Written Testimony of Roger Bate[1] and Richard Tren[2] to the Senate Environment and Public Works Committee hearing on the role of science in environmental policy making, Wednesday 28th September, 2005, Room 406 of the Dirksen Senate Office Building.

Dear Mr. Chairman,

Thank you for inviting Africa Fighting Malaria to submit written testimony to this most valuable hearing. Africa Fighting Malaria is a health advocacy group based in South Africa and the US. We monitor the activities of aid agencies and health groups in Africa, and in other parts of the world, and advise those interested in policies to combat malaria and other diseases.

Executive Summary

This committee seeks to understand the influence of science in public policy and consequences of the misuse of that science in such policy. There can be few more compelling and tragic examples of the abuse of science and misuse in ongoing public policy than that of DDT and public health.

DDT helped eradicate malaria from Europe and the United States in the 1950s, and was used to eradicate malaria in many other countries in the following two decades. It is still used widely in at least a dozen countries (perhaps as many as two dozen), but these countries have been discouraged by virtually all United Nations organizations, donor agencies and commercial interests.

DDT is safe for human use and there has never been a peer-reviewed replicated study showing any human harm from the chemical, even though billions have been exposed to it (hundreds of millions in moderate to high doses). Its bioaccumulation and persistence in the environment have caused far less harm than is commonly believed. But small problems did occur when massive amounts were used in farming, and today, quite correctly, it is used solely in disease control where tiny amounts are used. But some environmental groups continue to conflate tiny vital use in disease control with massive and potentially dangerous use in agriculture. These groups have sustained pressure against its use for over three decades with disastrous results. Today, their mistaken rhetoric is repeated by aid agencies around the world.

The UN's World Health Organization has dithered and although not rhetorically opposed to DDT has purchased none in recent years. The malaria program of the United States Agency for International Development has been the subject of other Senate hearings for failure to use DDT, or even to make significant purchases of any useful commodities. Very recently a senior manager within the German corporation, Bayer Crop Sciences, has gone on record supporting EU threats of trade sanctions against those countries that seek to use DDT solely for malaria control.

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Ultimately it is poor children in Africa that pay for these policy failures, based on abused science. As President Bush has announced a massive increase in federal funds for malaria control, we urge the US Government to insist that years of scaremongering and bad science be reversed and to take a strong stance against the EU and Bayer Crop Sciences.

Introduction

Africa Fighting Malaria is a health advocacy group based in Johannesburg, South Africa and Washington DC. For the past five years, we have researched the political economy of malaria control and advocated improved malaria control policies from the various UN organizations and donor agencies. Much of our efforts have been directed towards improving the public and donor community's understanding of dichlorodiphenyltrichloroethane (DDT) and its place in malaria control.

Broadly we believe that scientific and public health officers in malarial countries generally know better than donors what their countries require, and should have far greater powers in determining the best public health interventions. Unfortunately, far too often, that power is taken away from them and malaria control policies are influenced by donor agency contractors with vested interests that use unsound science to support their case. The net result is that effective malaria control is undermined and many young children in malarial countries die before they reach their fifth birthday.

We greatly appreciate the opportunity to submit this testimony and warmly welcome the objectives of this hearing. The abuse of science and its effect on public policy has far reaching effects around the globe. The case study of DDT and its place in malaria control is a perfect example of how bad science and scaremongering allows government officials, UN agencies and private companies to put their own interests, commercial or otherwise, ahead of those that they are supposed to be assisting.

Our submission gives an overview of the malaria situation in Africa and the importance of DDT to malaria control. We will address the reasons given for banning DDT for agricultural use in the United States in 1972 and how this banning influenced the use of DDT in malaria control around the world. We will address the precautionary principle, which has increasing traction among policy makers, and will apply this principle to DDT in malaria control.

We will then summarize the way in which unsound science and scaremongering has influenced public policy with regard to malaria control and how lives have been lost as a direct result of such actions.

Malaria in Africa

The most recent and credible studies estimate that there are approximately 515 million episodes of malaria every year and that more than two thirds of those cases occur in Africa[34]. Overall 2.2 billion people are at risk from malaria and even though these

[3] Robert Snow et al. "The Global distribution of clinical episodes of *Plasmodium falciparum* malaria" *Nature 434,* 214-217. 10 March 2005

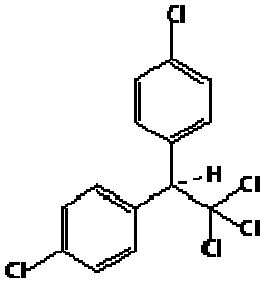
figures are conservative, the scale of the malaria problem is larger than previously thought. Of the four types of malaria that can infect man, the deadliest is *Plasmodium falciparum* and the vast majority of cases in Africa are of this lethal strain[5].

The World Health Organization estimates that over 1 million people die from malaria every year, most of these deaths occur in Africa among children under the age of 5[6]. Some estimates put the economic cost of malaria to Africa at over $12 billion per year and could reduce economic growth in Africa by 1.3% per year[7]. In spite of the enormous human and economic burden imposed by malaria, effective tools to halt the spread of the disease exist and several countries are using such tools and reducing cases and deaths accordingly. One such intervention is the careful spraying of small amounts of DDT on the inside walls of houses. As we explain below however, many countries are unable to use DDT because of a combination of donor country pressure, the threat of trade sanctions and misinformation and misunderstandings about the way in which DDT is used.

We give a brief history of the use of DDT and its role in malaria control. We then discuss the banning of DDT for agriculture and the pressure to reduce the use of DDT in malaria control. Last we address the stance that the donor community has taken to the use of DDT and their support of malaria control in Africa.

DDT in Malaria Control

DDT was first synthesized by Othmar Zeidler in 1874 when, as a German graduate student he was experimenting with different chemicals. Zeidler reacted chloral hydrate with chlorobenzene in the presence of sulphuric acid and found that it produced dichlorodiphenyltrichloroethane – DDT. Zeidler didn't actually do anything with the DDT that he produced and for almost sixty years the compound was unused.



Graphical depiction of DDT

During the 1930s a scientist working for the Swiss chemical company JR Geigy, Dr. Paul Mueller was looking for an insecticide to control clothes moths and happened upon DDT.

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[4] Snow et al. expose the fact that previous studies underestimated the scale of falciparum malaria in South East Asia.
[5] The other forms of malaria are *P. malariae*, *P. vivax* and *P. ovale*.
[6] WHO "World Malaria Report 2005" WHO, Geneva, www.rbm.who.int/wmr2005/html/exsummary_en.htm
[7] Jeffrey Sachs "Economic analyses indicate that the burden of malaria is great" Roll Back Malaria Partnership, WHO, Geneva, http://rbm.who.int/docs/abuja_sachs2.htm

Thus Mueller discovered one of mankind's most useful chemicals. There were numerous toxic substances available to control insecticides at the time, and although not realized at first, DDT's most revolutionary aspect was its ability to repel insects and not its toxicity.

The Allied forces first used DDT during the Second World War to control typhus, dusting civilians, concentration camp survivors, and their troops with DDT powder, which was highly effective at killing the body lice that transmitted the disease. Scientists soon noted that because of its ease of application and long lasting residual action, DDT would be useful in controlling another vector borne disease, malaria.

When it is used in malaria control, sprayers apply small amounts of DDT, usually 2g of active ingredient per square meter, on the inside walls of houses and under the eaves outside where mosquitoes rest between blood meals (this is known as IRS – indoor residual spraying). Because of its long lasting action – up to 1 year – DDT vastly improved malaria control as previously, shorter acting insecticides had to be applied to dwellings every 1 to 2 weeks. DDT works in three ways: it is a spatial repellent and as such repels mosquitoes so that they do not enter areas that have been sprayed; it acts as an irritant, so that those mosquitoes that were not repelled, are irritated and exit structures, often before they have fed; finally DDT is acutely toxic to the *Anopheles* mosquitoes and therefore very effective at killing them. With DDT, malaria control officers had within their grasp a tool that could potentially eradicate malaria.

