The International POPs Elimination Project (IPEP)

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

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Kenya POPs Situation Report: DDT, Pesticides and Polychlorinated Biphenyls

Physicians for Social Responsibility (PSR) - Kenya

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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.

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TO YOU ALL WE SAY “MUCHAS GRATIAS”

LIST OF ABBREVIATIONS

AAK	-	Agro Chemical Association of Kenya
APEG	-	Alkaline polyethylene glycol
ASP	-	Africa Stockpiles Programme
BAT	-	Best Available Techniques
BCD	-	Base-Catalyzed Decomposition
BEP	-	Best Environmental Practices
BHC	-	Benzene Hexachloride
BHC	-	(Lindane-pure gamma isomer)
DDD	-	Dichlorodiphenyldichloroethane
DDE	-	Dichlorodiphenyldichloroethene
DDT	-	Dichlorodiphenyltrichloroethane
DVBD	-	Division of Vector Borne Diseases
EMCA	-	Environmental Management and Coordination Act
EPA	-	Environmental Protection Agency
FAO	-	Food and Agricultural Organization
GEF	-	Global Environmental Facility
HCB	-	Hexachlorobenzene
HCH	-	Hexachlorohexane
ICIPE	-	International Center for Insect Physiology and Ecology
IPEP	-	International POPs Elimination Project
IPM	-	Integrated Pest Management
ITN	-	Insecticide Treated Net
IVM	-	Integrated Vector Management
KARI	-	Kenya Agricultural Research Institute
KEMRI	-	Kenya Medical Research Institute
KFA	-	Kenya Farmers Association
KPLC	-	Kenya Power and Lighting Company
MIS	-	Management Information Systems
MRLs	-	Maximum Residue Levels
NEMA	-	National Environmental Management Authority
NGO	-	Non-Governmental Organization
NIP	-	National Implementation Plan
OCLs	-	Organochlorines
PCAK	-	Pesticide Chemical Association of Kenya
PCBs	-	Polychlorinated biphenyls
PCNB	-	Pentachloronitrobenzene
PCP	-	Pentachlorophenol
PCPB	-	Pest Control Products Board
POPs	-	Persistent organic Pollutants
SET	-	Solvent Electronic Technology
UNEP	-	United Nations Environmental program
UPOPs	-	Unintentionally Produced POPs
USEPA	-	United States Environmental Protection Agency
WHO	-	World Health Organization
WWF	-	World Wide Fund for Nature

EXECUTIVE SUMMARY

The objective of the Stockholm Convention is to protect human life and the environment from the harmful effects of POPs. Some of them (POPs) were banned but still persist in the environment. The main aim of this exercise was to generate credible data to enhance the visibility of the POPs problem in Kenya. The report describes the POPs (specifically DDT, Pesticides and PCBs) situation in the country, including information about known levels. The report also details sources of POPs and how these are being addressed at the national level. Attempts have been made to include measures required to reduce and eliminate POPs and their sources in Kenya.

Information on POPs was obtained through field visits, inspections, consultation with stakeholders and interviews. The available literature was reviewed to identify the historical use and existence of POPs. This was necessary in the identification of contaminated areas, storage facilities, determination of past and present use, health-seeking behavior, risk factors etc.

DDT

The results of the survey reveal that DDT has been used in the Kenyan environment since 1947 especially in the control of highland malaria. Though the product was banned for use in agriculture in 1986, and has not been used for public health purposes, new use of DDT is being experienced in upstream agricultural and water catchment areas of River Tana and Sabaki, which flow in to the Indian Ocean. The literature reviewed reveals high levels of DDT in humans, flora and fauna.

The study team visited 97 sites countrywide chosen on the basis of information gleaned from government officers – especially from the Ministry of Agriculture, Pest Control and Products Board and Division of Vector Borne Diseases (DVBD). Some of the sites that housed DDT stores especially in the 1980's had been pulled down. Marigat was highly suspected to have some stocks of DDT. However, the research team was not able to see any despite having received information that several tones had been delivered to the site immediately before the ban in 1986. It will therefore be important to pursue the issue further in order to determine the exact amount that was delivered and its fate.

This exercise reveals that most of the DDT is held with the Kenya Farmers Association in Nairobi, Rift Valley and Central Provinces. The association, which has branches countrywide, was incapacitated in the 1980's due to political pressure. Its national offices were rendered moribund but district branches continued to serve farmers' needs by supplying farm inputs albeit at low levels. Information on their active branches and stores was not forthcoming but it would be important to investigate them for DDT stocks. In Nyanza province – especially Mbita, DDT was administered mainly through aerial spraying especially for tsetse fly control. The stocks were held with the Municipal Council of Kisumu where personnel denied knowledge and existence of such stores – a contradiction of information provided by the DVBD personnel. The division further indicated that the Taveta and Pare tsetse fly control program relied solely on DDT in the 1960s. The division did not have information on the amounts that were used in the operation. It was however not possible to reach such areas since only water and soil sampling would be the main determinants of DDT persistence in those areas. Secondly, logistical constraints hindered traveling to that area. A total of 2154 kgs of obsolete DDT were identified countrywide.

The survey recommends that the identified stocks be pooled together for environmentally sound disposal, further and elaborate investigation of new DDT use, extensive roll out of pyrethrin based products as alternatives to DDT, further research to enable enhanced persistence of the pyrethrins, aggressive research on malaria chemotherapy and close monitoring of disease resistance, community based interventions using novel tools and methods, integration of malaria control programs in to poverty reduction strategies, strengthening control mechanisms to ensure that DDT is prevented from entering in to the country and urgent studies of association between DDT and other pesticides in Kitale and Turkana areas, which seem to have cases of endocrine disruption and other abnormalities in both humans and animals.

Pesticides

Pesticide use in Kenya has developed correspondingly with cash crop and food production since the advent of colonialism. The pesticides covered in this section are mainly Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex and Toxaphene. Their profiles and brief backgrounds are provided (courtesy of WWF).

Kenya is a net importer of pesticides except for pyrethrin-based products. Almost all of the industries import the raw materials for formulation except for pyrethrin extract, kaolin, soapstone, calcium carbonate and wattle bark. There are more than 11 pesticide manufacturing concerns. The majority of these concerns are subsidiaries of multinational corporations. There are a few companies manufacturing insecticides and fungicides such as copper oxy-chloride. Other types of pesticides formulated and marketed in the country include herbicides, miticides, plant growth regulators, insect repellents and soil sterilants.

Lindane has been nominated for addition to the Convention and it has passed the criteria outlined in Annex D for identifying persistent organic pollutants by the POPs Review Committee. Lindane was found to be more prevalent than other POPs pesticides cited by the Convention. The approximate quantity of Lindane based on this inventory survey stands at more than 41,201.8 litres. Gamma BHC was second in terms of distribution in the country and perhaps in quantity. Approximately, 380 kg and 336 litres of Gamma BHC were recorded during the inventory survey. Most of this Gamma BHC was found in KFA in Nairobi. The least findings were in Rift Valley and parts of Western Kenya (Kisii). Dicofol was found in two sites in Nairobi i.e. KFA and Twiga Chemicals. The total quantity was about 255 litres. Dicofol was also found in Farmers World in Nakuru in a bottle (quantity not indicated) and Mea store in Nakuru with quantity as 400 grams.

Overall, Nairobi and its environs had substantial amount of POPs pesticides banned by the Stockholm Convention. At KARI headquarters, there were an estimated 2,000 kg of obsolete pesticides suspected to be dieldrin while there were 13.6 kg of aldrin. Central and parts of Eastern Kenya was second with a total of 362.25 kg of aldrin (specifically in Ruiru). Rift Valley and parts of Nyanza (Kisii) were ranked third. Surprisingly enough more than 10 litres of aldrin were found in Egerton University, Njoro. North Eastern Kenya had 6 sites suspected to have dieldrin, aldrin and other POPs all buried in the ground. The coast and certain parts of Eastern Kenya appeared to be the least contaminated because there were no POP pesticides. These sites are of public health concern not only because they contain the obsolete POPs pesticides but a variety of other toxic POPs.

This survey has established that there are more than 2,375.85 kg and 10 litres of aldrin in the country. In addition, there are an estimated 3095m^3 of contaminated soils excluding sites in Jir, Habaswein and Tarbaj.

From environmental and public health point of view, these sites pose enormous risks both to the environment and the humans. For instance, the KARI, Egerton, Njoro, Ruiru, Wajir and Madera, Kitengela and perhaps other sites have potential to contaminate air, soil and to certain extent food, surface and ground water sources.

The survey concludes that there is need to strengthen the existing legislation and policy framework in the NIPs. Other areas contaminated with POPs pesticides should be identified, marked and remediated; occupational health measures should be developed to reduce or eliminate exposure to humans and the environment; environmentally sound disposal of POP pesticides should be exercised; there is need to develop and build institutional and stakeholder capacity to manage the obsolete and possible candidate POPs pesticides; development of a multi-stakeholder approach which can sustain the management of obsolete pesticides and other chemical programs (e.g. SAICM); community education and awareness of POPs pesticides and finally research on the health and environmental effects of POPs pesticides especially in contaminated areas.

Polychlorinated biphenyls (PCBs)

Brief background information of PCBs is provided in the Introduction. Technical information on PCBs indicates that they are a group of synthetic organic chemicals, which are formed when chlorine atoms replace hydrogen atoms in the biphenyl structure. There are 10 possible locations for substitution - 2 through 6 and 2' through 6'. The chemical formula can be expressed as $C_{12}H_{10-n}Cl_n$, where n, the number of chlorine atoms in the molecule, can range from 1 to 10. Theoretically, a total of 209 possible PCB congeners exist, but only about 130 of these are likely to occur in commercial products. Commercial PCB is a mixer of 50 or more PCB congeners.

The survey identified 41,175 kgs of PCBs of which 39,075 kgs belonged to Pan African Paper Mills. PCB was found in electrical transformers and capacitors manufactured before 1985. It is noteworthy that after 1985, use of PCBs in the manufacture of this equipment had been banned. PCBs identified in this inventory were thus in closed application - where the PCBs are held completely within the equipment. No PCB was identified in both open (PCBs are in direct contact with their surroundings and thereby may be easily transferred to the environment) and partially closed.

Eight locations were found to have PCB-containing equipment and also to have PCB waste. The commonly found formulations of PCBs were Pyranol and Askarel and these were identified in transformers and capacitors, respectively. Askarel is a mixture of tri- and tetrachlorobenzene and was the original PCB containing fluid used in the manufacture of capacitors. It is a clear liquid with a density of approximately 1.5kg/l and PCB content varies from 40-65% (UNEP, 2003).

Most of the post 1985 manufactured transformer equipment were found using coolants and lubricants that were supplied by different major multinational oil companies (Shell, Caltex, Total, etc). Some of the oils include Diala BG from Shell/BP, Rando oil from Caltex to mention but a few. The specifications of these products show that they were non-PCB. During the survey, use of hexachlorobenzene was not encountered. However this requires further confirmation through laboratory tests of samples collected during the inventory.

The awareness of dangers posed by the industrial POPs among the general public and many of the employees and management staff in many establishments is very low. Urgent attention needs to be paid to the complete absence of knowledge on safety methods of handling the equipment containing the PCBs. The local capacity to handle, manage and dispose industrial POPs is inadequate. The technologies that are used to safely handle and destroy industrial POPs are currently not available in Kenya. The capacity to analyze PCBs in the country is also inadequate. The country's leading laboratories lack reference standards for PCBs and other important accessories to enable timely analyses of samples.

The survey mentions existing PCB destruction technologies noting that most of them are incineration based and therefore do not qualify to be BAT or BEP, these include; incineration using cements kilns (identified in the Stockholm Convention Annex C Part II as having "the potential for comparatively high formation and release" of POPs), Gas Phase chemical reduction, Plasma arc systems, Base-Catalyzed Decomposition (BCD), Solvent Electronic Technology (SET), Molten materials Process, Electrochemical oxidation and Bioremediation.

The survey recommends that the NIP for PCBs should emphasize the urgent need to quantify all the PCB amounts, map them by site and immediately embark on steps to store them in an environmentally sound manner**.** An information management system (MIS) for PCB management be put in place, the "Unmarked graves" belonging to Kenya Electricity Generating Company (KenGen) require to be secured and appropriate remedial measures taken, investigations on possible use of transformer oil in the "Jua Kali"[1] sector as well as by the public at large need to be addressed in the NIP.

[1] Jua Kali is a generic term for the indigenous informal industrial sector conducted in crude settings

INTRODUCTION

The objective of the Stockholm Convention is to protect human life and the environment. Most of the banned POPs substances have been used and some continue to be used in agriculture and in pest control. The Convention seeks to reduce and eliminate 12 chemicals which include Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, Polychlorinated biphenyls and (PCBs). The convention also seeks for State Parties to take measures to reduce the production of Dioxins and Furans and restricts the use of DDT to public health use. These substances have been known to persist in the environment for many years and also bio-accumulate in humans and living organisms. POPs are known to be resistant to photolytic degradation and are semi-volatile. They are transported over long distances and tend to accumulate in the Polar Regions. In humans and animals, POPs tend to accumulate in the lipids and are passed on to children in the uterus and through breastfeeding. However most of the POPs that enter the human system are acquired through the food chain. The higher the position an organism or animal occupies in the food chain the greater the amount of POPs accumulation in their body system.

This study attempted to conduct national DDT, POPs pesticides and PCB inventory based on actual presence of the substances and also deriving from experience with historical use. Such experience could only be gleaned from literature review, past records and physical presence. While collaboration was forthcoming from most government departments it is important to note some critical departments did not have records of past DDT use though they acknowledged having used DDT before. However there seems to be abundant information from published sources right from 1963 though they do not state the amounts of DDT that were imported in to Kenya over the years. Information gathered through the Pest Control Products Board indicates that Kenya had an importation of 70 tones annually.

This study has paid more attention to DDT than other POPs pesticides and PCBs due to the special role it plays in the control of malaria vector and the controversy currently surrounding its ban. While the debate on the re-introduction of DDT for malaria vector control rages the extent of DDT contamination in Kenya is currently being down played by its proponents. Neither do they recognize the health impacts nor the environmental impacts of DDT. The literature review on DDT in Kenya reveals that all those who have studied the subject clearly avoided direct association of the substance with documented human health impact. The most authentic published studies have underscored the DDT body burden, food and water contamination as indicators of possible health impacts in Kenya. Conversely, this study noted with great enthusiasm the existence of a deformed animal sanctuary in Kitale (Western Kenya Province) where DDT was used extensively in the control of agricultural pests before 1986. A phone discussion with the proprietor indicated the existence of many such domestic animals, which are often destroyed at birth by their owners due to superstitious fears. The conversation also revealed that the problem extends widely to include the cotton growing areas of Turkana where DDT was used extensively in the 1970's. These are likely to be trans-generational effects of DDT and other pesticides used in these agricultural areas. Kitale is the breadbasket of Kenya and where insect pests affect maize production adversely. DDT was used extensively in Kitale for plant protection and seed dressing. Casual observations have also been made of possible long-term and transgenerational health effects which range from biliary atresia, indeterminate sex and hypospadias[2]. On the other hand there is an urgent need for an international team of scientists to investigate the phenomenon and its possible link to DDT and other pesticides.

Other than DDT the main pesticides investigated in this study are Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex and Toxaphene. They are basically synthetic organochlorine pesticides whose use has long been banned or restricted. A brief background of these POPs pesticides is provided in Part 3, which deals with POPs Pesticides.

