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International POPs Elimination Project

Fostering Active and Efficient Civil Society Participation in Preparation for Implementation of the Stockholm Convention

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Country Situation on Persistent Organic Pollutants (POPs) in India

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About the International POPs Elimination Project

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

IPEP has three principal objectives:

- Encourage and enable NGOs in 40 developing and transitional countries to engage in activities that provide concrete and immediate contributions to country efforts in preparing for the implementation of the Stockholm Convention;

- Enhance the skills and knowledge of NGOs to help build their capacity as effective stakeholders in the Convention implementation process;

- Help establish regional and national NGO coordination and capacity in all regions of the world in support of longer term efforts to achieve chemical safety.

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

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

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This report is available in the following languages: English

ABBREVIATIONS AND ACRONYMS

AICRP	The All India Coordinated Research Project
AIIMS	All India Institute of Medical Sciences
BAT	Best Available Techniques
BCD	Base catalysed decomposition
BEP	Best Environmental Practices
Bt	Bacillus Thuringiensis
CAS	Chemical Abstract Services
CII	Confederation of Indian Industry
COP	Conference of the Parties
CPCB	Central Pollution Control Board
CSIR	Council of Scientific & Industrial Research
CSO	Civil Society Organisation
CWM	Chemicals and Waste Management
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DE	Destruction efficiency
DRE	Destruction removal efficiency
EDB	1,2-dibromoethane
ECA	Environmental Chemical Agent
ESM	Environmentally sound management
FAO	Food and Agricultural Organisation
FICCI	Federation of Indian Chambers of Commerce and Industry
GDP	Gross Domestic Product
GEF	Global Environment Facility
GPCR	Gas phase chemical reduction
Ha	Hectares
HCB	Hexachlorobenzene
HCH	Hexachlorocyclohexane
HIL	Hindustan Insecticides Limited
HP	Himachal Pradesh
HW	Hazardous Waste
IARC	International Agency for Research on Cancer
IARI	Indian Agriculture Research Institute
ICAR	Indian Council of Agriculture Research
ICMR	Indian Council of Medical Research
IFCS	Inter- Governmental Forum on Chemical Safety
ILO	International Labour Organisation
INC	Intergovernmental Negotiating Committee
IOCC	Inter-Organization Coordinating Committee
IOMC	Inter-Organisation Programme for the Sound Management of Chemicals
IPEN	International POPs Elimination Network
IPEP	International POPs Elimination Project

IPM	Integrated Pest Management
ISO	International Organization for Standardization
ITRC	Industrial Toxicology Research Centre
IUGR	Intra-uterine Growth Retardation
LDH	Lactate Dehydrogenase
LWPS	Liquid Waste Pre-heater System
MEA	Multilateral Environment Agreements
MEO	Mediated electro-chemical oxidation
MNC	Multi-national Corporation
MOA	Ministry of Agriculture
MoEF	Ministry of Environment and Forests
MRL	Maximum Residue Limit
MT	Million Tonnes
NEERI	National Environmental Engineering Research Institute
NGO	Non-governmental Organisation
NIO	National Institute of Oceanography
NIOH	National Institute of Occupational Heath
NIP	National Implementation Plan
OCS	Octachlorostyrene
OECD	Organisation for Economic Co-operation and Development
OEWG	Open-ended working group of the Basel Convention
PACT	Plasma Arc Centrifugal Treatment
PAI	Pesticide Association of India
PAN	Pesticide Action Network
PBB	Polybrominated biphenyl
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PCN	Polychlorinated naphthalene
PCT	Polychlorinated Terphenyl
PFOS	Perfluorooctane sulfonate
PIC	Prior Informed Consent
PIL	Public Interest Litigations
POPs	Persistent Organic Pollutants
POPRC	POPs Review Committee
PVC	Polyvinyl Chloride
PVO	Private Voluntary Organizations
PWC	Plasma Waste Converter
RFI	RCRA Facility Investigation
SAICM	Strategic Approach to International Chemicals Management
SCMC	Supreme Court Monitoring Committee on Hazardous Wastes
SCWO	Super-critical water oxidation
SET	Solvated Electron (process)
SME	Solvent microextraction

T4	Thyroxine (thyroid hormone)
TB	Tuberculosis
TCDD	Tetrachloro-*p*-dibenzodioxin
TEQ	Toxic equivalent
TN	Tamil Nadu
TNC	Transnational Corporations
TRBP	Thermal Reduction Batch Processor
Tris	Tris (2,3 dibromopropyl) phosphate
TSH	Thyroid-stimulating Hormone
TWG	Technical Working Group on Pesticides
UK	United Kingdom
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNECE	United Nations Economic Commission for Europe
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training & Research
UP	Uttar Pradesh
USA	United States of America
WDP	Water-dispersible powder
WHO	World Health Organisation
WWF	World Wild Fund for Nature

UNITS OF CONCENTRATION

Mg/kg	Milligram(s) per kilogram. Corresponds to parts per million (ppm) by mass
***μ*g/kg**	Microgram(s) per kilogram. Corresponds to parts per billion (ppb) by mass
Ng/kg	Nanogram(s) per kilogram. Corresponds to parts per trillion (ppt) by mass

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EXECUTIVE SUMMARY

Background

Scientific studies have revealed that the present and future generations of human beings and wildlife would be exposed to the toxic effects of various industrial chemicals, pesticides and unintentional by-products. Some of these substances are persistent, toxic, bioaccumulate in human and animal tissues, and biomagnify leading to serious health concerns.

Persistent Organic Pollutants (POPs) are, as the name suggests, persistent and extremely toxic. Even when released in relatively small quantities they degrade very slowly. They remain in the environmental media for years. POPs are lipophilic and hence bioaccumulate in the fat tissue of organisms once exposed. They move from one level to higher level in the food chain and biomagnify. Furthermore, POPs have the ability to travel and concentrate in the environment and biota of regions far away from the original source of production through the long-range transport mechanisms through air and water. Thus POPs is an issue of national, regional and global concern.

In 1992, the UN Conference on Environment and Development adopted Agenda 21 including Chapter 19 on "Environmentally Sound Management of Toxic Chemicals Including Prevention of Illegal International Traffic in Toxic and Dangerous Products," In 1995, the UNEP Governing Council (UNEP GC) invited the Intergovernmental Forum on Chemical Safety (IFCS) and Inter-Organization Programme on the Sound Management of Chemicals (IOMC) to initiate an assessment regarding a short-list of 12 POPs. In 1997, efforts were initiated on a global scale to deal with POPs through the United Nations Environmental Programme (UNEP). In 1998, the Intergovernmental Negotiating Committee (INC) for POPs held its first meeting in Montreal to discuss the threats posed by the dirty dozen as an initial target for immediate action. Thereafter INCs were held in Nairobi, Geneva, Bonn and Johannesburg. A global legally binding treaty to protect health and the environment from POPs was adopted on 22 May, 2001, and entered into force on 17 May, 2004. The treaty bans some POPs, but restricts or otherwise controls others.

In an emerging consciousness pertaining to global chemical safety the Stockholm Convention forms the basis along with other instruments such as the Basel Convention on the Transboundary Movement of Hazardous Wastes and the Rotterdam Prior Informed Consent Convention (PIC). Various other treaties and agreements have followed emphasizing chemical safety. India became a Party to the Stockholm Convention in January 2006.

The report critically examines the country situation of POPs with respect to the sources, pollution pathways, levels, damages and effects. The report is corroborated with available information about POPs in the country.

Indian Perspective on POPs.

A highly populated and developing country like India is subjected to environmental contamination of POPs from several sources and activities. This leads to considerable exposure of all organisms as relatively high levels of POPs have been detected in all quarters of the environment, drinking water, food products and even human breast milk.

Sources

The identified sources of POPs in India include production units, illegal imports as well as stockpiles of obsolete pesticide stocks. Except for DDT, which continues to be used in vector control, seven other pesticide POPs listed in the Stockholm Convention are banned for manufacture and use in the country. However, stockpiles of unused POPs are a cause of concern mainly because in many places they still remain unidentified. According to an inventory developed by the Food and Agriculture Organization (FAO), there are 3346 MT of obsolete and banned stocks in stockpiles in India.

Uses

Legally in India, intentional use of POPs pesticides has been banned. DDT is the only POPs pesticide, which is used in vector control but has been banned for agricultural use. India may use up to 10,000 MT of DDT (at 50 per cent formulation) per year for malaria control programmes.

Another major challenge in India is phasing out PCBs from the electricity sector. There is no estimation of PCBs in capacitors and transformers, which makes the job all the more difficult. Oil in old transformers is recycled into new transformers and may contain PCB's. The ship breaking industry is also a major and growing source of PCBs in India.

Another critical issue in India is that of dioxins and furans, the sources of which are various like incineration, cement factories, PVC units, biomass burning, open burning etc.

Environmental and high levels of POPs

Environmental contamination through POPs is a cause of serious concern in India. Even after banning, all quarters of the environment -- air, water and soil samples continue to show considerable contamination. Though some studies do exist on pathways for environmental contamination there still exist major gaps. There are a few water studies available from ITRC, CPCB and others, but these have not been conducted in an organized manner so as to be indicative of any particular trend or pattern. DDT and dieldrin have been detected in several soil sediment samples indicating the possibility of pilferage for agricultural use, run off from the soil and eventually been detected in water and soil sediments.

Studies have revealed contamination of food by POPs and are a cause of concern in India where poverty and malnutrition has made the population more vulnerable to the deleterious effects of POPs. In a nationwide food survey in 2001, 75% of the samples had detectable levels of DDT with about 10-15% of the samples having levels of DDT that exceeded the levels prescribed by the FAO and World Health Organization (WHO). Aldrin and dieldrin were also frequently detected pesticides in foodstuffs. Compared to cereals and pulses, spices, milk products, oils and meat products were more heavily contaminated with POPs chemicals. Other studies also reveal a similar trend. Owing to the sizeable vegetarian population in India, dairy constitutes a principal component of the Indian diet. Indian dietary consumption of DDT is estimated to be amongst the highest in the world. Consequently, DDT levels in breast milk and maternal cord blood are also amongst the highest in the world. An issue of particular concern is the exposure of the foetus and newborn infants to POPs through placental blood, breast milk and baby food as high levels have been reported from various studies.

The presence of POPs in aquatic and terrestrial species has also been confirmed by various studies. Recent surveys reported in World Bank studies indicate significant levels of DDT, PCBs and dieldrin in inland as well as offshore fish samples. POPs residues in aquatic and marine life are indicative of contamination of water sources and bioaccumulation in the food chain. In India, dolphins, which are at the highest level of the food chain in large river systems, contain excessively high levels of DDT, chlordane, aldrin, dieldrin, heptachlor, HCB and PCBs, far in excess of standards for edible meat. Studies by BNHS postulate that DDT may be the cause of declining populations of sarus crane and vultures in various parts of India.

Health Issues

Serious health consequences are associated with POPs impacting both wildlife and the environment. International studies have revealed that wild life exposed to POPs have showed high rates of malformed genitalia, aberrant mating behaviour, sterility, cancer and immune system and thyroid dysfunction which might be the reason for decline in population of bottle-nosed dolphin, and beluga, common seals etc. Other known effects are thinning of the eggshells of fish-eating birds due to DDT exposure. These studies are suggestive of the fact that humans would experience similar effects as well. Studies in India have shown high blood pressure, hormonal dysfunction, intrauterine growth retardation etc. in people with high levels of DDT.

Some key issues that emerge are as follows:

The review and analysis brings out that there is still relative uncertainty as to how India will choose to act in the future regarding issues connected with POPs and chemical management. The key stakeholders need to play a strategic role in accordance with global commitment for eliminating POPs. The analysis suggested a number of areas requiring attention to strengthen India's efforts on the POPs front. They are discussed below.

- Lack of awareness amongst the general public on the POPs issue and lack of awareness on the technical front amongst industry
- Limited experience of government so far in effectively mainstreaming of POPs issues
- Perceptions of risk and uncertainty among all stakeholders regarding handling this issue
- Need for establishing a dialogue with a broader set of stakeholders
- Generally weak institutional capacity at regulatory levels
- Poor coordination amongst concerned departments and ministries
- Poor implementation of laws
- Need for capacity building
- Need for more research in the area
- Need for identifying future POPs in India
- Need for identification, handling and disposal of pesticide stockpiles
- Shifting to Best Available Technologies
- Improving monitoring and laboratory facilities
- Shifting to safer alternatives of POPs and future POPs
- Checking inadvertent production of POPs

1. BACKGROUND INFORMATION ON POPS

Persistent Organic Pollutants (POPs) are carbon containing chemical substances. They persist in the environment to a varying degree and are most often halogenated. Characterized by low water solubility and high lipid solubility, they bioaccumulate and biomagnify through the food web. POPs are said to be bioaccumulative because wildlife retain them in their bodies at concentrations higher than in food and water that originally contain them. When predators higher in the food chain consume wildlife contaminated with POPs, it results in very high concentrations of contaminants in their bodies[1]. This effect is referred to as biomagnification. Subsequently they pose a risk of causing adverse effects to human health and the environment. They are also semi-volatile, a property which permits these compounds either to vaporize or to be adsorbed on atmospheric particles. Hence POPs have the ability of long-range transport in air and water from warmer to colder regions of the world. They are detected in regions where they have never been used or produced[2]. Taking cognizance to the consequent threats they pose to the global environment, the international community has now, at several occasions, called for urgent global actions to reduce and eliminate releases of these chemicals.

Although many different chemicals, both natural and anthropogenic (i.e. produced by man), may be defined as POPs, 12 of them, all chlorine containing organic compounds, have been chosen as priority pollutants by the United Nations Environment Programme (UNEP) for their impact on human health and environment. The twelve POPs include many of the first generation organochlorine insecticides, e.g. DDT, aldrin, industrial chemical products such as PCBs (polychlorinated biphenyls) or, unwanted by-products such as dioxins and furans.[3] The 12 identified POPs are given in Table 1 while Table 2 gives a description of the uses, persistence and toxicity of POPs pesticides.

Table 1: List of 12 POPs

Pesticides	Industrial Chemical Products	Unwanted By-products
Aldrin	Polychlorinated biphenyls (PCBs)	Polychlorinated dibenzo-p-dioxins (PCDDs)
Dieldrin	Hexachlorobenzene (HCB)	Polychlorinated dibenzofurans (PCDFs)
Endrin		Polychlorinated biphenyls (PCBs)
Chlordane		Hexachlorobenzene (HCB)
DDT		
Heptachlor		
Mirex		
Toxaphene		
Hexachlorobenzene (HCB)		

Table 2: Description of the Uses, Persistence and Toxicity of POP Pesticide

Name	Uses	Toxicity	Persistence/ Fate
Aldrin	Control soil pests and wooden structures from termites.	Toxic to humans. Lethal dose for adult – 80 mg/kg body wt. Maximum Residue Limit (MRL) of the Food and Agricultural Organisation (FAO) and WHO range from 0.006 mg/kg milk fat – 0.2 mg/kg meat fat and 0.1 – 180 µg/l for water quality.	Metabolises to dieldrin. Binds strongly to soil and resistant to leaching in groundwater. Moderately persistent with a half-life in soil and water of 20 days to 1.6 years.
Chlordane	Used as a fumigant in the control of cockroaches, ants, termites, and other	There is evidence of endocrine disruption and it is a possible carcinogen in humans and disrupts the immune system. Acute toxicity for mammals is moderate. MRLs of the	Highly persistent in soils with a half-life of 4 years. It binds to aquatic sediments and bio accumulates in organisms.