After the Second World War, Southern European countries were the first to attempt IRS programs using DDT. Within a few short years DDT spraying had eradicated malaria from Europe. The United States Government adopted DDT spraying soon after the war, and its use successfully eradicated malaria by 1952. In 1945 the government of Bolivia started using DDT against *Aedes aegypti*, the mosquito vector of the dengue and yellow fever viruses.[8] By 1947 Bolivia had eradicated the mosquito. Bolivia's quick success encouraged the Pan American Health Organization to begin a hemisphere-wide program to eradicate *Aedes aegypti*. By the early 1950s many countries had eradicated or greatly reduced the distribution of this dangerous mosquito. Through their successes, the risks of dengue and yellow fever epidemics largely disappeared from Central and South America.

Table 1 below details DDT's dramatic impact on malaria cases in selected countries in the Americas.

Table 1 Changes in Malaria Morbidity in Countries Before and After Malaria Was Controlled or Eradicated by DDT [9]

Country	Years	Cases	% Change
Cuba	1962 1969	3,519 3	99.9

[8] Severo, O., *Eradication of the Aedes aegypti mosquito from the Americas*, in *Yellow fever: A symposium in commemoration of Carlos Juan Finlay*. 1955, The Jefferson Medical College of Philadelphia: Philadelphia, PA, USA. p. 39-58.

[9] World Health Organization, (1971) Executive Board, 42nd Session, Appendix 14 "The Place of DDT in Operations Against Malaria and Other Vector Borne Diseases" p 177. WHO, Geneva.

Dominica	1950 1969	1,825 Nil	100
Dominican Republic	1950 1968	17,310 21	99.8
Grenada and Curacao	1951 1969	3,233 Nil	100
Jamaica	1954 1969	4,417 Nil	100
Trinidad and Tobago	1950 1969	5,098 5	99.9
Venezuela	1943 1958	817,115 800	99.9

At the same time, many African and Asian countries started using DDT. The vector control programs in South Africa quickly adopted DDT in 1946 and before long the total malarial area was reduced by 80% to low lying border areas with Mozambique and Zimbabwe (then known as Portuguese East Africa and Southern Rhodesia). In the Transvaal Province[10], the number of malaria cases fell to about one tenth of the number of cases reported in 1942/43.

The number of malaria cases on the Indian sub continent was far higher than in South Africa, and the scale of success in malaria control was far more dramatic. In 1951, India's malaria control program began to use DDT and soon after saw some spectacular health benefits. Between 1953 and 1957, morbidity was more than halved from 10.8% to 5.3% of the total population and malaria deaths were reduced almost to zero (the use of new drugs was another key factor in mortality reductions).

After DDT was introduced to malaria control in Sri Lanka (then Ceylon), the number of malaria cases fell from 2.8 million in 1946 to just 110 in 1961. Similar spectacular decreases in malaria cases and deaths were seen in all the regions that began to use DDT. The newly formed Republic of China (Taiwan) adopted DDT use in malaria control shortly after the Second World War. In 1945 there were over 1 million cases of malaria on the island, however by 1969 there were only 9 cases and shortly thereafter the disease was eradicated from the island (and remains eradicated)[11].

In 1955, emboldened by the successes achieved with DDT against malaria, the WHO launched its malaria eradication program, based on the extraordinary successes that had been seen with DDT. The plan was funded mostly by the US Government and was based on four stages:

- preparation,
- attack,
- consolidation and

[10] After South Africa's political transformation to democracy, provincial borders were redrawn and the Transvaal province was turned into 4 new provinces – Gauteng, Mpumalanga, Limpopo Province and North West Province.
[11] World Health Organization, (1971) p 177

- maintenance

In the early 1950s cases of DDT resistance among various Anopheles species was detected by public health experts. In order to preempt the development of insecticide resistance, the WHO proposed that the attack phase would overwhelm the mosquito population with spraying and reduce the population dramatically before any insecticide resistance could develop. The attack phase was only supposed to last 5 years, after which it was anticipated that the transmission of malaria would have been interrupted for a sufficient period that the disease would be eradicated.

The WHO malaria eradication program has been characterized as a failure, and in as far it did not ultimately achieve eradication, that is true. However, the eradication program did dramatically reduce malaria cases and deaths around the world and save millions of live. The WHO no longer plans to eradicate the malaria, but seeks to control it, primarily by promoting its multi-partner Roll Back Malaria (RBM) campaign[12].

While the WHO's malaria eradication plan failed to eradicate malaria, it was extraordinarily successful at reducing malaria cases and deaths. RBM has failed to achieve anything like the kind of successes achieved in the 1950s and 60s by WHO.

In recent years several respected scientific and medical journals have criticized RBM and the agencies behind it. A recent article in the leading medical journal The Lancet, concluded that RBM had not only "failed in its aims, but it may also have caused harm."[13] In 2004, a commentary in the British Medical Journal called RBM "a failing global health campaign."[14] Again in 2004, the leading science journal Nature, published a special report on malaria which recommended, among other things, that legislators hold hearings into the agencies behind RBM to understand why the program is a failure and to take the necessary action to remedy the situation.

We believe that a major reason for the failure of RBM is that it has shunned the use of indoor residual spraying with insecticides, in particular DDT. As we explain below, there is little scientific basis for not supporting DDT in malaria control given the historic and contemporary success of the chemical in controlling malaria and the paucity of data relating to negative environmental or human health effects.

The public policy decisions relating to malaria control has relied on unsound science, and companies seeking to sell alternatives to DDT have used this corrupt process to their own advantage and are going even further in encouraging trade sanctions against countries that seek to use DDT in malaria control.

We now turn to the evidence, or lack thereof, against the use of DDT and discuss the process by which DDT was banned for agricultural use in the US.

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[12] Roll Back Malaria was formed in 1998 as a partnership between among others, WHO, UNICEF, the World Bank, US Agency for International Development (USAID). See www.rbm.who.int

[13] Lancet Editorial comment, "Reversing the failures of Roll Back Malaria" April 23 2005. The Lancet

[14] Gavin Yamey, "Roll Back Malaria – a failing public health campaign" *British Medical Journal*, 328, 1086-1087 (2004) http://bmj.bmjjournals.com/cgi/content/full/328/7448/1086

The campaigns against DDT

Rachel Carson's famous 1962 book *Silent Spring* questioned the impact that synthetic chemicals were having on the environment. Carson's argument was that DDT and its metabolites, DDE and DDD, thin bird eggshells, which leads to egg breakage and embryo death. Carson postulated that DDT would therefore severely harm bird reproduction and led to her theorised silent spring.

There is some evidence that DDT – actually one of DDT's metabolites, DDE – is linked to thinner eggshells for raptors. In particular, a 1975 study by Jeffrey Lincer found an inverse correlation between DDE in North American raptor eggs and eggshell thickness in the American Kestrel[15]. However despite numerous studies on DDT and eggshells, scientists still do not understand how the mechanism by which DDT is supposed to thin eggshells. DDT and its metabolites do not seem to have any effect on poultry, fowl, herring birds and most passerine birds[16].

Despite the evidence concerning the effect of DDE on kestrel eggs, there is a great deal of evidence to suggest that egg shell thinning was occurring long before DDT was ever used. A 1998 study for the Royal Society for the Protection of Birds in the UK found that eggshell thinning had actually begun 50 years before the introduction of DDT. It is likely that changes in habitat, all sorts of other pollutants (oil, lead, and mercury to name but a few), increased noise and other environmental factors could have had an impact on the eggshells.

