying programme was first introduced more than thirty years ago.

Furthermore, the report highlights the opportunities to make use of natural non-toxic alternative such as Paris green which was demonstrated as effective in eradicating more serious vectors such as the *Anopheles gambzae* in both Egypt and Brazil. There is at present a serious lack of support for research and implementation of effective local malaria prevention initiatives such as the highly effective mosquito repellant produced from *Lippia javanica*, a bush endemic to Southern Africa's malaria areas. This natural repellent has long been shown to be nineteen times more effective than commercial available mosquito repellants by South Africa's CSIR bio-prospecting research programme and yet no efforts have been made to commercialize or promote its usage to communities affected by malaria. The production of this locally derived non-toxic repellant will not only assist with malaria prevention but will simulate much needed local economic development in these areas affected by DDT.

The present lack of focus on malaria control and DDT usage in South Africa is demonstrated by failure of the Department of Environment and Tourisms (DEAT) as the designated national implementing agent of the Stockholm Convention in South Africa to establish the required DDT action plan. This failure is likely to stem mainly from DEAT's lack of capacity and ability to take over responsibility for initiated DDT programme of the Department of Health (DOH). Furthermore, DEAT's general lack of capacity to deal with POP issues is indicated in their failure to properly establish and manage the required process for National Implementation Plan (NIP). In order to address these issues DEAT will need to engage and work closely with DOH and other relevant stakeholders as a matter of priority in establishing an effective and informed NIP and DDT Action Plan.

DDT has been given special favour as a POP because of the perception that DDT is often the only solution to controlling malaria. South Africa is one of the countries calling for its continued use even though its main (if not only) malaria vector is controllable with pyrethroids and other safer natural alternatives. This continued and unnecessary promotion of POPs as a necessary evil largely serves the interest of the synthetic chemical industry who continues to profit from the day-to-day production of millions of tons of synthetic chemicals that have persistent and endocrine disrupting properties. Whilst the Stockholm Convention is distracted by the DDT debate there is little chance

that its powers will extend to the regulation of the production of thousands of other synthetic persistent chemicals that are found in South Africa's consumer and industrial products.

groundWork would like to acknowledge the mud hut dwellers in the Limpopo and Mpumalanga province into whose homes DDT is being sprayed unnecessarily. The only observed malaria vector in their areas is the *Anopheles arabiensis* which can be effectively controlled using pyrethroids. Since indiscriminate DDT spraying directly contravenes South Africa's obligations to the Stockholm Convention which only allows DDT to be used where there are no locally available safe, effective and affordable alternatives, it is groundWork's hope that the practice will be stopped immediately.

BACKGROUND

For decades now, DDT has been used extensively in disease vector control. Many developed countries in the past have "donated" DDT and other chemicals to developing countries in order to rid themselves of stock waste or chemicals that would soon reach their expiry date. DDT's use however has declined for a combination of reasons, including international regulations governing chemicals, growing insecticide resistance, documented evidence of environmental damage, concern about contamination of foodstuffs and suspicions about hazards to human health. Nonetheless, because DDT is regarded as being an inexpensive and effective '*tool*' to control malaria, a number of countries continue to make use of this persistent organic pollutant (POP) pesticide.

This report is a study outlining the extent of DDT usage and contamination in South Africa focusing primarily on the effect of its continued usage as a malaria vector control tool after it was re-introduced into the country during a localized malaria epidemic in 2000.

This report explores areas such as DDT contamination sites, the South African government's position on DDT, DDT and international commitments, health and DDT, chemical characterization, as well as alternatives and recommendations for DDT use.

This report has been prepared under the IPEP and findings will be disseminated to different stakeholders. The results of the study will serve to inform the development to the government's National Implementation Plan (NIP) under the Stockholm Convention on POPs. The outcomes of this report could also be disseminated through training and workshops both nationally and internationally. The report will be posted on the groundWork website and to the IPEN/IPEP website and other relevant network websites for online users.

1. INTRODUCTION

DDT is one of over 70,000 synthetic chemicals that were created and commercially released without proper and thorough testing. DDT is a known endocrine disrupting chemical [i] and its observed persistence and harm to the environment and human health has led to its classification as a persistent organic pollutant (POP) under the Stockholm Convention.

[i] Endocrine disruptors are chemicals or mixtures from outside the body that can interfere with the development or functioning of body systems in humans, wildlife, and especially their offspring, and may lead to irreversible adverse health effects.

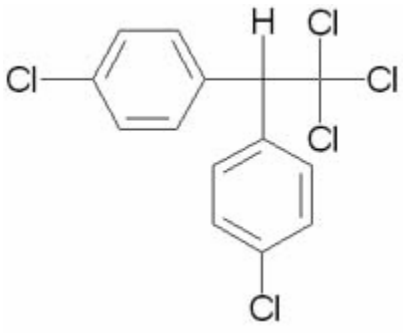

Figure 1: DDT – Dichlorodiphenyltrichloroethane chemical structure (C14H9Cl5)

Persistent organic pollutants (POPs) are toxic substances composed of organic (carbon-based) chemical compounds and mixtures. They are primarily products and by-products from industrial processes, synthetic chemical manufacturing and resulting wastes. The existence of POPs is relatively recent, dating to the boom in industrial production after World War II. Today, POPs are found almost everywhere - in human food, soil, air and water. Wildlife and humans around the world carry trace amounts of POPs in their bodies that may sometimes be at or near levels that can cause injury[1].

POPs pose a particular hazard because of several distinct characteristics: they are toxic; they are persistent, resisting normal processes that break down contaminants; they accumulate in the body fat of people, marine mammals, and other animals and are passed from mother to fetus; and they can travel great distances on wind and water currents and affect areas where they have never been used.

As DDT is an endocrine disrupting chemical (EDC), it is possible for even miniscule quantities, measured in parts per billion[1], to wreak havoc in human and animal tissue, causing nervous system damage, diseases of the immune system, reproductive and developmental disorders and cancers. As the science of endocrine disruption is less than two decades old it is certainly not definitive and the health effects of DDT and its combination with other EDCs is largely unknown.

DDT is a POP that was one of the earliest and most well known pesticides. It is an organochlorine pesticide that has been used for decades in agriculture and to combat insect vectors of diseases such as malaria and typhus. Its usage has led to a widespread contamination of water and soil resources and resulted in serious health effects in animals. Although banned in many countries, DDT continues to be used for residual indoor spraying (IRS) for disease vector control, mainly malaria, in a number of countries, including South Africa. DDT has proven to be an astonishingly effective killer of mosquitoes.

Malaria is caused by a protozoan parasite that is transmitted by mosquitoes. For decades, there have been two major strategies for curbing the disease: killing the infectious agent or killing the carrier. Reliably killing the protozoan has proved difficult as many older drugs are no longer effective and new ones are prohibitively expensive and delivering

and administering drugs to the susceptible populace presents daunting challenges. Killing the carrier has long been an attractive alternative.