[1] http://www.chem.unep.ch/pops/
[2] http://www.chem.unep.ch/pops/
[3] http://pops.gpa.unep.org/

	household pests.	FAO/WHO are 0.002 mg/kg milk fat and 0.5 mg/kg poultry fat. Water quality criteria range from 1.5-6 µg/l.	
Dieldrin	Mainly used in the control of soil insects.	MRLs by FAO/WHO vary from 0.006 mg/kg milk fat – 0.2 mg/kg poultry fat. Water quality criteria range from 0.1 – 1.8 µg/l. It mainly affects the central nervous system.	Highly persistent in soils with a half-life of up to 5 years. Persistence in air is 4-40 hours.
DDT	Used for vector control for diseases like malaria, dengue and kala-azar. It was also widely used on a variety of agricultural crops.	Eggshell thinning in birds. Acute toxicity of DDT in mammals is moderate. DDT has been shown to exhibit estrogen like activity and has been identified as a possible carcinogen for humans. The MRLs in food recommended by the FAO/WHO range from 0.02 mg/kg milk fat – 5 mg/kg meat fat. MRL in drinking water is 1 µg/l.	Highly persistent in soils with a half-life of 10-15 years and 7 days in air. Metabolises to DDE. It exhibits high bio concentration factors of 50000 for fish.
Endrin (72-20-8)	Used as an insecticide in cotton, rice, sugarcane and other crops. Also used as a rodenticide.	Highly toxic to fish, aquatic invertebrates and phytoplankton.	Highly persistent in soils (half-lives of up to 12 years reported). Bio concentration of 14 to 18000 is recorded in fish, after continuous exposure.
Heptachlor	It is primarily used against soil insects and termites. It is also used for plant insects and malaria vectors.	Toxic to wildlife at low concentrations. In birds, it induces behavioural changes, reduced reproductive success and mortality. It is listed as a possible human carcinogen. The main exposure is through food. MRLs by FAO/WHO are 0.006 mg/kg milk fat and 0.2 mg/kg meat or poultry fat.	Metabolised in soils, plants and animals to heptachlor epoxide, which is more stable and carcinogenic. It bio concentrates and has a soil half-life of 0.75-2 years in temperate climates.
HCB	Used for seed treatment. HCB is also a by-product of a large number of chlorinated compounds such as pesticides, solvents and chlorinated benzene. Emitted from waste incineration facilities.	In humans, it causes liver damage and is a possible human carcinogen.	Estimated half-life in soils of 2.7-5.7 years and 0.5-4.2 years in air. High bioaccumulation potential and long half life in biota.
Mirex	Used against control of ants as also a fire retardant for plastics, rubber, paint, paper and electrical goods. Never registered in India	It has moderate acute toxicity for mammals. It affects behaviour in fish and is toxic to crustaceans. There is evidence of its potential for endocrine disruption and possible carcinogenic risk to humans.	Most stable with a half-life of 10 years. Bio concentration factors of 2600 and 51400 have been recorded in some aquatic and terrestrial species.
Toxaphene	Used extensively for cotton pests, vegetables, fruits and cereal grains. Also used to combat livestock parasites.	Highly toxic to fish. Strong evidence exists for the potential of endocrine disruption and it has been listed as a possible human carcinogen.	It has a half-life of up to 12 years. It bio accumulates in aquatic organisms.

Source: Compiled from UNEP (2002c).

2. NATURE OF THE PROBLEM IN INDIA

There are 12 such chemicals identified by United Nations Environment Programme (UNEP) whose manufacture (intentional or unintentional), use, import and export are to be eliminated or reduced so as to eliminate or reduce release of POPs into the environment. India faces a frightening scenario of historic, current and potential poisoning by these most dangerous varieties of persistent chemicals, the POPs. This situation is a result of existing stockpiles of obsolete pesticides, the continuing production of organochlorine and other chemical pesticides, the continued use of DDT for vector control and the unmitigated expansion of chlorine-based industries in the country.

There is an urgent need for the policy and regulatory framework in the country to be strengthened to facilitate environmentally sound management of POPs and other chemicals. India has taken the first step by ratifying the Stockholm Convention, which is a global treaty to protect human health and the environment from POPs. To fulfill its various obligations, there is now a strong requirement for strengthening the institutional and human resources capacity for its management and significant improvement in the reduction of its use for disease vector control, and pilferage for use in agriculture. Stockpiles of POPs need to be identified and managed. Toxic waste that produces POPs needs to be managed or disposed of, in an environmentally safe manner. Cleaner technological options need to be explored and a shift of the industries towards clean production should be strongly encouraged in order to facilitate reduction and elimination of unintentional production of POPs. Against this backdrop a country situation report on POPs becomes crucial.

The present report is based on information collected from various sources, analysis of the same and representing the information in a simplified manner. A large part of the information on POPs was sourced from the library and internet search involving a thorough survey of available literature. This has been complemented with informal interactions with various stakeholders and experts.

Table 3: Persistent Organic Pollutants - Status in India

Chemical (Common Name)	Chemical name	Status in India	Effective dates
Aldrin	1, 2, 3, 4, 10, 10-Hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-1, 4-endo, exo-5, 8- dimethanonaphthalene ($C_{12}H_8Cl_6$)	***Banned*** Complete ban on manufacture, use, import, and export	***20 September 1996***
Chlordane	1, 2, 4, 5, 6, 7, 8, 8-Octachloro-2, 3, 3a, 4, 7, 7a-hexahydro-4, 7-methanoindene ($C_{10}H_6Cl_8$)	***Banned*** Complete ban on manufacture, use, import, and export	***20 September 1996***
Dichloro-diphenyltrichloro-ethane (DDT)	1, 1, 1-Trichloro-2, 2-bis-(4-chlorophenyl)-ethane ($C_{14}H_9Cl_5$)	***Restricted Use*** Banned for agricultural use; restricted use in health sector	***26 May 1989***
Dieldrin	1, 2, 3, 4, 10, 10-Hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydroexo-1, 4-endo-5, 8-dimethanonaphthalene ($C_{12}H_8Cl_6O$)	***Banned*** Complete ban on the manufacture, use, import and export but marketing of the stockpile has been permitted for two more yrs from the date of ban	***17 July 2001***
Endrin	3, 4, 5, 6, 9, 9-Hexachloro-1a, 2, 2a, 3, 6, 6a, 7, 7a-octahydro-2, 7:3, 6-dimethanonaphth[2, 3-b]oxirene ($C_{12}H_8Cl_6O$)	***Banned*** Complete ban on manufacture, use, import, and export	***1990***
Heptachlor	1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene ($C_{10}H_5Cl_7$)	***Banned*** Complete ban on manufacture, use, import, and export	***20 September 1996***

Hexachloro-benzene (HCB)	Hexachlorobenzene (C_6Cl_6)	***Banned*** Complete ban on manufacture, use, import, and export	***April 1997***
Mirex	1, 1a, 2, 2, 3, 3a, 4, 5, 5a, 5b, 6-Dodecachloroacta-hydro-1, 3, 4-metheno-1 Hcyclobuta[cd]pentalene ($C_{10}Cl_{12}$)	***Not Registered***	
Toxaphene	Polychlorinated bornanes & camphenes ($C_{10}H_{10}Cl_8$)	***Banned*** Complete ban on manufacture, use, import, and export	***25 July 1989***
Polychlorinated biphenyls (PCBs)	Polychlorinated biphenyls ($C_{12}H_{(10-n)}Cl_n$, where n is within the range of 1-10)	***Banned*** Complete ban on manufacture, use, import, and export	***Conflicting years: 1990 or 1960?***
Dioxins (PCDDs)	Polychlorinated dibenzo-p-Dioxins ($C_{12}H_{(8-n)}Cl_nO_2$)	***Unintentional***	
Furans (PCDFs)	Polychlorinated dibenzofurans ($C_{12}H_{(8-n)}Cl_nO$)	***Unintentional***	

3. POPs PRESENCE IN INDIA

Table 4 presents known sources, uses and examples of pathways of contamination for three categories of POPs mentioned above in India.

Table 4 Sources of POPs, Pathways of Contamination and Environmental Receptors

POPs Categories	Sources of release	Uses/Applications	Pathways of Contamination and Environmental Receptors		
			Air	Water	Soil
Pesticides	- Stockpiles - Manufacture of pesticides - Imports	- Agricultural spraying for soil and crop pests - Spraying/ land application (e.g., disease vector control, livestock)	- Stack emissions - Industrial emissions - Emissions during spraying	- Leakage from stockpiles - Industrial effluents (e.g., production waste) - Agricultural and other soil run-off	- Leakages from stockpiles - Industrial effluents (e.g., production waste) - Agricultural and other soil run-off
Industrial Chemicals (PCBs and HCB)	- Solid waste incineration - Sewage sludge - Ship breaking industry	- Raw material for industrial processes[4] - Electric equipment stocks	- Industrial emissions - Emissions from solid waste and sewage sludge incineration - Emissions from equipment and stocks - Industrial emissions	- Industrial effluents - Leakage from solid waste and sewage sludge dumps - Leakage from equipment, stocks - Industry (including ship-breaking) effluents	- Leakage from sewage sludge dumps - Industrial effluents - Leakage from equipment stocks - Industry (including ship-breaking) effluents

[4] For example, HCB is used as a raw material in the manufacture of synthetic rubber, as a plasticiser for polyvinyl chloride (PVC), as a rubber peptizing agent in the production of nitroso and styrene rubbers, as a chemical intermediate in the making of dyes and wood preservatives.

POPs Categories	Sources of release	Uses/Applications	Pathways of Contamination and Environmental Receptors		
			Air	Water	Soil
By-products (dioxins and furans, PCBs and HCB)	-By-products in manufacture of pesticides[5] and industrial chemicals -Industrial, thermal and medical incineration processes[6] - Transportation systems -Biomass burning -Forest fires/other wood combustion - Sewage sludge		- Emissions from industrial, thermal and medical waste incineration processes - Exhaust gas emissions from automobiles - Releases in biomass/ forest/wood burning - Emissions from sewage sludge incineration/ leakage from sewage sludge dumps	- Industrial effluents - Leakage from sewage sludge dumps	- Industrial effluents - Leakage from sewage sludge dumps - Settling of air emissions from incineration processes

The sources of Pesticides POPs can be typically characterized as point and non point.

Point sources of POPs pesticides are in the form of pesticide manufacturing facilities (both technical grade manufacturers as well as formulators) and stockpiles of obsolete, unwanted or date expired pesticides, which might be used in tobacco cultivation.

Non-point source arise due to the general application of pesticides in cultivation resulting in crop run offs or leaching into ground water reserves. Again different pesticides are applied during crop rotation. The pesticide residues remain in the soil and consequently find there way into the plant. Non point sources of pesticides may also be due to application of pesticides on other adjoining fields growing other crops. In the Indian context the use DDT as part of the malaria program also constitutes a non-point source. The issue associated with the use of DDT is its stated pilferage and its clandestine use in agriculture. Experts opined differently on the issue, with the majority suggesting that there is in fact significant diversion of National Anti Malaria Program (NAMP) acquired DDT. This view can be supported by the data on incidence of DDT levels in areas where it is not being sprayed for malaria control.

In brief, for India the primary sources of pesticide POPs include production, imports as well as stockpiles of obsolete pesticide stocks. Except for DDT that is restricted for use in vector control, seven pesticide POPs listed in the Stockholm Convention are already banned for manufacture and use in India. Sources of unintentional POPs are given in Table 5.

[5] For example, HCB is produced as an unintentional by-product in the manufacture of pesticides, industrial chemicals (e.g., carbon tetrachloride, trichloroethylene) and industrial processes (e.g., chloralkali industry).

[6] This includes waste incineration (municipal solid waste, medical and hazardous waste), burning of industrial fuels (coal and petroleum products in the power sector), other high temperature sources (e.g., cement and other ceramic industry) and various primary and secondary metal operations (e.g., iron ore sintering, steel production and scrap metal recovery) and production of chemicals (e.g., chlorinated phenols and phenoxy herbicides) and in the chlorine-based paper and pulp sector.

Table 5 Sources identified for unintentionally produced POPs by the Stockholm Convention

Industrial sources listed in Annex C – Part II with potential for comparatively high formation and release of POPs

- Waste Incinerators, including co-incinerators of municipal, hazardous or medical waste or sewage sludge
- Cement Kilns firing hazardous waste
- Production of pulp using elemental chlorine or chemicals generating elemental chlorine for bleaching
- Thermal processes in the metallurgical industry including, secondary copper production, sinter plants in the iron and steel industry, secondary aluminum production, secondary zinc production

Other sources listed in Annex C – Part III

- Open burning of waste including burning of landfill sites
- Thermal processes in the metallurgical industry not mentioned in Part II
- Residential combustion sources
- Firing installations for wood and other biomass fuels
- Specific chemical production processes releasing unintentionally formed POPs, especially production of chlorophenols and chloranil
- Crematoria
- Motor vehicles, particularly those burning leaded gasoline
- Destruction of animal carcasses
- Textile and leather dyeing (with chloranil) and finishing (with alkaline extraction)
- Shredder plants for the treatment of end of life vehicles
- Smouldering of copper cables
- Waste oil refineries

In India, the primary sources of dioxins and furans are high temperature combustion and high temperature manufacturing operations such as incinerators, metal smelting, pulp and paper production, among many others. Other two important but poorly understood sources of dioxins in India is the burning of biomass as a traditional source of household energy for cooking and heating and dioxins emitted from crematoriums where human bodies are burnt.

3.1. Health Care waste and condition of incineration of health care waste in India

Incineration is one of the biomedical waste treatment and disposal technologies that are covered by India's Biomedical Waste Rules of 1998 (amended twice in 2000). In 2000 Srishti, a public interest group conducted a survey of the status of operating incinerators in India and presented the results to MOEF and CPCB. The results indicated that most of the on-site incinerators at health care facilities in India were not in compliance with Biomedical Waste Rules. These findings led CPCB to issue draft guidelines allowing incineration only at CBWTFs unless a special permit for onsite incineration is obtained from CPCB. The draft guidelines for BMW incinerators specify the design criteria for the incinerator and the associated air pollution control device, as well as the minimum requirements in terms of training, personal protection equipment, emergency procedures for the incinerator operator.

Since the 1998 Biomedical rules have no specifications on the design of incinerators (only mentioning that incinerators have to be double chambered and only gave the emission criteria) hence there arose a need for guidelines to ensure selection/ installation of better incineration system[7].

The CBWTF was looked upon as an alternative to on site waste treatment facilities as hospitals increasingly realized the high cost involved in operations and maintenance of incinerators. Table 6 gives the comparative cost figures of operating an onsite incinerator versus subscribing to CBWTF. Also the CPCB found it difficult to monitor the proper functioning of these large numbers of incinerators in the country. There are 64 CBWTF functioning in the country.