Without any good evidence, Rachel Carson suggested that insecticides were responsible for the decline in numbers of eagles in America[17]. What Carson didn't point out was that the Bald Eagle had been placed on the endangered species list in 1921, 25 years before DDT was ever produced. In 1937, the bald eagle had disappeared from New England and had declined dramatically in Alaska – one reason was that $100,000 was paid in bounties for over 115,000 bald eagles between 1917 and 1942. The population of bald eagles actually started increasing quite dramatically in the 1960s and early 70s, while DDT was still being used.

Overall the number of birds in the US increased while DDT was being used. The Audubon Society reported in 1960 that 26 bird species had become more numerous since 1941 – interestingly some of those species included raptors[18]. It is likely that the bird

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[15] Lincer, J.L. (1975) DDE-induced eggshell-thinning in the American kestrel: a comparison of the field situation and laboratory results. *Journal of Applied Ecology*, **12:** 781-793.

[16] Passerine birds are perching birds that have feet with four toes so that they can grip onto branches. With around 5,400 species, more than half of all bird species are passerines.

[17] Like the robin, another American bird seems to be on the verge of extinction. This is the national symbol, the eagle. Its populations have dwindles alarmingly within the past decade. The facts suggest that something is at work in the eagle's environment which has virtually destroyed its ability to reproduce. What this may be is not yet definitely known, but there is some evidence that insecticides are responsible. Carson (1972) Silent Spring, Penguin, London, p 113.

[18] See Anon. 1942. The 42nd annual Christmas bird census." Audubon Magazine 44;1-75 (Jan/Feb 1942), and Cruicjshank, AD (editor) 1961. The 61st annual Christmas bird census. Audubon Field Notes 15(2); 84-300

numbers increased because DDT actually killed off many of the parasites that transmitted avian diseases.

Rachel Carson was not the only writer attacking DDT, among others, the biologist Paul Ehrlich wrote:

> The Department of Health Education and Welfare announced studies which showed unequivocally that increasing death rates from hypertension, cirrhosis of the liver, liver cancer, and a series of other diseases has resulted from the chlorinated hydrocarbon load. They estimated that Americans born since 1946 (when DDT usage began) now had a life expectancy of only 49 years, and predicted that if current patterns continued, this expectancy would reach 42 years by 1980, when it might level out[19].

The Department of Health Education and Welfare and Ehrlich were wrong. In 1980, life expectancy at birth for both males and females in the United States was 73.7 years, 31.7 years longer than Erhlich predicted in his alarmist and misleading publication.

Amid the growing pressure from environmentalist groups, in 1971 the newly formed Environmental Protection Agency (EPA) held scientific hearings into DDT. The hearings were held over 8 months, involved 125 witnesses, with 365 exhibits and produced a 9,312 page manuscript. The presiding judge, Edmund Sweeny noted that:

> …no Hearing Examiner will ever enjoy the privilege that I had in listening to so many leaders in the field of scientific and medical achievement…No restrictions were placed on the number of witnesses they could present, other than the necessary exhortations concerning relevance and materiality. The pros and cons of DDT have been well aired. I think the right of cross-examination spurred a genuinely sober assessment of the facts available, particularly on the question of the benefits and risks of DDT. [20]

Sweeny ruled that DDT should not be banned and with reference to the supposed environmental harms associated with DDT noted that:

> The uses of DDT under the registration involved here do not have a deleterious effect on freshwater fish, estuarine organisms, wild birds or other wildlife[21].

In his ruling Sweeny also noted that:

> "DDT is not a carcinogenic hazard to man... DDT is not a mutagenic or teratogenic hazard to man..."[22]

In other words, Sweeney concluded that DDT did not pose a cancer risk to humans, did not cause mutations in humans and did not pose a threat to developing foetuses. Overall,

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[19] Paul Erhlich, "Eco-Catastrophe" *Ramparts,* September 1969, p. 24-28 reprinted in *Ecocide and Population,* Michel Adelstein and Jean G. Pival, eds. New York: St. Martin's Press (1971).
[20] Edmund Sweeny, Introduction to the Examiner's Report (1972).
[21] Sweeney EM. EPA Hearing Examiner's recommendations and findings concerning DDT hearings., 40 CFR 164.32, 25 April 1972.
[22] Ibid

the conclusion of the hearings was that DDT was relatively benign and the allegations made against it did not stand up to scrutiny. There was no case for banning DDT, and yet Sweeney was overruled by the then administrator of the EPA, William Ruckelshaus who didn't even attend one hour of the hearings. The decision to ban DDT was essentially a political one without any grounding in good science[23].

The reality is that many of the catastrophic predictions made by Carson simply never materialized. Currently DDT is only approved for use in public health programs, which involve spraying tiny amounts of the insecticide on the inside walls of houses. The environmental contamination from this usage is negligible and so criticisms of DDT use on environmental grounds lack scientific validity and are largely irrelevant.

Since the discovery of DDT countless millions of people have been exposed to DDT in one way or another. In this respect AG Smith, of the Medical Research Council's Toxicology Unit at the UK's University of Leicester, writes in the respected peer-reviewed British medical journal, *The Lancet*, that "in the 1940s many people were deliberately exposed to high concentrations of DDT through dusting programmes or impregnation of clothes, without any apparent ill effect" Furthermore, since the 1940s, thousands of tonnes have been produced and distributed throughout the world and millions of people have come into direct contact with DDT. Initially, the distribution was restricted to soldiers in WWII and then to the general public in the aftermath of WWII. When demand for DDT escalated in the post WWII period, a plethora of studies were conducted with regards to DDT's safety for humans. Indeed, Smith notes, "If the huge amounts of DDT used are taken into account, the safety record for human beings is extremely good."

The political nature of the banning of DDT is exemplified by William Ruckelshaus's change in opinion about DDT. Before his position as the head of the EPA, Ruckelshaus was assistant attorney general, where he stated in a US Court of Appeals Report on August 31, 1970 that "DDT has an amazing and exemplary record of safe use, does not cause a toxic response in man or other animals, and is not harmful. Carcinogenic claims regarding DDT are unproven speculation."

However less than a year later when he was with the EPA, he addressed the US Audubon Society, of which he was a member, and noted that "As a member of the Society, myself, I was highly suspicious of this compound, to put it mildly. But I was compelled by the facts to temper my emotions ... because the best scientific evidence available did not warrant such a precipitate action. However, we in the EPA have streamlined our administrative procedures so we can now suspend registration of DDT and the other persistent pesticides at any time during the period of review."[24] Ruckelshaus later explained his ambivalence by stating that as assistant attorney general he was an advocate for the government, but as head of the EPA he was "a maker of policy."

[23] DDT was the first project that the EPA undertook and Ruckelshaus was probably keen to demonstrate the power of the newly formed authority.. On February 10th 1970, President Nixon announced, "we have taken action to phase out the use of DDT and other hard pesticides." This was before the EPA had even been established.

[24] Address to the Audubon Society, May 2, 1971. Source: Barrons, November 10, 1975.

DDT and Human Health

DDT is probably the most studied synthetic chemical in history and has been used around the world in various different forms and for different reasons for around 60 years. Often DDT was sprayed widely in the environment in enormous quantities and as DDT is persistent in some environments (such as soil), it is likely that most humans have some level of DDT or its metabolites DDE and DDT in their systems. Yet despite its widespread use and thousands of scientific studies, there is little or no compelling evidence to suggest that DDT causes any actual human health harm.

Annex 1 of this report contains a more detailed discussion of the evidence that DDT causes harm to human health. DDT is classified as a possible human carcinogen by the International Agency for Research on Cancer (IARC) which is the same classification given to coffee and numerous other every day foodstuffs. DDT is non-toxic to humans; even people who have attempted suicide by ingesting large amounts of DDT have failed in their endeavor. Although DDT is found in breast milk and is known to act as an endocrine disrupter (much like many natural substances), there are no data to suggest that it causes any actual human harm.