Part 4 deals with Polychlorinated biphenyls (PCBs). PCBs are a family of 209 compounds made up of attached benzene rings with varying numbers and locations of chlorine atoms. PCBs are characterized by their low flammability, low electrical conductivity, high resistance to thermal breakdown and to other chemical agents, and high degree of chemical stability. These qualities make them effective coolants, lubricants, and insulators. The physical attributes that make PCBs useful in industry also make them a serious health threat to workers, wildlife, and communities. PCBs' environmental persistence and long-range transport properties facilitate their movement to the earth's poles, which have become a storage reservoir for PCBs from temperate and tropical regions. First manufactured commercially in 1929, PCBs were produced by many countries including the U.S., China, Slovakia, Germany, Japan, Russia, and the United Kingdom. PCBs were exported throughout the world for use in transformers and capacitors, heat transfer and hydraulic systems, carbonless copy paper, industrial oils, paints, adhesives, plastics, flame retardants, and even to control dust on roads. Most countries outlawed PCB production in the 1970s, but large quantities are still in use. Of the estimated 3.4 billion pounds of PCBs manufactured worldwide (not including in the former Soviet Union) by 1989, up to two-thirds remain in use or in the environment. PCBs continue to enter the groundwater, soils, and atmosphere from multiple sources including old industrial equipment, recycled oil and materials, chemical manufacturing, landfills, and incineration of industrial and municipal waste. Even so-called "closed" industrial systems can release large amounts of PCBs. PCBs concentrate in the food web and bioaccumulate in the fatty tissue of wildlife and people. Virtually everyone has PCBs in their bodies. Chronic low-level PCB exposures can cause liver damage, reproductive abnormalities, immune suppression, neurological and endocrine system disorders, retarded infant development, and stunted intellectual function. Scientists are studying possible links to immune system damage and fertility problems in many marine mammals. The International Agency for Research on Cancer ranks PCBs as a probable human carcinogen[3].

[2] These observations were made from conversations with physicians and health workers based in Kitale
[3] WWF Fact Sheet on PCBs.

This study does not paint a complete picture of the situation due to several limitations including the low funding levels. It was therefore not possible to apply the FAO protocol for inventory taking of pesticides. Consequently laboratory sample analysis could not be conducted to determine levels of contamination. The information has therefore been gathered using qualitative methodologies.

Methodology

The project team comprised of project leader and research assistants who were recruited on location. The project leader consulted with the Ministry of Agriculture, National Environmental Management Authority (NEMA) and the Division of Vector Borne Disease on prospective DDT and POPs pesticides holding sites and institutions.

The research assistants were trained on location to capture the following information on DDT and POPs pesticides through physical inspection: storage, use, stockpiles or waste, location, quantity, country of origin, etc. Where the area of coverage was too large, additional research assistants were recruited and trained. All the assistants were provided with protective gears.

The FAO series of documents on obsolete pesticides was consulted for guidance e.g. "Training for Inventory taking of obsolete pesticides" FAO Pesticide disposal series 10 in the development of the information collection proforma. The assistants were given letters of introduction, which explained the importance of the inventory taking exercise, and emphasized that this was not being conducted for legal purposes but to comply with the Stockholm Convention whose objective is to "*protect humans and the environment*" The letters also explained that National Implementation Plan for DDT was being formulated to assist them dispose of their DDT stocks and these plans were dependent on this exercise.

The inspection, administering questionnaires and personal interviews, photographs of expired stocks as well as contaminated sites were taken. Other information considered included photographs of store, means/accessibility to the site, the type of community and environmental profiles next to the site/store and taking stock of everything in the store or facility and where possible discussed with the workers awareness of the health hazards.

The research assistants were fiscally facilitated to collect the information. At some stages personal interviews with key persons were conducted especially on the legal aspects of DDT use in agriculture. Further interviews were conducted on handling of DDT stocks.

DICHLORODIPHENYLTRICHLOROETHANE (DDT)

Definition of DDT

DDT (dichlorodiphenyltrichloroethane) is an organochlorine compound that persists in the environment and bioaccumulates in human and animal tissue. DDT in its pure form is a white, tasteless and odorless crystalline solid melting at 108.5° to 109° C and has a molecular weight of 354.50. It also has a vapor pressure of 1.5x10 ^{7} mm Hg at 20 ° C. Technical DDT, which is used as an insecticide is a waxy solid and has the following isometric composition: p, p'-DDT, 77.1%; o, p' –DDT, 14.9%; p, p'-DDD, 0.3%; o, p' –DDD, 0.1%; p, p' –DDE, 4.0%; o, p' –DDE, 0.1%.

DDT's insecticidal properties were discovered in the 1930's by Swiss Chemist Paul Muller. The substance was used extensively during the 2nd World War to protect troops from malaria and typhus as well as to protect crops. This was mainly due to its insolubility in water, persistence, long half-life of 10-35 years and high contact toxicity[4].

DDT currently is produced in only two countries—China and India. India's production capacity is less than 10,000 metric tonnes per year and is not fully utilized. China's production capacity is unknown. African countries that are currently using it for malaria vector control are importing it except for Ethiopia that has begun to synthesize it lately[5].

Toxicity of DDT

A number of clinical manifestations of DDT toxicity in humans have been reported variously. Very large doses are followed promptly by vomiting, due to local gastric irritation. Delayed emesis and /or diarrhea may occur (the mechanism is not understood according to Gosselin (1985). Numbness and paresthesias usually of lips, tongue, and face are some of the facial symptoms indicating DDT poisoning. Malaise, headache, sore throat, fatigue, weakness may be experienced. In some instances coarse tremors (usually of neck and head and particularly of eyelids), apprehension, ataxia, and confusion have been reported. In some cases convulsions both clonic and tonic may alternate with periods of coma and paresis. In the absence of convulsions, vital signs are essentially normal, but in severe poisonings the pulse may be irregular and be abnormally slow. If pulmonary edema supervenes, it is probably an expression of solvent intoxication. Death is usually due to respiratory failure from medullary paralysis. In acute exposures, recovery is usually complete within 1-3 days, but sometimes weakness or paralysis and ataxia may persist for weeks. It has been

[4] WWF, Hazards and Exposures Associated with DDT and Synthetic Pyrethroids Used for Vector Control.

[5] Information available from the Ethiopian Embassy in Nairobi reveals that the commercial attaché has embarked on extensive marketing of DDT among African countries.

demonstrated by scientists who examine the function of cells in the body that chemicals like DDT attach to proteins in cells known as "hormone receptors." Under usual conditions, these receptors attach to such hormones as the sex hormones estrogen and testosterone, and allow them to complete their functions in regulating female (estrogen) and male (testosterone) functions. When hormonally-active chemicals attach to these receptors, they may mimic the normal hormone, increasing female or male functions, or they may block the normal function, resulting in decreased female or male functions.

DDT has been shown to be a hormone-disrupting chemical that can affect the reproductive and nervous systems. Studies in mice, rats, seals, and dolphins indicate that DDT compromises the immune system. The U.S. Environmental Protection Agency has identified DDT as a probable human carcinogen, based on laboratory studies. Another recent publication by Chen and Rogan published in Emerging Infectious Diseases 9(8):960-964, indicates that DDT may have a substantial impact on infant mortality, by increasing the risk of pre-term birth and by decreasing the duration of breast-feeding after birth. In this paper, Chen and Rogan conclude that DDT may cause comparable increase in infant mortality through these mechanisms compared to the decrease in infant mortality it causes by killing mosquitoes and thus reducing malaria cases.

DDT in the Kenyan environment (sources and levels)

Despite banning DDT and other organochlorine pesticides (OCLs) in the West in early 1970's (Wiktelius and Edwards 1997) the production of OCLs in developed countries and their use in developing countries continued through the 1970s and 1980s into the 1990s because they were, no longer under patent agreement, were inexpensive to manufacture, and were very effective in pest control. This implies that the manufacturing was basically meant for the third world countries and basically Africa despite the fact that OCLs were banned in the developed world on public health grounds. In Africa, the use of OCLs continued well into the 1990s for the control of mosquitoes, tsetse flies, and desert locusts as well as to combat various crop, animal, and human pests. Some of these uses involved extensive spraying of large areas of nonagricultural land, thereby exposing many groups and species of wildlife to their residues. Although there is some evidence of a gradual decline in the use of OCLs in Africa, they are still being used in appreciable quantities. During the past 25 years, there have been 50 published reports of OCL residues in the various groups of invertebrate and vertebrate animals constituting the African fauna (Wiktelius and Edwards 1997). These have been based on a diverse range of surveys, target animals, sampling methods, and analytical techniques. Moreover, they are extremely regionally biased, the most intense surveys being in Zimbabwe, Kenya, Egypt, and South Africa. DDT was the most commonly used OCL, accounting for about half the total use, followed closely by dieldrin and HCH. Birds and fish have been sampled most intensively, with relatively few studies on other taxa. This assertion however brings forth the problem of dearth of research on many aspects of OCL's and their health and environmental effects in Africa.

In Kenya the first recorded use of DDT (Garnham 1948) was during a trial in Kericho district in 1947. This followed a spirited colonial government campaign to control the perennial highland malaria epidemic in that region. Roberts (1964) provides an elaborate account of further malaria control program in the region with a combination of DDT, Dieldrin and B.H.C. He notes that these substances were singularly ineffective and houseflies developed resistance leading the local population to believe that these insects thrived on the insecticides. The insecticide resistant houseflies led to a sharp increase in gastro-enteritis and a sudden typhoid epidemic.

DDT was introduced in Kenya as an acaricide in 1956 to combat tick menace. It was banned for use in livestock in 1976. It was subsequently banned for agriculture 1986 but was restricted for use in disease vector control. Restriction was occasioned by the health and environmental effects implicated in its use. For example residues were found in foodstuffs of animal origin, increased resistance of pests and its bioaccumulation in the environment. Another study by Koehman et al (1972) indicated contamination of the Rift valley lakes though levels of DDT were notably low. However DDT, DDE and dieldrin were isolated in bird and fish tissues collected in Lake Nakuru.

A study carried out in Kenya in the mid- 1980s indicated high levels of DDT were used in both agricultural and public health undertaking. High levels of DDE and DDT were observed from a test of 367 domestic eggs from 61 farms in Central Kenya and 41 maternal blood, milk, subcutaneous fat and umbilical cord blood samples from mothers who delivered through caesarean section in Kenyatta National Hospital. It means that other Kenyans have been exposed to DDT through the food pathways and have bequeathed the DDT and other mixtures of persistent organic pollutants to their children who are now more than 20 years old. Similarly another longitudinal study indicated high levels of DDT in mother's milk. The study indicates that levels of DDT in the mothers' sera ranged from 1.69mg/kg in milk fat of nomads in Loitokitok to 18.73mg/kg milk fat in human milk from Rusinga Island. The implication is that the mean estimated sum of DDT exceeded the daily tolerable intake by 17 times Kanja et al (1986).

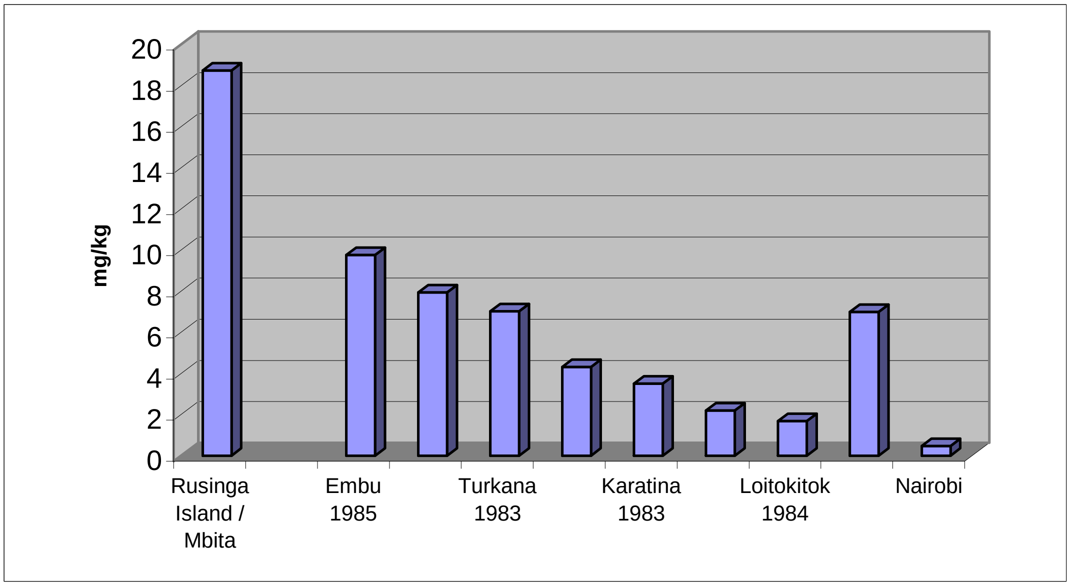


Figure 1: DDT in breast milk in Kenya
(Adapted from Organochlorine Pesticide in Human Milk from different areas of Kenya 1983-1985 by Kanja et al 1986)

Figure1 indicates higher than normal DDT and DDE levels especially in Rusinga Island and Mbita. These areas were subjected to intensive DDT spraying in the control of vector borne diseases such as malaria, African sleeping sickness, bilharziasis and fascioliasis. The main objective of this program was to eradicate tsetse flies, and water snails. A similar program was also mounted in the main rice growing areas of Mwea Tabere settlement scheme and Kano plains.

Kahunyo et al (1986) report results of a chicken egg sampling study in seven distinct geographical regions in Kenya. Out of one hundred and five eggs, eighteen samples contained DDT levels far exceeding the practical residue limit of 0.5 ppm. The mean DDT content was 0.68 ppm. This study reveals the persistence of the various metabolites of DDT.

As reported in the next section, DDT was extensively used in the Hola and Bura irrigation schemes in the control of cotton pests. Munga (1985) examined DDT and endosulfan residues and levels in fish lipids in Hola. The results are contained in Table 1.

Table 1: DDT residue in Labeo gregorii tissues

Tissue	Mean fat content %	mg kg^{-1} fat	mg kg^{-1} ww
Muscle	0.27	17.14	0.13
Liver	8.59	10.68	0.92
Eggs	1.99	19.63	0.38

Source: Munga (1985).

Mitema and Gitau (1990) analyzing pesticide levels in Nile perch from Lake Victoria detected mean levels of 0.99 and 0.45 ppm in fat and the fat and fillet with a range of 0.002 to 4.51 kg^{-1} fat lipid and 0.004 to 0.19 mg kg^{-1} . The study concludes that DDT and its metabolites constituted the largest concentration of OCL residues in the fish species studied. Similarly the inland Lake Baringo fish had concentrations of DDT of 0.4 mg kg^{-1} ww of p,p' DDE in the muscle tissue (Lincer 1981) a finding similar to that noted by Munga (1985) in the Hola irrigation scheme study.

Wiktelius and Edwards (1995) looking at studies conducted in Kenya, Zimbabwe, South Africa and Egypt noted that DDT constituted the highest level of organochlorine (OCL) pesticide contamination in the African fauna. They specifically note that OCL residues reported in the African fauna between 1971 and 1995 tended to be significantly higher overall than those published for Europe and U.S. In particular residues for DDT and dieldrin in African birds and their eggs were greater than those, which had been incriminated as causing reproductive failures in European and U.S. birds. In addition, high DDT and dieldrin residues were reported in African fish at levels that could potentially affect their reproduction have chronic toxic and behavioral effects and even drastically affect their population. It is important to note from this review that considerable OCL residues were found in crocodile eggs.

Persistence of DDT in the Kenyan Environment

The persistence of DDT in the Kenyan environment has not been studied independently of other pesticides. Most published studies have provided comparative analysis of DDT (as an organochlorine pesticide) with organophosphates and carbamates. This is partly due to the fact Kenya stopped use of DDT in agriculture in 1986. However DDE and DDD are being detected mainly in water and soil samples especially in the Indian Ocean coast of Kenya (Lalah et al 2001). Everaarts et al (1997) measured p.p' DDE at concentrations ranging from 32.1 to 508 ng g^{-1} organic carbon at the mouth of River Sabaki and Kiwaya Bay. DDE was however present in all the samples at levels ranging from 15 – 48 ng g^{-1} of lipid in both bivalve and gastropod mollusks. While these concentrations were notably low they are however strong indicators of long-term contamination and further indication that the ban of use of DDT for agriculture might not be effective. Further more these levels of contamination indicate that marine life at the coastal estuaries might be affected invariably. In a laboratory simulated study (Mbuvi 1996) monitoring the distribution of p;p' DDT in aquaria set up to simulate tropical marine eco-system noted that oysters accumulated DDT at a much faster rate reaching a maximum at 24 hours with a bioaccumulation factor as high as 19.273 before gradually declining. The simulation also indicated a steady build up of DDT residue in the sediments with a top layer (at 1 cm) concentration of 95%. The study concluded that DDT distributes widely in marine environment with most of it being taken up by aquatic organisms.