DDT was used extensively in Africa and the rest of the world until the late 1970s as a farming pesticide. But widespread spraying was eventually shown to kill fish and threaten birds. DDT became a "pariah" chemical. It is cheap to buy and its effects are long lasting. The estrogenic nature of DDT and the anti-androgenic nature of its metabolite, p,p'-DDE, have been linked to a rise in reproductive abnormalities in both humans and wildlife over the last 20 - 40 years.

DDT is a synthetic chemical that did not exist anywhere on earth until it was created for in a German laboratory in 1874. Decades later, in 1939, Swiss chemist Paul Mueller pulled it off a shelf and tested it, along with many other synthetic substances, for its ability to kill insects. DDT distinguished itself both by its amazing efficacy and its breadth of action by interfering with nervous system function. It proved deadly to almost anything with six, or even eight, legs. It was dirt-cheap to produce compared to other chemicals in use and it could be quickly and easily synthesized in chemical laboratories from inexpensive ingredients[2].

In the pantheon of poisons, DDT occupies a special place. It's the only pesticide condemned in pop song lyrics - Joni Mitchell's famous "Hey, farmer, farmer put away your DDT now" - for damaging the environment. Banned in the United States more than 30 years ago, it remains America's best known toxic substance. Like some sort of rap star, it's known just by its initials; it is the Notorious B.I.G. of pesticides. Many African governments are calling for access to the pesticide, believing that it is their best hope against malaria, a disease that infects more than 300 million people worldwide a year and kills at least 3 million, a large proportion of them children[2]. And this has raised a controversy of Solomonic dimensions, pitting environmentalists against advocates of DDT use.

The dispute between them centres on whether the potential benefits of reducing malaria transmission outweigh the potential risks to the environment. But the problem is not that simple. This is a dispute in which science should play a significant role, but what science tells us is that DDT is neither the ultimate pesticide nor the ultimate poison, and that the lessons of the past are being ignored in today's discussion.

DDT had been a mainstay of many countries' fight against malaria, a disease that is a growing threat to health in some parts of the world especially countries in the tropics. For this reason, many African governments are calling for access to the pesticide, believing that it's their best hope against malaria.

There is a strong media-backed lobby by DDT advocates to perpetuate DDT use in Africa, often resorting to anti-environmentalist drama and discrediting of Rachel Carson's hard evidence[3], vetted by US President Kennedy's Science Advisory Committee[4], that meticulously described how DDT entered the food chain and accumulated in the fatty tissues of animals, including human beings, and caused cancer and genetic damage. Environmental activists are accused of having "blood on their

hands" and causing more than 50 million "needless deaths" by enforcing DDT bans in developing nations. In his best-selling anti-environmentalist novel "State of Fear", Michael Crichton writes that a ban on using DDT to control malaria "has killed more people than Hitler."

The common theme amongst the pro-DDT lobbying group is the perpetuation of the perception DDT is safe, and that there are no effective natural alternatives and the refusal to acknowledge that alternatives, such as Paris Green, have been shown to eradicate serious malaria vectors such as the *Anopheles gambzae* in other countries such as Brazil and Egypt[5].

The United Nations Environment Program (UNEP) has identified DDT as a persistent organic pollutant that can cause environmental harm and lists it as one of the "dirty dozen" whose use is scheduled for worldwide reduction towards ultimate elimination. The Stockholm Convention on POPs permits the production and use of DDT strictly for disease vector control under WHO recommendations and guidelines and "*when locally safe, effective and affordable alternatives are not available*" to the countries where DDT is used[6]. The WHO supports the use of DDT in combating malaria especially in the poorest endemic countries, and states "*that restrictions on DDT under the Stockholm convention should be accompanied by technical and financial mechanisms to ensure that effective malaria control is maintained, to at least the same level, through vector control methods that depend on less pesticides generally and DDT in particular*"[6].

After more than five years of DDT usage in South Africa there has been little sign of national or international support into the exploration of non-DDT alternatives. One exception to this is the research underway at the CSIR exploring the use of natural plant-based mosquito insecticides and repellents. As with other CSIR research this project receives limited funding and is guided by profit under its bio-prospecting programme. In 2001, the CSIR identified a highly effective mosquito repellent made from *Lippia Javanica,* a plant commonly found in South Africa's malaria areas that was 19 times[ii] more effective a repellent than citronella[7],[40]. The repellent can be locally produced by the local communities in South Africa's malaria areas. At the time of writing this report [iii] it was not possible to purchase this product anywhere in South Africa. This example highlights the abysmal level of support for research, development and implementation of DDT alternatives.

It is arguable that the continued perpetuation of the perception that DDT usage to control malaria is unavoidable and that DDT is not really harmful to human health and the environment has lessened research into suitable alternatives as well as decreased political will to resolve the problem and heed the call for the expansion of the Stockholm Convention's original list of POPs to include other persistent endocrine disrupting chemicals, many of which are in everyday production and use[23].

[ii] In accordance to South African Bureau of Standards (SABS) olfactometer tests conducted by the CSIR
[iii] April 12, 2006

2. SOUTH AFRICA AND THE STOCKHOLM CONVENTION

South Africa is a party to the Stockholm Convention which was established to eliminate the production, use and emissions of POPs while preventing the introduction of new chemicals with POPs-like characteristics and ensuring the environmentally sound destruction of POPs waste stockpiles. The Convention sets out the actions to be taken by Parties to reduce and, where feasible, eliminate releases of by-product POP chemicals. Technical and financial assistance is offered to developing country Parties to help implement the Stockholm Convention.

Of the numerous POPs that are prevalent in our environment, the twelve most persistent, bioaccumulative chemicals were initially identified under the Convention for priority action. The United Nations Environment Program (UNEP) has identified DDT as a persistent organic pollutant that can cause environmental harm and it is listed as one of the initial twelve chemicals, collectively known as the "dirty dozen", whose use is scheduled for worldwide reduction and elimination. However, due to concerns surrounding public health and malaria, it has been approved in a limited number of countries including South Africa until "*locally safe, effective and affordable alternatives are available*" [6].

After the malaria epidemic in 2000, South Africa became a voice in the call for the continuation of DDT usage. On the 10th December 2000 in Johannesburg South Africa, as the UNEP concluded the fifth and final round of negotiations on a treaty to ban persistent organic pollutants, now the Stockholm Convention, the South African government was instrumental in the signing of a treaty that allowed for DDT usage as disease vector control. South Africa has continued to promote the use of DDT as a necessary intervention for malaria control, re-expressing their commitment to the continued use of DDT for malaria control during the First Conference of the Parties (COP1) of the Stockholm Convention held in Uruguay, May 2005.