The absence of any credible, scientific evidence against DDT on environmental and/or human health grounds has not stopped individuals, organizations and agencies for calling DDT use to be scaled back. In 2001, the World Health Organization developed an "Action Plan for the Reduction of Reliance on DDT in Disease Vector Control" on the basis of an earlier World Health Assembly resolution (WHA resolution 50.13) that called for the reduction in the use of insecticides in the control of vector-borne diseases[25]. In 2001, the UN Environment Program's Stockholm Convention on Persistent Organic Pollutants granted an exemption for DDT to be used in vector-borne disease control. However, according to the WHO, the Convention also recognized "the need to work towards a longer-term goal of reducing reliance on vector control programmes on pesticides in general and DDT in particular to safeguard ecosystem (sic) and human health alike from the insidious effects of POPs pesticides."[26]

The above statement exposes an inherent bias against insecticides and against DDT in particular. Even though there is little or no evidence of environmental or human health harm from DDT and there is overwhelmingly strong evidence in favor of DDT as a public health tool, pressure against its use continues.

One way of evaluating the need for DDT is to apply the precautionary principle (its possible that the EPA DDT ban was based on an ultra-precautionary concern about DDT's effects). There are various interpretations of the precautionary principle, but a popular definition is known as the Wingspread Definition and states:

> "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect

[25] World Health Organization "Action Plan for the Reduction of Reliance on DDT in Disease Vector Control" WHO/SDE/WSH/01.5 *WHO*, Geneva, 2001
[26] Ibid. Forward by Dr Richard Helmer, Director, Protection of the Human Environment.

> relationships are not established scientifically. In this context the proponent of the activity, rather than the public, should bear the burden of proof."

US Government policy analyst Indur Goklany suggests that when evaluating a chemical such as DDT, one should apply the precautionary principle with regard to four criteria[27]. First, one should evaluate the impact on human mortality and morbidity where human lives must be considered to be more important than bird or animal life. Second, one must evaluate the immediacy of the threat, where immediate threats should be considered more important than potential threats in the future. One reason for this is that in the future we may have some method of mitigating the potential negatives consequences of the chemical. Third, one must consider the uncertainty surrounding the use of DDT, where any outcomes that we know of with certainty must be given more weight than any outcomes that we are uncertain about. Lastly, one has to consider the irreversibility criterion; whereby potentially negative outcomes that are irreversible must be treated more seriously than those that are reversible.

When evaluating the use of DDT, applying every one of these criteria would rule in favor of DDT use in malaria control. Due to DDT's remarkable effectiveness in averting human illness and death from vector borne diseases and the negligible impact on the environment when used in public health, the first criterion must rule in favor of DDT.

Second, the immediacy criterion must rule in favor of DDT. Every thirty seconds a child dies from malaria and yet in the 60 years that DDT has been used, no scientific replicated study has been able to point to actual human harm from the insecticide. Even in the unlikely event that some negative human health effect was scientifically proven in the future, the fact that lives can be saved by using DDT right now, one must reject calls for DDT not to be used.

Third, given the certainty of illness and potential death that arises from malaria and the ongoing uncertainty surrounding the impact of DDT on human health and the environment, again, one must rule in favor of DDT when evaluating the uncertainty criterion.

Lastly, we know that when DDT was banned for agricultural use, levels of DDT and its metabolites DDE and DDD in the environment fell. The potential environmental harm that could arise from DDT is therefore reversible, however it is impossible to reverse the deaths that arise from malaria. Once again, on this criterion, one can only favor DDT.

In summary, when malarial countries evaluate the risks that their citizens face from disease and apply the precautionary principle to DDT, they can only favor its use in malaria control. It is perhaps for this reason that countries in Africa are returning to the use of DDT in malaria control, however not without opposition from donor

[27] Indur Goklany (2001) "The Precautionary Principle" Cato Institute, Washington DC

agencies, private enterprise with vested interests in the use of other insecticides and the European Union.

DDT in malaria control today

South Africa maintained its IRS program using DDT from 1946 to 1996. In 1996 the Department of Health replaced DDT with synthetic pyrethroid insecticides. As DDT is best sprayed on traditional mud structures, and an increasing number of houses in rural malarial areas are made in the western style with plastered and painted walls, the government was correct to attempt to introduce alternative insecticides. However, largely because agriculture uses synthetic pyrethroid insecticides, insecticide resistance soon became a problem. A highly efficient malaria vector, *Anopheles funestus*, believed to have been eradicated in the 1970s, soon reappeared in South Africa.[28] What followed was one of the worst malaria epidemics in the country's history. Malaria cases rose from around 6000 in 1995 to over 60 000 in 2000.[29]

In early 2000, South Africa reintroduced DDT to malaria control in KwaZulu Natal Province, the province worst hit by the epidemic. In 2001, South Africa further introduced new artemesinin-based combination therapies to treat malaria patients. The combination of effective insecticides and drugs ensured that malaria cases fell by almost 80% by the end of 2001.

In 2000 a privately funded IRS program in the Zambian Copperbelt Province began using DDT in its IRS program. The DDT spraying was solely responsible for 50% decline in malaria cases after just one spraying season.[30] The success of this program continues and has influenced national malaria control policy such that other parts of Zambia have implemented DDT IRS programs. Other southern African countries that have successfully used DDT to control malaria include Swaziland, Namibia, Zimbabwe and Madagascar.

All of these countries ensure that well structured, vertical malaria control programs use DDT, programs that have good scientific oversight and control and monitor the use of the chemical (Zimbabwe's economy has collapsed and its program is far less effective than before, but nevertheless it was previously successful). For instance, when Zambia returned to using DDT, it did so with the full cooperation and involvement of the Environmental Council of Zambia (ECZ), Zambia's equivalent of the Environmental Protection Agency (EPA). It is directly in the interests of malaria control program managers to ensure that no DDT is diverted to agriculture or some other use – should that happen it may jeopardize their control programs by causing insecticide resistance.

Despite the clear and unequivocal success of DDT in malaria control in several southern African countries, there is still a great reluctance, or outright refusal, among the various

[28] K Hargreaves et al. (2002) "Anopheles funestus resistance to synthetic pyrethroid insecticides in South Africa." Medical and Veterinary Entomology, 14, no.2: 181-89

[29] South African Department of Health, *National Malaria Update* (SA Dept of Health, 2003, Pretoria)

[30] B Sharp et al. (2002) "Malaria control by residual insecticide spraying in Chingola and Chililabombwe, Copperbelt Province, Zambia" *Tropical Medicine and International Health*, 7, no 9: 732-36

UN agencies involved in malaria control to support indoor residual spraying (IRS) and/or DDT.

For instance, WHO's Geneva office, which is far removed from those offices in malarial countries, has either ignored DDT or actively discouraged its use. An example of this anti-DDT and anti-insecticides bias is found in the 2003 Africa Malaria Report which is a fine example of WHO Geneva's stonewalling of DDT and more generally of IRS[31]. Although this report advertises itself as a comprehensive study on the malaria situation, it barely mentions IRS, even though this is the main method of malaria control for much of southern Africa.

The United States Agency for International Development (USAID), like most other donors, has followed WHO and other UN agency lead and has not supported IRS for many years. USAID's official position is that it will only promote DDT as a "measure of last resort". This gives the agency carte blanche never to support DDT as they can always claim that other tools of malaria control have not been tried.