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[7] www.cpcb.nic.in

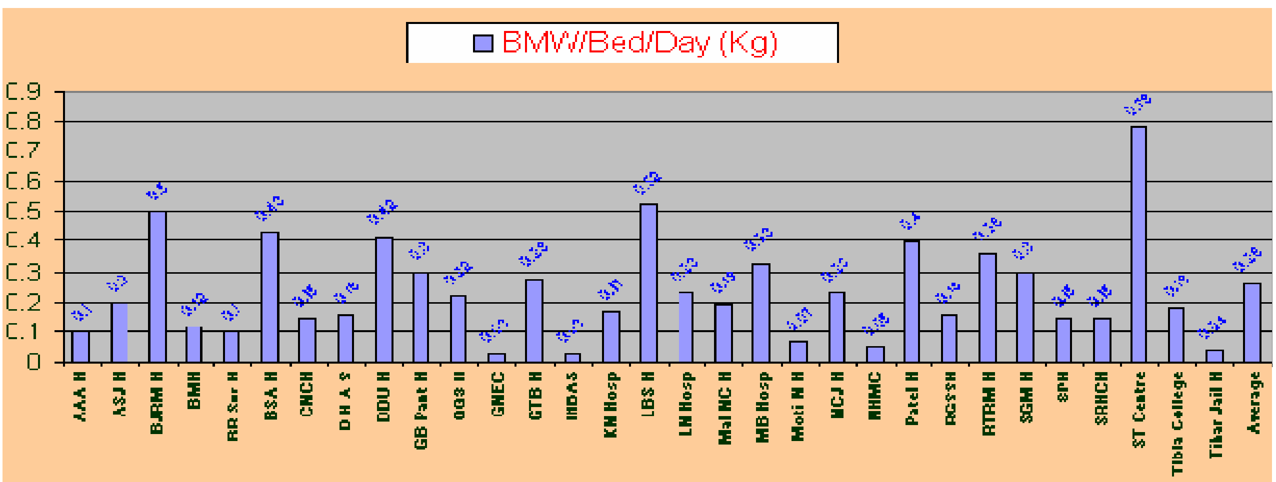
Table 6 a Cost comparison of running incineration- Onsite Vs Off site

S.No.	No. of beds	Amount of incinerable waste (Kg/m)	Amount spent in running onsite incinerator (Rs./m)	Amount paid to centralised facility (Rs./m)	Savings when outsourced (in %)
1	500	3000	83,135	50,000	40
2	1000*	4500	2,48,000	67,500	72
3	500	3300	59,000	50,000	15
4	230	NA	50,000	30,000	40
5	300	800	50,000	15,000	70
6	600	2100	60,000	31,500	47.5
7	100	1350	47,000	20,000	57
8	All MCD Hospitals	16500	2,66,000	2,47,500	7
9	600*	2700	85,000	40,500	53

** Incinerator still operational. Amount of waste is calculated on the basis of average waste generated per bed*

Biomedical Waste generated in Delhi Government Hospitals in December 2004 is given in Table 7

Table 7 Biomedical Waste generated in Delhi Government Hospitals



Source: www.health.delhigovt.nic.in

In September 2004, The Ministry of Health along with WHO approached the CPCB to seek permission for disposing syringe waste generated in the Universal Immunization Program (UIP) through open burning. This proposal was however rejected because of the active civil society representation in the technical approval committee. As the issue was not specifically covered in the BMW rules, the CPCB issued a progressive guideline for disposing the waste generated during UIP. These guidelines are non burn technologies specific and recommend treatment of these wastes through options like autoclaving, chemical disinfection, micro waving and sharps pits.

Despite the progressive initiatives the toxic POPs emission problems persists with incinerators.

The International POPs Elimination Network (IPEN) in early 2005 studied the free-range chicken eggs collected near potential sources of U-POPs as named by the Stockholm Convention for presence of U-POPs. The neighbourhood of the Queen Mary's Hospital, Lucknow medical waste incinerator in Uttar Pradesh (India) was selected as a sampling site since medical waste incinerators are known to produce dioxins and furans as well as hexachlorobenzene and PCBs.

Results and Discussion

Levels of dioxins found in sampled eggs collected near the Queen Mary's Hospital, Lucknow medical waste incinerator in Uttar Pradesh were five and half times higher than the EU dioxin limit for eggs. In addition, the samples exceeded the proposed limits for PCBs (in WHO-TEQs) by 4.7-fold. The results of the analysis of a pooled sample of 4 eggs are summarized in Tables 8. Pooled sample fat content was measured at 12.5%.

Table 8 Measured levels of POPs in eggs per gram of fat.

	Measured level	Limits	Action level
PCDD/Fs in WHO-TEQ (pg/g)	19.80	3.0[a]	2.0 [b]
PCBs in WHO-TEQ (pg/g)	9.40	2.0 [b]	1.5 [b]
Total WHO-TEQ (pg/g)	29.20	5.0 [b]	-
PCB (7 congeners) (ng/g)	75.34	200 [c]	-
HCB (ng/g)	3.80	20 (10) [d]	-

Abbreviations: WHO, World Health Organization; TEQ, toxic equivalents; pg, pictogram; g, gram; ng, nanogram.

[a] Limit set up in The European Union (EU) Council Regulation 2375/2001 established this threshold limit value for eggs and egg products. There is even stricter limit at level of 2.0 pg WHO-TEQ/g of fat for feeding stuff according to S.I. No. 363 of 2002 European Communities (Feeding stuffs) (Tolerances of Undesirable Substances and Products) (Amendment) Regulations, 2002.
[b] These proposed new limits are discussed in the document Presence of dioxins, furans and dioxin-like PCBs in food. SANCO/0072/2004.
[c] Limit used for example in the Czech Republic according to the law No. 53/2002 as well as in Poland and/or Turkey.
[d] EU limit according to Council Directive 86/363/EEC, level in brackets is proposed new general limit for pesticides residues (under which HCB is listed) according to the Proposal for a Regulation of the European Parliament and of the Council on maximum residue levels of pesticides in products of plant and animal origin, COM/2003/0117 final - COD 2003/0052.

Table 9 shows that the level of dioxins in eggs expressed as fresh weight exceeded the limit for commercial eggs in the USA by 1.5 fold. The US Food and Drug Administration estimates a lifetime excess cancer risk of one in 10,000 for eggs contaminated at 1 pg/g ITEQ. The samples collected near the Queen Mary's Hospital, Lucknow medical waste incinerator in Uttar Pradesh (India) exceeded this cancer risk level.[8]

Table 9: Measured levels of POPs in eggs collected near the Queen Mary's Hospital, Lucknow medical waste incinerator in Uttar Pradesh (India) per gram of egg fresh weight.

	Measured level	Limits	Action level
PCDD/Fs in WHO-TEQ (pg/g)	2.48	1[a]	-
PCBs in WHO-TEQ (pg/g)	1.18	-	-
Total WHO-TEQ (pg/g)	3.65	-	-
PCBs (7 congeners) (ng/g)	9.42		
HCB (ng/g)	0.48	-	-

Abbreviations: WHO, World Health Organization; TEQ, toxic equivalents; pg, pictogram; g, gram; ng, nanogram.

[a] U.S. Department of Agriculture Food Safety and Inspection Service [Memo 8 July 1997] Advisory to Owners and Custodians of Poultry, Livestock and Eggs. Washington, DC: U.S. Department of Agriculture, 1997. FSIS advised in this memo meat, poultry and egg product producers that products containing dioxins at levels of 1.0 ppt in I-TEQs or greater were adulterated. There is an even more strict EU limit at level of 0.75 pg WHO-TEQ/g of eggs fresh weight for feeding stuff according to S.I. No. 363 of 2002 European Communities (Feeding stuffs) (Tolerances of Undesirable Substances and Products) (Amendment) Regulations, 2002.

[8] was estimated (using a cancer potency factor of 130 (mg/kg-day)-1 and rounding the risk to an order of magnitude) for consumption of 3-4 eggs per week (30 g egg/day) contaminated at 1 ppt ITEQ[8, 8]

The measurements of U-POPs in this study represent the first data on U-POPs in chicken eggs ever reported in India. The surprisingly high-levels of U-POPs observed in the egg samples support the need for further monitoring and longer-term changes to prevent medical waste incineration as a common source of dioxins as well as other U-POPs.

Since there is no emphasis on training of health care workers the segregation practices remain poor in most parts of India. Hence PVC plastic waste, broken thermometers containing mercury end up in the incinerable waste stream.

There is often improper operation of the incinerator where it is operated at temperatures below the stipulated limit. This leads to uncontrolled release of POPs.

Taking cognisance of these problems The Supreme Court on April 2005, issued notice to the Centre and the Central Pollution Control Board (CPCB) on a public interest petition seeking the replacement of the existing system of burning bio-medical waste in incinerators with a new pollution-free technology of disposal by chemical treatment. The petitioner contended that burning of bio-medical waste caused more air pollution as per latest studies.

4. POLLUTION PATHWAYS

Before pesticide POPs were banned, pesticide POPs applied on target pests would ultimately end up in all quarters of the environment (air, water and soil), in other non target species and ultimately end up in the food chain. The sprayers of such pesticides would also be exposed to the toxics effects both acute and chronic. Such pollution pathways have been to a certain extent reduced or eliminated after the banning of the pesticide POPs. However, two sources of pesticide POPs still remain. Though HCB is banned in India Lindane is allowed for use as a pesticide. During the production phase it is suspected that the other more potent isomers land in the environment. Another POPs pesticide, DDT, though banned for use as a pesticide but allowed for use as a vector control in India. DDT sprayed for vector control finds its way into environmental media. Table 9 Gives the By Effects of pesticides on the environment

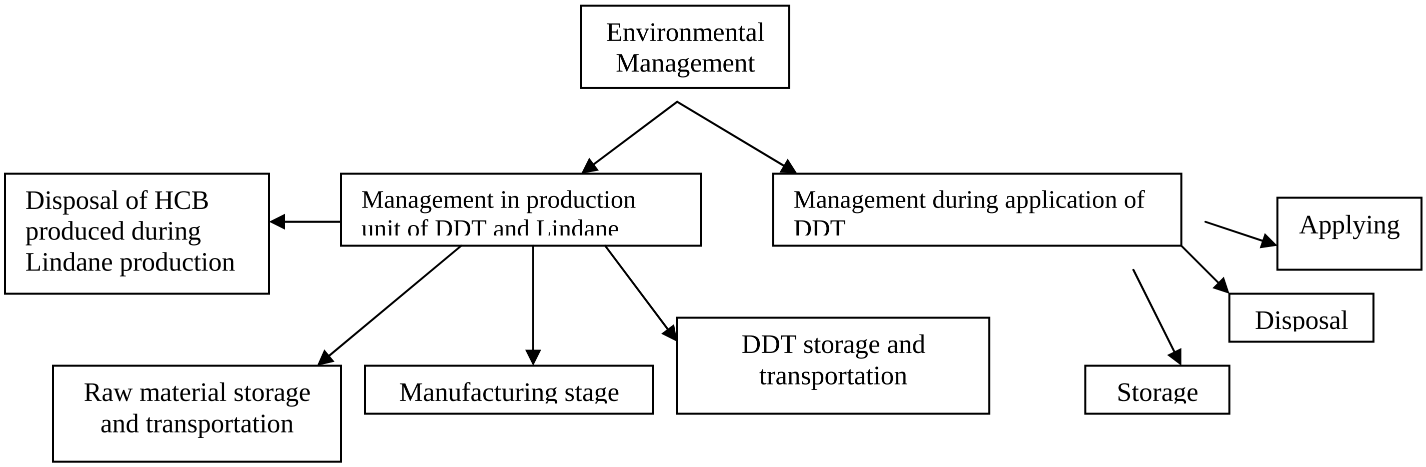
Table 10: By effects of pesticides on the environment

Elements of Environment	Potential by effect
Abiotic environment	Presence of residual amounts in soil, water and air
Plants	Presence of residual amounts
	Damage because of phytotoxicity
	Changes in the vegetative development (when herbicides are used)
Animals	Presence of residual amounts in domestic and wild animals
	Physiological actions (non vitality of birds' eggs)
	Extermination of definite wild species (mammals, birds, fish)
	Extermination of beneficial, harmful and entomophagous insects)
	Change in the number of insects

Source: World Bank Discussion Paper

It is felt that DDT used for vector control in India can get into the ecosystem at various junctures such as production, transport, storage and application. Also in case of Lindane during its production, HCB produced inadvertently also lands in the ecosystem. In terms of environmental management, there are many stages in the product life cycle of DDT and Lindane, where care needs to be taken to prevent the contamination of the environment. Flow chart 1 describes the environmental management of these POPs during manufacture and application.

Block diagram of environment management in pesticide manufacture and application



In India, after the banning of POPs pesticides, unintentional and industrial POPs release is now the main source of POPs. Also DDT used in vector control eventually lands up in environmental media and becomes a source of POPs. Such release into the environment happens in unmonitored manner. Industrial processes are at times unclean releasing POPs like waste incinerators not adhering to standards releases dioxins and furans. Owing to their properties of persistence, lipophilicity and volatility, POPs bioaccumulate and biomagnify in animal and plant tissues and get transferred across boundaries far away from their source of production.

Water proves a pathway of contamination of POPs. Water can get contaminated through leakage of stockpiles, industrial effluents and agricultural and other soil runoffs. For POPs other than pesticide POPs pathways would include solid waste and sewage sludge dumps, leakage from equipment, ship breaking activities etc. Soil is also an effective pathway for contamination when there is settling of air emissions from incineration processes. The other means of contamination of soil are leakages from stockpiles, industrial effluents (e.g., production waste), agricultural and other soil run-off, leakage from equipment stocks, industry (including ship-breaking) effluents.

Air can be a pathway through stack emissions of certain industries, emissions during spraying, emissions from solid waste and sewage sludge incineration, emissions from industrial, thermal and medical waste incineration processes, exhaust gas emissions from automobiles, releases in biomass/ forest/wood burning, emissions from sewage sludge incineration/ leakage from sewage sludge dumps.

Air and water act as the primary long-range mechanisms for transport. POPs have the propensity to travel and concentrate in the environment and biota of regions far away from the original source. In the global environment atmospheric transport is considered to be the major pathway for dispersion of POPs. The transport of POPs by air is much faster than by water, though the latter serves as a large reservoir of POPs with higher concentrations[9].

POPs are an issue of global, regional and local concern due to their physical and chemical properties, the biological effects they have on a variety of species, their potential for contamination at the local, regional and global levels due to long-range transport, together with the various pathways that increase exposure to them.

Models of global pathways describe the atmospheric distribution of POPs to colder regions of the world, and their transport and deposition in basins and watersheds, e.g., Lake Ontario and other Great Lakes[10]. PCBs, DDT and chlordane are common in remote polar regions of the world. Studies of the Inuit population in Greenland where the traditional diet includes carnivores such as seals show that maternal blood has among the highest PCB levels in the world. These are substantially higher than the Canadian guideline value of 5µg/l for women of reproductive age[11].

[9] World Bank
[10] UNEP 2002d, 2002f, 2003
[11] Loganathan and Kannan 1994, Simonich and Hites 1995,

In India, though some pathway studies exist yet there are major gaps. There is for example a complete absence of studies, which deal with the behaviour of POPs in the colder climes of India, say the Himalayas. This could be significant since POPs are transported to colder regions through convection currents where they persist for longer periods. The Himalayas, as a meteorological barrier could possibly be a major sink for POPs to re-enter the ecosystem through rivers and the atmosphere. However, pathway modeling for the South East Asia Region indicates large sources of DDT and PCBs in the region and relatively slower transport out of it. This implies that PCBs and DDT are less volatile and tend to remain closer to the source[12].

5. LEVELS

5.1. Human

Very high levels of DDT have been reported in human fat tissues from India. Dieldrin and aldrin have been detected in Delhi, while PCB, dioxins and furans have been detected in South India though at levels lower than developed countries. Studies in Uttar Pradesh have revealed that DDT levels in blood of people occupationally exposed to DDT as part of malaria control were significantly higher than that in groups not so exposed[12]. Further, in India, the population residing near estuaries polluted by agricultural discharges, industrial activity and shipping activities are likely to have significantly higher DDT levels in their blood than those living in non-estuarine areas[13].

DDT usage in India for vector control is a cause of serious concern because of consequently greater human exposure to it. Studies show that those Indian districts with more intensive spraying of DDT to prevent malaria show higher concentrations of DDT in human breast milk. These results are consistent with those from other parts of the world such as Mexico, Ukraine, Kazakhstan and the former Czechoslovakia, where heavier local and regional use of POPs is associated with elevated human breast milk levels.