When the Convention came into force in May 2004, the South African Government's Department of Environment and Tourism (DEAT) was nominated as the national implementing agent tasked with the preparation of a National Implementation Plan (NIP) by the 17th of May 2006 [iv]. This plan includes the formulation of an action plan to control the use of DDT for disease vector control as well a preliminary DDT inventory. Furthermore, South Africa is required to report[v] every three years on the amount of DDT used, including plans for strengthening of regulatory controls and measures to strengthen health care[8] as well as create public awareness about POPs.

South Africa has not been able to fulfill their commitments to monitor and evaluate DDT usage in the country. DEAT, by their own admission[9], as late as April 2006, has not prepared the NIP and the associated DDT action plan or the preliminary DDT inventory. Neither have they embarked on any form of public POPs awareness-raising programme. At the time of writing this report[vi] they were in the process of appointing a contracting agent to manage the NIP process with the hope of delivering this information by

[iv] As required by Article 7 of the Stockholm Convention
[v] Annex II, part II, of the Stockholm Convention
[vi] 12th April, 2006

December 2006. This appointment and the resulting transfer of responsibility to an unknown entity has taken place without consultation with any of the local non-industry backed NGOs and civil society groups who were attempting to engage with the NIP process. Civil society has an important role to play in NIP development and implementation of the Convention. In fact, Article 7 of the Convention calls for consultation with "…national stakeholders, including women's groups and groups in the health of children, in order to facilitate the development, implementation, and updating of their implementation plans."

3. DDT USAGE IN SOUTH AFRICA

3.1 Agricultural

DDT was widely used as a pesticide by farmers in South Africa until its use for agricultural purposes was outlawed in 1974. It is commonly accepted that informal DDT usage continued after 1974 fueled by obsolete agricultural stockpiles and possibly even from the Malaria Control Programme, which continued to use DDT until it stopped in 1996. By as late as 1995, significant stockpiles of DDT were still to be found in agricultural areas that were never a part of a malaria control programme[10,11]. It has also been observed that one[vii] of these stockpiles vanished, apparently without trace[12].

3.2 Malaria control

DDT has been used since the 1940 as an effective method of malaria control. DDT revolutionised 'traditional' indoor residual spraying methods because it was, and still is, cheap, easy to use, and long lasting. There have been ongoing environmental campaigns against its use, and indeed against any sort of indoor residual spraying. Many "green" groups built their reputations by their campaigns to ban DDT during the 1970s. The same groups now try to influence donor agencies and the WHO to move away from DDT usage. On a global scale DDT production is decreasing, and its use is limited to those few countries that still have stockpiles, such as South Africa, or whose governments produce the chemical. DDT's continuing effectiveness and the need to rotate insecticides to prevent insect resistance, mean that many countries still rely on DDT for malaria control.

South Africa initiated its DDT IRS malaria control programmes in the 1940s and 1950s during which time its use is credited with the eradication of the *anopheles phenestus*, which was at that time the major malaria vector in South Africa[13].

In 1996, the government stopped DDT usage and relied mainly on pyrethroid insecticides which were proven to be effective against the *Anopheles arabiensis*, which was at that time the only malaria vector in the country.

[vii] Two tons of DDT in Stellenbosch

DDT IRS was reintroduced in South Africa during 2000 at the height of a malaria epidemic associated with the emergence of a pyrethroid resistant strain of the *anopheles phenestus* in KwaZulu Natal[viii].

DDT usage has now been extended into other areas such as the Limpopo Province and the Mpumalanga Province although these provinces have no recorded incidence of the *anopheles phenestus* and the only malaria vector there is the *Anopheles arabiensis*, which can be effectively controlled using pyrethroids. This practice of indiscriminate DDT spraying seems to contravene South Africa's obligations to the Stockholm Convention which clearly states that, under the WHO recommendations and guidelines, DDT can not be used where "locally safe, effective and affordable alternatives are available."

No evidence has been made public to suggest that the government's post 2000 indoor residual DDT spraying programme has not been successful in eradicating the *anopheles phenestus*, as it did before in the 1950s[13]. Furthermore, it is likely that DDT is no longer required in KwaZulu Natal based on the observed efficacy of a previous DDT indoor residual spraying programme which eradicated the *Anopheles phenestus* in South Africa during the 1950s. Without proper monitoring of the *A. phenestus* population it is not possible to ascertain the necessity of South Africa's DDT usage.

3.3 Quantities

In 2000, at the height of the malaria epidemic, the KwaZulu-Natal Department of Health (DOH) applied 7 tons of DDT in a desperate measure to save lives. Little is publicly known about the DDT usage between 2000 and 2006 but it has been revealed that by October 2005 South Africa had accumulated as much as 274 tons[14] of DDT stocks for use in its malaria control and that the DOH had contracted AVIMA (Pty) Ltd to supply a further 112 tons[15] of DDT for the period August 2005 to July 2007. Assuming that all of this DDT is to be used by the end of 2007, South Africa will have had to spray an average of 280,000 homes[ix], directly affecting the lives of at least 1.125 million South Africans[x].

In the absence of a DDT action plan[xi] it is not clear what the actual DDT usage is, although industry sources[15] suggest that the actual DDT usage is in the order of 33 tons[xii] per year, which implies that an average of only 48,125 homes[ix] are sprayed and that South Africa may be adding to their existing 274 ton DDT stockpile at a rate of 22 tons per year[xiii].

[viii] The malaria outbreak took place along the border of Mozambique over a period of heavy rains and disastrous flooding.

[ix] An estimate based on the following assumptions: 2 grams per m^2 sprayed onto $120m^2$ per house at a spraying frequency of twice a year (required for phenestus), including 30% losses to atmosphere and over spraying.

[x] Assumes an average of 4 persons per household.

[xi] In the absence of the DDT action plan, which the Government considers as the official public reporting mechanism for DDT usage it is necessary to estimate DDT usage from previous DDT sales.

[xii] AVIMA, the current contracted supplier of DDT to the DoH, estimate that South Africa consumes an average of 67 tons every two year.

[xiii] Disbarring overzealous spraying of DDT.