Several studies have been conducted to determine the persistence of DDT and other organochlorine pesticides in Kenyan tropical soils. Lalah et al (2001) studying the major environmental factors that influence rapid disappearance of pesticides from tropical soils in Kenya attribute the rapid dissipation of DDT from soils to their high volatization rates that are favoured by more adverse climatic conditions that prevail in the tropics such as high temperatures, intense solar radiation all year round and higher levels of microbial activity. Notably organochlorine pesticides do not disappear from the Kenyan environment but simply get relocated from soils to water and get distributed over wide areas due to the volatization process coupled with geographical activities. High rates of volatization emphasized by the authors of this study indicate the reality of the possibilities of long-range transfers of organochlorine pesticides to the Polar Regions. This study also reveals that rich agricultural soils in temperate regions like in the highlands of Kenya have comparatively low dissipation rates since DDT binds to organic carbon, preventing loss through volatization and leaching. The study further noted that the half-lives of dissipation obtained for DDT and DDE were comparable to those reported from other tropical countries where similar procedures and methods were used.

Extensive use of DDT for agricultural pest control was witnessed largely in Uasin Gishu District especially in the control of maize pests. Cotton growing in Turkana District, Hola and Bura irrigation Schemes on River Tana also benefited greatly from DDT use in the 1960's and 1970's. Records from Tana River Development Authority indicate an annual use of 12 tons of DDT largely for cotton pest control. It was applied as 5% dust at 5.5 to 11.0 kg per hectare. At some stage a combination of monocrotophos and DDT of ratio 10:40% was applied with ultra low volume (ULV) equipment at 2.5 to 3.0 L/ha. However during the 1980s systematic shift away from DDT to synthetic pyrethroids and endosulfan was witnessed. These records do not explain this sudden and systematic replacement of DDT.

Other than cotton and maize rice irrigation schemes in Ahero (Nyanza province and Mwea (Central province) also used DDT especially in the control of malaria vector in the 1980's. It appears that DDT use in the agricultural catchments of River Nyando has contributed to presence of DDT in its waters.

New DDT use in Kenya

It is important to note that Kenya has not used DDT officially since 1986 when it was banned for use in agriculture. However a publication by Wandiga et al (1999) indicates significant DDT use in agriculture. The study entitled "*Distribution of organochlorine Pesticides in Marine Samples along the Indian Ocean Coast of Kenya*" found that the mean residue concentrations of the organochlorine compounds in seawater samples were contaminated with Lindane, aldrin, α- endosulfan, p,p, DDE, dieldrin, p,p DDD and p,p DDT in

1997. In water samples from the confluence of River Sabaki which flows the central highlands, a region of intensive agricultural and human load activities p,p DDT was detected (0.295 ng g^{-1}) during the rainy seasons in the same year. However samples taken during the dry seasons did not yield any positive results. (See Table 2 below)

Table 2: DDT Levels measured at four sites at the Kenyan coast

	Mean residues in water (ng g^{-1} ± sd)			
	Sabaki	Kilifi	Mombasa	Ramisi
p,p - DDE	0.213±0.032	0.299±0.175	0.175±0.456	0.064±0.035
p,p – DDD	0.295±0.231	0.177±0.146	0.072	0.058±0.017
p,p - DDT	0.168±0.067	0.370	BDL	0.194±0.073

Source: Wandiga et al (1999) BDL – Below Detectable Level

Table 2 reveals higher concentrations of DDT and its metabolites in River Sabaki and this distributes in equally high levels at its estuary in Kilifi indicating both old and new use upstream. Another indication is that of higher levels at Ramisi, which is also the estuary of River Athi. One other notable observation by the authors of this study is that p, p' DDT is often used in the disinfection of the Kilindini harbor of Mombasa (Yugi 2000, Barasa 1999). It is important to note that though this practice is a necessary public health undertaking, other suitable, effective and environmentally friendly alternatives are available.

The implications of these findings are that new DDT is being used upstream of both major rivers that drain in to the Indian Ocean. River Athi begins from tributaries and rivulets that drain to the coffee growing areas of Kiambu district. Similarly River Tana and its feeder rivers (and rivulets) traverse large areas of coffee farming in Muranga Embu and Meru districts in Kenya. This points a clear finger at the illegal use of DDT in the control of coffee pests. However this needs to be corroborated by findings from plant samples. Nairobi as a commercial center seems to be implicated as the main source of DDT use in agriculture. This implies the existence of weak or non-existent monitoring infrastructure. It is important to note that the Pest Control Products Board (PCPB) as regulatory body is limited in staff and equipment. Secondly it is an implication of illegal importation or illegal trafficking of DDT even at this time that Kenya is at cross-roads on whether to use DDT for malaria vector control or not.

Study Team Findings of DDT

The study team visited 97 sites countrywide. These sites were chosen on the basis of information gleaned from government officers – especially from the Ministry of Agriculture, Pest Control Products Board and Division of Vector Borne Diseases (DVBD). Some of the sites that housed DDT stores especially in the 1980's had been pulled down. Marigat was highly suspected to have some stocks of DDT. However, the research team was not able to see any despite having received information that several tones had been delivered to the site immediately before the ban in 1986. It will therefore be important to pursue the issue to determine the exact amount that was delivered and its fate.

This exercise reveals that most of the DDT is held with the Kenya Farmers Association in Nairobi, Rift Valley and Central Provinces. The association with branches countrywide was incapacitated in the 1980's due to political pressure. Its national offices were rendered moribund but district branches continued to serve farmers' needs by supplying farm inputs albeit at low levels. Information on their active branches and stores was not forthcoming but it would be important to investigate them for DDT stocks. In Nyanza province – especially Mbita DDT was administered mainly through aerial spraying especially for tsetse fly control. The stocks were held with the Municipal Council of Kisumu where personnel denied knowledge and existence of such stores – a contradiction of information provided by the DVBD personnel. The division further indicated that the Taveta and Pare tsetse fly control program relied solely on DDT in the 1960s. The division did not have information on the amounts that were used in the operation. It was however not possible to reach such areas since only water and soil sampling would be the main measures of DDT persistence in those areas. Secondly logistical constraints hindered traveling to that area.

Table 3: Number of sites visited

Region	**Number of sites Visited**	**Number of stores with DDT stocks**
Nairobi	18	3
Rift valley	19	3
Coast Province	16	0
Central Province/ Eastern	46	1
North Eastern	2	0
Western/Nyanza	5	0
Total	**97**	**7**

Table 3 indicates the DDT outlets in Kenya by region. Priority sites visited were 97 out of a total of initially targeted 120. These sites suspected to have either used or stored DDT in any form.

Plate 1: DDT stocks at KFA stores in Nairobi

Table 4: Quantities of DDT identified by province

Area	Site Store	Common name	Commercial name	Qty (kg/L)	Supplies
Nairobi	KFA Nairobi Ltd	DDT	5% Dust Didimac	125	Murphy
	KFA Nairobi Ltd	DDT	25% EC Didimac	151	Twiga
	KFA Nairobi Ltd	DDT	5% Dust Didimac	740	ExMurphy
	KFA Nairobi Ltd	DDT	5% Dust Didimac	30	Not available
	Twiga Chemicals	Dicofol	Kelthane	6L	Not available
	Murphy	Dicofol	18.5% EC Mitigan	250L	Not available
Central/ Eastern	NIB Mwea	DDT	Dust Didimac	10	Murphy
Rift Valley	Njoro, Egerton	DDT	Dust Didimac	80	Not available
	Faida seed Company-Nakuru	DDT	Killpest	401	Not available
	Mea, Nakuru	Dicofol	Kelthane	361	Not available
TOTAL				**2154 (kg)**	

Table 4 indicates that DDT stocks were found only in Nairobi, Rift Valley and central Provinces. Though extensive forays were carried out in Western Kenya, Nyanza and Coast Provinces no stocks were found. This is probably due to the fact that the KFA stores in these areas were closed down permanently.

Plate 2: Obsolete DDT (in dust form) found at Egerton University

Due to the fact that KFA has stocks (87% of the study findings) in their custody, it seems likely that its other branches could be secretly supplying farmers. On the other hand the presence of DDT in fish samples could also be indicative of its use in the upstream areas of River Nzoia, Yala, Kuja and Miriu on the Kenyan side. However it should be borne in mind that the Kavirondo Gulf is the main breeding area for Lake Victoria fish and therefore attracts predatory fish species from all other parts of the Lake like the Nile Perch, which sits at the top of the fish food chain, hence has a higher bioaccumulation factor.

The study team visited Kitengela area on suspicion of DDT contamination. Soil samples were taken to the government chemist for analysis. The results revealed no presence of DDT contamination, though aldrin and dieldrin were detected. These were stocked at the site by the Desert Locust Control Organization in the mid 1960's. These have since been disposed of through chemical dilution and were sold back to chemical manufacturers. The soil samples from Wajir site also revealed that it was a sister site to the Kitengela one.

Alternatives to DDT in Kenya

Pyrethrins

The ultimate goal of the Stockholm Convention is to eliminate DDT. Parties that request exemption to use DDT must actively promote research and development of safer and affordable alternatives. Pyrethrins are currently rated as the safest alternatives to DDT because they are biological products. The Pyrethrum Board of Kenya has recently produced pylarvex, pymos and pynet to be used in different settings in the control of malaria vector. These products (Pymos™ 0.6 EC, Pynet ™ 5 EC and 0.5 EC) consist of natural pyrethrins, synergists and emulsifiers. Under limited laboratory testing Pymos™ 0.6 was found to have an enhanced residual capacity greater than 5 months. These products fit into the Roll Back Malaria program whose cardinal strategy is use of ITN to limit the human vector contact. According to published data (Sum, et al. (2002) the three pyrethrum products exacted high mortality on mosquitoes and would be suitable for malaria control in stable transmission areas. These products could benefit Integrated Vector Management. It should be borne in mind that these products are continuously being researched to improve their stability.

Integrated Vector Management (IVM)
This is the public health variant of the Integrated Pest Management (IPM), which is the use of a cost effective combination of pest control measures that is appropriate to local conditions and priorities and relatively safe for human health and environment. From the vector control stand point IVM is generally less risky and more effective due to combination of one or more vector control methods. Profound in this method is the combination of both chemical and non-chemical methods. However chemicals are used as the last line of intervention. IVM methods include public health measures like drainage of still and swampy waters. In rice growing areas these include, drainage of canals to avoid water stagnation, shifting of planting schedule to avoid optimal mosquito breeding conditions; and introduction of aquatic plants *Azolla*, which is also valuable as natural fertilizer and also covers the whole water surface thereby interfering with mosquito oviposition, larvae and pupae. Clearance of pond algae could have dual benefits since the algae can be used to manufacture fancy paper as well eliminate mosquito menace. The International Center for Insect Physiology and Ecology (ICIPE) is currently pioneering research on community based IVM strategies in Malindi and Mwea.

Malaria Chemotherapy

In Kenya malaria accounts for more than 30% of total the disease burden. Children under 5 years of age are the most vulnerable as malaria claims 2,000 childhood deaths daily. It is estimated that 26,132 deaths occur per year due to malaria. This translates into the deaths of 3-5 children per hour in the country. In Kenya *plasmodium falciparum* is the commonest malaria infection agent (accounting for 98%) while *plasmodium malarie* and *plasmodium ovale* contribute 2% of total malaria infection. Currently malaria is increasingly spreading to other areas, which previously had no malaria. This is attributed to global warming which has made it possible for the malaria parasite to develop in mosquitoes in these areas.

Most malarial infections take place in villages far removed from health care facilities. This impedes prompt and correct diagnosis, which is crucial to treatment and management outcome. Hand in hand with this is the compliance with treatment regime, which is often difficult to monitor especially in cases where the patients are ravaged by poverty. This infers the urgent need to decentralize diagnostic and treatment facilities to those affected. On the other hand community education on diagnosis and treatment could help stem the death toll from malaria. This concept is reflected in the 1994 Ministry of Health policy framework, which also proposes inter-alia strengthening of case management as a matter of priority. Development of guidelines for malaria diagnosis, treatment and prevention in the face of drug resistant malaria strains require new methods and approaches in its containment.

Chloroquine has been the first line anti-malarial treatment in Kenya for a long time until the malaria parasite developed resistance. The first indigenous incidence of chloroquine resistance was recognized in an infant in Kisumu in 1983. The shock reality of chloroquine resistance was realized when it shot from 0 in Turkana (Clarke et al.1996), to 56% in Western Kenya, 61% in non-endemic areas and 72% at the Kenyan Coast (Khan and Neville 1996).

In East Africa both pyrimethanine/suphadoxine and chloroquine cost less than $0.2 per treatment. The Artemisinin and derivatives though expensive at the moment are the most promising treatment alternatives. They are fast acting and reduce the parasite biomass by approximately 10,000 fold per asexual (2-day) circle compared with 100 – 1,000 fold for other antimalarials (White 1997). They are most effective against multi-drug resistant parasites and are also gametocidal. The main limitation of artemisinin and derivatives is that they have a much shorter half-life though this does not compromise its potency. The specter of resistance to artemisinin is real and needs to be guarded against. The genetics of malaria parasite reveal that the parasite's genetic mutations may occur at an independent loci and this is the one mechanism that has enabled the parasite to survive elimination. As such a combination of artemisinin, chlorproguani, dapsone or/ and mefloquine would expose the residual parasite to maximum drug concentrations leading to total elimination from the host. Another artemisinin and two antifolate drugs chlorpoguanil and dapsone combination (Lapdap) was recently launched in the Kenyan market by Kenya Medical Research Institute (KEMRI). It is important to examine the factors that led to massive chloroquine resistance.

Recommendations on Eliminating DDT

1. The stocks of DDT which are currently being held by stockists, retail outlets, institutions of higher learning need to be collected and stored in a centralized place where they can be disposed of in ways that do not pose harm to humans, animals and the environment.
2. There is an urgent need to investigate the new DDT use in the environs of Nairobi and Central Province in general. Further to this it will be important to analyze plant samples for DDT contamination, as this will provide leads to the sources.

3. The Pyrethrum Board of Kenya products i.e. Pylarvex, Pymos and Pynet have already been tested and proven efficacious using the WHO laboratory testing standards. All the three products had KD_{50} at 5 minutes and KD_{100} at 10 minutes in the WHO huts where they were tested. It is important to roll out these products in different malaria transmission scenarios to determine their practical efficacy. Further to pyrethrins have been reputed to have no mammalian toxicity. However these pyrethrins have been stabilized using pipernoil butoxide. It would be important to underscore whether there is any toxic effect associated with this inert substance.
4. The pyrtherins still need to be stabilized further in order to make them withstand photolytic processes that seem to break them much faster when used outdoors.
5. Promotion of pyrethrins for malaria vector control has multiple benefits. On the one hand natural pyrethrins are environmentally friendly and biodegradable. Secondly small-scale farmers in Kenya currently grow pyrethrum. The production capacity has recently declined due to non-payment and lack of market, which has led to poverty. Currently the Board holds about 60,000 tons due to lack of market and owes the farmers more than Ksh. 6 billion (US$ 75m). The application of pyrethrins in field situations requires no specialized skills and expensive safety gear compared with DDT. The WHO guidelines for the application of DDT require that public health officers apply the substance. This translates in to higher costs in terms of personnel emoluments. On the other hand it cannot be integrated in to community-based activities. Extensive use of pyrethrins would reduce poverty amongst the small-scale growers. Pyrethrum could present a window for economic recovery for Kenya.
6. There is further need to develop malaria chemotherapy, which target drug resistant malaria parasite strains. Multiple drug combinations should also be used to stem drug resistance. Over-dependence on Artemisinin (currently the drug of choice) in malaria chemotherapy is dangerous. The drug inhibits calcium flow in the malaria parasite leading to over-accumulation and death of the parasite. The parasite has the capability to mutate especially when faced with forced natural selection. More research is required to produce new medicines.
7. Current projects at ICIPE cover larval control of malaria vectors, behavioral and chemical ecology of malaria vectors, vector competence of malaria vectors, bio prospecting for mosquito repellents and larvicides from plants and control of mosquito larvae using microbicides such as *Bacillus thuringiencis israelencis*. These are products suited for community based intervention and require large-scale roll out.
8. Malaria is a development problem, which seems to be exacerbated by poverty. In reality the level of economic decline corresponds diametrically with the rise in malaria disease caseloads in malaria endemic areas. Economic improvement and poverty reduction could translate into reduction of malaria.
9. Nationally there is an urgent need to establish DDT surveillance and monitoring system capable of detecting new DDT use as soon as possible.