Given the lipophilic characteristics of POPs, it is expected that POPs will accumulate in adipose tissues. For example, PCDD/DF levels were 312 pg/g of fat in samples taken near a municipal dumping site in Southern India[14]. This level was significantly higher than levels of 2-3 pg/g of fat lipid reported from countries around the world[15].

An issue of particular concern is the exposure of the human foetus and newborn infants to POPs through placental blood, breast milk and baby food as high levels of these contaminants have been reported in these substances[13] Indian samples showed the highest levels of dioxin-related compounds in human breast milk in a study comparing data from Asian developing countries.

Several Indian studies point to high levels of POPs in human body fluids and tissues[14]. In 1996, a study in North India found that the daily intake by newly born infants of DDT and aldrin was 7 and 27 times greater than the respective ADI set by the WHO (Siddiqui and others 2002). Similarly, another study in North India found that the daily intake of DDT residues in one-month old infant was above the ADI in 85% of the samples (Gupta 2001).

5.2. Wild Life

Numerous studies provide evidence of the presence of POPs in aquatic and terrestrial species in the region. As with most of the other data about POPs in India, the information is dispersed both temporally and spatially and thus provides a limited picture of contamination of aquatic life forms. However, recent surveys indicate significant levels of DDT, PCBs and dieldrin and its metabolites in inland as well as offshore fish samples (Shailaja and Singhal 1994, Shailaja and Sengupta 1990, Kannan and others 1995, Shailaja and Nair 1997, Senthilkumar and others 2001,

[12] UNEP 2002b
[12] Dua 1998
[13] Srivastava and others 1993
[14] Kunisue and others 2001
[15] WHO 2002a
[13] World Bank Discussion Paper
[14] Dureja and others 1991, Siddiqui and others 2003, Nair and others 1996, 1992,

Kumari and Sinha 2001, Kumari and others 2001). Pesticide residues in fish are indicative of contamination of water sources and bioaccumulation higher up in the food chain.

Dolphins are at the highest level of the food chain in the large river systems of India. They have been found to contain high levels of DDT, chlordane, aldrin, dieldrin, heptachlor, HCB and PCBs -- far in excess of standards laid down for edible meat. Dioxins and furans have also been detected in dolphin tissue[15]. These findings highlight the potential for significant damage to the dolphin population due to POPs contamination. High levels of PCBs measured in turtle and fish tissue in Southern India could be connected to oil leaks from transformers in the region. Dioxin and furan levels have also been measured in fish in North and South India and that indicates their presence in the environment. To understand the effect of industrial activity in the region further sampling and analysis of dioxins and furans is required. Table 10 gives a synopsis of POPs load in aquatic species.

Table 11: Studies indicating POPs loads in aquatic species

Location (year)	**Tissue Sample**	**DDT ng/g mean (range)**	**Other POPs ng/g mean (range)**	**Reference**
Delhi (NA)	Clam Fish	40 (30 – 82) 122 (47 - 267)	-	Nair 1989
Marine (NA)	Marine Fish	Op' (0 – 7) Pp' (0 - 42)	Heptachlor (0.1 – 4) Aldrin (2 – 90) Dieldrin (0 – 1) Endrin (3 – 80)	Radhakrishnan 1989
Tamil Nadu (1987 – 91)	Fish Turtle Crab	(0.86 – 75) (0.52 – 1.4) (5.8 – 59)	PCBs (0.75 – 40) HCB (0 – 0.2) PCBs (3.4 – 6.9) HCB (0.01 – 0.02) PCBs (2.9 – 29) HCB (0 – 0.03)	Ramesh 1992
Eastern Arabian Sea (1987 – 88)	Coastal Fish Open Ocean Fish	(0 – 54.3) (0 – 204.5)		Shailaja 1989
Southern Bay of Bengal (1990-91)	Zooplankton	(4.0 – 6.2)	Aldrin (0.19 – 0.78)	Shailaja 1994
Northern Bay of Bengal (1990-91)	Zooplankton	(268.73 – 1587.76)	Aldrin (ND)	Shailaja 1994
Bay of Bengal (1990-91)	Fish	(1.31 – 30.03)	Aldrin (0 – 1.03)	Shailaja 1994
Arabian Sea (Pre-Monsoon, 1991)	Zooplankton Fish	(3.36 – 38.4) (0.43 – 132)	Aldrin (0 – 11.21) Aldrin (0 – 4.53)	Shailaja 1997
Arabian Sea (PostMonsoon,1991)	Zooplankton Fish	(31.8 – 140) (48.3 – 435)	(0 – 13.5) (0 – 6.73)	Shailaja 1997
Delhi (1989-93)	Fish	(1.6 - 27)	PCBs (0.77 – 110) Ald&Dield (1 – 15) Chlord (0.14 – 2.1)	Kannan 1995
Bombay (1989-93)	Fish	(6.1 - 140)	PCBs (0.38 – 6.8) Ald&Dield (0.5 – 2) Chlord (0.47 – 2.2)	Kannan 1995
Kolkata (1989-93)	Fish	(4.2 – 62)	PCBs (1.6 – 9.5) Ald&Dield (0.37 – 3) Chlord (0 – 0.27)	Kannan 1995
Patna (1989-93)	Fish	160	PCBs 20 Ald&Dield 5.4 Chlordane 30	Kannan 1995

[15] Kannan and others 1994, Senthikumar and others 1999a, Kumari and others 2002

Location (year)	**Tissue Sample**	**DDT ng/g mean (range)**	**Other POPs ng/g mean (range)**	**Reference**
Bengal (NA)	Fish	(0 – 892)	Aldrin (0 – 169.3)	Joshi 1996
Ganges (1988-92)	Dolphin	(77 – 13000)	HCB (0.06 – 7.2) Aldrin (0.11 – 29) Dieldrin (0.16 – 59) Hept (0.06 – 8.7) PCBs (4.6 – 620) Chlord (1.1 – 76)	Kannan 1994
Ganges (1988-92)	Fish	160	HCB 0.24 Aldrin 2.7 Dieldrin 2.9 Hept 3.5 PCBs 20 Chlord 30	Kannan 1994
Ganges (1992-96)	Dolphin	(750 – 64000)	Chlord (1.9 – 240) HCB (0.4 – 19) PCBs (180 – 13000)	Senthilkumar 1999
Ganges (1993-96)	Fish	(60 – 3700)	Chlordane (0.8 – 18) PCBs (65 – 270) HCB (0.07 – 0.5)	Senthilkumar 1999
Ganges (1993-96)	Benthic Invertebrates	(250 – 740)	Chlord (3 – 30) PCBs (34 – 47) HCB (1 – 21)	Senthilkumar 1999
Ganges (1996)	Dolphin	(171.9 – 13700)	Aldrin (4.0 – 9.2)	Kumari 2002
Ganga, Patna (1997)	Fish	(13.6 – 1665.9)		Kumari 2001
Gang Canal – Near Delhi (1997)	Benthic Macrovertebrae	(501.22 – 2786.67)	Dieldrin (0 – 308.73)	Sharma 2001
North India (NA)	Dolphin Fish		Dioxin (0.015 – 0.22) Furan (0.011 – 0.42) PCBs (8.4 – 123.48) Dioxin (0.04 – 0.082) Furan (0.017 – 0.048) PCBs (16.01 – 32.63)	Senthilkumar 2001a
South India (NA)	Fish		Dioxin (0.009–0.033) Furan (0.002-0.004) PCBs (2.18 – 4.12)	Senthilkumar 2001a
Trivandrum	Turtle		Dioxin (0 - 0.004) Furan (0 – 0.124)	Unpublished Dr M Anbu

High levels of POPs found in bird species are also of concern and representative of high exposure of wildlife and the environment (Sanpera and others 2003, Senthilkumar and others 2001a, 1999, Muralidharan and others 1992). A study has indicated that the levels of PCBs in birds may be increasing in India. However, on the whole, DDT accumulation is of greater concern in birds migrating to India with lower concentrations of PCBs (Tanabe and others 1998). It has also been postulated that DDT may be the cause of declining populations of some bird species, such as sarus crane and vultures, in parts of India (Muralidharan 1993, 2000, Prakash 1999). Table 11 gives a synopsis of studies on tissue sample of terrestrial species and avifauna.

Table 12: Summary of the studies on tissue sample of terrestrial species and avifauna

Location (year)	Tissue Sample	DDT ng/g mean(range)	Other POPs ng/g mean (range)	Reference
Delhi (1988-89)	Earthworm Pigeon		HCB 13 (5 – 18) HCB 10 (6 – 13)	Nair 1989
Tamil Nadu coastal areas (1987-91)	Lizard Bird (Resident)	(4.1 – 7.7) (0.6 – 1800)	PCBs (4.7 – 13) HCB (0.03 – 0.31) PCBs (2.9 – 76) HCB (0 – 0.57)	Ramesh 1992
Tamil Nadu (NA)	Wild Bird Eggs Poultry Eggs	(96 – 624) 11 (0 – 1316)		Regupathy 1992
Tamil Nadu coastal areas (1995)	Birds (Resident) Birds (Local Migrant) Birds (Migrant) Bat		PCBs (120 – 1000) PCBs (190 – 890) PCBs (80 – 2000) PCBs (190 – 330)	Senthilkumar 1999
South India Agri areas (NA)	Bat Birds (resident) Birds (local migrants) Birds (migrants) Egg Yolk	(0.4 – 670) (0.8 – 3600) (67 – 13000) (9.2 – 3300) (10 – 8700)	PCB (3.8 – 230) HCB (0 – 5.6) Chlordane (0 – 2.1) PCB (6.5 – 940) HCB (0 – 1.2) Chlordane (0 – 12) PCB (30 – 640) HCB (0 – 2) Chlordane (0 – 2.3) PCB (18 – 4400) HCB (0 – 4.7) Chlordane (0 – 10) PCB (56 – 1700) HCB (0 – 33) Chlordane (0 – 78)	Senthilkumar 2001
All India (NA)	Chicken Lamb Goat Birds (Raptors)		Dioxin 0.011 Furan 0.014 PCBs 0.11 Dioxin 0.013 Furan 0.018 PCBs 0.313 Dioxin 0.019 Furan 0.023 PCBs 0.242 Dioxin (0.24 – 2.7) Furan (0.019 – 1.00) PCBs (10.05 – 99.7)	Senthilkumar 2001a

5.3. Environment

In India there have been few studies of POPs in air. DDT and aldrin have been detected in the air in some Indian cities. The few studies are not conclusively reflective of POPs pollution in the air in India as a cause of serious concern. However, a NIO study suggests the possibility of long-range transport within the region by the atmospheric pathway. To get a more comprehensive understanding it is necessary to have a study spread out geographically all over India conducted at regular intervals. Table 12 presents synopsis of the studies in India.

Compared to air, POPs contamination in water has been more extensively studied in India. However, there is a need to conduct studies about POPs in industrial effluents, agricultural run offs and fresh water sources on a continuous basis. Sporadic studies have done to monitor POPs levels in major rivers like Gomti and Yamuna but such studies are done on an unplanned manner. The data cannot be used to analyse the increase or decrease in levels of POPs in river water. In the mid to late 1990s, high levels of DDT were detected in the river Yamuna in Delhi and, especially during the monsoon season, in a number of lakes in Uttar Pradesh state[16]. In some cases, DDT residues in fish and water samples exceeded internationally prescribed standards. Aldrin and dieldrin have also been detected in environmental samples[17]. It is suspected that these high levels in water sources could be due to runoff of DDT used for malaria control. Another possible source could be runoff from agricultural areas indicating illegal use of DDT in agriculture.

It is a matter of concern that in India, groundwater in some locations in the states of Jharkhand, West Bengal, Himachal Pradesh and Delhi have levels of DDT, aldrin, dieldrin and heptachlor that are in excess of prescribed standards[18]. A 2002 study of 17 bottled water brands in India, DDT was detected in about 80% of the samples at much higher levels than the European Union standards for drinking water[19]. This indicates that water is an important source for human exposure to POPs. Drinking water samples from Delhi, Mumbai, Chennai, Kolkata, Varanasi, Allahabad, Ahmedabad and Nagpur show DDT contamination higher than the WHO drinking water recommendations[20].

Soil sediments of rivers and drain sediments also show presence of aldrin, dieldrin, chlordane and DDT[21].Soil sediments of various rivers in India have been found to have detectable levels of aldrin, dieldrin, chlordane and DDT. Marine sediments at the mouth of estuaries in the west and east coasts of India were found to have aldrin, dieldrin and DDT with higher concentrations along the east coast[22].

CPCB survey results:

Lindane, DDT and aldrin have been the predominant pesticides observed.

Among all, Lindane has been reported at 4 out of 6 locations and its highest concentration (277 ng/l) is recorded at Renukoot (Code SG3), followed by Anpara (Code SG5), Renukoot (Code SG2) and Bina (Code SG6).

DDT has been recorded at 2 locations viz.: Obra (SG1) and at Bina (SG6), the former location reported highest concentration of 216.2 ng/l.

Aldrin was recorded only at Bina (Code : SG_6).

Source: CPCB Annual Report 2002-2003

Table 13: Results of monitoring Environmental samples in the India

AIR				
Location (year)	**Sample Type**	**DDT level Mean (range)**	**Other POPs level Mean (range)**	**Reference**
India (NA)	-	micrograms/m3 (0.076 – 528)	Aldrin (1.0 – 240)	Ramesh 1989
Delhi (1985)	Airborne dust	ng/mg 3.32 (1.3 – 7.14) ng/m2/day 10.38 (4.06 – 22.31)		Kaushik 1991
Ahmedabad (NA)	-	ng/m3 7.21 – 51.19		Bhatnagar 2001

16 NIH 1998-99, Dua and others 1998, CPCB 2000, Sarkar and others 2003
17 Nair and others 1991
18 CPCB 1995, CPCB 1995a, Mohapatra and others 1995, Singh 2001
19 Mathur and others 2003
20 Communication from Dr N Thacker, NEERI, 2003
21 Sethi and others 1999
22 Sarkar 1997, 1998

SURFACE WATER				
Delhi (1980-82)	Rain water	(0.22 – 108)		Agarwal 1987
Delhi (NA)	Rain water		HCB 1.92 (0 – 5.97)	Nair 1989
Faridabad (NA)	Rain water		HCB 0.96 (0.33 –1.59)	Nair 1989
Ganga (1986-91)	River	(0 – 5.8082)		Singh 1992
Andhra Pradesh (1993)	Agri, River, Tank, Canal	(0 – 251)	Aldrin (0 – 10.96) Dieldrin (0 – 17.43)	Reddy 1997
Nainital (NA) March July November	Lakes	 (2.13 – 25.85) (5.85 – 37.17) (3.43 – 15.08)		Dua 1998a
Nainital (NA)	Tap water	(2.75 – 15.82)		Dua 1998 a
Gomti (1993-99)	River	(0 – 7.81)	Aldrin (0 – 0.059)	Singh 1996, Singh 1999
Yamuna (1995-2001)	River	(0 – 1.44)	Dieldrin (0 – 0.129) Aldrin (0 – 0.237)	CPCB 2000
Yamuna (1995-99)	Drain	(0 – 4.0)	Dieldrin (0 – 0.383) Aldrin (0 – 1.39)	CPCB 2000
Yamuna, Delhi (1999)	Urban, River		PCB ng/l(0.190 – 1.92)	Parivesh 2001
Yamuna, Delhi (1999)	Urban, Drain		PCB ng/l(0.288 – 6.545)	Parivesh 2001
Kumaon (1999)	Stream	(0 – 0.07)		Sarkar 2002
Hindon post monsoon (NA)	River	(0.46 – 11.46)		Ali 1998-99
Yamuna, Delhi (NA)	Urban, River	0.12	Chlordane 0.000008 PCB 0.041	Anbu 2002
Cooum, Chennai (NA)	Urban, River	0.0016	Chlordane 0.001 PCB 0.0015	Anbu 2002
Ulsoor, Bangalore (NA)	Urban, Lake	0.0031	Chlordane 0.00054 PCB 0.048	Anbu 2002
Mandori, Goa (NA)	Suburban, River	0.0011	Chlordane 0.000035 PCB 0.0026	Anbu 2002
Hooghly, Kolkata (NA)	Urban, River	0.0015	Chlordane 0.00018 PCB 0.00045	Anbu 2002
Ganges, Varanasi (NA)	Urban, River	0.135		Anbu 2002
Ganges, Farukkabad (NA)	Agri, River	0.832		Anbu 2002
Trivandrum (NA)	Well		Aldrin 2 Dieldrin 2	Communication from Dr CSP Iyer
Nagpur (NA)	Canal, Lakes, Ponds	(0 – 1.65)		Communication from Dt N Thacker
Kolleru, Andhra Pradesh (NA)	Lake	(0 – 0.198)	Dieldrin (0 – 0.086)	Rao 2000
Gujarat (NA)	-Agriculture + Malaria control -Agriculture	0.00756 0.00427		Kashyap 2002