3.4 Brief Life Cycle Assessment of DDT used for Malaria Control in South Africa

Although a full life cycle analysis and assessment of South Africa's DDT IRS programme is expected to be presented in the country's NIP and DDT action plan, based on the present level of limited information available to the public we know the following:

- The supply of DDT in South Africa is subject to a public tender process every two years.
- DDT is formulated in South Africa but imported as technical material (active ingredient)[14] creating the increased risk of accidental spillage in sea transport.
- DDT is supplied in cartons containing ten sachets each with 670 grams of DDT powder.
- One sachet of DDT is mixed into a twenty litre knapsack sprayer and then the solution is sprayed onto indoor walls at an application rate of 2 grams of DDT per square meter, leaving a clear white deposit.
- During the spraying process, some DDT will enter atmosphere, suspended in particle form.
- Ordinary skin contact with the walls will easily remove the DDT which could then foreseeably enter the food chain of the householders and their guests. This theory is supported by the evidence[16] showing that the levels of the DDT metabolite, DDE, in the bodies of residents of DDT sprayed houses in the Limpopo province was 216.5 mg/kg[xiv]
- All empty DDT sachets are placed in sealed containers which are then returned to the company contracted to supply the DDT. If these returns are audited, it is not public information at present[xv].
- The national DDT supplier then contracts a registered hazardous waste contractor to safely dispose of the containers and their contents.
- Although methods of disposal vary from incineration to hazardous waste storage, there is a need for safe, commercially-viable, non-combustion methods of POPs disposal that do not generate POPs or other toxic chemicals. More biocompatible methods of DDT disposal might possibly include the use of earthworm enzymes which are reported[17] to be successful in breaking down POPs.

3.5 Concerns

South Africa's current DDT usage to control malaria creates a number of immediate concerns and issues that will hopefully be addressed in the DDT action plan which forms a part of South Africa's NIP on POPs. These concerns are:

- The outbreak of *anopheles phenestus* responsible for the malaria epidemic was restricted to KwaZulu, and yet DDT usage was extended to the Limpopo and Mpumalanga provinces where malaria is only attributed to the *Anopheles arabiensis* vector which is effectively controlled with pyrethroids.
- Without proper information on the population levels of *phenestus*, as would be included in the NIP - DDT Action Plan, the continued need for reliance on DDT

[xiv] p,p'-DDE concentration adjusted for total lipids

[xv] Both DOH and AVIMA were reluctant to discuss or divulge any figures on DDT usage. The public reporting mechanism was seen to be the responsibility of DEAT through their NIP DDT Inventory and Action Plan.

usage cannot be properly ascertained. It is highly likely that current, post 2000, indoor residual DDT spraying may have already successfully eradicated the *anopheles phenestus* from the South Africa as it did before in the 1950s[13] thus negating continued *ad hoc* use of DDT.

- South Africa is obliged [xvi] by its commitment to the Stockholm Convention, and by its constitution (section 5.4 Ethics and Human rights) to explore the feasibility of safer alternatives to DDT in order to ensure that due process is followed in justifying its continued support of DDT spraying. This implies the provision of adequate funding and support for research, development and testing of new and existing alternatives, including natural non-toxic alternative technologies [xvii] that were used to successfully eradicate malaria vectors[5] in other countries.
- Householders living in homes where DDT is sprayed are not routinely warned about the chronic and harmful endocrine disrupting effects associated with low-level DDT exposure. Given the known harmful effects of DDT, citizens, especially pregnant and lactating mothers, should have the privilege of an informed choice before DDT is sprayed in their houses.
- DDT is used only in low-income homes characterized by cement or mud walls[18] as it is not applied homes with painted surfaces[xviii]. Highlighting the fact that DDT control measures in South Africa are confined mainly to the poor, uneducated and unsuspecting portion of the population.
- South Africa appears to be accumulating a large "excess" stockpile of DDT[xix]. As there is no safe method of DDT disposal, this practice is highly questionable. It would be more appropriate to carry a minimal reserve and order DDT on a just-in-time[xx] basis.

As pointed out, the practice of indiscriminate use of DDT seems to contravene South Africa's obligations to the Stockholm Convention which clearly states that, under the WHO recommendations and guidelines, DDT can not be used where "locally safe, effective and affordable alternatives are available."

[xvi] South Africa is a signatory of the Stockholm Convention which allows for the use of DDT only when there are no "safe, effective and affordable alternatives are available".
[xvii] Paris Green was responsible eradication of the malaria vector *Anopheles Gambiae* was in Brazil in 1940 (Soper and Wilson) and Egypt in 1945, (Shousha).
[xviii] Spraying DDT onto walls smooth walls at the correct application rate creates an excessive run-off on smooth walls, leaving a white residue. Other insecticides (such as Pyrethroids) are less liquid making them more suitable for painted surfaces.
[xix] 274 tons as of October 2005
[xx] A production inventory control system developed by Toyota, Japan, in order to minimize the expenses associated with carrying unnecessary inventory levels.

4. MALARIA AND DDT

4.1 Malaria in South Africa

Malaria imposes enormous human suffering and economic costs on many poor countries. Recent estimates support that 4.8 million people in South Africa (10% of the population) are affected by the disease. In South Africa, malaria is categorised as seasonal and unstable, with the mosquito *Anopheles arabiensis* the major malaria vector, while the parasite *Plasmodium falciparum* accounts for the majority of malaria-related morbidity and mortality[19].

Prior to 1960, the *Anopheles phenestus* was the major malaria vector in South Africa, although it was eradicated by IRS DDT spraying in the 1950s[13]. Evidence[19] shows that the *phenestus* began to slowly re-emerge[xxi] in KwaZulu Natal from 1996. Furthermore, this recent strain of the *phenestus* was resistant to the pyrethroid insecticides that were being used to effectively control the *Anopheles arabiensis.* By 1999 and 2000 the levels of *phenestus*, which were still restricted to KwaZulu Natal, led to a malaria epidemic which claimed over 400 lives. In 2000, during the height of the epidemic, after consultation with experts both local and international, the DOH recommended that DDT be used to control the pyrethroid-resistant vector as DDT was seen as the cheapest and most effective insecticide available. DDT was reintroduced in KwaZula Natal in the year 2000.

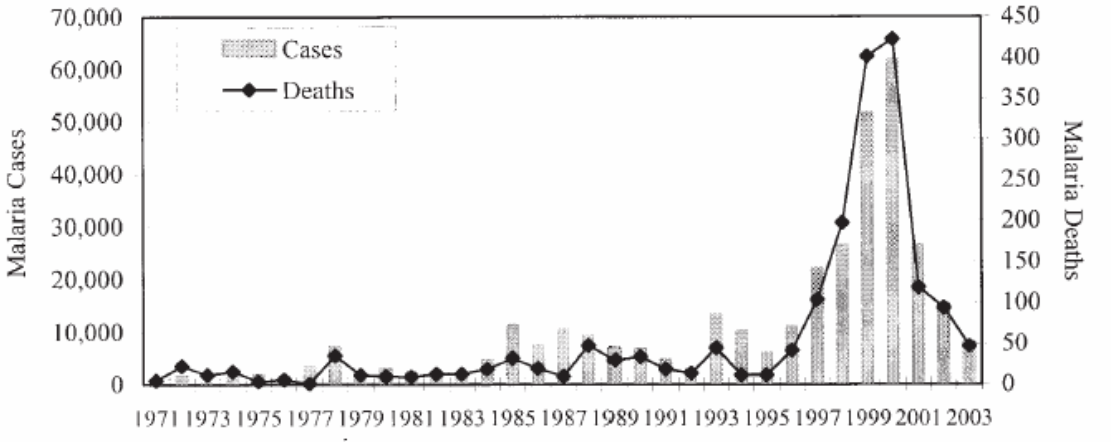

Figure 2: Annual number of notified cases and deaths due to malaria in South Africa (1971–2003)[20]

The *Anopheles phenestus*, which is still common to Mozambique and Tanzania is an efficient vector of malaria because it is a domestic, human-linked species which seldom, if ever, feeds on anything other than humans[13]. As the *phenestus* rests and feeds inside human habitations it is particularly susceptible to indoor spraying of DDT. In the 1940's and 1950's when South Africa initiated its Malaria Control program, *phenestus* disappeared[13].