> "in those (relatively rare) cases where DDT is truly needed for malaria control, the benefits of its use as a vector control tool are considered to outweigh the risks the chemical presents to human health and the environment.[32]"

While some misplaced concern for the environment and human health may be part of USAID's reasons for refusal to fund IRS, the more significant reason is likely to be the vested interests that influence its spending plans. In 2004, USAID's budget for malaria control stood at around US$80 million. However, the agency provides no documentation that it spends a single cent buying either insecticides or effective artemsinin drugs for malaria control[33]. The vast majority of the agency's budget is directed towards US-based consultants who 'advise' malaria control programs and conduct nebulous projects that have no clear deliverables. USAID, like most other donor agencies, is far more comfortable directing its funding to its own consultants, rather than the departments of health in the countries they are supposed to be assisting.

Should an aid agency wish to support IRS, either with or without the use of DDT, it would have to direct funds specifically into a Department of Health or some other agency that would then procure insecticides, spray pumps and hire and train the required personnel. However for this to happen, the aid agency and its preferred contractors would lose control of the funds and the power that those funds give them; something they appear loath to do.

Several congressional hearings have been held in order to understand better USAID's malaria control program, to increase its transparency and accountability and to improve

[31] World Health Organization (2003) Africa Malaria Report, WHO, Geneva. http://www.rbm.who.int/amd2003/amr2003/amr_toc.htm
[32] Pers Comm. Brian Hirsch, USAID, 20 June 2001
[33] Roger Bate & Benjamin Schwab (2005) The Blind Hydra, USAID Fails to Control Malaria. American Enterprise Institute, Washington DC, April 22 2005

its overall performance[34]. Indeed, in April 2005 Senators Brownback (R, KS), Landrieu (D, LA) and Coburn (R, OK) as well as yourself, Mr. Chairman, introduced the End Neglected Diseases Bill (S.950) which is designed to set earmarks for commodity procurement made by USAID and to increase the transparency with which USAID spends taxpayers money. (See Annex 2)

We appreciate the fact that Senate appropriators have included language in the Foreign Operations and Related Program Appropriations Act that requires the purchase of commodities and we hope that this Senate language is retained in Conference. (See box below) Given USAID's poor track record on malaria control in the past, we would have preferred to see specific earmarks for USAID malaria spending in the appropriations language. We are however reassured in the knowledge that the US Senate will exercise sufficient oversight over USAID to ensure that it does indeed purchase sufficient commodities for malaria control.

HR 3507 – Department of State, Foreign Operations and Related Program Appropriations Act, 2006 (Engrossed Amendment as Agreed to by Senate)

Malaria

SEC. 6125. Of the funds appropriated under the heading `Child Survival and Health Programs Fund', not less than $105,000,000 should be made available for programs and activities to combat malaria: Provided, That such funds should be made available in accordance with best public health practices, and considerable support should be provided for the purchase of commodities and equipment including: (1) insecticides for indoor residual spraying that are proven to reduce the transmission of malaria; (2) pharmaceuticals that are proven effective treatments to combat malaria; (3) long-lasting insecticide-treated nets used to combat malaria; and (4) other activities to strengthen the public health capacity of malaria-affected countries: Provided further, That no later than 90 days after the date of enactment of this Act, and every 90 days thereafter until September 30, 2006, the Administrator of the United States Agency for International Development shall submit to the Committees on Appropriations a report describing in detail expenditures to combat malaria during fiscal year 2006.

In July 2005, President Bush announced a significant increase in funding for malaria control of $1.2 billion over five years. It is now clear that these funds will be utilized by USAID, yet without specific legislation that would compel the agency to purchase commodities that save lives and to support activities that are proven to work, the funds will probably be wasted.

In addition to the way in which USAID favors its own contractors over the needs of malarial countries when funding malaria control, it now appears that private companies have been taking advantage of the bad science and misinformation around the use of DDT in order to advance their own commercial interests.

[34] On 12 May 2005, the US Senate Subcommittee on Federal Financial Management, Government Information and International Security (FFM) held a hearing into the practices of USAID on malaria control..

For several years, the Government of Uganda has been attempting to reintroduce the use of DDT to its malaria control program. The WHO reports that in 2003 there were over 12 million cases of malaria and around 93% of the 27 million strong population live at risk from the disease. The decision to use DDT is a wise one, based on the successful use of DDT in the past in Uganda and the contemporary success of DDT in malaria control in other African countries. In a pilot project between 1959 and 1960 in the Kigezi district of Uganda, DDT spraying ensured that malaria parasite prevalence for all ages fell from 22.4% to just 0.5% when DDT was sprayed three times a year and from 12.5% to 0% where it was sprayed twice a year[35].

Yet opposition to DDT is considerable and on February 2 2005, the UN news agency IRIN reported that the European Union had cautioned Uganda against using DDT. Specifically the agency reported:

"If Uganda is to use DDT for malaria control, it is advisable to do so under strictly controlled circumstance and in consultation with other countries in the region that may be affected." In addition the EU has called for a parallel system to monitor foodstuffs and to take corrective measures "to address DDT-related health concerns of consumers in Uganda and in export destinations."[36]

On 26 April 2005, the EU made further statements in order to discourage Uganda from using DDT. The UN Newswire reported that chief of the EU mission in Uganda, Sigurd Illing, said "there could be dire consequences for the country's exports to Europe - which account for more than 30 percent of Uganda's total exports - if DDT was detected in export commodities such as horticultural produce. The EU has strict maximum limits of pesticide levels in products meant for animal or human consume, especially on prohibited chemicals such as DDT."

Africa Fighting Malaria recently obtained evidence that the EU is being supported by among others, Bayer Crop Science, a division of the giant multi-national chemical and pharmaceutical company that produces alternatives to DDT[37]. In an email dated September 23 2005, Dr. Gerhard Hesse of Bayer Crop Sciences first admits that his company has a direct commercial interest in DDT not being used and then states that on the basis that some DDT might be diverted from public health programs to agriculture, he and his company therefore:

" fully support EU to ban imports of agricultural products coming from countries using DDT."[38]

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[35] World Health Organization, (1971) Executive Board, 42nd Session, Appendix 14 "The Place of DDT in Operations Against Malaria and Other Vector Borne Diseases" p 179. WHO, Geneva.

[36] UN Newswire "EU cautions over plans to use DDT to fight malaria" February 2 2005. http://www.reliefweb.int/rw/RWB.NSF/db900SID/DDAD-699MXX?OpenDocument

[37] Bayer Crop Sciences recorded annual sales in 2004 of over US$ 7bn. For more information on Bayer Crop Sciences see. http://www.bayer.com/subgroups/bayer-cropscience/page1311.htm

[38] Pers comm. Dr Gerhard Hesse September 23 2005

Without providing any actual evidence that DDT was indeed being diverted out of public health programs and into agriculture, Bayer Crop Sciences is ignoring decades of evidence of safe and effective use of DDT and is playing on the misguided fears about the insecticide.

We fear that commercial entities such as Bayer and intransigent and ineffective agencies such as USAID are using bad science and fear about DDT in order to advance their own particular interests. The outrageous tragedy is that children in Uganda and elsewhere are paying with their lives and facing a blighted future so that this coalition of industrial concerns and public agencies can maintain their power base and profits.

Standing in stark contrast to the behavior of aid agencies such as USAID is the Global Fund for AIDS, TB and Malaria (GFATM). This organization acts purely as a funding agency, providing funds for projects that an expert panel considers feasible and valuable. The GFATM does not seek to advise a country on how to conduct its public health programs; it simply provides funds for projects that an expert panel has vetted. Perhaps it is precisely because of this difference in structure that the Global Fund is currently funding some of the most successful malaria control interventions, which include IRS and DDT, while the bilateral donor agencies are funding ITNs, which have failed to reduce the incidence of malaria in any significant way.