Coupled with this is the urgent need to mark potential sources of acquisition and strengthen control mechanisms to ensure the substance is prevented from entering in to the country. Special attention needs to be paid to the borders between Kenya and Ethiopia. Ethiopia is a user, a producer and has stockpiles of obsolete DDT. Illegal trafficking is very likely given the porous borders with Kenya.

10. There is an urgent need to embark on studies of association between DDT and other pesticides in Kitale and Turkana areas, which seem to have cases of endocrine disruption and other abnormalities in both humans and animals. This requires international collaboration.

PESTICIDES

Pesticides in Kenya

Kenya is a net importer of pesticides except for pyrethrin-based products. Almost all of the industries import the raw materials for formulation except for pyrethrin extract, kaolin, soapstone, calcium carbonate and wattle bark. There are more than 11 pesticide manufacturing concerns. Majority of these concerns are subsidiaries of multinational corporations. There are a few companies manufacturing insecticides and fungicides such as copper oxy-chloride. Other types of pesticides formulated and marketed in country include herbicides, miticide plant growth regulators insect repellents and soil sterilants.

Table 5: POPs Pesticides imported into Kenya 2001- 2004

YEAR	Type of POP Pesticide	Quantity Lindane (kg)	Quantity Dicofol (litres)	Source
2001	Lindane TK (99.5%)	2,000	-	France
2001	Lindane (20%w/w+Thiram 2.7%w/w)	15,000	-	South Africa
2002	Dicofol[1] (Kethane) 197g/l Mitigan (18.5%)	-	4,800	Italy
	Lindane (mutane)			Italy
2002		2,000	5,000	
	Dicofol (Kethane) 197g/l,			South
2003	DDT content not more than 1%			Africa
	Lindane 99% TK (pure			Italy
2003	gamma HCH isomer) Lindane	11,000	4,000	
			-	France
2004	99% TK (pure gamma HCH isomer)	10,000		
			-	China
	Lindane + Dicofol			
TOTAL		**40,000**	**13,800**	

(Source: PCBP)
[1] DDT is an intermediate produced during Dicofol manufacturing

As an agricultural economy, Kenya's demand for pesticides is relatively high. The import demand is further fuelled by regional consumption in land locked countries like Uganda, Rwanda and Burundi. Indeed the development of horticultural farming in Kenya equally increased the demand in the late 1990's.

Conversely the horticultural export market insistence on minimum residue level seemed to have lowered this demand, which exhibits a decreasing trend towards 2000 (see Figure 2 below).

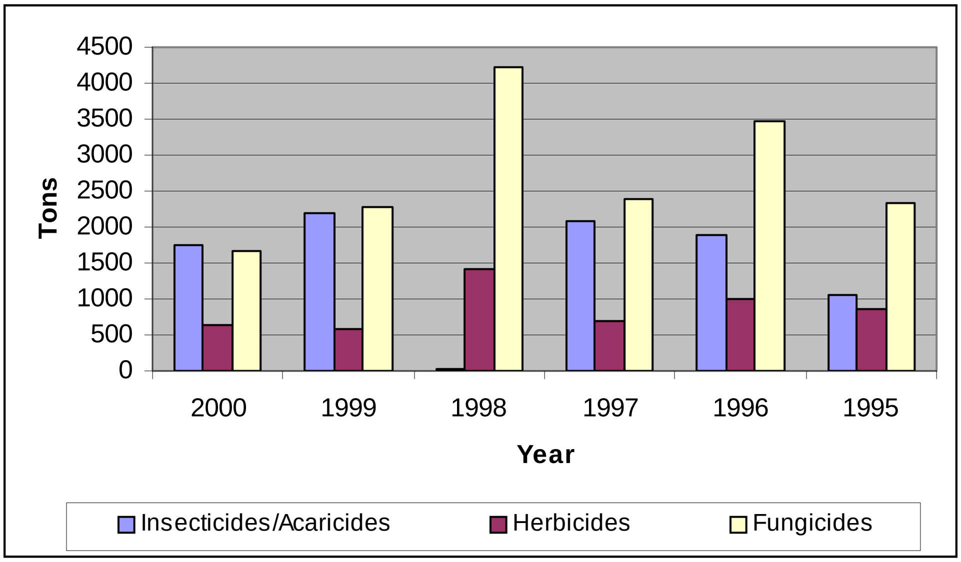


Figure 2: Kenya's Consumption of Major Pesticides (1995-2000)
(Source Pesticide Control and Products Board)

Study findings by Regions

Nairobi Region and its environs

In Nairobi and its environs the key sites and personalities visited and consultations carried included the Chief Public Health Officer, Ministry of Health, Nairobi City Council, Department of Vector Borne, Division of Vector Borne Disease, based at the National Public Health Laboratories and Division of Malaria Control, Ministry of Health. In certain sites, a proportion of the heads of the sites/departments expressed concern that they understood that over 30 years or so POPs pesticides were used by their centers to control insect vectors and rodents because of out-breaks of plague along Kenya-Tanzania boarder. They also stated that they have not used any of the banned pesticides since then. Similarly KFA sites and particularly the headquarters were visited. In addition, KARI headquarters and Twiga Chemicals were also visited. Overall, a total of 12 sites were visited in Nairobi alone.

The inventory for POPs pesticides as well as other pesticides is shown in Table 6. So far, out of 115 sites targeted for visits or as priority sites a total of 85 priority sites were visited. This represents 74% of the visited sites and 26% remaining sites could not be visited due to unavoidable circumstances such as limitation of resources and other logistic constraints.

Table 6: Sites with suspected and non-targeted POP pesticides in Nairobi and its environs

Site Name	Type of POP	State	No. of containers	Quantity (kg)	Quantity (litres)
KFA-Nairobi	Dicofol	Liquid	10	-	250
	Gamma HCB	Powder	1	25	-
	Gamma HCB	Powder	12	300	-
	Gamma HCB	Powder	138	55.2	-
	Gamma HCB	Liquid	60	-	24
	Lindane	Liquid	780	-	312
	Lindane	Powder	20	8	-
	Lindane	Liquid	4	-	80
	Lindane	Liquid	9	-	1.8
	Captafol (Difalaton)	Powder	1	25	-
	Aldrin	Powder	34	13.6	-
KARI Hqs	Highly suspected to have dieldrin & dieldrin	Liquid & Solids	Unknown	2000	Unknown
Twiga Chemicals	Dicofol	Liquid	6	-	4.89
Total			**1,065**	**2,426.8**	**672.69**

In KFA, Nairobi, 34 small containers were found containing 13.6 kilograms of aldrin, while in Kajiado and in particular the Kitengela stores (site) was found to be contaminated with a variety of chemicals with highly possible presence of POPs pesticides including those covered under the Convention. Indeed, the Kitengela contaminated area is approximately 195m^2 and the depth of the area is yet to be determined. The contaminated soil is approximately 400 tons.

The other important area visited was the Kenya Agricultural Research Institute (KARI), based at the National Research Laboratories. There were five stores stocked with obsolete pesticides and only 3 were scrutinized to establish whether they had assortments of POPs pesticides. The other 2 were inaccessible because no one knew where the keys were. One store (21.6 m^2) in a permanent building there were non- POP pesticides in excess of 50 kg (solids and liquids). In the other 2 accessible stores each with an average area of 5.6 m^2, there were assortments that were highly suspected to be dieldrin in the order of 500kg in one of them, while in the other one, there were stacked containers highly suspected to be holding about 1500 kg of POPs pesticides with unknown types.

Central and certain parts of Eastern Region

In Central and Eastern parts, 40 sites were expected to be visited but during the interview period, 28 sites were physically visited and 5 out of 28 (18%) were found to have Lindane which has been nominated for inclusion in the Convention and recently passed the screening criteria outlined in Annex D at the POPs Review Committee meeting in November 2005 (see Table 7).

Table 7: Distribution of sites with POP pesticides in Central and Eastern Region (n=5)

Site Name	Type of POP	State	No. of containers	Quantity (kg)	Quantity (litres)
KFA- Embu	Lindane	Liquid	757	-	757
Thuti Factory	Lindane	Liquid	109	-	109
Kiruga Factory	Lindane	Liquid	198	-	198
KFA – Nanyuki	Lindane	Liquid	40,000	-	40,000
Ruiru (Tatu Estate)	Aldrin	Solid	14	362.25	-
Total			**41,078**	**362.25**	**41,064**

An estate in Ruiru (Tatu) was found to have 14 containers of powdery obsolete aldrin whose weight was 362.25 kilograms. It was noted that out of all the sites visited during the inventory exercise, Sockinoff Company in Ruiru had better storage facilities for their obsolete pesticide stockpiles.

Rift Valley and certain parts of Western Region

Even though 27 sites were physically visited in Rift Valley and parts of Nyanza, specifically Kisii, only 7/27 (26%) sites were found to have POP pesticides. Interesting enough Egerton University, Njoro had 10 litres of obsolete aldrin. It is suspected that the University which specializes in agricultural and animal husbandry training could be having unidentified POPs pesticides.

Table 8: POPs pesticides in Rift Valley and parts of Nyanza (Kisii)

Site number and name	Type of POP	State	Number of containers	Quantity (kg)	Quantity (litres)
1. Egerton	2.5% Aldrin	Powder	1 Plastic		10
University	Aldrin	Liquid			
2. Egerton	(Pestkiller)			-	
University					
3.Chege	20%Lindane			-	20
General Store,	(Ant killer)	Liquid			
Nakuru	Lindane				36
4.Chege	Lindane	Liquid	1 Bottle	0.4	
General Store,	Dicofol				
Nakuru	Dicofol/Kelthane	Liquid	1 plastic		
5. Faida Seed	(Related to DDT)	/powder			-
Co, Nakuru	0.65% BHC				
6. Farmers		Liquid	25 Drums		200
World,	Lindane				
Nakuru					
7. Mea,					
Nakuru					
8. Egerton					
University					
9. Kenya Seed					
Company					
Kitale					
Total			**25 Drums & 2 Plastic Containers**	**0.4**	**266**

N/B

i) At site 5, a sample of 20% Lindane was collected for lab analysis.

ii) At sites, 2 & 3, there was intention to collect samples at the site/store but the head of the department denied clearance to the research team.

iii) At site 7, No indication of containers and quantity, however, the company uses. 20% Lindane+ 26% thiram for seed dressing. Lindane is included in this survey since it has been nominated for inclusion in the Convention and meets the criteria for a POP according to the Convention's POPs Review Committee.

iv) Wherever the store management was cooperative, photographs and samples were taken and are available.

Coast Region and certain parts of Eastern

In Coastal region (Mombasa Municipality and North Coast), 15 sites were scheduled to be visited, however, 16 sites were visited. These sites were mainly in Wudanyi town and Mombasa town/municipality, North Coast including Malindi town. During the survey, a visit to Badar Agro-Supplies, Mtwapa, found the store to have a variety of pesticides and presence of Kelthane – a trade name for

Dicofol, which is produced using DDT and whose production is permitted by the Convention.

Generally, there were no sites with POP pesticides in this region, however, the Director of Casuarin Pest Exterminators, Malindi, conceded having used DDT a long time ago. Most of the 16 sites visited in Coast (Mombasa and its environs, North Coast including Malindi) did not have POP pesticides with exception of Lomaster Agro-Vet Supplies store at Wudanyi. This particular store had Murton (Lindane + Thiram) - a pesticide whose manufacturer/distributor was Murphy Company. In another store, Badar Agro-Supplies at Mtwapa, Kelthane was present and the label indicated that Twiga Chemicals was the manufacturer/distributor.

North Eastern Region

Initially 5 sites were to be visited however, there were two known areas in Wajir and one in Mandera where a variety of obsolete POPs pesticides were buried. In Wajir, the two sites are the Army Camp and the Wajir Livestock Marketing area. The contaminated area at the Army Camp is approximately 200m^3 while the Wajir Livestock Marketing contaminated soil area is approximately 800$m^{3.}$ Jir, Habaswein and Tarbaj are the other sites in the North Eastern known to have buried variety of POPs pesticides. These include Lindane, dieldrin and aldrin. The three areas are estimated to have *c*ontaminated soil in the order of 6,000 $m^{3.}$ In Mandera town, specifically by the Airstrip, the contaminated area is estimated to be twice the size of the two areas in Wajir, i.e. 2,000 m^3

Summary and Conclusion on non POPs and POPs pesticides

Lindane has been nominated for addition to the Convention and it has passed the criteria outlined in Annex D for identifying persistent organic pollutants by the POPs Review Committee. Lindane was found to be more prevalent than the POPs pesticides currently cited by the Convention. The approximate quantity of Lindane based on this inventory survey stands at more than 41,201.8 litres. Gamma BHC was second in terms of distribution in the country and perhaps in quantity. Approximately, 380kg and 336 litres of Gamma BHC were recorded during the inventory survey. Most of this Gamma BHC was found in KFA in Nairobi. The least findings were in Rift Valley and parts of Western Kenya (Kisii). Dicofol was found in two sites in Nairobi i.e. KFA and Twiga Chemicals. The total quantity was about 255 litres. Dicofol was also found in Farmers World in Nakuru in a bottle (quantity not indicated) and Mea store in Nakuru with quantity as 400 grams.

Overall, Nairobi and its environs had substantial amount of POPs pesticides banned by the Stockholm Convention. At KARI headquarters, there were an estimated 2,000Kg of obsolete pesticides suspected to be dieldrin while there were 13.6 Kg of aldrin. Central and parts of Eastern was second with a total of 362.25 kg of aldrin (specifically in Ruiru). Rift Valley and parts of Nyanza (Kisii) were ranked third. Surprisingly enough more than 10 litres of aldrin were found in Egerton University, Njoro. North Eastern had 6 sites suspected to have dieldrin, aldrin and other POPs all buried in the ground. Coast and certain parts of the Eastern region were the least because there were no POP pesticides. These sites are of public health concern not only because they contain the obsolete POPs pesticides but a variety of other toxic substances.

This survey has established that there are more than 2,375.85kg and 10 litres of aldrin in the country. In addition, there are an estimated 3095m^3 of contaminated soils excluding sites in Jir, Habaswein and Tarbaj.

From environmental and public health point of view, these sites pose enormous risks both to the environment and the humans. For instance, the KARI, Egerton, Njoro, Ruiru, Wajir and Madera, Kitengela and perhaps other sites have potential to contaminate air, soil and to a certain extent food, surface and ground water sources.