GROUND WATER				
Singrauli, UP (1994)		(0.063 – 0.403)	Aldrin (0.001 – 0.271) Dieldrin (0.001 – 0.26)	CPCB 1995a
Parwanoo, HP (1994)		(0 – 0.276)	Aldrin (0 – 0.063) Dieldrin (0 – 0.008)	CPCB 1995a
Kala Amb, HP (1994)		(4970 – 197130)	Aldrin (0 – 30500) Dieldrin (0 – 152000)	CPCB 1995a
Najafgarh, Delhi (1994)		(0 – 0.274)	Aldrin (0 – 0.138) Dieldrin (0 – 0.0745)	CPCB 1995a
Andhra Pradesh (1994)		(0.115 – 0.298)	Aldrin (0.166 – 0.965) Dieldrin (0.034 – 0.389)	CPCB 1995a
Karnataka (1994)		(0 – 114.422)	Aldrin (0 – 7.5) Dieldrin (0 – 0.043)	CPCB 1995a
Madhya Pradesh (1994)		(0.066 – 1.098)	Aldrin (0.001 – 0.023) Dieldrin (0.001 – 0.134)	CPCB 1995a
Dhanbad (1994)		(2990 – 66669)	Aldrin (0 – 582) Dieldrin (0 – 193)	CPCB 1995a
Durgapur (1994)		(959 – 44851)	Aldrin (0 – 173) Dieldrin (0 – 125)	CPCB 1995a
Howrah (1994)		(1554 – 6128)	Aldrin (19 – 198) Dieldrin (166 – 265)	CPCB 1995a
Delhi (1994-95)		(0 – 1.867)	Aldrin (0 – 0.16) Dieldrin (0 – 0.428)	CPCB 1995
Delhi (1995)		(0 – 0.6204)	Aldrin (0 – 0.3543) Dieldrin (0 – 0.0387)	CPCB 1995
Agra (NA)		(0.202 – 0.686)	Aldrin (0.012 – 0.104) Dieldrin (0.091 – 0.412) Heptachlor (0.008 – 0.112)	Singh 2001a
DRINKING WATER				
Delhi		5.26		Communication from Dr N Thacker, NEERI
Agra		3.1		
Kanpur		2		
Ahmedabad		0.2		
Mumbai		3.02		
Chennai		10.4		
Nagpur		1.63		
Kolkata		0.56		
Varanasi		0.13		
Allahabad		0.2		
SOIL SEDIMENTS				
Inland				
Yamuna (1976-78)	Urban, River sediment	(0.007 – 5.63)		Agarwal 1986
Delhi (NA)	Urban		HCB 0.024 (0 – 0.165)	Nair 1991
Delhi (NA)	Urban		Dieldrin 0.004 (0.0002 – 0.03) Aldrin 0.013 (0.0003 – 0.12)	Nair 1991
South India (1988)	Agri	(0.022 – 0.068)		Kannan 1997
South India (NA)	Sediments	(0 – 0.0038)	PCB (0 – 0.0018)	Senthilkumar

	Transformer soil		HCB (0 – 0.0002) PCB (0 – 0.2) HCB (0 – 0.0012) Chlordane (0 – 0.0005)	2001
Yamuna (1995-99)	River sediment	(0 – 0.306)	Dieldrin (0 – 0.047) Aldrin (0 – 0.006)	CPCB 2000
Yamuna (1995-99)	Drain sediment	(0 – 1.026)	Dieldrin (0 – 0.217) Aldrin (0 – 0.316)	CPCB 2000
Yamuna (1999)	Urban, River sediment		PCB (0.0006 – 0.0089)	Parivesh 2001
Yamuna (1999)	Urban, Drain sediment		PCB (0.0002 – 0.281)	Parivesh 2001
Ganges (NA)	River sediment	0.0001 – 0.036	Chlordane (0 – 0.0049) PCB 0.0041	Senthilkumar 1999[1]
Yamuna (NA)	River sediment	0.018 – 0.236		Sethi 1999
India (2001)	Agri	(0.005 – 0.049)		Indian Ocean 2002
Agra (NA)	Urban	(0.42 – 1.78)	Dieldrin (0.25 – 1.39) Aldrin (0.10 – 0.68) Heptachlor (0.07 – 0.69)	Singh 2001a
Nagpur (NA)	Landfill		PCB (0.496 – 1.2)	Thacker 2002
Trivandrum (2002)	Transformer soil		PCB (0.007 – 0.256)	Interaction with Dr M Anbu
Marine				
West coast (1980's)	Marine	(0 – 0.179)	Dieldrin 0.00088 Aldrin (0.00095 – 0.035)	Sarkar 1987
Bay of Bengal (NA)	Marine	(0.020 – 0.790)	Dieldrin (0.050 – 0.510) Aldrin (0.020 – 0.530)	Sarkar 1988
India (NA)	Marine	(0 – 0.14)	Aldrin (0 – 0.81)	Indian Ocean 2002
West Coast (NA)	Marine, Estuarine	(0.0011 – 0.017)	Dieldrin (0.0007 – 0.0033) Aldrin (0.0001 – 0.00026)	Sarkar 1997
East Coast (1998-00)	River mouths Coastal	(0.05 – 0.22) (0.02 – 0.4)	Dieldrin (0 – 0.25) Aldrin (0 – 0.35) PCB (0 – 0.0014) Dieldrin (0 – 0.175) Aldrin (0 – 0.15) PCB (0 – 0.0011)	Sarkar 1998
Srilanka west coast (NA)	Coastal	(0.00009 – 0.0016)		Bhattacharya 2003
Hooghly (1998-00)	Estuarine	(0 – 0.08)		Bhattacharya 2003

5.4. *Food*

It is a matter of grave concern that POPs are still being detected in food surveys in India. In a 2001 nationwide food survey, conducted by AICRP on pesticide residues in 2001 and 2002 on samples of vegetarian and non vegetarian diet, three-fourths of the samples had detectable levels of DDT, with about 10-15% of the samples exceeding the MRL prescribed by the FAO/WHO[23]. Next to DDT, aldrin and dieldrin are the most frequently encountered organochlorine pesticides in foodstuffs. Spices, milk products, oils and meat products were more heavily contaminated with POPs than cereals and pulses. Similar consistent trend of high contamination is noticed across a number of surveys of oils, milk and meat. High levels of POPs are also detected in meat. Dairy products, that constitute a principal component of the Indian daily diet, contribute as much as 80% of the dietary intake of

[23] Communication with Dr DB Saxena, 2003

pesticide residues[24]. India's butter has DDT levels that are among the highest in the world while levels of HCB and PCB levels are comparable with many other countries. In India there is a practice of spraying of DDT in cowsheds and dermal application of DDT on cattle, which might be a reason for the high levels. Apart from this, it is also noted that there are also certain unscrupulous activities like the dipping or spraying of cultivated grain, vegetables and fish to enhance their shelf life and visual appeal[25]. POPs residues in individual food items may be small, yet these studies are significant when viewed in the context of daily food intake and the fact that POPs have the ability to biomagnify and bioaccumulate.

6. DAMAGES CAUSED

Pesticide POPs causes damages to human and animals.

Primarily a pesticide POP can enter an adult body through four ways. They may enter the body through the following:

- Absorption through the skin (dermal absorption),
- Inhalation,
- Ingestion and
- Absorption through the eyes (ocular absorption).

In addition, POPs may be transferred in utero or during breast feeding.

Absorption Through the Skin

Dermal absorption refers to the intake of a substance through the skin. In most DDT work situations dermal exposure is the most common way in which it can enter the body. Dermal absorption may occur from a splash, spill or drift when mixing, loading, applying or disposing of the pesticides for vector control. When sprayed in jungles as in the North Eastern States of India, it may also result from being exposed to plant residue or during cleaning or repairing contaminated equipment. Even small amounts of DDT allowed to remain on the skin and be absorbed into the body, can poison a person. Absorption is affected by skin condition, location of the exposure of DDT. Skin on different areas of the body absorbs pesticides at different rates. The small of the back, the head, eardrums, groin area, and armpits tend to be more absorptive.

The quantity of DDT absorbed into the body depends on several factors:

- The part of the body exposed to the pesticide
  Different parts of the body absorb pesticides differently. The skin on the forehead is 43 times more absorbent than the skin on the arch of the foot.

- The condition of the exposed skin
  Damaged skin (cuts, abrasions, skin rashes) absorbs more readily than intact skin. Hot sweaty skin also absorbs more pesticides than cool dry skin. Hence vector control sprayers working in India are more vulnerable to direct exposure to DDT as the climate is generally hot and humid.

Inhalation

Inhalation refers to absorption of airborne particles of a substance through the respiratory system. Protecting the lungs is especially important because pesticide powders, dusts, gases, vapours and especially very small spray droplets can be inhaled during mixing, loading or application or when pesticides are applied in confined areas. Once breathed into the lungs, DDT can enter the bloodstream rapidly and completely.

Breathing DDT dust is very dangerous, especially when working in poorly ventilated space with other toxic chemicals.

[24] Kalra 1999, Sarkar 2001, Kathpal and others 1992, Nigam 2001, John and others 2001
[25] Interaction with Dr D.B Saxena, AICRP ; Khan 1998a

Ingestion

Ingestion or oral exposure refers to the intake of a substance by mouth. Accidental oral exposure occurs most frequently when pesticides have been taken from the original labeled container and put into an unlabeled bottle or food container. Chemicals can also be swallowed when eating, drinking, smoking, or even licking one's lips after handling pesticides. Since many pesticides are rapidly and completely absorbed by the intestinal tract, it is essential to always wash one's hands and face (sprayers) thoroughly before eating, drinking, or smoking.

Absorption through the Eyes

Ocular absorption is the intake of a substance through the eyes. Under certain conditions and with certain pesticides, absorption through the eyes can be significant and particularly hazardous. Eyes are very sensitive to many pesticides and considering their size are able to absorb surprisingly large amounts of chemical. Serious eye exposure can result from a splash or spill or by rubbing the eyes with contaminated hands or clothing.

Human exposure

Human exposure to POPs are either directly from the environment or occupational and through the food chain. Some groups of people like workers in DDT and Lindane units, DDT sprayers etc. are exposed to POPs in their occupations. It is possible to document three distinct types of human exposure to POPs given in Box 4.

Box: Three distinct types of human exposure to POPs

High-dose acute exposure: typically results from accidental fires or explosions involving electrical capacitors or other PCB-containing equipment, or high dose food contamination.

Mid-level chronic exposure is predominantly due to the occupational exposure, and, in some cases, also due to the proximity of environmental storage sites or high consumption of a POPs-contaminated dietary source, such as fish or other marine animals.

Chronic, low-dose exposure is characteristic for the general population world-wide as a consequence of the existing global background levels of POPs with a variations due to diet, geography, and level of industrial pollution. Low level and population-wide effects are more difficult to study. People are exposed to multiple POPs during their lifetime and most people today carry detectable levels of a number of POPs in their body.

(WFPHA, 2000).

6.1. Human Health and POPs

The presence of POPs has been detected in the blood, muscles and other tissues particularly in fatty tissues of the general human population in all over the world. The Table 14 shows the evaluation of carcinogenic risk to humans for the 12 POPs made by IARC, International Agency for Research on Cancer. Table 15 shows potential human effects of individual POPs. Exposure to POPs can be associated with the following health effects in humans:

- Immune system biochemical alterations
- Reproductive deficits
- A shortened period of lactation in nursing mothers
- Neurobehavioral impairment including learning disorders, reduced performance on standard tests, and attention deficits
- Diabetes
- Cancer

Table 14: Evaluation of carcinogenic risk to humans for the 12 POPs

IARC (International Agency for Research on Cancer) Classification	POPs
Group 1: The agent (mixture) is carcinogenic to humans	2,3,7,8-Tetrachlorodibenzo-*para*-dioxin (TCDD)
Group 2A: The agent (mixture) is probably carcinogenic to humans	Mixtures of polychlorinated biphenyls
Group 2B: The agent (mixture) is possibly carcinogenic to humans	Chlordane DDT Heptachlor Hexachlorobenzene Mirex Toxaphene (mixtures of Polychlorinated camphenes)
Group 3: The agent (mixture or exposure circumstance) is unclassifiable as to carcinogenicity in humans	Aldrin Dieldrin Endrin Polychlorinated dibenzo-*para*-dioxins (other than TCDD) Polychlorinated dibenzofurans

Source: http://pops.gpa.unep.org/02healt.htm

There have been some identified studies on the effects of POPs on humans.

The potential human effects of individual POPs are listed below.

Table 15: Potential human effects of individual POPs

Effects	Aldrin, Dieldrin	Chlordane	DDT	Toxaphene	Mirex	BHC	PCBs, Dioxins, Furans
Reproduction and development	✓	✓	✓	✓	✓	✓	✓
Cytochrome P450 system	✓	✓		✓	✓	✓	✓
Porphyria						✓	✓
Immune system	✓	✓	✓	✓	✓	✓	✓
Adrenal effects			✓	✓		✓	✓
Thyroid and retinal effects			✓	✓		✓	✓
Mutagenic							
Carcinogenic effects	✓	✓		✓	✓	✓	✓
Skeletal changes				✓			✓

Source: North America 2002

Indian studies provide evidence that a contributing factor to infant mortality is the linkage between DDT exposure and elevated blood pressure as well as intrauterine growth retardation (IUGR)[16] in pregnant women. Studies have also highlighted the increased incidence of miscarriages due to the transfer of DDT, aldrin and dieldrin from pregnant mothers to their developing foetuses. Other effects of POPs include its influence on the functioning of the thyroid in adults (Srivastava and others 1995, Siddiqui and others 2002, 2003, Rathore and others 2002). Table 16 gives a synopsis of the various studies.

[16] Birth weight is below the 10th percentile of birth weight for gestational age.