Summary and Conclusion

We hope that this testimony has shed some light on the importance of DDT as a public health insecticide and has explained how bad science and the vested interests of commercial organizations, various UN bodies and career bureaucrats has restricted its use in malaria control. We now have evidence that the private sector is complicit in using the threat of trade sanctions to stop Uganda and possibly other countries from using DDT. The role that Bayer Crop Science and the European Union has played in undermining malaria control in Uganda deserves further investigation and we feel that legal action through the World Trade Organization should not be discounted.

Mr. Chairman, we thank you for the opportunity to make this submission and sincerely hope that this hearing will advance the use of good science and expose the disastrous and long term consequences that arise when good science is ignored.

Annex 1

DDT and Human Health.

Is DDT toxic to humans?

DDT's detractors claim that DDT is toxic to humans and when ingested leads to tremors, liver damage, neurological disorders, to name a few. Scientists have studied very few chemicals as extensively as DDT, either experimentally or in human beings. Before DDT was ever used, extensive tests were conducted to establish the safety and efficacy of the chemical. According to West and Campbell,

> "..literally hundreds of animals were experimented upon before DDT was used in the Services. It was administered by mouth, cutaneously and sub-cutaneously; it was rubbed on the skin, with and without the presence of fatty oils…and then a complete history of any pathological symptoms recorded. Post-mortem examination was carried out on all the important organs and tissues, and microscopic slides made of the examination of the degree of affection. The decision was finally made in favor of the use of DDT…."[39]

Even prior to the ban, one of the leading scientific journals, Science, ran a large number of papers on DDT. The majority of these papers were antagonistic, despite the editor of Science, Phil Abelson's own conclusion that:

> "...DDT and its relatives are not truly persistent but are slowly destroyed in soil. DDT is slowly degraded in man, and it is also excreted, so that concentrations do not build up indefinitely."

Malaria specialists refuted the numerous claims against DDT, however the assault on the chemical persisted despite the lack of evidence.

Professor Chris Curtis of the London School of Hygiene and Tropical Medicine has studied the health of 'spraymen', insecticide public health sprayers, from Brazil and India who had been exposed to DDT "was similar to other men of their age."[40] Furthermore, a controlled study conducted on the long term effects of DDT exposure in the early 1950s, which was funded by the United States Public Health Service, found that despite the volunteers in the sample consuming as much as 35 milligrams of DDT every day for 18 months, no adverse effects were found, either at the time of the study or during the follow up investigation ten years later. Indeed, AG Smith notes, "Ingestion of DDT, even when repeated, by volunteers or people attempting suicide has indicated low lethality, and large acute exposures can lead to vomiting, with ejection of the chemical".

Smith summed up the prevailing evidence on DDT human toxicity as follows:

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[39] -West. T.F. and G.A. Campbell, *DDT and Newer Persistent Insecticides*, New York: Chemical Publishing Co., Inc. (1952).

[40] Curtis CF and Lines JD "Should DDT be banned by international treaty" Parasitology Today vol. 16, no. 3, 2000 pp 119-121

> In the 1940s many people were deliberately exposed to high concentrations of DDT thorough dusting programs or impregnation of clothes, without any apparent ill effect. There are probably few other chemicals that have been studied in as much depth as has DDT, experimentally or in human beings.[41]

An agency that has conducted considerable research into DDT is the Agency for Toxic Substances and Disease Registry (ATSDR). This agency forms part of the US Department of Health and Human Sciences and is charged with assessing the health hazards and health effects arising from exposure to hazardous substances. The ATSDR works with its sister organization, the Centers for Disease Control (CDC) and has a joint office of the Director of the National Centre for Environmental Health.

The ATSDR contains the following conclusions for non-occupational inhalation exposure: "No studies were located regarding death in humans or animals after inhalation exposure to DDT *or any of its derivatives* DDE, and DDD". Furthermore, they note that "No studies were located regarding cardiovascular, gastrointestinal, haematological, musculoskeletal, hepatic, renal or dermal effects in humans or animals after inhalation exposure to DDT, *or its derivatives* DDE and DDD" (ATSDR 2002). More broadly the ASTDR states that "studies have monitored human tissue and blood for DDT and its metabolites, but no correlation has been made between the levels found in these tissues and specific disease states."[42]

Thus in terms of the toxicity of DDT and its derivatives on both an acute and chronic basis, the results tend to suggest that DDT is relatively harmless to humans and animals.

Does DDT cause cancer in humans?

The International Agency for Research on Cancer (IARC) categorizes DDT as a possible human carcinogen. The IARC is part of the World Health Organization and its mission is:

> " to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses, and fellowships."[43]

The IARC has five categorizations of carcinogenicity:

Group 1: The agent (mixture) is carcinogenic to humans. The exposure circumstance entails exposures that are carcinogenic to humans.
Group 2 (two classifications):
Group 2A: The agent (mixture) is probably carcinogenic to humans. The exposure circumstance entails exposures that are probably carcinogenic to humans.

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[41] A.G. Smith, "How Toxic is DDT?" *Lancet*, Vol. 36, No.9226, July 22, 2000.) http://www.malaria.org/smithddt.html.
[42] ATSDR Toxicological Profile of DDT, 2002, p. 206, http://www.atsdr.cdc.gov/toxprofiles/tp35.html
[43] http://www.iarc.fr/

Group 2B: The agent (mixture) is possibly carcinogenic to humans. The exposure circumstance entails exposures that are possibly carcinogenic to humans.
Group 3: The agent (mixture, or exposure circumstance) is not classifiable as to carcinogenicity in humans.
Group 4: The agent (mixture, exposure circumstance) is probably not carcinogenic to humans.[44]

The IARC classifications list the agents or groups of agents according to their carcinogenic risk. The classifications also list mixtures of products as well as the likely circumstances in which humans may be exposed to cancer risk. Some of the agents that make up Group 1 include asbestos, mustard gas, plutonium 239, radium 224,226,228 and their decay products and X and gamma radiation. The mixtures that make up group 1 include tobacco, wood dust and Chinese-style salted fish and the circumstances that would put one at risk to Group 1 agents include tobacco smoking, furniture and cabinet making, boot and shoe manufacture and repair and aluminum production.

Group 2A agents include androgenic (anabolic) steroids, Benzedrine-based dyes and ultraviolet radiation A,B and C. The mixtures of agents are made up of, among others, creosotes and diesel engine exhaust and the circumstances under which humans may be exposed to Group 2A products include hair dressing, petroleum refining and using sun beds and sun lamps.

Group 2B agents include aflatoxin, insecticides such as DDT and chlordane, lead and zidovudine which forms part of the HIV/AIDS treatment AZT. The mixtures contained in Group 2B include coffee, carageenan, which is used as a thickener in many dairy products and east Asian-style pickled vegetables. The likely activities that would expose humans to these agents and mixtures are dry cleaning, carpentry and joinery and textile manufacturing.

The agents that are non-classifiable according to their carcinogenicity, Group 3 agents, include fluorescent lighting, fluorides, dieldrin, sulphur dioxide and surgical implants including dental implants and silicone. The mixtures of products include tea, fuel oil, diesel fuels and printing inks and the circumstances of exposure to the various products include the use of personal hair dying products, the manufacture of leather goods and paint manufacture.

The only substance that IARC has officially declared to probably not be a carcinogen, the sole member of Group 4, is caprolactam, which is used in the manufacture of synthetic fibers. All other tested substances fall into Groups 1 to 3.

Although the World Health Organization's cancer agency ranks DDT in the same category as coffee, the US Environmental Protection Agency (EPA) classifies DDT as a probable human carcinogen, giving it a higher carcinogen weighting.

[44] http://monographs.iarc.fr/monoeval/grlist.html

Based upon these classifications it would appear that the EPA possesses additional information about DDT's potential carcinogenicity that IARC does not have, but that is not the case. Both agencies appear to have considered exactly the same data.