[xxi] Maleria cases recorded in KwaZulu Natal at health facilities during the winter months were high and between 1996 – 1999 reported malaria cases increased from an average of 600 cases per month to over 2000 cases per month (Maharaj *et al*, 2005)

The re-emergence of the *phenestus* after an absence of over thirty years was to great cost. By the end of 1999, the number of malaria cases stood at 50,000 for South Africa - far higher than in recent decades. From 2000 to 2002 the economic cost for malaria ranged between US$15 million and US$41 million, excluding estimates of the human suffering and estimates of lost investment in malarial areas.

Table 1: Summary of Economic Costs of Malaria (thousands of rand)[21]

	1996	1997	1998	1999	2000	2001	2002
Number of malaria cases	23,907	20,513	22,690	50,321	61,934	25,731	15,074
Direct costs							
Malaria control program	55,000	60,000	68,000	79,000	90,000	96,000	102,000
Cost of treating and hospitalizing patients	6,979	6,203	8,151	16,319	21,179	11,324	8,210
Indirect costs							
Malaria patient lost productivity	7,664	10,276	8,272	16,322	19,972	11,497	6,194
Family care—lost productivity	116	132	161	373	497	224	142
Mortality costs	38,175	38,890	59,140	131,170	151,410	46,678	40,247
Cost per case	4,514	5,630	6,352	4,824	4,580	6,443	10,341
Total (rand)	107,935	115,503	144,148	242,759	283,697	165,796	156,793
Total (US$ 000)	25,122	25,069	26,059	39,711	40,906	19,271	14,909

Source: Tren and Bate, 2004

4.2 Resistance to DDT

DDT has in some cases failed to eradicate malaria in many parts of the world, not because of environmentalist restrictions on its use but because it simply stopped working effectively[2]. Insects are known to have a phenomenal capacity to adapt to new poisons. Anything that kills a large proportion of a population favours those few individuals that manage to survive due to random mutation. In the continued presence of the insecticide, susceptible populations can be rapidly replaced by resistant ones.

By 1972, when the U.S. DDT ban went into effect, 19 species of mosquitoes capable of transmitting malaria, including some in Africa, were resistant to DDT. Genes for DDT resistance can persist in populations for decades. Spraying DDT on the interior walls of houses is advocated as the solution to Africa's malaria problem, but this practice led, however, to the evolution of DDT-resistant mosquitoes 40 years ago and will almost certainly lead to this again in many places unless resistance monitoring and management strategies are put into place.

Pockets of resistance to DDT in some mosquito species in Africa are already well documented[2]. There are strains of mosquitoes that can metabolize DDT into harmless by-products and mosquitoes whose nervous systems are immune to DDT. There are apparently even mosquitoes who avoid the toxic effects of DDT by resting between

meals not on the interior walls of houses, where chemicals are sprayed, but on the exterior walls, where they do not encounter the chemical at all[2].

Although DDT-resistant populations of *Anopheles* mosquitoes (malaria vectors) have evolved in different parts of the world, they have so far not been recorded in Southern Africa[22]. However, experts[19] warn that the continued use of DDT may lead to resistance in Southern Africa.

5. ENVIRONMENTAL, SOCIOECONOMIC, AND HEALTH CONSEQUENCES

DDT is one of a several thousand synthetic chemicals that were manufactured and released into the environment without adequate toxicity testing. Like DDT, many of these chemicals were later found to have serious endocrine disrupting effects which can potentially lead to cancers, immune system dysfunction, abnormal sexual, cognitive and physical development, trans-generational cancers and other diseases such as asthma and endometriosis. The combined synergistic effects of exposure to two, or more, of these persistent chemicals is unknown and many scientists believe that the continuous uncontrolled release of these harmful chemicals amounts to the largest, and possibly the most dangerous, uncontrolled experiment in our history[23].

5.1. Observed effects of DDT exposure on humans

5.1.1 Acute effects

DDT and other chlorinated insecticides act to stimulate and depress the central nervous system[24]. Neuro-developmental effects in humans following single doses from 6 to 10 milligrams include nausea, headaches, diarrhoea, and irritation of the mucous membranes, tremors and convulsions, and nervous system abnormalities[25, 26]. DDT may also damage the liver and central nervous system, causing excitability and seizures in people.

5.1.2 Chronic effects

As DDT is an endocrine disrupting chemical (EDC)[i], which interferes with the body's own hormone system, it can be hazardous at extremely low doses, posing particular danger to those exposed in the womb[30, 23]. During prenatal life, endocrine disruptors can alter development and undermine the ability to learn, to fight disease, and to reproduce.[23]

Although DDT exposure has not been linked conclusively to cancer, it has been linked to reproductive effects in humans which include: environmental oestrogen and anti-androgen effects on foetuses and breast feeding infants, decreased fertility, still births, neonatal deaths and congenital defects among children of chronically exposed workers[26].

Exposure to the estrogenic pesticide, DDT, and its anti-androgenic metabolite, p,p'-DDE, affects male reproductive parameters as confirmed by a recently published study[27] of inhabitants in the malaria endemic-areas in Chiapas (Mexico), where DDT was sprayed

in homes until 2000. Results showed a direct causal link between non-occupational exposure to DDT and poorer semen parameters, indicating adverse effects on testicular function and/or the regulation of reproductive hormones and the most severe category of incomplete DNA condensation was also positively correlated with p,p'-DDE concentration. The conclusion was that "clearly, even non-occupational exposure to DDT potentially has adverse consequences on male reproductive health, and thus the development of alternative methods of pest management should be encouraged"[27].

In a study in India, a group of men who worked with DDT were found to have decreased fertility, with a significant increase in stillbirths, neonatal deaths and congenital defects among their children. Israeli men with unexplained fertility problem were also found to have high blood levels of DDT[26].

Post generational female reproductive ability is also affected by DDT. A recent US study[28] indicates a link between DDT and delays in pregnancy in the daughters of exposed women 30 years after birth, where an increase of as little as 10 micrograms of DDE per litre was associated with a one-third decrease in the chance of becoming pregnant within a menstrual cycle.