Table 9: POPs Pesticides as Per Stockholm Convention

Region/ Area	Site Name	POPs pesticides type	State	Qty (Kg) or Area	Qty in lts	Use
Nairobi & Environs	Nairobi-KFA	2.5% Aldrin	-	13.6kg	-	Insecticide
	Kitengela	Aldrin , dieldrin and variety highly probable as per convention	Solids & Liquids	Appx-400 tones of contaminated soil (Appx.95.1 m³)		Variety
	KARI HQs	Highly suspected to have dieldrin & other probable POPs as cited by convention	Stacked in containers	2000	Unk	Insecticide & A variety
Central & Parts of Eastern	Ruiru (Tatu Estate)	Aldrin	Powder 14 containers	362.25 kg	-	Insecticide
Rift Valley & Parts of Nyanza (Kisii)	Egerton University	2.5% Aldrin	Liquid-plastic container	- -	10	Insecticide
North Eastern	Wajir- Army Camp	Aldrin, Dieldrin	Solids & liquids	200m³ of contaminated soils	Unk	Insecticide
	Wajir Livestock Marketing Area	Aldrin, Dieldrin	" " "	800m³ of contaminated soil	Unk	"
			" " "	Two areas of Wajir (2000m³)	Unk	"
	Mandera Town (Airstrip)	Aldrin, Dieldrin	" " "	Unknown contaminated area of Mandera	Unk	Unk
	Jir*	Unk	"		Unk	
	5. Habaswein*	Unk	"	Unknown contaminated area of Habaswein	Unk	
	6. Tarbaj*	Unk		Unknown contaminated area of Tarbaj		

* Source: Ibraham Jella, (NEMA), UNK - Unknown

Outcome and POPs pesticides management

Best Available Technologies (BAT) and Best Environmental Practices (BEP)

In, Kenya, the technology to destroy hazardous and obsolete chemicals in an environmentally safe manner is very limited. It is understood that the Kenya Institute of Waste Management under contract by the Agro-chemical Association of Kenya incinerated the aldrin and dieldrin, which were stocked at the Kitengela site. This happened despite the fact that no incineration facility in Africa meets the set standards by FAO to dispose of obsolete pesticides. (See Press Release by the Ministry of Agriculture in Annex 3).

Suggestions are currently being floated to have cement-manufacturing factories incinerate the POP pesticides since they claim to attain temperatures of more than 1200 degree Celsius. This could run contrary to Annex C Part II, which lists cement kilns firing hazardous waste as having the "potential for comparatively high formation and release of these chemicals."

The Africa Stockpiles Programme (ASP) proposes to ship the obsolete pesticides from African member states for incineration somewhere outside of the continent. Environmental concerns have been raised regarding the use of this method since it will definitely produce dioxins and furans. However these fears may be laid to rest since the incineration will be a one-time exercise and strict measures will be made to ensure that obsolete stockpiles do not accumulate. Kenya is not a participant in the ASP and the quantities of obsolete pesticide stockpiles are very little. However the main challenge is the decontamination and remediation of the contaminated grounds.

There are no documented methods detailing on how to manage and dispose of the obsolete POPs pesticide empty containers. The Basel Convention Secretariat has developed guidelines on handling contaminated containers but not disposal. NEMA is in process of developing regulations and guideline standards to effectively control pesticides empty containers. Hence there is need for this aspect to be included in the National Implementation Plan.

Recommendations

1. As noted earlier there exists a legal system and institutional framework specifically for pesticides and several other types of legislations as cited in this report. However, there is need to strengthen them in the NIPs

2. The existing pieces of legislation and institutional framework need to be strengthened and given direction on how to deal with obsolete POPs pesticides

3. It is very likely that there are more contaminated sites with obsolete POPs pesticides than those cited in this report (such as Kitengela, Wajir and

Mandera burial sites) and further exploration and cleaning of the priority sites during the NIP project is highly recommended.

4. There is need to develop technologies for the purpose of management and, destruction and institute clean-up mechanisms for the obsolete pesticides or make arrangements to use the regional or continental based technologies if they exist for the same purpose. These technologies should not generate POPs or other toxic substances as by-products.

5. Develop practical and affordable practices for protecting the workers, environment and communities at large from the adverse health effects. Rather than reinventing the wheel, adopt and adapt BAT and BEP being applied in countries in the region that have already undertaken the NIP exercise/project.

6. As a measure to protect health and environment at large, it is prudent to adopt and implement Environmental Management and Coordination Act (EMCA) draft chemical regulation which recommends environmentally sound methods for handling, management and disposal of hazardous chemicals including POPs. Some of these include and not limited to the following:

   - Waste prevention and minimization;
   - Sampling analysis and monitoring of POP pesticides;
   - Proper handling, collection, packaging, labeling, transportation and storage;
   - Application of environmentally sound disposal methods;

7. Consideration and application of other disposal methods when destruction or irreversible transformation does not present the environmentally preferable option.

8. Develop, and build institutional and stakeholder capacity to manage the obsolete and possible candidate POPs pesticides.

9. Inter-sectoral and international collaboration with relevant parties and continue to seek civil society, private sector and donor support to sustain the management of obsolete pesticides and other chemical programs (e.g. SAICM).

10. Educate exposed communities on the dangers of exposure to pesticides

11. Research the health and environmental effects of POPs pesticides especially in contaminated areas.

POLYCHLORINATED BIPHENYLS (PCBs)

Polychlorinated biphenyls (PCBs) have been employed in industry as heat exchange fluids, in electric transformers and capacitors as dielectric fluids (insulators) and as an additive in paint manufacturing, carbonless copy paper, sealant and plastics, formulation of lubricating and cutting oils, as adhesive, and as fire retardant. Hexachlorobenzene on the other hand is used as a fungicide in food crops and is also released during the manufacture of certain chemicals and as a result gives rise to dioxins and furans.

The PCBs are a group of synthetic organic chemicals. They are formed when chlorine atoms replace hydrogen atoms in the biphenyl structure. There are 10 possible locations for substitution - 2 through 6 and 2' through 6'. The chemical formula can be expressed as $C_{12}H_{10-n}Cl_n$, where n, the number of chlorine atoms in the molecule, can range from 1 to. Theoretically, a total of 209 possible PCB congeners exist, but only about 130 of these are likely to occur in commercial products. Commercial PCB is a mixer of 50 or more PCB congeners.

PCBs have been produced on an industrial scale for more than fifty years and have been exported as chemicals to virtually every country in the world. In equipment containing PCBs, they have taken trade names such as Asbestol, Askarel, Bakola, Chlorinol, Chlorphen, Dykanol, Pyranol, Saft-T-kuhl and Sovol.

PCBs' usefulness stems from their chemical stability and heat resistance. As stated above, commercial PCBs consist of a mixture of congeners, the most abundant of which tend to be readily biodegradable. A smaller portion of PCB congeners, however, tends to be "dioxin-like" PCBs, which are very stable and resistant to biodegradation and metabolism (UNEP, 1999). These latter congeners have been found in all environmental matrices. Relatively large amounts were released due to inappropriate disposal practices, accidents, and leakages from industrial facilities.

PCBs bio-accumulate in the fatty tissues of exposed animals and humans and this exposure is believed to be responsible for a wide variety of health effects. PCBs may be considered a historical waste as they have been in industrial use throughout the twentieth century.

On the other hand, HCB also an industrial chemical was originally introduced in 1940's as a seed dressing for cereal crops to prevent fungal disease. It can be present as impurity in several biocides and it is a by-product of incomplete combustion (UNEP, 2000). HCB is both toxic to humans and animals when long-term exposure occurs. Its main health effect is liver disease. Hexachlorobenzene is also known as an endocrine disruptor and probable carcinogen (UNEP, 2002).

In Kenya electric equipment and thermal fluids have depended mostly on imports. Thus, the most feasible avenue of entry of PCBs has been through importation of equipment and synthetic chemicals.

Table 10: Sites that were targeted in the PCB inventory

Region	Sites Visited
Nairobi	Nation printers, KPL, Color Print, Madhu Paper, Associated Battery Manufacturers, Bamburi, KAM, Pearl Cleaners, Coca-cola, Mobil, Exide, Kenya Breweries, KPLC Nairobi South Depot, Colgate Palmolive, Unilever, KIRDI, KEBS, Sara Lee, Rai plywood, Firestone, Crown Berger, Coates and Brothers, BOC, Bata, Kiwi, E.A Cables, Farmers Choice
Rift Valley	KPLC Eldoret, Olkaria Geothermal, Nakuru Blankets, Eveready Batteries, Brooke Bond, James Finlay, Raiplywood Eldoret, Magadi Soda Company, Gilgil Telecom, KPLC Naivasha, KPLC Nakuru, Geothermal Plant, Gigil Industries, Diatomite, Unga
Nyanza/Western	Homalime, Muhoroni Sugar Company, Fish Processor 2000, Telecoms Kisumu, KPLC Kisumu, Chemilil Sugar company, Webuye PanPaper, Mumias Sugar company, Swan Millers, Swan Industries
Central/Eastern	Premier Bags and Cordage industries, Kenya Tanning Extract, KPLC Thika, KPLC Nyeri, KenGen Power plants (Mesco, Sagana, Kamburu, Tana, Kindaruma, and Wanjii power stations), KBC station at Komarock, Metal Box, Brookside Daries, Delmonte, Leather, TTM
Coast	Kenya Oil refineries, Kaluworks, Kenya Ports Authority, Tsavo Power, IPP

Survey findings on PCBs

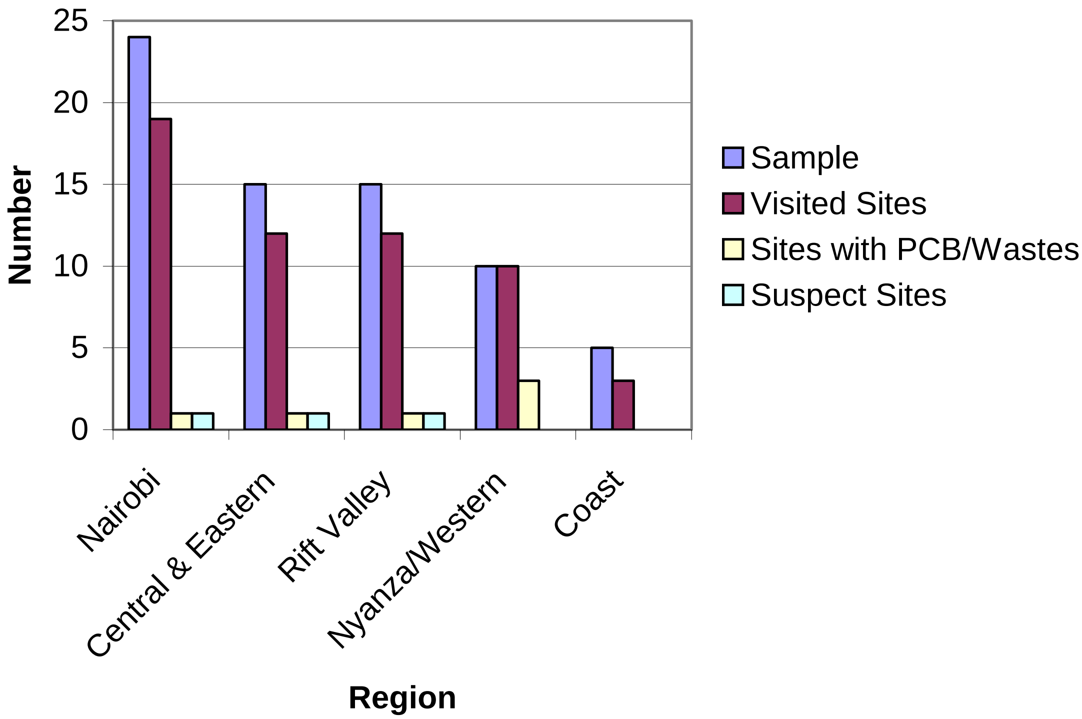
The results are that industrial POPs, PCB problem exists in Kenya. PCB was found in electrical transformers and capacitors manufactured before 1985. It is noteworthy that after 1985, use of PCBs in the manufacture of this equipment had been banned. PCBs identified in this inventory were thus in closed application - where the PCBs are held within the equipment. No PCB was identified in both open (PCBs are in direct contact with their surroundings and thereby may be easily transferred to the environment) and partially closed (the PCB oil is not directly exposed to the environment, but may become so periodically using typical use) systems.

Eight locations were found to have PCB-containing equipment and also to have PCB waste. The commonly found formulations of PCBs were Pyranol and Askarel and these were identified in transformers and capacitors, respectively. Askarel is a mixture of tri- and tetrachlorobenzene and was the original PCB containing fluid used in the manufacture of capacitors. It is a clear liquid with a density of approximately 1.5kg/l and PCB content vary from 40-65% (UNEP, 2003).

Most of the post 1985 manufactured transformer equipment were found using coolants and lubricants that were supplied by different major multinational oil companies (Shell, Caltex, Total, etc). Some of the oils include Diala BG from Shell/BP, Rando oil from Caltex to mention but a few. The specifications of these products show that they were non-PCB. During the survey, use of hexachlorobenzene was not encountered. However this requires further confirmation through laboratory tests of samples collected during the inventory.

Most of the capacitors in use were non-PCB cooled or were the dry-type. Figure 3 shows the pictorial representation of the industrial POPs inventory, by region.

Figure 3 Outcome of Industrial POPs inventory



The Nairobi Region

In the Nairobi region, 29 sites were selected and visited. Two sites were found to have equipment-containing PCBs. These were the Kenya Power and Lighting Company Ltd. (KPLC) site at the Nairobi South Depot. This site is a yard containing about 2000 disused transformers. At this site a transformer that had been labeled PCB was found. A random sampling of 50 transformers was done based on year of manufacture (the pre 1985 transformers) and their country of origin. The transformer liquid was tested for presence of PCB using the simple destiny test. Only one transformer (standard size transformer) out of the fifty sampled was suspected of PCB contamination. The other site was the Unilever (K) Limited found also to have PCB waste in a metal box container measuring 2.5

m long by 1m high by 0.75 m wide containing PCB-cooled capacitors. The box was stored within the Unilever compound, a junkyard, where other junk materials are stored. It is important to note that at the Unilever site, awareness of health and environmental risks associated with PCBs was high though the management and staff did not know how to dispose of the fluid. At the Firestone East Africa Limited Company (Now Sameer Industries) the survey team was informed that the PCB-containing transformer had been replaced with non-PCB transformer sometimes in the early 1990s. The PCB – the same company that replaced the transformer reportedly shipped transformer to the United States of America.

Regeneration of used transformer oils from decommissioned transformers from all parts of the country is done at the KPLC Isiolo Road Depot. The regenerated oil is reused in reconditioned transformers carried out at the same site and these are later used across the country. The regeneration process at the facility would likely result in cross contamination of the transformer oils with PCB.

Western /Nyanza Region

In the Western/Nyanza region, fifteen sites were targeted but only eleven were actually visited. PCB containing equipment and PCB wastes were found at three different locations. The Pan African Paper mill, reportedly the largest power consumer in the region and also in the country, has its own transformers - over 40 in number. At this particular location 20 transformers had Pyranol PCB type-coolant. These transformers varied in sizes from 1000 KVA to 5000KVA. Seventeen of the 20 transformers were still in use and three were out of service after developing internal faults. The three were sealed, isolated and stored in a secured enclosure. The transformers originated from the General Electric Company in the United States of America in the 1960s. The amount of PCBs at the Pan African Paper Mill was estimated to be 39 metric tones. There was an appreciable level of general awareness of the health and environmental risks associated with PCBs at this facility.

PCBs were also found at Muhoroni Sugar Company. This is an Agro-based company dealing with processing of cane sugar. At this location PCBs were found in two capacitors impregnated with Askarel PCB type and were still in circuit. At the same site two other capacitors of the same Askarel PCB cooled type were found mixed with disused spare parts in a junkyard within the factory premises. Furthermore at this site two empty shells of capacitors of similar Askarel PCB cooled type were found in a workshop and this raised the suspicion that PCBs could have been emptied within the premises. At the Muhoroni Sugar factory, there was complete lack of awareness of PCBs presence and its associated health and environmental hazards. It is possible that PCB exposure to human and the environment could have occurred at this particular facility.

The other facility in the region PCB materials were found is the Swan Industries in Kisumu specifically the wheat and maize flour confectionery factory. At this site six capacitors were found to contain Askarel PCB type cooling liquid. There was also lack of awareness about PCBs presence and associated concerns at this particular location.

Central/Eastern Region

In the Central/Eastern region sixteen sites were earmarked for visiting. However, in the region twelve sites were visited. In this region, PCBs were found at the Premier Bags and Cordage Industries, Juja in Thika. The company dates to1930s and specializes in the manufacture of sisal bags. At the factory four capacitors still in circuit were found to contain PCB type coolant. And at the same location, six old capacitors containing cooling oil that had no information regarding the nature and type of the dielectric fluid were found. These six capacitors could be suspected its oil to contain PCB-type dielectric fluid.