Table 16 Synopsis of the various studies of health effects of POPs

Studies	Synopsis of Health Effect
Siddiqui 2002	Study showed a correlation between mothers with systolic blood pressure greater than 115 mmHg had greater levels of DDE than those with systolic pressure less than 115 mmHg. It is assumed that because of the cardiovascular effects of DDT, there might be an underlying association between the levels of DDT and the blood pressure of mothers.
Siddiqui 2003	Study indicated that exposure of pregnant women to organochlorine pesticides may increase the risk of Intra Uterine Growth Retardation (IUGR), which is a contributing factor for infant mortality in India. Here, IUGR is taken to mean a birth weight below the 10^{th} percentile of birth weight for gestational age. There was a significant negative correlation between body weight of newborn babies and p.p'-DDE in maternal blood and p.p'-DDE in cord blood. The results show that the levels of DDT in the blood samples of mothers with normal babies was lower than for those mothers whose babies showed IUGR
Siddiqui 2003	Study shows transfer of DDT, aldrin and dieldrin from pregnant mothers to the developing foetus. A higher level of these pesticides was detected in mothers undergoing premature labour or abortions than in those undergoing full term normal delivery
Shrivastava 1995	The serum levels of thyroxine and thyroid simulating hormones in 103 rural subjects with respect to blood levels of organochlorine pesticides and occupations was examined in a study. 24.3% of study subjects had depleted thyroxin levels in association with significantly lower organochlorine pesticide residues in blood. Sex, nutritional status, thyromegaly or handling of pesticides in the course of work was not found to be a factor contributing to depleted thyroxine levels. The results of this study show that organochlorine pesticide levels in blood are inversely associated with circulating levels of thyroid hormones.
Shrivastava 1995	In a study that brings forth the immunosuppressant aspect of POPs exposure, it was stated that symptoms like fatigue, lethargy, increased sensitivity to cold, constipation and breathlessness were found to be significantly lower in people with lower depleted serum T4 levels (depleted T4 levels indicates hypothyroidism). The results of the study show that organochlorine pesticide levels in blood are inversely associated with circulating levels of thyroid hormones.
Rathore 2002	A study was conducted to assess the burden of organochlorine pesticides and their influence on thyroid function in women. 123 women from Jaipur city in 1997-98 were tested. 100 women had normal thyroid hormone levels while 23 women had depleted T4 and high TSH levels (high TSH levels indicate hypothyroidism). Dieldrin was found to be significantly high in the hypothyroid subjects. It has been suggested that chlorinated hydrocarbons may be goitrogenic chemicals that disrupt hormone activity. Women of lower age groups had higher pesticide levels. This could be due to greater exposure of the younger generation as well as the excreting of pesticide by older women during menses and childbirth.
Karnik 2001	Exposure to immunotoxic POPs chemicals in the environment may be expected to result in more subtle forms of immunosuppression that may be difficult to detect, leading to increased incidences of infections such as influenza and common cold.

6.2. Impact on Wild life

In India, organochlorine pesticide pollution (including POPs) studies indicate to be of serious concern with respect to wildlife. However, due to the lack of regular monitoring efforts in the region, the acuteness of the problem neither highlighted nor well understood[17]. Some studies have been identified that bring out certain documented instances of POPs effects on wildlife in India and presented in Table 17

Table 17 POPs effects on wildlife in India

Studies	Synopsis
Khan 1998	On treatment with DDT, low LDH (lactate dehydrogenase) activity was observed in mature and immature adult female Cybister confusus, a variety of fish. Increased LDH activity has been observed in Human serum and muscles under stressed conditions.
Rajmannar 2000	DDT's sub-lethal concentrations' effects were observed in the fish Labeo rohita. DDT is also used to control arthropod parasites of cultured fish. It was found that there are quantitative changes in the fish, rohu, exposed to sub-lethal concentrations. There were non specific effects on metabolic pathways
Ruparelia 2001	Effluents from certain pesticide companies including HIL, New Delhi (DDT) was tested for toxicity on zebra fish. The results of the study suggest that all untreated effluent samples were more toxic than the respective treated effluents. The reduction in toxicity was greater than 90% for the POPs pesticides factory's effluents.
Gurusamy 2000	Fresh water fish (Lepidocephalichthys thermalis) were exposed to different concentrations of DDT for 10 days. The rate of oxygen consumption was noted to be decreasing with increasing duration of exposure and concentration level. Decreased rate of oxygen consumption was noted even in the lowest concentration of DDT (0.02 ppm). Usually such a reduction is due to hypoxia and the interference of DDT with the respiratory metabolism.
Khan 1998	Aldrin and DDT toxicity was tested on Daphnidae, a type of cladocerans or small aquatic crustaceans also called water fleas. They form an integral part of the food web in the aquatic environment.
Selvarani 2002	Fishes from the Palayakayal estuary in Tuticorin, TN were exposed to PCB concentrations of 0.6, 2.0, 4.0 and 6.0 mg/kg. Low doses of PCB enhanced microsomal protein content in the liver and heart, which subsequently decreased in higher concentration. Thus it was concluded that PCB 1232 at higher doses brings about significant changes. It was noted that with lower PCB doses, the fish systems try to restore the normal condition with an initial increase of the constituents of the drug metabolising system
Prakash 1999	Vulture populations and distribution including the nesting distribution was studied from 1985 - 1988, 1990 - 1992 and 1996 - 1999 in Keoladeo National Park, Bharatpur. A decline of 96% was recorded in the population of the white backed vulture and 97% in long billed vulture. The population of King and Egyptian vultures remained stable over the decade as is expected in the case of large and long lived birds.
Prakash 1999	Circumstantial evidence suggests pesticide contamination and disease as the most likely causes of vulture population decline. The vulture population has shown symptoms of pesticide contamination like breeding failure due to non hatching, breaking of eggs in the nest, failure to lay and death of nestlings. High adult mortality is also recorded. It is possible that due to a different metabolism, the vulture accumulates pesticides faster than other species. The few vulture tissue samples from the Park analysed so far have, however, not shown any significant load of pesticides. Detailed investigation of the pesticide load in the vulture and its food has been suggested.

[17] Interaction with Dr S.A Akhtar, EIA Cell, BNHS

Vijayan 2003	Apart from vultures, in Rajasthan, sarus cranes have succumbed in large numbers to pesticide poisoning. In Bharatpur alone, 18 carcasses of sarus cranes were found within three years (1987-90). The birds had fed on wheat treated with Aldrin.
Muralidharan 1993	Between 1987-88 and 1989-90, 18 Sarus Cranes, more than 50 Collared Doves and a few Black Rock Pigeons were found dead during winter in Bharatpur, which coincided with the application of Aldrin in the crop fields around the park. Very high levels of Dieldrin and Aldrin at much higher levels than the lethal level (4 – 5 ppm) clearly indicate that Dieldrin, after being metabolised from Aldrin, was responsible for the deaths. A decline in the breeding population of Sarus Cranes in Bharatpur has been noticed, and is suspected to be an indication of its general population trend.
Muralidharan 1992	In 1988, organochlorine pesticides were measured in the eggs of eight species of colonial water birds breeding at the Keoladeo National Park, Bharatpur. The total organochlorine load was highest in the eggs of the grey heron and lowest in the cattle egret. Although neither DDT nor any other organochlorine was reported to have a significant correlation with eggshell thickness in any of the species, the residue levels were high enough to raise concern and warrant intensive study.
Naoroji 1999	A study examined samples of eggshells of raptors (the lesser fish eagle) from the Corbett National Park for the presence of DDT, Dieldrin and PCBs and found alarmingly high levels. This has also been coupled with observations that the breeding of the lesser fish eagle has been severely affected with eggs not hatching and fledglings dying within a few days.
Rahmani 2001	In an article, an indirect consequence of the use of pesticides on natural environments has been presented. Until the early 1950s, the Terai region (around the Corbett National Park) was thinly populated except for the tribal Thurus. Virulent malaria protected it from human interference until DDT permitted colonization of the Terai and its subsequent conversion from grasslands to croplands and settlements.

7. POPs: A PART OF EMERGING GLOBAL CHEMICAL AGENDA

In order to provide a strategic framework for chemical management attempts have been made through several conventions like the Basel Convention on the Transboundary Movement of Hazardous Wastes, the Rotterdam Convention on Prior Informed Consent, the Montreal Protocol, the Stockholm Convention and other treaties and agreements have attempted to provide a framework for chemical management across the world.

In this context, the lack or poor enforcement of laws regulating chemical production, usage, import and export etc. in developing countries like India is a cause of serious concern. It augments environmental pollution and consequently exposure of all living organisms to these hazardous substances. India is signatory to a number of multilateral environment agreements (MEA) and conventions as given in Table 18.

Table 18 Conventions and Status

Convention	Entry Into Force	India's Status	Date Signed/ Ratification, Acceptance (A), Approval (AA), Accession (a)
Basel Convention on Transboundary Movement of Hazardous Wastes, 1989	5 May, 1992	Signed and Ratified	15 March, 1990/ 24 June 1992
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	24 Feb, 2004	Not Signed	24 May 2005 a
Stockholm Convention on Persistent Organic Pollutants (POPs)	May 17, 2004	Signed and Ratified	14 May, 2002/ 13 January 2006

8. CIVIL SOCIETY'S ROLE IN GLOBAL POPs CONTROL ACTIVITIES

It has been accepted that civil societies have an important role to play in helping society better understand POPs, POPs sources, the extent of harm that POPs can cause, and the kinds of precautions required to reduce and eliminate exposure to POPs. NGOs can also contribute by assisting governments with effective policies through information inputs that can translate to implementing the Stockholm Convention. In addition, NGOs can help build public support and secure commitments to ensure that appropriate measures to reduce and eliminate POPs.

8.1. Background on Civil Society's Initiatives on POPs

Presently, governments in all countries are grappling with the economic and political interests related to POPs elimination in their respective countries. At this juncture, the role of civil societies becomes crucial because these groups advocate for raising awareness among the masses about the impact of POPs, monitor government efforts to ban and eliminate POPs, highlight levels of POPs contamination in the environment, and demand regulation on issues pertaining to contamination of POPs and POPs-like chemicals, illegal manufacture, use and trade of POPs in the country.

Champions of civil societies have taken initiatives, faced challenging opposition and yet achieved success in pressurizing governments to sign the Stockholm Convention and work towards a National Implementation Plan. Civil Society, includes a wide range of social organizations such as civil society organisations (CSOs), non-governmental organizations (NGOs), private voluntary organizations (PVOs) plays a vital role as participants, collaborators, legitimises and watch dogs to ensure effective policy implementation.

India has a long history of civil society involvement. Since 1980's the NGO sector became more formal and socially recognized.[26] In India, many national and international networks of civil societies are working on encouraging reduction in the usage of pesticides and shifting towards safer alternatives and organic farming. They are functioning as watchdogs monitoring levels of pesticides and other contaminants in food and all quarters of the environment to try ensure the Right to Life to all citizens as guaranteed by the Indian Constitution. NGOs in India have played a crucial role in creating a supportive environment for POPs elimination and reduction. Some NGOs have been participating in POPs and related activities for many years. The NGOs followed and contributed to the UNEP negotiations, which led to the Stockholm treaty. The NGOs have been participating in the workshops and meetings related to pesticides in the country and have been active in hosting various national and international multi stakeholder workshop. They have also published extensively on the issue and try to raise the level of credible knowledge on it. In fact, many of the policies on pesticides framed by the government are on the basis of inputs from NGOs and Public Interest Litigations (PILs) filed by them.

However, there are many small NGOs who work in isolation and are most often not aware of the activities undertaken by other NGOs. Due to lack of information they fail to realize that all these issues are inter-related. In India there is yet to be a concerted movement for reducing pesticide usage, looking at safer alternatives of pest control and encouraging organic farming.

Till date there are several NGOs who are not aware about POPs and its impact on health and environment. There is an urgent need to build their existing capacities so that they can better address the issues of inadvertent production, illegal manufacture, usage and trade of POPs in the country.

8.2. How NGOs can better address the POPs issue

- There should be better coalition, both nationally and internationally of NGOs working on similar issues

Though international NGO activity has grown steadily in India, most NGOs operate within a single country and frequently they function within a purely local setting. Most often they have narrowly-defined, short term goals and objectives. There is a need for jointly working together in coalitions on the POPs and pesticide issues so that individual NGO work can all add to the campaign on broad ideals of reduction of pesticide usage and shifting to

[26] http://www.inwent.org/E+Z/1997-2002/de601-9.htm

safer alternatives. Only then can they function effectively as pressure group or lobby group and bring about change in the society.

- Difficulty in identifying common goals

NGOs are very diverse and by no means are equally laudable for their work in their respective fields. However, while some NGOs are fiercely independent, others are known as the creatures of governments and businesses interests. Some have hundreds of thousands of members around the world while others speak for only a handful of people. Some have large central secretariats and some are very decentralized. Often, there are many competing NGOs in the same policy field and their mutual contest for influence can undercut political effectiveness. Many respected NGOs work hard to overcome this narrowness by operating in close partnership with others. Some NGOs themselves specialize in coalition-building. But with such diversity, deliberations about common issues like POPs and pesticides often require leadership by a particular group. Many times this becomes a constraint and a common platform cannot be created.

- There should be alliance between trade unions and NGOs

The alliances between trade unions of the pesticide industry and NGOs have to be an essential element of an international labour strategy against pesticide contamination to balance the growing power of transnational corporations (TNCs) on a global scale. Both unions and NGOs are civil society actors. They have in common are specific agendas for the improvement of society.

- Capacity building of NGOs

The NGOs should be assisted with capacity building to develop and strengthen their capacities to address the threats posed by POPs and pesticides so that they can effectively promote transition to sustainable alternatives, create information exchange and distribution channel, facilitate local polluting industries to transfer to cleaner technologies and efficiently raise awareness about the issue in the community.

- Financing

NGOs are usually financed by a combination of sources. Traditionally, membership dues have provided the main source, but today NGOs tap many other sources including grants or contracts from governments and international institutions, fees for services, profits from sales of goods, and funding from private foundations, corporations and wealthy individuals. Large international NGOs may have operational budgets in the tens of millions of dollars, but most small NGO working in rural settings have to do with very meagre budgets, which are often insufficient to carry on their campaigns and activities. Many good initiatives are either stalled or nipped in the conception process itself due to fund crunch.

9. EFFORTS TO DEAL WITH POPs

9.1. Role of Government

The government of India has some existing institutional structure to deal with chemical management and related MEAs including the Stockholm Convention.

For GEF and MEAs in India, The Ministry of Environment and Forests (MoEF) is the focal point. Its role is to ensure effective implementation of legislations, monitoring and control of pollution and establishing standards for quality for the environment.

The Central Pollution Control Board is a statutory authority attached to the MoEF. It is responsible for the prevention and control of industrial pollution and assists in the establishment of standards while ensuring compliance with the Environment Protection Act.

The designated agencies, which have the responsibility of ratifying and implementing the Stockholm Convention, are the MoEF and the Ministry of Agriculture (MoA). They are the nodal ministries for dealing with pesticides. The Ministry of Environment and Forestry also has a Hazardous Substance Management Division. It is responsible for ensuring that India meets its commitments under the Stockholm, Basel and Rotterdam Conventions.

Other stakeholders in the government in the arena of chemical management are the Ministry of Health and Family Welfare, the Ministry of Chemicals and Fertilizers and the Ministry of Labour. The Ministry of Health and Family Welfare manages pollution risks for consumer products and food. It is also the sole authorized user of DDT in India and mandates the amount and use of DDT in health programs for vector control. The Ministry of Chemicals and Fertilizers, is responsible for the development and regulation of the chemical, petrochemical and related industries. The Ministry of Labour has purview over all issues concerning occupational health and safety.

The Government of India has recently also constituted a multi-sectoral National Steering Committee to oversee the development of the National Implementation Plan for POPs and monitor activities needed for compliance with the Convention[27]. The core Members of the NIPs Committee (National Steering Committee) are as follows:.