5.2. Known health effects of Indoor Residual Spraying of DDT on South Africans

5.2.1. Adverse effects on male reproduction

The abstract of an ongoing study[16] of males in the Limpopo Province echoes a similar conclusion of the Mexican study[27]: "Non-occupational exposure to DDT is associated with poorer semen parameters in men, suggesting adverse effects on testicular function and/or the regulation of reproductive hormones. The effect of DDT on male reproductive health should not be ignored[16]. It is distressing to note that the quantities of DDT found in the Limpopo men (p,p'-DDE concentration adjusted for total lipids was 216.5 ± 211.3 mg/kg) is substantially higher than those found in the Mexican study (p,p'-DDE concentration adjusted for total lipids was 45 ± 32 mg/kg).

5.2.2. Increase in incidents of preterm births, underweight babies

In a study[29] of 45 pregnant women admitted to the labour ward at Tshilidzini Hospital (a public hospital 3 km outside the DDT- sprayed area in Limpopo Province), the average p,p'-DDE concentrations adjusted for total lipids in these women was found to be 24.75 mg/kg and ranged as high as 419.91 mg/kg.

The high levels of DDT and its metabolites found in South Africans who are exposed to indoor spraying is cause for concern because the studies[30] show that DDE exposures of a mere 10mg/kg has been linked to pre-term births and underweight babies. Longnecker *et al*. (2001)[30] demonstrate a powerful association between DDE levels in mothers' serum and the likelihood of premature birth. The higher the contamination level, the more likely was preterm birth. They also show that contamination is linked to the baby's size, with babies more likely to be small for their gestational age when born to mothers with higher DDE levels.

5.2.3. Increase in urogenital birth defects

The study[29] of pregnant mothers and babies in the remote rural province of Limpopo conducted to addresses the hypothesis that newborns in a high-risk malaria area have high DDE values and a high prevalence of urogenital birth defects, it was observed that 3.65% babies were born with abnormal and ambiguous genitalia, and 0.86% were born with abnormalities that raised particular concern. The study concluded that the "concordant high prevalence of urogenital birth defects and the DDE concentrations in cord blood in babies born in a DDT-sprayed area should be regarded as a matter of extreme international concern" and "that the continued use of DDT for vector control in developing countries and the possible impact on the reproductive health effect of newborns in these areas should be addressed as a matter of extreme international urgency".

5.2.4. Contaminated breast milk in lactating mothers

In a study[31] undertaken in KwaZulu-Natal, samples were collected from mothers attending clinics from Jozini and Mkuze (areas exposed to agricultural and malaria control insecticides), and mothers from Gwaliweni clinic (not covered by the malaria spraying programme, serving as reference area). Milk from selected mothers from Jozini had significantly higher levels of total DDT and its metabolites (4.48 mg/kg milk fat) than those from the control group at Gwaliweni (1.1 mg/kg milk fat).

A previous study concludes that intake by a breastfed baby in South Africa's anti-malaria sprayed areas will greatly exceed allowable daily intake levels defined by the FAO and the WHO on a lifetime intake basis[32]. This is a particular concern as the sexual, cognitive and physical development of babies has been shown[23] to be sensitive to endocrine disruption, and neuro-developmental toxic effects for rats for single or repeated doses at a similar level of 5mg/kg include liver damage, tremors, decreased thyroid function, and impaired neurological exposure[25].

5.2.5. Potential Increases in Infant Mortality

The high levels of DDE found in pregnant and lactating mothers in areas where DDT residual indoor spraying is practiced (refer section 5.2.3) can be shown to be potentially linked[33] to infant mortality on two grounds.

1) Mothers with serum DDE levels above 5mg/kg have been shown[34, 35] to nurse their babies 40% - 50% less than mothers with little or no DDE. An infant that is not breast feeding at under two months of age is 5.8 times more likely to die than an infant that is breast feeding (Figure **3**).

2) Mothers with DDE exposure above 10 mg/kg as observed in the Limpopo province will suffer a 3-fold increase in preterm birth[30]. Preterm birth, in turn, has a strong link to infant mortality. Babies born before term are significantly more likely to die.

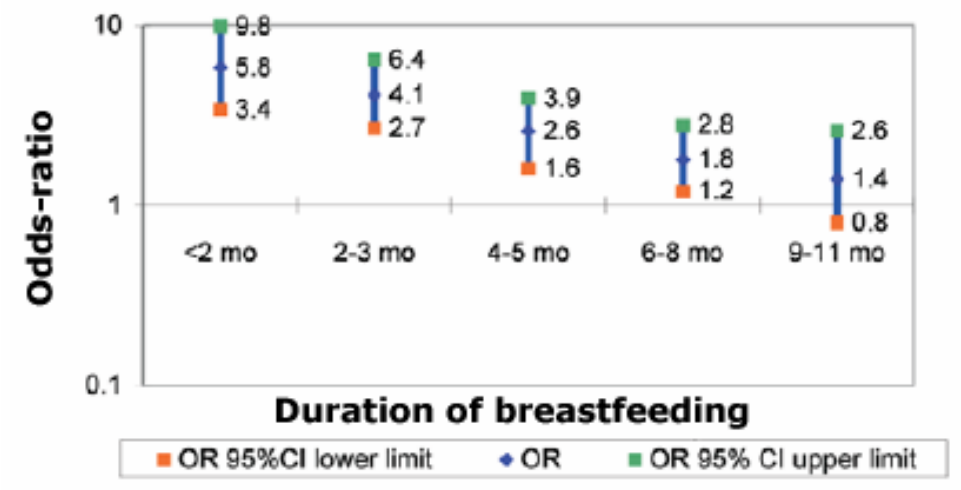

Figure 3: WHO Graph comparing infant mortality with lactation duration

The observed exposure levels of DDE in mothers living in houses selected for the IRS programme may[xxii] increase infant mortality[33] by up to 9% because of preterm births, and 20% because of shortened lactation. In other words, DDT may cause a comparable increase in infant mortality as compared to the potential decreases in infant mortality it may cause by killing malaria carrying mosquitoes.

5.2.6. Other health impacts

Studies show that DDT produces a number of ill effects on wildlife and laboratory animals with similar endocrine systems to humans. It unlikely however that it will be possible in the near future to find a direct causal link to these and other endocrine disrupting effects such as cancer and immune system deterioration in humans for the following main reasons:

1) Ethics of performing DDT exposure testing on humans, in particular trans-generational tests which would require the controlled exposure of the developing foetus to DDT in the womb.
2) The prohibitive costs associated with testing for the effects of endocrine disrupting chemicals at the levels that they may effect the endocrine system, i.e. parts per trillion[23].
3) The prohibitive costs and time required (at least 18 years) to perform proper trans-generational testing on humans. The trans-generational nature of EDCs requires multigenerational testing to observe the long-term chronic effect of critical exposures to the foetus such as trans-generational cancers. Such studies can take a matter of months with mice but up to at least 18 years with humans.
4) A lack of incentive in developed countries to fund DDT studies where its usage is banned.
5) A lack of funding for independent research into DDT exposure, especially in the areas where DDT is still used; for example the studies by the University of

[xxii] By means of extrapolation of calculations from US and Mexico studies (Chen & Rogan) to match the observed exposure levels of DDE in mothers in South Africa.