Likewise EPA appears to have used similar data, but it appears to assign more weight to animal studies than does IARC. To be classified as a probable carcinogen (Class B2), as DDT is, there needs to be ""sufficient" evidence from animal studies" and ""inadequate evidence" or "no data" from epidemiologic studies."

One of the most common allegations against DDT is that it is carcinogenic, yet neither EPA nor IARC have reached this conclusion. Although this allegation has been publicized widely by various organizations and commentators, there is little substance to the claim.

Furthermore, the Agency for Toxic Substances and Disease Registry notes reviewed studies testing the hypothesis that DDT and its metabolites could cause cancer in humans. The ATSDR, which is an agency of the US Department of Health and Human Services, reviewed breast cancer, pancreatic cancer, Hodgkin's disease and Non-Hodgkin's Lymphoma, multiple myeloma, prostate and testicular cancer, endometrial cancer and the occurrence of any other cancer. Their conclusion was that:

> "The possible association between exposure to DDT and various types of cancers has been studied extensively, particularly breast cancer. Thus far, there is no conclusive evidence linking DDT and related compounds to cancer in humans"[45] (ASTDR 2000).

The Health and Human Services report makes it clear that HHS has arrived at similar conclusions to IARC as to carcinogenicity for the report states. "Overall, in spite of some positive associations for some cancers within certain subgroups of people, there is no clear evidence that exposure to DDT/DDE causes cancer in humans."

Leading US toxicologists, Bruce Ames, who was awarded the top scientific honor, the National Medal of Science by President Clinton in 1999, and Lois Gold of University of California at Berkeley, put the cancer risk associated with DDT into a wider perspective. Their research shows that even at the height of DDT's usage in agriculture, the cancer risk associated with DDT was far lower than that of the cancer risk associated in everyday foodstuffs.

For instance, our intake of coffee is about 50 times more carcinogenic than our intake of DDT before it was banned. Figure 1 below shows clearly the risk – represented by the Human Exposure Dose/Rodent Potency dose – the relative cancer risk of DDT compared with chemicals that we consume in everyday food products.

Figure 1 Human Exposure Dose/Rodent Potency of possible human carcinogens. (Ames and Gold 1999)

[45] ATSDR, (2002) p 124

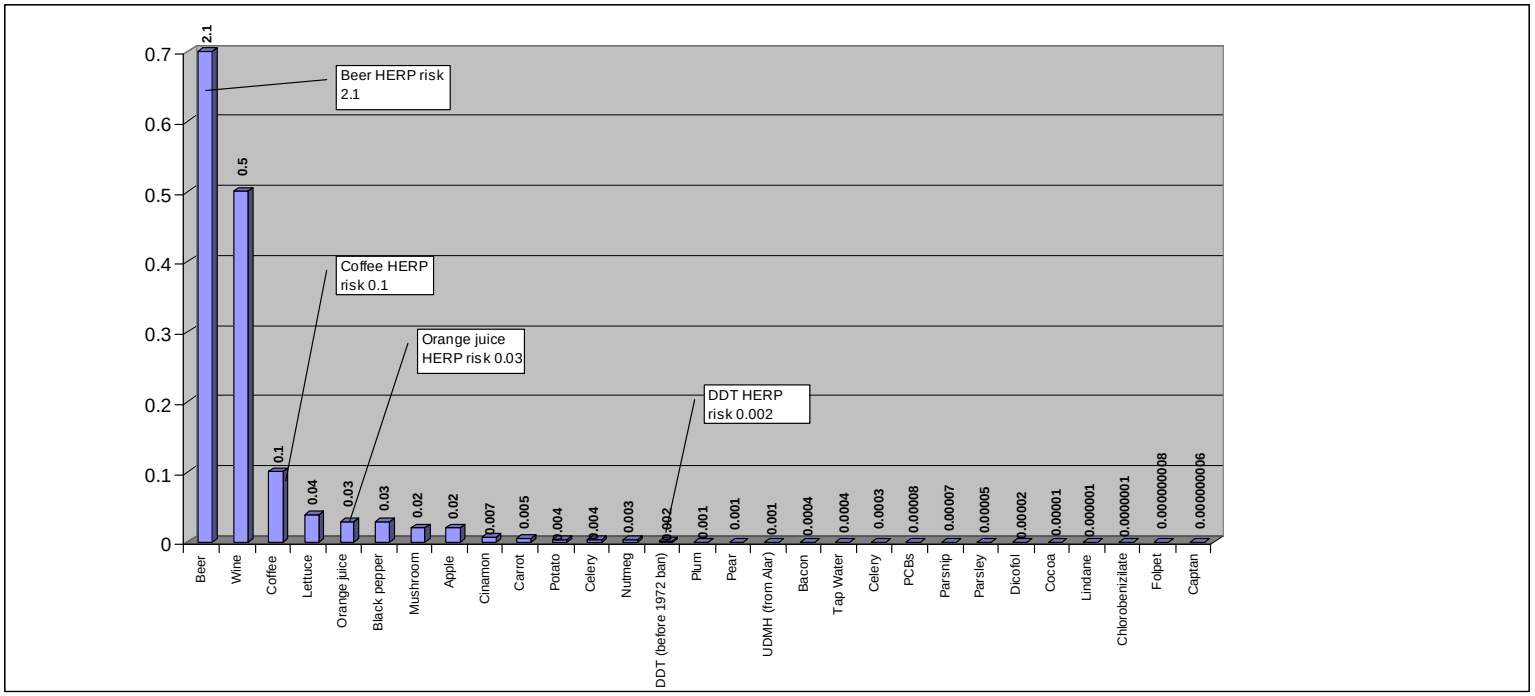

Table 2 below gives more detailed data for some of the possible carcinogenic hazards features in figure 1 above. Some of these carcinogenic substances that many of us ingest as part of a normal, balanced diet, are classified in groups 1, 2A and 2B of the IARC rating system. For instance, 8-Methoxypsoralen which is found in celery, parsnip and fresh parsley is classified in Group 1 and as a carcinogenic to humans. Of course the exposure at which humans encounter this substance means that the Human Exposure Rodent Potential hazard is only 0.0002% for celery, 0.00007% for parsnip and 0.0005% for fresh parsley.

Coffee contains several possible carcinogens, such as caffeic acid and catechol, both of which are classified as Group 2B, possible human carcinogens. Indeed caffeic acid is found in several foodstuffs, such as apples, plums, pears, lettuce and carrots.

Table 2 Selected ranking of possible carcinogenic hazards from average US exposures

Possible hazard HERP (%)	Average daily US exposure	Human dose of rodent carcinogen	Potency TD_{50} (mg/kg/day)[a]	
			Rats	Mice
2.1	Beer, 257g	Ethyl alcohol 13.1ml	9110	(-)
0.5	Wine, 28.0g	Ethyl alcohol 3.36ml	9110	(-)
0.1	Coffee, 13.3g	Caffeic acid 23.9mg	297	(4900)
0.04	Lettuce, 14.9g	Caffeic acid, 7.90mg	297	(4900)
0.03	Orange Juice 138g	d-Limonene 4.28mg	204	(-)
0.03	Pepper, black 446g	d-Limonene, 3.57mg	204	(-)
0.02	Mushroom (*Agaricus bisporus* 2.55g)	Mixture of hudrazines, etc. (whole mushroom)	-	20,300

0.02	Apple, 32.0g	Caffeic acid, 3.40mg	297	(4900)
0.007	Cinnamon, 21.9mg	Coumarin, 65.0mg	13.9	(103)
0.002	Carrot, 12.1g	Caffeic acid, 374g	297	(4900)
0.002	DDT: daily US avg before 1972 ban	DDT, 13.8g	(84.7)	12.3
0.001	Pear, 2.00g	Caffeic acid, 240mg	297	(4900)
0.0008	DDE, daily US avg before 1972 ban	DDE 6.91 mg	(-)	12.5
0.0002	Celery, 7.95g	8-Methoxypsoralen, 4.86mg	32.4	(-)
0.00001	Cocoa, 3.34g	a-Methylbenzyl alcohol 4.3mg	458	(-)

a = no data in CPDB; (-) = negative in cancer test; (+) = positive cancer test(s) not suitable for testing TD_{50}

In summary, agency opinion and the written literature finds no good evidence linking DDT or its metabolites with human cancer. Given the fact that DDT has been used in enormous quantities for over six decades and that many studies into its potential carcinogenicity have been conducted, without drawing any evidence thereof, we can be relatively secure in asserting that DDT is not responsible for cancer in humans.