Moreover at the same facility, a junkyard area measuring 2-meters by 3 meters was suspected contaminated with Askarel PCB waste. Empty shells of two capacitors were found at the junkyard area and there was presence of liquid spillage on the area specified. At the location there was complete unawareness of the presence of the PCBs as well as the health and environmental hazard posed by PCBs.

Another facility that was found to have PCBs is at the Kenya Broadcasting Corporation (Komarock Station) Transmitter Station. This is a facility located some 50 kilometers from Nairobi city off the Kangundo Road, and has a disused transformer contained PCB-type fluid. The transformer had been imported from France in 1980. There was trace of leakage of transformer oil around the transformer. It was reported that the workers could have been using the oil as "medicinal" ointment. Although the management was aware of the presence of PCBs (in fact they called the Project Coordinator and informed of its presence), and its potential hazard and dangers to human health and environment were completely lacking within the personnel found at the station.

Rift Valley Region

In the Rift Valley region, sixteen sites were identified but only eleven were visited due to logistics reasons. In the region PCBs-containing equipment were found at the Brooke Bond company (lately renamed Unilever Tea) undertaking a number of ventures, including tea farming and processing and electric power generation. Seven capacitors, in circuit, containing PCBs were also found in two tea factories at Chagaik Tea and Kimari Tea factory. The tea factories belong to the same company. However, the capacitors had been isolated and were monitored for any fluid leakage on regular basis.

At the Nakuru Blanket industries, 10 capacitors that are oil filled and are old had no information on the plaque plate regarding the type of the coolant and thus could be considered PCBs suspect.

At the Magadi Soda a report on the status of PCBs at the facility was prepared in mid 1990s. The report revealed 51 items with a total volume mineral transformer oil of 18,809 litres contaminated with PCBs in varying concentrations of between 1 – 39 ppm. The average PCBs contamination was 9 ppm. This amount of PCBs is notably below the threshold value of 50 ppm permitted by the Stockholm Convention. Nonetheless the oil was successively drained and "incinerated". However, the maximum temperature of incineration used was 1000^{o}C, slightly below the recommended incineration temperature for PCBs, which is 1100^{o}C according to the Magadi Soda report which was also confirmed by the management.

Coast Region

In the Coast region, five facilities were earmarked for visiting but only three were visited. These were Kenya Oil Refinery, Kaluworks and Kenya Ports Authority (KPA). The first two facilities had their electrical equipment cooled by mineral oil. It was not possible to get information from the Kenya Ports Authority since they have not sent back the proforma used for data collection.

During the visit to the Nairobi Ruaraka Breweries, the team was informed that their Mombasa factory had one transformer containing PCB. The equipment was however shipped to Tanzania, in 1992. The recipients of the transformer were informed that the equipment contained PCBs. Table 11 provides a summary of the findings by location, site and quantities.

Table 11 Location and approximate quantity of PCB identified in the inventory

Region	Company name	Type of Equipment	Pieces of Equipment	Estimated of PCB (kg)
Eastern	KBC	Transformer	1	1350
Nairobi	Unilever (K) Ltd.	Capacitors	Containerized in a box	
	KPLC	Transformer	1 labeled PCB 1 *	500 Variable
Central	Premier bags and Cordage Industries	Capacitors	6	60
Rift valley	Brooke bond (Chagaik tea Factory and Kimari Tea factory)	Capacitors	7	84
Western/Nyanza	Pan African paper Mills	Transformers	20	39075
	Swan Industries	Capacitors	6	60
	Muhoroni Sugar company	Capacitors	6	45
Total				**41175**

* One transformer out of the 50 sampled was found to have been contaminated with PCBs

Inventory outcomes and POPs management

The preliminary inventory of industrial POPs across the country revealed a number of issues relating to the industrial POPs and PCBs in particular:

- The absence of documentation that could have aided in proper rationalization of manufacture, import and export of industrial POPs in the relevant departments such as Kenya Ports Authority.

- Limited awareness concerning industrial POPs existence in the country was found in a number of places - mostly the multinational firms. These included Firestone East Africa Limited, East African Breweries Limited, Brooke Bond Kenya limited, KPLC limited, Pan African Paper Mills Limited, major oil companies and the Magadi Soda Company.

- The KPLC had an initiative in 1998 to cleanup PCB contaminated site at its Juja Road Sub-station. At this site 150 capacitors were buried after they were found containing PCBs. They had leaked and contaminated the soil. A contractor was hired to excavate and ship the soil and the capacitors to Finland for destruction. Similar efforts were noted at the Magadi Soda Company, where consultant's study made recommendations for the management of PCB contaminated mineral oil from the premises.

- It is widely held that transformer oil from KPLC is generally sought after in the makeshift (otherwise known as "Jua Kali") garages for cooling electric welding machines. Besides, PCBs stocks may be in the hands of general public using it as ointment for medicinal purposes. The danger posed by this usage is obviously grave. It was not possible to assess the quantities of PCBs that may be held by the Jua Kali sector as well as by the general public. However it is urgent that research be conducted on health seeking behaviour to find out the extent of the practice. Verbal autopsy could be used to complete the picture of PCB poisoning. Consequently this would identify the pre-disposed populations who should be targeted for health education.

- It is common practice after the construction of power stations, to burry in unmarked "graves" wastes generated during the construction process. Such "graves" are suspected to contain hazardous materials including industrial POPs. The possible locations of such graves are the Seven Forks Dam, Olkaria Geo-Thermal Station, Turkwell Gorge, and Kipevu (all belong to KPLC). Concern is that these "graves" are located within water catchment areas and thus pose potential danger to populations consuming these waters.

- The industrial POPs are likely to be found in pre-1985 electrical equipment (transformers and capacitors). Most of the equipment is likely to be in circuit particularly the transformers in the Kenya Power and Lighting Company electricity transmission and distribution system. A method needs to be devised to identify and mark such equipment.

The industrial POPs problem in Kenya is virtually in all regions of the country. In particular PCBs are likely to be found in electrical equipment transformers and capacitors at the old factories, especially the pre-1985 supplies. A big number of large factories closed down sometime in 1980/90s and others relocated to neighboring countries due to unfavorable economic climate in Kenya. The electrical equipment they used for production and which could contain PCBs is still found in their former premises. It is not possible to estimate amounts of PCBs such facilities could have unless physical searches are extended to such facilities. Consequently the entry import data of industrial POPs in Kenya are not available.

The awareness of dangers posed by the industrial POPs among the general public and many of the employees and management staff in many establishments is very low. Urgent attention needs to be paid to the complete absence of knowledge on safety methods of handling the equipment containing the PCB. The local capacity to handle, manage and dispose of industrial POPs is inadequate. The technologies that are used to safely handle and destroy industrial POPs are currently not available in Kenya. The capacity to analyze PCBs in the country is also inadequate. The country's leading laboratories lack reference standards for PCBs and other important accessories to enable timely analyses of samples.

Although the country has enacted laws and regulations regarding evaluation of a large body chemical substances, industrial chemicals are sometimes not subject to regulations except in terms of meeting commercial standards (Kihumba, 1995). However, one can take solace in that Kenya is a signatory to a number of Multilateral Environmental Agreements like the Basel Convention, which regulate hazardous substances.

Field assessment shows that management and disposal of PCBs has been the duty of the equipment owners who have previously gained awareness from different sources. These include manufacturers of the PCB containing equipment and general environmental awareness through workshops and seminars. In such cases, the owners have resorted to using different methods in handling and disposing of PCB equipment and wastes.

PCB destruction technologies

Destruction of PCBs is one of the major challenges facing the implementation of the Stockholm Convention globally. Most developing countries and economies in transition currently do not posses PCB destruction technologies that can pass the BAT and BEP test. In South Africa for example PCBs are diluted to 50 ppm and stored while awaiting suitable destruction technology other than incineration.

The majority of PCB wastes are destroyed by high temperature incineration that purportedly gives rise to almost total oxidation of organic products into carbon dioxide and safely disposable oxidation by-products. Any chlorine present is presumably converted to hydrogen chloride gas, which is removed, and either neutralized or recovered for further use. Though incineration of any POPs or waste is neither BAT nor BEP it would still be important to mention the basic principles behind them.

i) Incineration using cements kilns.
Cement kilns are high temperature rotary kilns designed and constructed for production of clinker that is pulverized to make cement. Cement production is an energy intensive process. This has led in recent years to a growing trend, particularly among the industrialized countries, of substituting various wastes for portions of conventional fuels used in cement production. This method is however cautioned by the Stockholm Convention as a possible significant source of POPs.[6]

ii) Gas Phase chemical reduction
This method involves hydrogen reacting with chlorinated compounds, at high temperatures, yielding primarily methane and hydrogen chloride.

iii) Plasma arc systems
Plasma arc systems utilize high temperatures (5000 to 15,000^{o}C), resulting from the conversion of electrical energy to heat, to produce plasma. They involve passing a large electric current through an inert gas stream. Hazardous contaminants, such as PCBs, dioxins, furans, and pesticides are broken down into their atomic constituents, by injection into the plasma, or using the plasma as heat source for combustion or pyrolysis.

iv) Base-Catalyzed Decomposition (BCD)
There are two versions of Base catalyzed Decomposition waste treatment method. One version involves remediating soils and sediments contaminated with PCBs, dioxins and furan. It involves pre-treatment in a two-stage process that first removes chlorinated organics from soil and then destroys them by dechlorination.

The other version is called “Glycolate” process. It is a full-scale technology in which an alkaline polyethylene glycol (APEG) reagent is used. Contaminated soils and the reagent are mixed and heated in a treatment vessel. The APEG reagent dehalogenates the pollutant to form glycol ether and /or other hydroxylated compound and an alkali metal.

[6] Annex C Part II of the Stockholm Convention

v) Solvent Electronic Technology (SET)

The Solvated Electron Technology (SET) is a method of reducing halogenated hydrocarbons in a mixture of sodium or other alkali metals in liquid ammonia. For the destruction of 1kg of PCB the process requires 200-400grams of metallic sodium. This could increase if the PCB material is not pure or dry. The SET process is one of the very few available technologies with demonstrated capability of treating PCBs in soils, sludge, and oils to less than 2ppm.

vi) Molten materials Process

This technology uses a molten metal (sodium), a molten slag or molten salt (generally sodium carbonate). Molten metal is also known as catalytic extraction process. The process uses heated bath of molten metal to catalytically disrupt molecular bonds of contaminants and convert hazardous wastes into products of commercial value. In the molten slag process, the waste to be treated is blended with steelworks dust and fluxing agents, extracted, dried with heat from furnace off-gases and fed into a foaming slag layer which forms at the top of the molten iron in an electric arc furnace at a temperature of 1500^{o}C. The waste sinks into the slag phase; metal oxides are reduced to metals and all organic materials to their basic elements.

vii) Electrochemical oxidation.

The process was first developed as a means of destroying organic waste arising within the nuclear industry and for wastes arising from decommissioning stockpiles of chemical weapons. The technology has been used on a small scale for the destruction of PCBs. Destruction of waste material is carried out by electrochemical oxidation using highly reactive form of silver (Ag++) ions based on the membrane electro-chemical cell widely used in chemical industry.

viii) Bioremediation

This technology can be very environmentally sound though it is a long process for decision makers who are always in a hurry to achieve dramatic effects regardless of long-term effects. Bioremediation technologies utilize indigenous or inoculated microorganisms including fungi, bacteria and other microbes, to degrade organic contaminants found in soil and /or ground water, converting them to harmless end-products

Summary on treatment technologies

The existence of PCBs in Kenya necessitates suitable solutions to eliminate them in order to comply with the requirements of the Stockholm Convention. As mentioned earlier, Kenya has no capacity to destroy PCBs in an environmentally sound manner hence the need to look in to the most economical way to dispose of the current stock of PCBs. In this light, the following alternatives need to be explored:

- Identifying a recipient country, which has appropriate technology to destroy PCBs. PCB, stock and PCB waste could be shipped after the necessary legal agreements have been put in place and agreed upon. However this may be hampered by the requirements of the Basel Convention. For example country "B" (which is a State Party to the Basel Convention) may refuse a vessel carrying PCBs for country "A" destined for country "C" docking facilities in its territory even for refueling and procurement of essential maritime supplies.
- PCB disposal options should be keenly explored and a disposal time scale drawn.
- The procedures and measures for handling PCBs or PCB destruction technologies must consider only environmentally acceptable technologies. For example the cheapest option like dumping the PCB waste should never be an option.

Priority areas

The National Implementation Plan (NIP) for PCBs is yet to be drawn. The stakeholders for this thematic area of the Stockholm Convention need to incorporate those companies with large amounts of PCB oil wastes like KPLC and Pan Paper Ltd. This survey notes that this inventory is far from complete but presents a benchmark for the development of an initial NIP for PCB management. The NIP for PCBs should emphasize the urgent need to quantify all the PCB amounts, map them by site and immediately embark on steps to store them in an environmentally sound manner. The Basel Convention has produced guidelines for collection, transportation and storage of hazardous waste, which could be referred to for guidance.

A management information system (MIS) for PCB management needs to be put in place. This could include among other things name and address of the equipment holder, location and description of equipment, the quantity of PCB contained therein and dates and types of disposal envisioned.

The "Unmarked graves" belonging to Kenya Electricity Generating Company (KenGen) need to be secured and appropriate remedial measures taken. The NIP should identify the exact locations of these graves and tests carried out to determine the presence of POPs and the extent of contamination.

Investigations on possible use of transformer oil in the "Jua Kali" sector as well as by the public at large need to be addressed in the NIP.

A notification and verification policy or legislation for companies decommissioning PCB containing equipment needs to be addressed in the NIPs under policy framework and legislation. This is aimed at protecting the general public as well as preventing trafficking of PCBs.

The NIPs should prioritize PCB chemical body burden in exposed humans, animals and plants to ascertain PCB contamination. This should be part of locally generated information, which would be important for decision-making and for public education and awareness.

Outputs and recommendations for the industrial POPs

The outcome of the industrial POPs preliminary inventory shows that a number of areas need to be addressed. Table 12 shows some of the outcomes and recommendations.

Table 12: Output and recommendations for the industrial POPs

Output	Recommendation
Lack of awareness of PCBs among employees and the public	♦ Awareness needs to be stepped up to reach employees and the public through the various channels – electronic, mass media, etc.
Inadequate capacity to test industrial POPs in terms of laboratories and equipment	♦ Local capacity to test/screen industrial POPs should be boosted by identifying laboratories in research institutions and institutions of higher learning which could be assisted to acquire the necessary testing equipment. ♦ Staff in the identified laboratories should be trained to test PCBs.
There are many old closed factories and some which were contacted did not cooperate	♦ The relevant government agency should liaise with all potential suspect PCB-containing equipment owners to facilitate access.
Many transformers belonging to KPLC, which could contain PCBs, are in-circuit and could not be accessed during the inventory.	♦ KPLC should organize with the relevant government agency (NEMA) how to access the equipment or provide necessary information regarding the PCB status of the equipment.
Unmarked graves in power generating stations could contain POPs.	♦ The locations should be identified and exhaustive analysis of possible contamination carried before the National Implementation Plan.
The Jua kali sector uses transformer oil in its production and manufacturing processes.	♦ An exhaustive investigation on the extent of use of transformer oil in the sector should be carried out.
Kenya lacks Legislation touching on industrial POPs (PCB and (Hexachlorobenzene) directly	♦ A Legal Notice referencing the Stockholm Convention should be published.
Adequate and satisfactory capacity to handle and destroy PCBs in the country lacking	♦ An in depth evaluation of the available PCB destruction technologies should be carried out.
Onsite assessment of PCBs not possible due to lack of suitable screening kits	♦ Provision of PCB screening kits should be included in the NIP program

Laws currently regulating POPs pesticides

Attempts to regulate pesticide use in Kenya date back to the colonial era when the Public Health Act, Cap 242 was enacted on 6th September 1921. This was followed by the enactment of Cap 358, which dealt with the Cleansing of Cattle being enacted on 27th April 1937. This Act prescribed various formulations for eradicating ticks. These Acts have however been revised severally though they have retained their core functions to date.