Pretoria into the effects of DDT exposure in the Limpopo province are severely restricted by the lack of adequate funding[xxiii].

6) The impossibility of finding a perfect control group because of the ubiquitous exposure of humans to POPs and other synthetic EDC in the environment that would have a similar array of antagonistic effects to DDT and its metabolite DDE. It is estimated that no person has been born since 1950 without suffering some form of endocrine disruption from EDC pollution. The synergistic effects of exposure to more than one type of endocrine disruptors are also not yet fully understood by medical science.

5.3. Effects on wildlife and aquatic environment

The environmental effects of DDT were first documented by Rachel Carson in 1962 in her work 'Silent Spring' which meticulously described how DDT persisted in the environment and how it had entered the food chain and accumulated in the fatty tissues of animals, including human beings, causing cancer and genetic damage. Although at first her work received extensive criticism from industry it was later vindicated[4] by the US President's Science Advisory Committee[xxiv]. By 1972, the pesticide had become the "poster poison" for fat-soluble chemicals that accumulate in food chains and cause extensive collateral damage to wildlife (including charismatic predators such as songbirds and raptors), and a total ban on the use of DDT went into effect in the United States.

The recent science[xxv] of endocrine disruption has revealed further effects of DDT on animals. However, there has been a limited amount of research done on the effects of DDT as it has been banned in most developed countries and so EDC research scientists have concentrated their efforts on other more popular chemicals that are still in use today.

It is important to note that all vertebrates share a similar endocrine system and so the observed effects of these chemicals on wildlife will have similar effects on humans[xxvi].

Adverse health effects of DDT in animals include reproductive and developmental failure, possible immune system effects, and the widespread deaths of wild birds after DDT spraying of crops. As is the case with many organochlorine insecticides, a major target of acute DDT exposure is the nervous system. The observed effects of DDT's estrogenic and anti-androgenic properties on wildlife include: reproduction abnormalities in birds mammals, the feminization of males (alligators and Florida panthers) as well as eggshell thinning of offspring[26]. Neurodevelopment toxic effects for rats for single or repeated doses (5mg/kg) include liver damage, tremors, decreased thyroid function and impaired neurological exposure[25].

Long-term administration of DDT has brought about neurological, hepatic, renal and immunologic effects in animals. Research has shown that DDT prevents androgen from binding to its receptor thereby blocking androgen from guiding normal sexual

[xxiii] There are not enough resources to fast-track much needed studies into DDT linked preterm birth and infant deaths.
[xxiv] Under the Kennedy administration.
[xxv] Post 1990
[xxvi] As demonstrated with PCBs where rats and humans have similar resultant diseases

development in male rats and resulting in abnormalities. Evidence has been found in alligators in which hatchlings from DDE-painted eggs are sexually indeterminate; possessing both male and female reproductive characteristics[26].

In laboratory cultures of whole phytoplankton from the Caspian and Mediterranean seas, DDT reduced primary production by as much as 50% at a concentration of 1 ppb. In fish, a single exposure to o,p'-DDT can lead to a complete, permanent and functional sex reversal[36]. Bivalve molluscs, on the other hand, with their ability to concentrate organochlorine pesticides appear to be only affected at levels greater than 10 mg/l[37].

Long-range atmospheric transport of DDT into the northern countries, including the Arctic, is well documented; DDT has been detected in Arctic air, soil, snow and ice, and virtually all levels of the Arctic food chain. Many studies indicate that bottom sediments in lakes and rivers act as reservoirs for DDT and its metabolites. Despite a twenty-year ban in the U.S, DDT is still found concentrated in soils and freshwater sediments.

5.4 Ethics and Human rights

As with other POPs and synthetic Endocrine Disruptive Chemicals (EDC), the environmental contamination in South Africa for DDT is not well characterized. South Africa does have limited EDC and dioxin testing facilities that are not properly accredited. Extrapolating international data into the South African context, based on its current EDC usage and waste disposal practices, would imply that it is impossible at present for any South African to prevent harmful exposure to these highly toxic chemicals. Although the present malaria control programme seeks to minimize the exposure of wildlife and the general population at large, it is foreseeable that DDT used in this programme could contaminate the environment in a number of ways. Once released in the environment, both human and animal populations[xxvii] could be irreversibly impacted ***without their knowledge or consent*** by pervasive and persistent DDT molecules and their harmful metabolites.

South Africans are blessed with a constitution[38] that protects human rights. The usage of POPs and other harmful EDCs contributes to the ubiquitous presence of these harmful chemicals in the environment and directly violates at least two of these rights as follows:

> *(i) Everyone has the right - (a) to an environment that is not harmful to their health or well-being. (b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation.*[xxviii]
>
> *(ii) Everyone has the right to bodily and psychological integrity, which includes the right to security in and control over their body.*[xxix]

[xxvii] Vertebrates, including humans, share similar immune systems that can be irreversibly impacted by minute exposures to synthetic endocrine disrupting chemicals.
[xxviii] Chapter 2, section 24 of the Constitution of South Africa
[xxix] Chapter 2, section 12 (2) of the Constitution of South Africa

The above rights need to be balanced against the 'the right to life' of those people living in malaria effected areas. This right to life, which is guaranteed by the South Africa's constitution, can be used to justify DDT usage as an effective method of malaria vector control which clearly has the ability to save lives. However, properly claiming this right would require that DDT be shown to be the only safe alternative, after due process was performed in the exploration the use of safer and effective alternatives for malaria vector control. Safe alternatives that have been used to eradicate more dangerous malaria vectors in other countries[5] do exist.

The ethics of spraying in homes without informing the residents of the known and potential dangers associated with DDT, particularly to pregnant mothers, is a highly questionable practice. Before DDT can be used on laboratory rats at any South African university, no matter how small the amount, the experimenters have to convince an ethics committee. The residents of Limpopo, Mpumalanga and KwaZulu-Natal are afforded no such protection. Furthermore, as DDT is sprayed only in homes without painted walls it is mainly the poor who will suffer the consequences of direct DDT exposure in South Africa.