DDT and Endocrine Disruption

The possibility that man-made chemicals, such as DDT, could disrupt the functioning and development of an organism came about during the 1990s. Scientists from a range of disciplines have proposed that synthetic chemicals can interfere with glands and hormones in humans and animals. This is not something that can easily be dismissed – the ATSDR confirms that DDT given during pregnancy can slow the growth of a foetus and it may change the way the reproductive and nervous systems work. Some studies have showed that DDT or its metabolites can mimic the properties and actions of natural hormones. Tests on rats have shown that DDT can delay puberty and tests on mice showed that DDT could cause neurobehavioural problems when they grow up.

This may sound very worrying, but it is likely that even if DDT acts in this way, it is likely to be biologically insignificant. While the studies into endocrine disruption are of course important, they should be weighed against many studies conducted over many years that can find no harm to the reproductive capability or general health of monkeys, dogs, rats and so on.

One study conducted in 2001 by Mathew Longnecker observed that as maternal serum DDT levels increase, so do the odds of small-for-gestational-age and preterm infants[46]. Yet there were many flaws with Longnecker's study. For instance over half of the children selected for the study were expressly chosen because something was wrong with them. Boys were specifically included because they had deformations of the penis, testicles or nipples and both boys and girls that deviated from normal cognitive and neurological tests were selected. In essence, Longnecker 'cherry picked' his data. Furthermore the study does not explain if DDT-related effects were found in the children

[46] Longnecker MP, Klebanoff MA, Zhou H, Brock JW. "Association between maternal serum concentration of the DDT metabolite DDE and preterm and small-for-gestational-age babies at birth" *Lancet* 358:110–4 (2001).

that were randomly chosen. The study is also flawed because the researchers fail to disclose what objective standard they used to judge smallness-for-gestational age. Most worryingly, the researchers did not control for the presence of other organochlorines. Given that at least one other organochlorine – PCBs – was found in the same pregnant women, it would seem to be highly relevant and important to control for this factor.

Longnecker's study and others fail to demonstrate that DDT is associated with endocrine disruption, small-for-gestation age and reduced lactation.

It is important of course, as with the claims about DDT and cancer, to put the endocrine disruption allegations into some sort of context. It is crucial to link endocrine disrupting compounds with adverse human health effects because the human diet contains naturally occurring endocrine disruptors in fruits and vegetables. Indeed the effect of naturally occurring endocrine disruptors in foodstuffs such as potatoes, carrots, peas, beans, apples, garlic and coffee is far stronger than the hormonal effects of synthetic chemicals. As Stephen Safe, Professor of Toxicology at Texas A&M University explains, "the amount of estrogenic compounds found in a single glass of cabernet wine is 1000 times greater than the estimated daily intake of estrogenic organochlorine pesticide residues."[47]

Not only have the potential endocrine disrupting action of organochlorines not been put in perspective, but claims persist that chemicals such as DDT are linked to declining male reproductive capacity and to breast cancer[48] [49]. Pressure against the use of organochlorines (among them DDT) persist because of the claim that they are linked to a fall in sperm quality. In 1992 Danish scientists of the Copenhagen University Hospital[50] published a paper showing that the number of sperm cells in men's semen had fallen over the past 50 years.

The study was widely reported by the media and used very effectively by environmentalist groups such as Greenpeace in their campaign against synthetic chemicals. The study has however been widely criticized and subsequent studies have found stable sperm counts. Part of the problem with these studies is that we do not have reliable pre-1970 data and so time series comparisons of sperm quality are inherently unreliable. According to Stephen Safe, "researchers have found no correlation between chemical exposures and measures of decreased male reproductive capacity. Demographic differences are more likely to account for the differences seen in the initial studies.[51]"

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[47] ibid, p. 190

[48] Liroff, R "Reduction and elimination of DDT should proceed slowly" *British Medical Journal*, **Vol 321**. 2 December 2000, pp 1404-1405

[49] World Wildlife Fund *Resolving the DDT Dilemma*, World Wildife Fund (1998)

[50] Carlsen, E, Giwercman A, Keiding, N, Skakkebæk, N "Evidence for decreasing quality of semen during the past 50 years" *British Medical Journal* **Vol. 305**, pp 09-13

[51] Safe (2000) p 190. For instance, we know that the shorter the time since an ejaculation, the lower a man's sperm count is. During the time period chosen 1992 Danish study, statistics have shown that the frequency of masturbation has doubled for unmarried men (from 30 times a year to 60) and it also rose for married men (from 6 times a year to 24). At the same time the frequency of marital coitus also increased from around 1.9 times a week to 3 times a week (for married 30-year olds). So the sexual revolution of the 1960s could contribute greatly to the any observed decrease in sperm quality. Lomborg, B The *Skeptical Enironmentalist*, Cambridge, 2001. p 240

More recently a study conducted in the Limpopo Province of South Africa failed to find any strong evidence for a link between DDT and low semen quality among DDT spraymen[52].

The theory of endocrine disruption does not fix on a precise role that DDT is supposed to play. Because of this, the theory of endocrine disruption is hard to prove or disprove. However, given the paucity of data supporting any harm from DDT and the decades of actual data supporting the fact that wherever DDT has been used, both mortality and morbidity have fallen and populations have risen, one can safely conclude that the evidence in favor of DDT disrupting the endocrine system is weak or non-existent.

DDT and Non-Hodgkin's Lymphoma

As with breast cancer, attempts have been made to associated DDT and its metabolites with non-Hodgkin's lymphoma; and as with breast cancer, the conclusion of the scientific community simply does not support the association.

A 1998 study found that "no strong consistent evidence was found for an association between exposure to DDT and the risk of non-Hodgkin's lymphoma."[53] A study of nonfarmers and farmers in four Midwestern states also failed to find an association between DDT exposure and NHL. The ATSDR notes that the odds ratio for the occurrence of NHL "were lower and not statistically significantly elevated above unity for using or handling DDT applied to animals or applied to animals and crops combined. When adjusted for use of other individual pesticides or pesticide groups, when evaluated by type of non-Hodgkin's lymphoma disease, or when stratified by co-exposure to 2,4-D and organophosphate pesticides, no significant odds ratios were observed. No association was observed between estimated duration of DDT use and occurrence of non-Hodgkin's lymphoma, adjusted for use of other pesticides."[54]

[52] Dalvie MA, Myers JE, Thompson ML, Robins TG, Dyer S, Riebow J, Molekwa J, Jeebhay M, Millar R, Kruger P. "The long-term effects of DDT exposure on semen, fertility, and sexual function of malaria vector-control workers in Limpopo Province, South Africa." Envrion Res 2004 Sep;96(1):1-8

[53] Barris D, Zahm SH, Cantor KP, Blair A "Agricultural use of DDT and risk of non-Hodgkin's lymphoma" pooled analysis of three case-control studies in the United States." Occup Environ Med 55:522-7 (1998)

[54] ATSDR, Toxicological profile, DDT, p 119.

Annex 2

Text of the End Negelected Diseases Act (S - 950)