- Ministry of Agriculture
- Chemicals
- Ministry of Health and Family Welfare
- Labour Ministry
- Commerce and Industries
- Ministry of External Affaires
- ITRC, Lucknow
- NIOH
- CII

Though the members of the Steering Committee includes representatives from the Ministries of Environment and Forests, Agriculture, Chemicals, Health, Commerce and Industry and External Affairs, the industry Associations, Scientific Institutions and Research Institutes, but the civil society representation is lacking on the committee.

Though this framework is in place yet there is inadequate consultative mechanism. This is a major hindrance in the effective operationalisation of this framework. Another area of concern is the prioritisation of issues pertaining to chemical management and development of sector-specific agendas of various ministries.

9.1.1. Government National Emission Standards for Pesticides Manufacturing Industry

In the pesticides industry, pollution generates in all forms i.e. emissions, POPs as micro contaminant, wastewater and solid/hazardous waste due to thermodynamic limitations, incomplete reaction, failure of stoichiometric requirement of raw materials in the process operation, impurities present in raw materials, etc. Gaseous emissions could be channelised i.e. coming out through vent/stack from specific production process or fugitive in nature (leaks spills etc.), containing several gaseous pollutants. Handling of emissions being sensitive with respect to impact, the emphasis is often given to adopt appropriate pollution control technologies.

The pesticides industry is critical in terms of nature of raw material usage and final products/by-products, which demands special care/attention. It is well established that the process of development of industry-specific-standards considers techno-economic feasibility as the criteria. This criterion demands the review of technologies for control of pollutants emanating from the industries and cost implications due to pollution control equipments and bearing on health and the environment. Therefore, looking at the complexity the findings of the study, have been reviewed to suggest the best practices being followed in advanced countries, and options for improvement in terms of technologies (*best available and best practicable*) suitable to Indian pesticide industries.

The Central Board has identified priority pollutants, control technologies, efficiency of control and presently achievable standards. Besides studying the existing technologies, a review of best available technologies has been made through an expatriate consultant considering the best practicable technologies, while considering the economic

[27] Personal communication, Dr. Hosapetu and Chanda Chaudhry, MOEF

feasibility for the purpose of arriving at suitable emission standards. The standards are however at present only proposed and will be finalised through consultation process.

9.1.2. Development of Toxicity Factor as a Governing Parameter

The cumulative governing parameters are preferred in environmental sampling such as AOx for all halides. Synergistic and Antagonistic effects of different combination of pollutants will not be addressed, if individual standards are prescribed for each pollutant. Thus the governing parameters indicate the necessity of having detailed analysis of each constituent and as such represent the cumulative effects. Such parameters are encouraged for regulatory purpose for ease in checking the compliance. Therefore, with the same perception, a common parameter to represent the toxicity has been developed by the Central Pollution Control Board i.e. Toxicity Factor. It is defined as the dilution factor of the effluent at which 100% survival of Zebra fish (*Brachidanio rerio - Hamilton Buchanan*) ensured for 48 hours. Means, toxicity factor 1 represents the effluent sample without dilution with water, Toxicity factor 2 represents addition of same amount of water with the effluent (1:1); Toxicity Factor 4 represents (1:3 – one part effluent and 3 parts of water) *etc*.

The tests for Toxicity factor have been carried out with respect to wastewaters arising from pesticides, bulk-drugs, dye and dye intermediates, textiles and tanneries. The results have been processed statistically to assess the present percent level of achievement by the respective industrial sectors.

9.2. Industry Perspective

9.2.1. An overview of Indian Chemical Industry

The chemical industry in one of the oldest domestic industries in India, contributing significantly to both the industrial and economic growth of the country since it achieved independent in 1947[28]. It is one of the fastest growing sectors of Indian economy and contributes to 13% of GDP. Western India accounts for 45-50% of total Indian chemical Industry. India was a net importer of chemicals in early 1990s, but has now become a net exporter due to reduction in imports because of implementation of many large scale petrochemical plants like Reliance etc. and also because of tremendous growth of exports in sectors like bulk drugs and pharma, pesticides, dyes and intermediates.

The chemical Industry in India is fragmented, dispersed and multi faceted. Both large and small players are present in fine and speciality chemicals, including multinational companies. The wide and diverse spectrum of products can be broken down into a number of categories, including inorganic and organic chemicals, drugs and pharmaceutical, plastics and petrochemicals, dyes and pigments, fine and specially chemicals pesticides and agro-chemical, and fertilizers[29].

Chemicals are sometimes sold directly to large customers and through distribution channels. Distribution channels mostly consist of stockists and dealers spread all over India addressing small segments and retail market[30].

The chemical Industry is highly heterogeneous with following major sectors: Petrochemicals, Inorganic Chemicals, Organic Chemicals, Fine and specialties, Bulk Drugs, Agrochemicals, and Paints and Dyes

9.2.2. Pesticide Industry Overview

The Indian economy is largely agrarian in nature with agriculture sector contributing one-third of the total GDP[31]. Indian pesticides market is the twelfth largest in the world with a value of US$ 0.6 billion, which is 1.6 percent of the global market pie[32]. With over 400 million acres under cultivation and over 60% of the country's population

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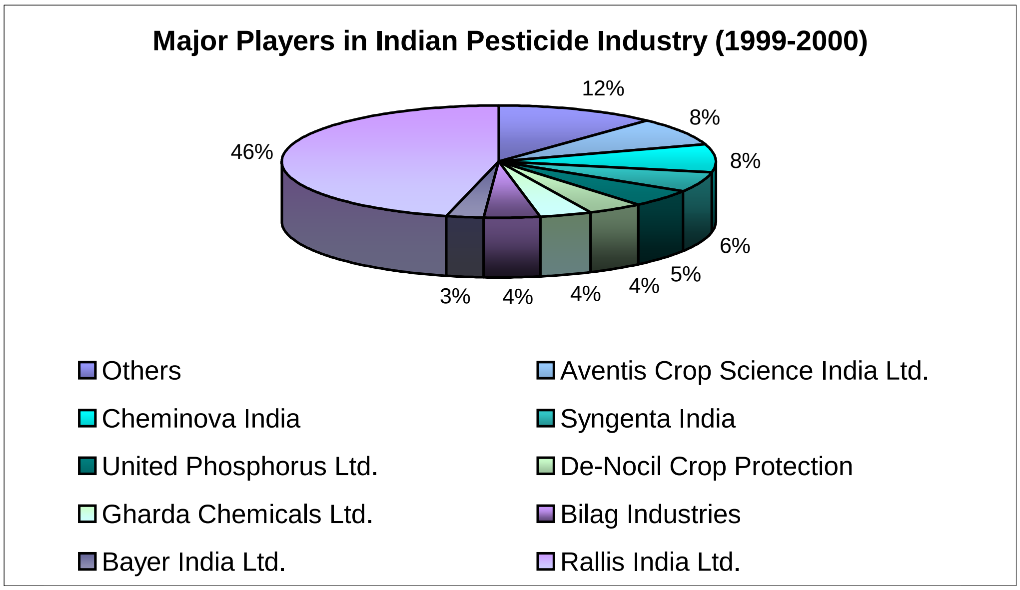
[28] PAI
[29] http://www.asiatradehub.com/india/chemicalindustry.asp
[30] IARI scientist
[31] http://www.mindbranch.com/products/R351-0011.html
[32] http://www.mindbranch.com/products/R351-0011.html

dependent on agriculture, the country's economy depends on the agricultural sector to a substantial extent[33]. Pesticides are also referred to as agrochemicals in India.

The industry manufactures two main types of products:

a) Technical grade pesticides (the basic concentrated chemical compound) and
b) Formulations from these technical grade pesticides (the usable form of pesticides). Technical grade pesticides are both manufactured locally as well as imported.

Agricultural usage of pesticide in India commenced in 1949 with the application of BHC for locust control[34]. From a modest beginning in 1947, when DDT was first used for malaria control, pesticide consumption in India has grown to a total market size of over Rs. 45000 million in FY 03. The total installed capacity of technical grade pesticides is approximately 140,000 tpa. The production figures are given in table. This diagram shows the major players of Indian pesticide industry and their share in the market.



Source: The Indian Chemical Industry: New Directions New Hope, 2000

Table 19 Production of pesticides

PRODUCT	INSTALLED CAPACITY	('000 MT)[35]							(MT)[36]			
		92 - 93	**93 - 94**	**94 - 95**	**95 - 96**	**96 - 97**	**97 - 98**	**98 - 99**	**99-00**	**00-01**	**00-02**	**02-03**
Insecticides	81.9	73.4	71.8	75.6	77.7	84.1	60.4	66.0	46195	43584	47020	48350
Fungicides	10.7	5.3	5.5	6.0	6.6	7.3	9.2	8.0				
Herbicides	4.8	2.0	1.3	1.5	1.4	1.6	1.9	1.7				
Weedicide	10.3	2.2	2.7	5.1	8.5	7.3	7.33	6.7				
Rodenticides	0.9	0.27	0.51	0.46	0.40	0.40	0.5	0.5				
Fumigants	1.6	1.0	1.5	1.8	1.8	1.9	1.6	1.8				
TOTAL	**110.2**	**84.17**	**83.31**	**90.46**	**96.40**	**102.6**	**80.9**	**80.9**				

Source: http://www.energymanagertraining.com/chemical/chem_overview.htm; http://www.ncipm.org.in/asps/DisplayPesticides.asp

[33] http://www.researchandmarkets.com/reportinfo.asp?report_id=54548
[34] http://www.researchandmarkets.com/reportinfo.asp?report_id=54548
[35] http://www.energymanagertraining.com/chemical/chem_overview.htm
[36] http://www.ncipm.org.in/asps/DisplayPesticides.asp

Salient Features of the Agrochemical Industry

- India is a large agricultural economy, which is the major user. Average Indian consumption of pesticide is 1/20th of world average
- Market size 100,000 MT (in terms of technical grade)
  - US$ 800 million
  - Growth 10% pa
- Consumption varies depending on crop and region
- Cash crops like sugarcane, tobacco etc. are the major consumers of pesticides (above 60%)
- Two types of producers -- Technical: 40 nos.; Formulators: above 500 nos.
- Major players -- Indian: United Phosphorus, Rallis and Excel; Multinational: Hoechst Agrevo, Novartis, Bayer etc

India is the second largest manufacturer of agrochemicals with 145 pesticide molecules registered in the country[37]. 65 technical grade pesticides are manufactured indigenously. The bulk of the production is insecticides followed by fungicides and herbicides.

There are around 400 manufacturing units involved in the production of pesticides and their formulations. Also almost every MNC barring the Japanese have invested in the production of pesticides in India. Certain Indian companies have made substantial investments and have made a name and reputation for themselves in the world markets. India is now recognized as an important source for supply of generic products. A very large number of units in the small-scale sector are involved in formulations and sell their products essentially on regional basis[38].

9.2.3. Consumption

Per hectare consumption of insecticide/pesticide in India is 570 gram/ha[39]**.** The pesticides consumption in our country is uneven. A very representative example of this would be say the state of Uttar Pradesh (UP). The consumption of Western UP is far more than say Eastern UP. The same would hold true for the crops, especially the rice crop. Herbicide consumption of this crop seems to be essentially in the north-western part of the country with far less consumption in certain southern states. Yet millions of the rice hectares lose out to weeds[40]. Within the crop segments cotton is king for the pesticides industry with over 50%-55% consumption leaving the gamut of so many other crops from the benefits of chemical crop protection.

9.2.4. Industry Viewpoint

A major issue facing the industry is proliferation. Despite the fact that the Insecticides Act 1968 and rules thereof was promulgated to "regulate" the production rate of pesticides, over 30,000 registrations have been granted leaving no room to implement any sort of regulation whatsoever, or long-term prospects.

The biggest sufferer in this whole game is the consumer who when goes to buy a pack of say Monocrotophos, is confronted with over 100 brands which have gone through the same registration and licensing procedure. The price of the same one litre pack may vary from Rs. 180 to Rs. 300 per litre. Still more and more Monocrotophos registrations and licenses are being granted. This is not merely true for generic molecules like MCP, but even in a high tech product like neem several new brands are floating in the market.

All this has given a great impetus to fly by night operators who are now making a killing. As per an industry estimate, the market value of spurious product is estimated at Rs. 500 crores per annum whereas the industry turnover is around Rs. 2500 - 3000 crores. To top it, the spurious manufacturers - users are at a distinct advantage for no laws bind them, since inspection in India is unmanageable.

The industry acknowledges that they have failed to introduce newer and safer formulations only due to this continued proliferation and are stuck with the same old Dusts/ Ecs/ WDPs and granules. The farmers of India have also been deprived of the benefits of newer molecules primarily because they always come from developed

[37] http://www.chemexcil.gov.in/panel3.asp
[38] http://www.ficci.com/ficci/media-room/speeches-presentations/2000/oct/oct6-indiachem-salil.htm
[39] http://www.ficci.com/ficci/media-room/speeches-presentations/2000/oct/oct6-indiachem-salil.htm
[40] http://www.ficci.com/ficci/media-room/speeches-presentations/2000/oct/oct6-indiachem-salil.htm

countries and due to lack of patent protection so far, hardly any new molecules were seen in the Indian market during the 80s and the 90s. In fact, the MNCs have been careful in introducing their hugely successful molecules in India only after their patents have expired or are about to be expired.

CropLife India

The leading Indian and international companies got together to change the name of their trade association from Pesticide Association India to CropLife India. Together they account for over 70 per cent of the Rs 4,000-crore crop protection industry in India. Crop protection is the term used to explain their role as manufacturers of pesticides. The members of the association are: BASF India, Bayer CropScience India, Cheminova India, DE-NOCIL Crop Protection, EI DuPont India, Excel Industries, Indofil Chemicals Company, Isagro (Asia) Agrochemicals, Monsanto India, Rallis India, Shaw Wallace Agrochemicals and Syngenta India.

Major manufacturers say they have strong company policies to encourage what they term 'responsible use of the chemicals', 'safe use of chemicals' and they sometimes use the term 'product stewardship'. There have so far been a number of global industry initiatives - including the Safe Use Campaign and the Responsible Care Initiative. The issue according to industry in the developing world is not about toxicity of chemicals but about the unsafe handling of pesticides[41]. The safe use of crop protection products in general emphasizes on special aspects of transport and storage, and the use of advanced application techniques. But according to many scientists[42] there are no safe uses of application of pesticides. The highly toxic nature of some of the chemicals and the conditions for users in developing countries renders both of these initiatives inadequate.

10. SOME CRITICAL ISSUES FOR INDIA

10.1. Illegal manufacture and trade in POPs

Under the Stockholm Convention, countries must regulate trade in POP pesticides. There are, however, reports of unauthorized trade in some substances within the region. India, for instance, imported chlordane, while aldrin, chlordane and heptachlor were apparently exported after their ban in 1996. Information is not available to determine whether such exports constitute sales of existing stocks, illegally manufactured POPs or both (RFI 2000, Toxics Link 2003).

Estimates of smuggled POPs in Bangladesh expected to be smuggled from India as given in Table 23. Tables 20, 21 and 22 provide information on the reported commercial activity on POPs pesticides. It is interesting to note that chlordane has been imported subsequent to the date of its ban while aldrin, chlordane and heptachlor have been exported subsequent to the ban suggesting illegal manufacture and trade in POPs. Government has however denied.