6. ALTERNATIVE PRACTICES

A number of pyrethroid based insecticides have demonstrated their efficacy against the *Anopheles arabiensis,* the primary (if not the only[xxx]) malaria vector in South Africa, at much lower application quantities than DDT[32]. Although not as persistent as DDT, these synthetic pyrethroids are also endocrine disrupting chemicals and so their uses should be replaced with safer, natural alternatives some of which are listed below.

6.1. Integrated Pest Management (IPM)

Pesticides are used as an easy way out since less toxic methods are seen as more time-consuming, but they can be just as effective because they prevent mosquitoes at the source - in water - by killing larvae, as opposed to focusing on adult insects. IPM requires responsible controllers to monitor mosquito populations and target larvae.

6.2. Bacillus thuringiensis israelensis (Bti)

To reduce larvae populations, *Bti* bacteria that damage the mosquito's stomach or the larvae can be used. Because it targets only mosquitoes, black flies, and some midges, *Bti* is considered safe for humans and natural systems. Tests[39] show that *Bti* kills nearly all the mosquito larvae in a typical pond, halting breeding for up to 45 days. *Bti* is used extensively in richer countries like the US and Germany, where people are more informed of the dangers of DDT and will not accept its usage.

[xxx] No public evidence has emerged to suggest that the *phenestus* has not once again been eradicated

6.3. Paris green

Paris green is a natural product that was once commonly used for larval control and is attributed to have been used effectively to eradicate malaria in many countries before 1950. Its most notable successes were in Egypt as well as against a 10 year old infestation of the most dangerous malaria vector *Anopheles gambzae* in Brazil[5]. Paris green is prepared by combining it with road dust, ash powder, talc powder or charcoal powder. The dusting method of application is done on surface water. The larvae feed on the Paris green and die. Paris green can be applied to rice paddy fields and slow running streams.

6.4. Natural predators

In Wilmette, Illinois, natural larvae predators, such as mosquito fish (Gambusia), stickleback, or guppies are used to control mosquitoes and are particularly effective in artificial water-bodies. It is important to carefully consider the introduction of non-native fish species.

6.5. Wetland enhancement

Wetland enhancement can work by increasing water circulation and displacing the stagnant-water-loving mosquito. While this may alter the environment, it's better than the old practice of draining valuable wetlands. . An environmental assessment should be performed during the planning stages of a wetland enhancement programme.

6.6 Lippia Javanica

Mosquito control can be found in the extraction of the essential oils from *Lippia javanica*, an indigenous plant that grows in the malaria areas of South Africa. The repellent has a pleasant smell and its potential as a personal protection measure against *An. arabiensis* mosquitoes, the principal malaria vector, was demonstrated to be 19 times[7] more effective than citronella. The CSIR has patented the discovery as part of their Bio-prospecting Programme.

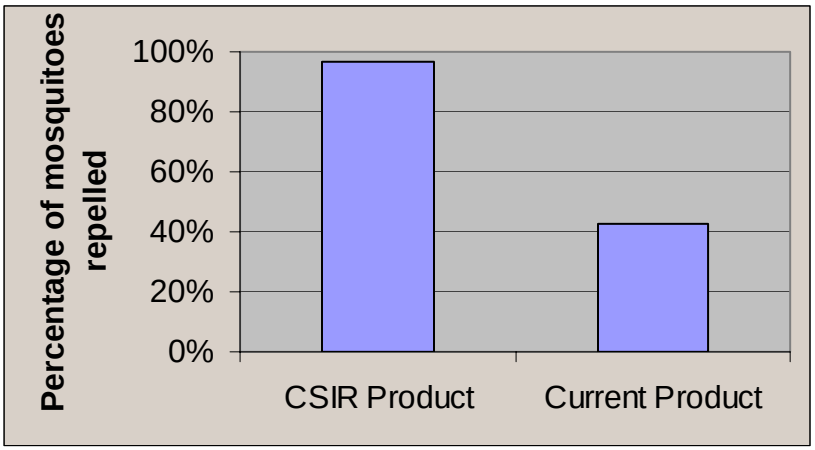

Figure 4: Results of CSIR efficacy tests for *Lippia javanica*[7]

L. javanica is abundantly available locally during the wet summer season and the repellent is relatively easy to prepare and apply. It is remarkable that more than five years after it was discovered[7, 40], this repellent is still not available to the general public.

6.7. Other natural alternatives

Other alternatives include impregnated bed nets containing natural or synthetic EDC-free insecticide, solar-powered high frequency electronic mosquito repellents, or the topical application of oils and herbal extracts like coconut oil, cymbopogan, lantana, geranium and neem oil. Other complementary measures include the use of bed nets and house screens, planting lemon trees, fumigating homes by burning eucalyptus branches and leaves, paving irrigation channels, screening water storage tanks and eliminating waste water.

7. RECOMMENDATIONS

The federal government, as a party to the Stockholm Convention on POPs, needs to meet the obligations enshrined in the Convention by setting up processes to phase out and ultimately ban DDT and in so doing set the precedence for other African countries to follow.

The approval of an emergency budget must be considered in order to effectively initiate appropriate responses to stop the use of DDT. Adequate financial and technical resources must be provided to undertake integrated vector management programs, research into alternatives, education and awareness, as well as waste management and reduction, which is to be tied into the Africa Stockpiles Program (ASP) as well as the SAICM, which our government needs to monitor more closely.

The objective of the ASP is to clean up and safely dispose of all obsolete pesticide stocks from Africa and help to prevent future accumulations. It is recommended that the SA government explore the alternatives immediately and halt the use of DDT so as to prevent health effects, as well as the accumulation of DDT stocks in future which will not help in fulfilling the goals of the ASP.

The establishment of a DDT taskforce must be set up to assess South African DDT exposure levels especially in IRS malaria areas, prioritize treatment for people exposed and undertake environmental cleanup under the ASP.

The present practice of prescriptive use of DDT without adequate and appropriate warnings as to its health effects needs to be revised. People exposed to DDT, especially pregnant women, must be adequately informed of its dangers.

The government must prioritise a strategy of DDT replacement by providing adequate

funding for the research, development and implementation of natural non-DDT alternatives some of which already exist[xxxi]. The SA government needs to explore these options as possible solutions to the DDT crisis as part of the NIP implementation.

Research is needed on the hazards from chronic exposure to synthetic pyrethroids being used as alternatives to DDT for indoor spraying and to impregnate bed nets.

Targeted programs emphasising reduced reliance on pesticides and better environmental protection should be developed and supported by WHO, WB, UNEP, and other multilateral and bilateral assistance agencies.

Resistance monitoring and management strategies for DDT usage must be immediately put into place.

The federal government needs to stop overselling DDT's capacity to solve the malaria problem as the present IRS DDT programme is causing irretrievable harm to its citizens. The government's present paradigm is perpetuating this harm and delaying the use of more effective long-term methods such as the alternatives mentioned in this report. Government needs to recognise the complexity of the DDT problem to act promptly.

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