The Voluntary Precaution Scheme for the agricultural industry adopted in the 1950's is today widely viewed as a precursor of the landmark Poisonous Substances Ordnance of 1954. This Act derived from the United Kingdom Act of 1952, which provided for workers' protection against the risk of poisonous substances used in agriculture. A further development occurred in 1957 when the Pharmacy and Poisons Act was enacted in 1957 by Westminster. This Act sought to regulate the pharmaceutical practice as a profession and also to regulate trade in drugs and poisons. The Act included veterinary drugs, poisons and, stipulated conditions, and rules for sale and labeling of poisons including pesticides.

On 11th May 1965, the Parliament passed an act for the prevention of adulteration of food, drugs, chemical substances, and incidental and connected matters. This Act attempted to define "chemical substances" as any substance or mixture of substances prepared, sold or represented for use as; germicide, disinfectant, insecticide, rodenticide, antiseptic, pesticide, vermicide or detergent. The significance of this Act is that this was the first time an Act was enacted with set standards declaring tolerance levels in ppm for pesticides in foodstuffs. Though this law has never been amended, its implementation (enforcement) has remained in limbo.

Other legislations that could cover regulation of production and use of POPs include Agriculture Act, Cap318; the Fertilizers and Animal Foodstuffs Act, Cap 345; the Water Act, Cap 389, Plant protection Act, Cap 324 and the Forest Act, Cap 385. It is evident that in Kenya Parliament passes sectoral laws for control and regulation of environmental matters. This implies a lacuna of an all-encompassing Act, which could harmonize all environmental laws. It is hoped that the Environmental Management and Coordination Act of 1999 will in its second amendment provide clear guidelines and standards as well as an efficient enforcement framework necessary for the implementation of the environmental laws. Currently implementation of these regulations is ineffective and the penalties provided can no longer serve as deterrents.

Current legislations

There are comprehensive legislative frameworks to regulate the production, use, importation and registration of pesticides in Kenya. These frameworks are to be found within schedules dealing with the Ministries of Health, Agriculture, Labour, Trade and Industry, Environment and Livestock and Fisheries. However the Pesticide Control Act of 1982, which created the Pest Control Products Board in 1983, is the main regulatory organ for pesticides. Pest Control product is defined as "a device, product, organism, substance or a thing that is manufactured for directly or indirectly controlling or preventing, destroying, attracting or repelling any pest. The Board regulates the importation, exportation, manufacture, distribution and use of various pesticides in Kenya in all sectors of agriculture and health or of organic functions of plants and animals. It is worth noting that prior to 1983 there were no provisions requiring regulation of use of pesticides in Kenya.

The main functions of the Pest Control Products Board are;

Regulatory

1. To register and approve for use all pest control products
2. To regulate the sale and distribution of pest control products through licensing of imports and exports
3. To inspect and license all facilities used for the manufacture, storage and distribution of pesticides
4. To analyze any pesticide for efficiency before recommending for use.

Technical

1. To receive and evaluate data from manufacturers and importers on the merits of pest control products
2. To undertake as appropriate, short and long term research to evaluate the impact of pesticides on the environment
3. To collect information from international organizations such as FAO, WHO, EPA, UNEP etc that is relevant to pesticide use and regulation.

Training and information

To educate and inform the users and the general public on matters concerning the safety and danger of using pesticides. Other functions that fall under this category are advising relevant authorities on aspects of pesticide management, training government extension agents and other interested personnel on pesticide management, and advising the government on the status of approved pesticides.

Table 13: Some banned or restricted pesticides in Kenya

Some of the banned pesticides in Kenya	
Common name	***Formerly used as***
Dibromochloropropane (DBCP)	Soil fumigant
Ethylene dibromide (EDB)	Soil fumigant
2,4,5,T phenoxy herbicide	Herbicide
Chlordimefom	Acaricide/insecticide
All isomers of HCH	Insecticide
Chlordane	Insecticide
Captafol	Fungicide
Heptachlor	Insecticide
Toxaphene (Camphechlor)	Acaricide
Endrin	Insecticide
Parathion (methyl and ethyl)	Insecticides
Restricted pesticides in Kenya	
Common name	***Permitted Use***
Lindane	Seed dressing only
Aldrin, Dieldrin	Termiticide in building industry –
DDT	Public health only (Control of mosquitoes)

(Source: Pesticide Control Products Board)

Table 13 (above) indicates that Kenya has banned the production and use of five pesticides that are included in the Stockholm Convention. Three others (aldrin, dieldrin and Lindane) are restricted. Dieldrin and aldrin are no longer available in the country but there is evidence of massive contamination by these two especially in Wajir Livestock market, Kitengela and possibly Wilson Airport. These substances were dumped at these sites by the Desert Locust Control Organization in the mid-1960.

Candidate pesticides for registration in Kenya are subjected to rigorous scrutiny through well-established scientific processes to ensure that they do not pose health risks or accumulate to undue residue levels. The procedure therefore determines the product efficacy, safety and environmental impact before use or marketing. The government has come up with the tabulation of maximum residue levels (MRLs) or tolerable limits contained in Food, Drugs and Chemical Substance Act, Laws of Kenya Cap 254 revised in 1980.

Though the PCPB has elaborate functions of controlling the production, use and distribution of pesticides in Kenya, the Environmental Management and Coordination Act assumes the overall role of coordinating all matters pertaining to the environment. This body has strong linkages with other international bodies like UNEP, FAO and WHO, which develop policies and information globally. For example the agricultural industries are expected to adhere to the FAO code of conduct on the use and distribution of pesticides.

The Agro-chemical Association of Kenya (AAK) formerly known as the Pesticides Chemical Association of Kenya (PCAK) ensures that members adhere to the ethical objectives especially in observing safety, packaging, labeling and use of these products. This association brings together pesticide manufacturers and distributors of agro-chemicals in Kenya.

Regulation of PCBs

Kenya has defined an institutional framework that can handle Industrial POPs under the auspices of the National Environment Management Authority, which falls under the Ministry of Environment, Natural Resources and Wildlife. Nonetheless, it is suggested that the National Implementation Plans should prioritize PCB management, education and research on exposure of the general public.

Kenya's existing legal framework is not specific enough to deal with industrial POPs management. However, a legal notice specific to requirements of the Stockholm Convention can be published with a timeline, which is consistent with the requirements of the Stockholm Convention. In other words Kenya has yet to domesticate the Stockholm Convention, which will have specific legislation for PCBs.

The Basel Convention that covers Trans-boundary movement of hazardous materials across State Parties was ratified in 2000. This in addition to other conventions could form a solid legal basis on which movement and handling industrial POPs (PCB materials) wastes for purposes of destruction can be based. The National Environment Management Authority (NEMA) is currently reviewing legislation on chemicals and toxic wastes.

Efforts to deal with POPs

Immediately upon signing of the Stockholm Convention in May 2001, the government of Kenya appointed the National POPs focal point whose duties included the coordination of POPs awareness activities. A national committee compromising of stakeholders on the implementation of the Stockholm Convention in Kenya was formed. Thematic sub-committees i.e. UPOPs, Pesticides, PCBs and DDT expert committees were also set up to provide vision and guidance in the implementation process. With a fully functional Secretariat, the national POPs office immediately embarked on the POPs enabling activities with assistance from the Global Environmental Fund (GEF). A plan of action was put in place and culminated in the first ever National POPs Awareness Workshop in 2002 June.

In 2003 a spirited debate erupted on the re-introduction of DDT for malaria vector control. The Kenya Medical Research Institute (KEMRI) spearheaded the debate. Most of the debate was carried out in both print and audio-visual media. This prompted the national POPs focal point to convene a round table consultation. Though a majority of those who attended the meeting were from the government, the NGO representatives were against the immediate re-introduction of DDT for malaria vector control. They based their arguments on the fact that the department of public health and the division of malaria control had managed to control an anticipated malaria epidemic with synthetic pyrethroids. Most of the government representatives especially from KEMRI strongly opposed the NGO position and at the conclusion of the meeting no consensus was arrived at. It is worth noting that the Ministry of Health has not indicated that they will use DDT for malaria control in the near future. The Director General of the National Environmental Management Authority (NEMA) issued a paid up advertisement in the local dailies to state the Ministry of Environment's position on the DDT (See Annex 2 – Why DDT should not be introduced for malaria control in Kenya)

Due to the public pressure generated by the debate the Ministry of Health instructed the division of malaria control department to formulate a DDT and malaria policy. A team of stakeholders with PSR-Kenya representing the public interest NGOs came up with a policy framework whose cardinal premise was that DDT be reserved for use only when other alternatives have failed. This has remained the cornerstone of the Ministry of Health policy on DDT and Malaria Control.

The government commissioned a team of scientists to carry out a POPs inventory. The team has held several meetings with thematic experts with a view to developing a holistic picture of the national POPs situation in Kenya. A draft document has already been produced and outlines several key issues that will be addressed in the National Implementation Plans (NIP). On the other hand the process for formulating the NIPs began in earnest when the NIP committee was formed.

Kenya participated in a one-week training workshop on regional training workshop on POPs and Alternative Approaches to Malaria Control in Africa (20th - 27th June 2004). The workshop drew 14 participants drawn from Kenya, Uganda, Tanzania, Ethiopia, Zimbabwe, Zambia and Malawi. The training workshop was designed for public health professionals who are actively involved in the management and decision-making process related to vector control and vector-borne disease control. The main objectives were to:

1. Strengthen the capacity of national disease control programs on environmentally sound alternatives and management options for POPs, with particular emphasis on reliance on the use of DDT.
2. To provide technical and managerial skills on integrated vector management leading to incorporation of IVM in to vector control programs as an alternative approach to the use of pesticides for vector control programs.
3. Enhance the understanding of basic concepts of IVM and address issues associated with the role of vectors in disease transmission and their control.
4. Incorporate the components of IVM in to vector control programs and facilitate the training of additional health personnel on implementation of

integrated vector management as an alternative approach to use of pesticides for vector control programs.

The government has set up a committee on National Capacity Needs Self Assessment currently being coordinated by the National Environmental Management Authority in collaboration with UNEP. The objective of this exercise is to focus on the capacity needs and priorities required for the implementation of the conventions on Bio-diversity, Desertification/Land degradation, Climate Change and POPs Convention.

NGOs and POPs

Currently there are very few NGOs involved in the anti POPs campaign. This is mainly due to the fact that this is a highly technical area, which requires high level of intellectual acumen, which is often lacking in many NGOs. This is attested to by the fact during INC2 in Nairobi, IPEN organized a one-day NGO forum to induct NGO activism in this area in Kenya. The meeting was attended by more than 38 NGOs but surprisingly enough only PSR-Kenya was able to embrace the POPs challenge and has continued to lead in the anti-POPs campaign since then. Only three NGOs are actively involved in the campaign against POPs in Kenya. However there are potential NGOs like Center for Industrial Ecology, which have the expertise in chemicals management.

The major obstacle to NGO participation in the anti-POPs campaign is that the POPs is a relatively new area in the “Sustainable environment” campaign. Most local donors either do not understand it or have not developed focal areas for funding POPs activities. For example UNEP Small Grants Program is only now developing a focal area for POPs funding. Secondly NGO’s have not been able to access funding for POPs activities under both bilateral and multilateral pecuniary arrangements unlike other programs like soil conservation, climate change and bio-diversity.

Other NGOs that participate in the NIPs are also currently engaged in the development similar proposals for GEF funding especially in the four thematic areas of the Stockholm Convention.

State of Stockholm Convention ratification and the NIP

Kenya signed the Stockholm Convention on 23rd May 2001. The instruments of ratification were deposited with the United Nations on 24th September 2004 and Kenya became a State Party on 23rd December 2004. The main delay in ratification was occasioned by the change in government, which took place in 2002. Kenya sent a high-powered delegation led the Director General of NEMA to the 1st Meeting of Conference of Parties in Uruguay in May 2005. Kenya has completed the National Implementation Plans for DDT but not for the three other thematic areas namely pesticides, UPOPs, and PCBs.

PSR-Kenya in conjunction with the DDT expert committee is preparing a GEF proposal based on the National Implementation Plans for DDT. The project title is *Evaluation and Demonstration of efficacy, cost effectiveness and sustainability of DDT alternatives for malaria control and development of adaptation to climate change policy in disease management in Kenya* and has multiple participants implementing various components. The rationale of the study principally focuses on the contention that "*alternatives as a matter of necessity must be safe, effective, affordable, and sustainable and fit within the recommended vector management technologies*". PSR-Kenya will implement the health and environmental evaluation component. The main objectives of this project component are: documentation of short-term clinical manifestations of exposure to pyrethrins; treatment of the clinical manifestations associated with exposure to pyrethrins in the course of testing for their efficacy; compare the health and environmental effects of the pyrethrins and synthetic pyrethroids used in ITNs or LLINs and to determine the toxicokinetics (absorption, disposition and bioaccumulation) of the pyrethrins and synergists in lactating mothers, children under 5 years of age and in those applying them and to determine the persistence and toxic effects of Pylavex™ 0.6EC (as a larvicide) in other aquatic organisms other than mosquito larvae. Five expected outcomes of this component are: treatment of adverse clinical manifestations of exposure to the pyrethrins during the course of the evaluation and demonstration exercise; documentation of health effects of the pyrethrins used in malaria vector control; increased knowledge on health effects of the pyrethrins on a cross-section of vulnerable populations; and strategies for managing short and long term health and environmental effects of these products put in place and treatment modalities of clinical effects of pyrethrins developed.

Public awareness activities

The NGO community has also mounted spirited campaigns to address POPs issues in Kenya. In September 2003 PSR-Kenya and Health Care Without Harm conducted a training exercise on the Management of medical waste for representatives of 200 Community Based Organizations in Nairobi. The overall objective of this training was reduction of dioxin emission and occupational safety. This has been followed up by PSR-Kenya consultative meeting with representatives of hospital heads in Nairobi on the management of hospital waste.

On 22nd March 2004, PSR-Kenya authored a full-page article in the East African Standard challenging the World Bank recommendation to sell the Pyrethrum Board of Kenya. The organization took the opportunity to educate Kenyans on the health effects of DDT and the important role the Board was already playing in the search for alternatives to DDT as required by the Stockholm Convention. Other than the educative aspect the gist of the article was to promote the new products, which have been produced by the Board in the fight against malaria vector, Pylarvex - kills mosquito larvae and pupae in their breeding habitants, Pymos for aerial and indoor residual spraying to kill adult mosquitoes and Pynet for treating mosquito nets kills and repels adult mosquitoes. The residual capacity of Pylarvex is 6 months.

The Pyrethrum Board of Kenya has embarked on vigorous research to increase the residual capacity of pyrethrins to make it last longer especially where it will be used for indoor residual spraying. The three products mentioned above have already been registered with the Pesticide Control and Products Board.

Public interest was excited upon the release of the Kenya egg report[7]. The report revealed that eggs collected from free-range chickens near the Dandora Waste Dump contained dioxins at levels 28 times above the European Union limit. The media (especially the East African Standard and Kenya Television Network) interviewed a cross section of POPs experts with a view to eliciting the health and environmental effects of dioxins. PSR-Kenya has since received requests to conduct investigations especially on the link between cancer and the metallurgical companies based in the immediate environs of Nairobi. In Dandora many residents are worried about the possible relationship between the rising disease prevalence in the area and dioxins released through the practices at the dump.

Poor funding of POPs activities remains the main obstacle for increased public visibility of POPs. Recently UNEP through the NEMA conducted a capacity self-needs assessment of major stakeholders in Climate Change, Bio-diversity and POPs. There are high hopes that this exercise might culminate in the facilitation of the organizations and institutions to promote anti-POPs activities. PSR-Kenya is currently working towards generating, distilling and disseminating information amongst stakeholders in order to build and sustain their capacity to respond to the challenges of implementing the Stockholm Convention.

The joint communiqué released by UNEP-SGP and IPEN provides an even greater opportunity for IPEN Participating Organizations. On 13th May 2003, CEAG Africa organized a consultative workshop on "*Dioxin Reduction in Nairobi – A community based Approach*". The workshop was attended by Representatives of Community based Organizations that are involved in waste management in Nairobi, senior government officials, NGOs and officials from the UNEP-SGP – the funders of the workshop. The workshop resolved to prioritize elimination of practices that lead to production of dioxins and furans in Nairobi and mandated CEAG Africa to provide leadership to the joint project. A grant proposal is currently being formulated with the consent of UNEP-SGP offices in Nairobi.

Recommendations on inventories

Currently the national Inventory on POPs in Kenya is still embargoed since the final draft is yet to be presented to the Ministry of Environment, NEMA and Stakeholders. The final draft is currently being finalized. The final document will

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[7] DiGangi J. Petrlik J, The Egg Report, Contamination of chicken eggs from 17 countries by dioxins, PCBs and hexachlorobenzene, International POPs Elimination Network, 2005.

be shared at a stakeholders' forum for adoption and ownership. The results of this study have been shared liberally with the National POPs office and will be incorporated in to the national inventory. However a peremptory look at the inventory reveals that a lot of information is yet to be captured in order to reflect the true POPs situation in the country. The inventory therefore requires constant updating. Even though there is still dearth of complete information most thematic groups have gone ahead to complete the NIPs. The section on DDT has not captured obsolete stocks held by the military, Desert Locust Control Organization and possibly malaria control agencies.

New POPs

Though the issue of new POPs has not been discussed formally in any of the forums convened by the Committee on the Implementation of the Stockholm Convention, concerns are currently being raised over Lindane, Paraquat and Endosulfan. These have been discussed in light of discussions emanating from the COP1. We will seek to encourage the Kenya government to pursue these three and Dicofol as candidate POPs.

Resources on POPs

Websites, databases, reports, academic researchers, laboratories, etc
www.pops.int
www.psr.org

REFERENCES

1. Barasa M.W., Studies on Distribution of Organochlorine Pesticides in a Tropical Marine Environment along the Kenyan Coast, MSc. Thesis, Department of Chemistry, University of Nairobi (1999).

2. Clarke, D., H. Odialla, J. Ouma, V. Kenny, R. NacCabe, B. Rapuoda and W.M. Watkins. A malariometric survey in Turkana District, Kenya: Chemosensistivity in *vivo* of *Plasmodium falciparum* infections and identity of the vector. Trans. Roy. Soc. Trop. Med. Hyg 1996; **90**:302-304.

3. Everaats J.M.; Van Weerlee E.M; Fisher C.V.; Hilegrand M. Th. J. Polychlorinated biphenyls and cyclic pesticides in sediments and microinvetebrates from the coastal regions of different climatological zones. International Conference July 1-5 Vienna IAEA –SM –343/45 International Atomic Energy Agency, Vienna 1996.

4. Garnham P.C.C. Brit. Med. J., ii, 45. Control of Epidemic Malaria in Kenya Highlands by DDT. Impregnation of huts – First year's result – Interdepartmental Insecticidal Committee's Report Kenya (unpublished).

5. Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. III-136]

6. Kahunyo JM, Froslie A, Maitai CK. Organochlorine pesticide residues in chicken eggs: a survey. J Toxicol Environ Health. 1988;24(4):543-50.

7. Kanja L.W.; Skaare J.U; Ojwang S.B.O.; A comparison of organochlorine pesticide residue in maternal adipose tissue, maternal blood, chord blood and human milk from mothers infant pairs; Arch. Environ. Contam Toxic 22, 21-24

8. Khan B. and C.G. Neville, 1996. Trends in P. *falciparum* resistance to chloroquine in Kenya – an analysis of of the available data for the period 1980-1995 (unpublished report).

9. Kihumba F.N. Report on Pilot Study on National Information Systems on Chemicals in Kenya (1995).

10. Koeman J.H.; Pennings J.H.; Goeij, J.J.; Tjoe P.S.; Olindo P.M.; Hopcrafts, J.; (1972); A preliminary report on Possible contamination of Lake Nakuru in Kenya with some metals and chlorinated hydrocarbon pesticides; J. Aplli. Ecol. 9: 411-416

11. Lalah, J.O., Studies on dissipation and metabolism of a variety of insecticides under Kenyan environmental conditions. PhD Thesis University of Nairobi (1993)

12. Lalah JO. Wandiga SO, Yugi PO, Barasa MW, Jumba IO, The distribution of organochlorine pesticides in marine samples along the Indian Ocean coast of Kenya. Environ Technol. 2002 ov; 23(11):1235-46.

13. Lincer J.L; Zalkind, D; Brown, L.H; Kopcraft J. (1981) Organochlorine Residue in Kenya Rift valley Lakes. J. App. Ecol. 18:157-171.

14. Mbuvi S, Distribution of p;p' DDT in Tropical Marine Eco-system; MSc thesis, Department of Chemistry, University of Nairobi.

15. Mitema, E.S. and Gitau F.K. 1990. Organochlorine residues in fish from lake Victoria, Kenya. *Afr. J. Ecol.* 28(3): 243-9.

16. Munga D.; 1985 DDT and Endosulfan residues in fish from Hola Irrigation Scheme, Tana River Kenya, (MSc thesis). Department of Chemistry University of Nairobi.

17. Roberts, J.M.D., Control of Epidemic Malaria in the Highlands of Western Kenya, Journal of Tropical Medicine and Hygiene, Vol. 67 (nos. 1-12) January – December 1964.

18. Sum, K.S., Kuria, J.N., Vulule, J.M, Rapuoda, B.A., and Waweru, J. Pyrethrum, a Viable Alternative to DDT in Mosquito Control.

19. UNEP, 1999 Guidelines for Identification of PCBs and Materials Containing PCBs. First Issue. UNEP Chemicals.

20. UNEP Chemicals 2000 GEF: Regionally Based Assessment of Persistent Toxic Substances. Guidance Document for collection, assembly and evaluation of data on sources, environmental levels and impacts of persistent substance. UNEP Chemicals.

21. UNEP Chemicals 2002. Riding the world of POPs: A guide to the Stockholm Convention on Persistent Organic Pollutants.

22. Wandiga SO, Yugi PO, Barasa MW, Jumba IO, Lalah JO. The distribution of organochlorine pesticides in marine samples along the Indian Ocean coast of Kenya. Environ Technol. 2002 ov; 23(11): 1235-46.

23. White N. J. Assessment of Pharmacodynamic properties of Antimalarial Drugs in vivo: Antimicrob. Agents Chemother, 1997; 41:1413-22

24. Wiktelius S, Edwards CA. Organochlorine insecticide residues in African Fauna: 1971-1995. Rev Environ. Contam. Toxicol. 1997; 151:1-37. Review.

25. Yugi, P.O.; The distribution of organochlorine pesticide residue in a tropical marine environment along coastal region of Kenya; MSc. thesis, Department of Chemistry, University of Nairobi

26. Yugi, P.O. The Distribution of Organochlorine Pesticides Residues in the Marine Environment along the Coastal Region of Kenya, MSc. Thesis, Department of Chemistry, University of Nairobi (2000).

ANNEXES

Annex 1: Facilities and sites inspected for DDT

Areas and sites that were visited

REGION	SITES VISITED
NAIROBI	KFA, MOH, Twiga Chemicals, KMS, Nairobi City Council- Dept of Public health, Murphy Chemicals, Baraka Agro vet, Huplan Kenya Ltd, Nairobi Vet Centre, desert locust store at Wilson Airport, HCDA, Kitengela store/Kenya institute of waste management Kitengela, KARI, KETRI, E.A. Seed Co., Osho Chemicals, Elgon Chemicals, Rhino Chemicals
COAST PROVINCE	Wundanyi - District Agricultural Office (DAO), KFA, Wema Agro-Vet and General store Mombasa: Kenya Ports Authority, KFA, Badfar Agro-Supplies Mtwapa, Mombasa Farmers Centre, Mpeketoni- Lamu. Kilifi – KEMRI Malindi: Municipal Council, bindahman Agro-Vet, Casuarina pest control Services Ltd.
CENTRAL PROVINCE & EASTERN PROVINCE	Thika: Thika Municipality, Cirio Del Monte, Kakuzi, SOCFINAF Coffee Estates-Ruiru Murang'a; Mugama Farmer's Coop. Union and Societies, Maragua Coop.Union, Kirinyaga: Inoi Farmers Cooperative society, Mwea New Down Town, National irrigation Board Mwea, KARI, Mwirua FCs, Mutira FCS, Mwea Ginneries, Thabiti Agro-Vet, Fair price Waguru Embu: KFA, KARI, DAO, ATDC stores, Karuga factory, Thuti, Gakunda FCs, Njeriria Factory, , Mastermind tobacco (Muconoke), Kirin AgroBio Embu. Nyeri; Mathira Farmers cooperative union, Nyeri Municipality, Mukurwe-iniFCs, KFA. Meru: Meru Central: Gaiti Cotton Ginnery, , MoA, Kaguru, Meru Central Farmers Union, Kiagaari and Nthima FCS Meru North: Ruri FCs, Tigiji Factory, Kanjaru FCs, Murichia, kamachia FCS, Meru South: Meru Farmers Cooperative, Mitheru FCS, Kanji Keru FCS, Bwee FCS, Kirubia Tharaka; Tharaka cotton ginnery, Kibwezi
NORTH EASTERN	Mandera and Wajir
RIFT VALLEY	Nakuru: DAO, Faida seed co., Farmers World, Cooper Kenya, Farmers Partner, KFA, Kenya seed company, Meya Ltd., Mea, general store, Technology farm-Njoro, National plant Breeding, research Centre- KARI Njoro, Egerton University. Kericho; KFA, Kipsigis farmers, ponasliu Agro-Vet, DAO, Naivasha: KFA, Oserian and Sher Flower farms
WESTERN/ NYANZA	Kisii: DAO Jumbo Agro-Vet, KPCU, Kisii farmers Coop. Union. L. Victoria, KEMRI, Kisumu City Council.

ANNEX 2: Statement by the Director General NEMA

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY
P.O BOX 67839 NAIROBI 00200
TEL 020 – 609013/27
FAX: 020-608997

WHY DDT SHOULD NOT BE RE-INTRODUCED FOR USE IN MALARIA CONTROL IN KENYA

Dichlorodiphenyltrichloroethane (DDT) in an organochlorine insecticide, which is effective against mosquitoes but not environmentally friendly. It persists in the environment hence is labeled as one of twelve persistent organic pollutants (POPs) that are toxic and do not biodegrade easily; the other eleven are aldrin, dieldrin, chlordane, heptachlor, hexachlorobenzene, mirex, toxaphene, dioxins, polychlorinated biphenyls and furans.

Harmful environment effects of DDT have been recognized since 1950s when Swiss scientists established association between unborn and functionally impaired calves whose mothers had been grazed on DDT Sprayed pastures. Studies on human volunteers, non-human primates and other mammalian species indicate that DDT may cause a number of adverse effects ranging from acute toxicity to cancer. Other studies have implicated DDT in increased testicular cancer, reduced sperm count and sperm quality (which lowers fertility), premature births and lower birth weights. Some studies have also linked DDT to high number of hypospadias (urethra opening on the scrotum), which used to affect one in hundred male children born in the US. Exposure to DDE a metabolite of DDT has also been linked to precocious puberty. Consequently, DDE has been linked to shortened period of lactation in breastfeeding mothers.

A study carried out in Kenya in mid -1980 indicated high levels of DDT was used in both agricultural and public health undertaking. High levels of DDE and DDT were observed from a test of 367 domestic eggs from 61 farms in Central Kenya and 41 maternal blood, milk, subcutaneous fat and umbilical cord blood samples from mothers who delivered through caesarean section in Kenyatta National Hospital. DDT enters the human body system through the food chain.

If DDT is to be imported and applied strictly as recommended, elaborate and costly preparations must be made. Furnaces should be put up to incinerate DDT remnants and their containers. Separate washing facilities for personnel handling the chemical must be provided to avoid water contamination. Amount of DDT that would be required in any one year in Kenya to control malarial runs into hundreds of metric tones; how will such quantities be stored and transported to house holds country wide without contaminating the environment?

The international Stockholm Convention, which Kenya signed in May 2001, restricts DDT to Public Health use only if there are no safer alternatives. Most countries of the World have banned use of DDT completely. Only twelve countries in the developing world are still using DDT in malarial control. However some of these countries are registering an increase in childhood cancers. For example, 5% of children below 5 years old in Mauritius are report as dying of cancer. Additional, Ethiopia, which manufactures and uses DDT for malarial control is still experiencing malaria epidemics with increasing mortality rates.

There are safer and locally produced natural pyrethroids which are very effective against mosquitoes. The pyrethrum Board of Kenya produces the following efficacious insecticides and larvicides:

- Pylarvex kills mosquito larvae and pupae in their breeding habitants
- Pymos for aerial and indoor residual spraying to kill adult mosquitoes
- Pynet for treating mosquito nets kills and repels adult mosquitoes.

The above enumerated products have been tested and found to be extremely effective against adult, larval and pupal stages of mosquitoes.

Kenya produces 80% of global output of pyrethrum whose products we should use in malaria control programmes. The latest trials of synthetic pyrethroids produced in other countries have been found to be inferior in efficacy to our locally produced ones.

Pyrethrum compounds are biodegradable and have no harmful metabolites after is. As a country which produces excessive pyrethrum flowers, we can use our crop to save our environment which is in a state of having every natural gift polluted, while at the same time raise the standard of living of our rural poor.

From the foregoing, Kenya has no justification at all to resort to DDT in controlling mosquitoes. Kenya stands to loose European and other developed countries' market for horticultural produce and fish markets as these countries have totally banned the use of DDT. Even if DDT is imported for public health use exclusively, there is no guarantee that it will not be illegally used for agricultural purposes to the detriment of our agricultural exports and health of Kenyans. We have alternatives.

Prof. Ratemo W. Michieka Ph.D, EBS
DIRECTOR-GENERAL

Annex 3: Statement by the Ministry of Agriculture

The Standard September 21st 2005

REPUBLIC OF KENYA
MINISTRY OFAGRICULTURE
PRESS RELEASE

The Ministry's attention has been drawn to an article in the Daily Nation of 15th September 2005 on page 23 with the heading "*How Kitengela was poisoned*". The story contains untruths which the Ministry would wish to clarify as follows;

1. **Background**
   - A temporary shed was erected in 1967 to store emergency stocks of pesticides for control of locust invasions.
   - The site then was far from any human habitation as the Kitengela area was not as habited as it is at the moment
   - In 1980, in order to properly secure the site to prevent harmful effects to the environment, people and animals, the Ministry in collaboration with the Agro-chemical industry through the Agrochemical Association of Kenya (AAK) undertook the following actions
     - A trench was dug around the shed to protect adjacent land
     - In 1994, the Ministry and the industry with the assistance from a donor project decided to clean up the entire country of obsolete pesticides and the site was used as temporary storage

2. **Current Status**

Since the site had been in use for considerable period of time, an assessment of the site was done and the following steps were taken:

- Three other sheds were built over the soil to stop the rain water carrying the contaminated soil away from the site.
- The floor of the shed was cemented to further protect the site from likely contamination.
- The Agrochemical industry contracted the Kenya Institute of Waste Management (KIWM) to undertake incineration
- The Ministry put up a big sign board at the gate warning members of the public to keep their animals and themselves away from the site
- The Ministry and Agrochemical industry (AAK) planted many trees and flowers at the site to act as buffers.
- The Ministry will carry out an environmental impact assessment (EIA) and where necessary undertake a decommissioning audit

3. **Public not in danger**
   - The Ministry and the Agrochemical Industry (AAK) wish to inform members of the public that our shed poses no danger to them and their livestock. We however caution them to observe the posted warning signs at the site.
   - The government is in the process of regulating waste management. Industries will be required to incinerate waste, which is the best available method technology and is not unique to Kenya. The existing incineration facility operates to high incineration standards. The facility is duly accredited and regularly audited by the National Environment Management Authority (NEMA).
   - The Ministry wishes to convey its dismay at the report whose intention is to attract donor funds and alarm the public.

James E. O. Ongwae	**Gitau Macharia**	**Samwel Gachanja**
Permanent Secretary	**Chairman- AAK**	**CEO-PCPB**