Table 20: Production, Import Export data of DDT, Heptachlor and Chlordane[43]

Activity (Values in MT Technical grade)	**95-96**	**96-97**	**97-98**	**98-99**	**99-00**
Production - DDT	6017	4147	4215	3357	3638
Import - DDT	0.00	6.00	6.00	0.00	0.00
Export - DDT	54	133	175	16	64
Import - Heptachlor	0.30	0.00	0.00	0.00	0.00
Export - Heptachlor	48	17	0	0	0
Import - Chlordane	9.00	1.00	10.00	0.00	0.00
Export - Chlordane	9	3	29	4	8

Source: Presentation by Dr P S Chandurkar, Plant Protection Adviser to the Govt. of India during the regional meeting of the UNEP-GEF PTS regional priority setting meeting, September 2002

41 Saxena 2005
42 Rengam PAN
43 This information on imports and exports is presented considering the authority of the source and the fact that it has been presented in the UNEP-GEF PTS regional priority setting meeting. Other sources (Pesticide Association of India - PAI) have indicated figures that are different from this information (e.g. Chlordane export for 95-96 in the PAI data is 21 MT whereas in the data presented by Dr Chandurkar, it is 9 MT.)

The export of POPs from India subsequent to their ban is an indication of the continued existence of possible hotspots in India in terms of production and storage facilities. Details regarding the amounts and destination of some of these exports are given below:

Table 21: POPs pesticides exports from India for the period Apr 1998 – Dec 1999

Product	Country	Qty Tonnes
DDT	Australia	22
	FRG	20.150
	Israel	20
	Bangladesh	40
	Belgium	1
	Chinese Taipei	11.5
	Italy	48.2
	Japan	16
	Nepal	1.695
	Spain	1
	USA	4
	Total	**185.595**
Aldrin	Bangladesh	8.3
	Brazil	5.130
	Chinese Taipei	17.550
	PRC	6
	Denmark	9
	Egypt	4.6
	France	15.640
	Germany	1.760
	Italy	13
	Kenya	0.376
	Korean Republic	0.1
	Mexico	10
	Netherlands	84.340
	Saudi Arabia	10.800
	Singapore	0.1
	Turkey	13.173
	UAE	12.500
	USA	0.023
	Vietnam	0.2
	Zambia	0.25
	Total	**212.847**
Chlordane	Bangladesh	16
	Egypt	27
	Total	**43**

Source: Trojan Horses 2000, Toxics Link

Table 22: Import and Export of Aldrin and their CIF values during the year 1997-98 to 2001-2002

Source	1997-98 Qty	1997-98 CIF Value	1998-99 Qty	1998-99 CIF Value	1999-00 Qty	1999-00 CIF Value	2000-01 Qty	2000-01 CIF Value	2001-02 Qty	2001-02 CIF Value
Export	202	565	244	741	378	1264	1055	3866	1595	6212
Import	10	115	36	169	496	1941	1043	6652	864	4282

Source: Dept. of Commercial Intelligence and Statistics, Calcutta, 25/10/2002

Table 23 Estimates of smuggled pesticides in Bangladesh

Trade name	Common name	Packet size	Smuggled price (Takas)	Estimated quantity smuggled
Eldrin 20 EC	Endrin	1 litre	235	25 KL
Dieldrin 20 EC	Dieldrin	I litre	235	25 KL
Chlordane 20 EC	Chlordane	I litre	235	35 KL
DDT	DDT	1 Kg	30	100 MT
Heptachlor 40 WP	Heptachlor	1 Kg	30	60 MT

Source: Pesticide Association of Bangladesh Report. Communication from Dr Hayat

10.2. Stockpiles

Stockpiles of banned and or date-expired POPs are a potential source of exposure in India. Abandoned factories and storage warehouses may contain such stockpiles and they are often situated in poor rural areas near farms and in urban areas near markets, food stores and houses. The Supreme Court Monitoring Committee (SCMC) in its recent visit to abandoned DDT factory in Delhi estimated 200 Kgs of DDT dumped inside its premises[44].

Information on such stockpiles is extremely poor. Available data points to small stockpiles of 0.8 MT of aldrin in India. A FAO inventory of stockpiles in India suggests the total obsolete and banned stocks in India amounts to 3346 MT (both POPs and non-POPs) though it could not determine the exact formulations, chemical names or locations of the stockpiles[45]. The identification of stockpiles in India and appropriate measures for their disposal requires greater attention**.**

10.3. DDT usage in vector control in the country

Malaria Prevention sans DDT

That malaria kills is not a revelation. WHO data reveals that approximately 300 million people worldwide are affected by malaria and between 1 and 1.5 million people die from it every year. Previously extremely widespread, the disease is now mainly confined to Africa, Asia and Latin America. It spreads through mosquitoes, which acts as the vector. Vector control is one of the most effective measures to prevent malaria transmission.

DDT (Dichloro-diphenyl-trichloroethane) usage for controlling this dreaded disease began during the Second World War. DDT was the main product used in the global efforts, supported by World Health Organization (WHO), to eradicate malaria in the 1950s and 1960s. This campaign resulted in unbridled use of DDT and a significant reduction in malaria transmission. During the same period, DDT was also commonly used as a pesticide. With the publication of Rachel Carson's Silent Spring, the hype lifted and the euphoria faded. The ugly truth of cancer, nervous disorders, reproductive dysfunctions etc. started finding linkages to DDT. Behind the veneer of being a wonder chemical, which saved lives, DDT emerged as a Persistent Organic Pollutant (POP). This means that it can aggressively persist in the environment long after its initial application (up to 12 years). DDT and its breakdown products have the propensity to enter the food chain and accumulate in fatty tissues (bioaccumulation) magnifying several thousand times its ambient concentrations. Manifestations of its adverse effects are borne by both wildlife and human population.

DDT has been banned or restricted for vector control in 56 countries and it is illegal to import in 102 countries. This sparked off a debate in the wider public health environment forum on the risk of DDT usage as against its benefit to control malarial. Pro-DDT advocates continue to argue that DDT levels in the environment are already falling and will continue to fall once it is banned for agricultural use worldwide. Hence, in their opinion the developing nations

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[44] Chakrovorty, 2005
The SCMC was set up by the nation's apex court in October 2004 to monitor the progress in implementation of the HW Rules as well as a series of orders passed by the court since 1995.
[45] RFI 2000

should be allowed the much less harmful public health usage of DDT. On the other hand, anti-DDT activists armed with scientific literature argue that the health risks associated with its use is far greater in comparison to its efficacy as a cheap vector control chemical.

Under the Stockholm Convention, the production and use of DDT is restricted to the acceptable purpose of disease vector control in accordance with the World Health Organisation (WHO) recommendations and guidelines on the use of DDT and when locally safe effective and affordable alternatives are not locally available. This exemption is available to countries provided they have notified the Secretariat of their intention to produce and/or use DDT upon becoming a Party. India can use up to 10,000 MT of DDT (at 50 per cent formulation) per year for malaria control programs. These programs involve indoor residential spraying in rural areas and a majority of the budget is spent on the purchase and application of insecticides.

It appears that DDT is becoming increasingly ineffective in controlling malaria due to growing chemical resistance of malaria vectors. This may not justify its continued use even though the costs involved in the use of alternative pesticides (e.g., malathion and deltamethrin) are several times higher as indicted in Table 24.

Table 24 Comparison of Cost of Residual Spraying with DDT with Other Possible Alternatives

Insecticide (Concentration)	Requirement in MT per million population	Cost Per MT, Rs.	Cost of insecticide per million population (Rs. in '00,000s excluding operational costs)	Cost of insecticide per million population (in Rs. in '00,000s including operational costs)
DDT (50%)	150	84,857	Rs. 127.3 ($2.8)[a]	Rs. 169.5 ($3.8)
Lindane (6.5%)	336	50,000	Rs. 168.0 ($3.7)	Rs. 225.3 ($5)
Malathion (25%)	900	46,341	Rs. 417.1 ($9.3)	Rs. 543.0 ($12.1)
Deltamethrin (2.5%)	60	7,51,250	Rs. 450.8 ($10)	Rs. 490.1 ($10.9)
Cyfluthrin (10%)	18.75	24,04,000	Rs. 450.8 ($10)	Rs. 488.0 ($10.8)
Lambdacyhalothrin (10%)	18.75	24,04,001	Rs. 450.8 ($10)	Rs. 488.0 ($10.8)

[a] dollar equivalency calculated using US$1=Rs. 45

Source: Mitra and Tren (2002)

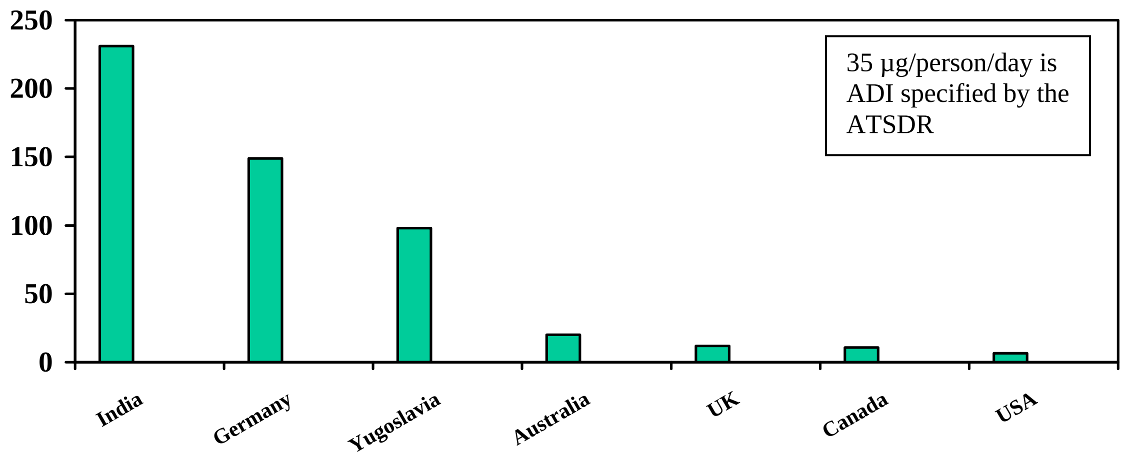
As an alternative to chemical control in India, bioenvironmental methods have been piloted. These tests may provide a basis for developing more cost-effective methods to address vector control. WWF's case study documents the Kheda district experience in India, where non-chemical approaches were demonstrated to be cost-effective. WHO's Roll Back Malaria campaign has compiled a sizeable number of non-DDT success stories from around the globe.

Admittedly, an approach that works in one location need not necessarily work in another because of differences in vectors and environmental settings. Nevertheless, the many success stories of alternatives to DDT gives hope that there are other safer, more effective packages of malaria control measures which can be implemented. A balanced approach is the call of the day. Alternative strategies to deal with the problem should be based on scientifically sound criteria, cost-effective analysis and a delivery system compatible with current trends in health sector reform. The strategies need to be country specific including decentralization of health services and intersectoral action at the local level.

Scientific research needs to go hand in hand with crucial policy changes. For example, poorly planned development projects like construction of dams and canals etc. can increase malaria incidence by creating habitats favourable for multiplication of mosquitoes.

Some of the factors contributing to high levels of POPs in food are the continued use of DDT for malaria control and uncontrolled and unmonitored emission of POPs. For remedial action, continuous and systematic monitoring of food is important in order to detect any possible contamination. This would also require that the Government of India's food monitoring laboratories become certified under guidelines for good laboratory practices.

Human Dietary Intake of DDT in Various Countries (µg/person/day)



Source: Sarkar (2001)

11. STATE OF STOCKHOLM CONVENTION RATIFICATION AND THE NATIONAL IMPLEMENTATION PLAN

India signed the Stockholm Convention on POPs on 14 May 2002 and has ratified it on 13 January 2006.

11.1. Focal Point and Steering committee for NIPs in India

The Ministry of Environment and Forests (MoEF), Government of India, is the focal point for POPs, in India. The MoEF has established and will chair a Steering Committee comprising representatives of the Department of Chemicals and Petrochemicals, Ministry of Chemicals and Fertilizers, Ministry of Agriculture, Ministry of Health and Family Welfare, Ministry of External Affairs, Department of Industrial Policy and Promotion, National Institute of Occupational Health, Industrial Toxicological Research Centre and the Confederation of Indian Industry[23].

Although it is obligatory for the government to include civil society in decision-making, the ground reality in India is much different. The civil society has been practically barred from the whole process. The position of civil society cannot be compared to a mere spectator since the process itself lacks the transparency. Groups such as Toxics Link that have been working on the issue of POPs have not been consulted on the issue. The process so far has lacked civil society participation and has been largely dictated by the government. No consultations were held with the stakeholders and neither is the final draft available for review.

11.2. National Implementation Plan (NIPs)

Preliminary assessment of the sources and stocks of POPs was the first step in the preparation of National Implementation Plan (NIP) to implement the Stockholm Convention. This was a part of the enabling activity, which was undertaken by the Government of India with the support of UNIDO.

This activity was undertaken by the Ministry of Environment and Forest through Industrial Toxicology Research Centre with the assistance of UNIDO under the Project Development Facility grant provided by GEF (Global

[23] http://www.gefonline.org/projectDetails.cfm?projID=1520

Environment Facility). Dr. PK. Seth served as a National Coordinator of the Project Team. The report has been submitted to the government through UNIDO. The status of the report is unknown.

The project study included fieldwork, a questionnaire, which were sent to regulatory authorities, industries, NGOs, research Institutions, and various government departments, to get information about the extent and nature of POPs being released in the environment, the kind of old stocks piled up, the details of any contaminated sites, etc.. The questionnaire also attempted to gather data on production, distribution, transportation, use, export and import of POPs. Besides the questionnaire, awareness workshops were held in five zones, which covered about 16 states of the country. In a period of two months about 10 workshops were held in 2004.

Through these attempts, it was found that aldrin, dieldrin, endrin, chlordane, heptachlor and toxaphene are banned for manufacture, use, import and export in India. DDT is banned for agricultural use and it's restricted use is permitted in public health sector for malaria control.

Mirex and HCB have never been registered as Pesticides in India. PCBs have never been manufactured in India. Small quantities have been imported but exact figures are not available. PCBs are mainly used in transformers, capacitors. There appears a need for a thorough study on PCBs in this country.

Unintended By-products like dioxins and furans are generated from municipal waste, burning of landfill sites, open burning of garbage. Capabilities to study Dioxins and Furans have just started in the country and these need to be expanded. Lot of capacity building is required for the estimation of Dioxins & Furans.

For the preparation and execution of the National Implementation Plan, the country has to expand the infrastructure, not only for the analysis of the POPs but, also for the regulation, treatment, disposal and for finding alternatives which are environmentally sound and safe and economically viable for a developing countries like India.

12. ALTERNATIVES TO POPs

Various alternate options, especially to POPs pesticides, are being promoted. Some of these are listed below.

Integrated Pest Management

The debate continues on the pros and cons of pesticide use. Those who seek to find another way often turn to Integrated Pest Management (IPM). From the view of environmental sustainability, IPM is now increasingly being looked upon as a viable option. This is pest control method that places the emphasis on prevention. Broadly, it emphasizes the use of bio-pesticides over chemical ones. Biological measures such as soil and seed treatment, field sanitation including weed removal and crop culture practices such as crop rotation, intercropping and field preparation are stressed upon in IPM. It is understood that most plant injury is caused by poor growing conditions. Weak plants are more susceptible to pests than healthy plants. Observation and early identification of problems is the key. However, application of pesticides is not excluded from an IPM program, but most often reserved as a last resort.

Cultural Controls

These include:

- Rotate crops.
- Remove pests from plants with a jet of water or by hand.
- Plant pest-resistant varieties.
- Keep weeds and debris out of the garden and flowerbeds.
- Provide regular irrigation and feeding but avoid over watering and over fertilizing.
- Eliminate standing water.
- Keep the area clean and free of debris.
- Prepare soil well. Healthy plants are more pest resistant.
- Mow lawns properly.
- Plant flowering, nectar-bearing plants to attract beneficial insects.

Mechanical Controls

These include:

- Use traps to attract and gather pests.
- Set up barriers such as row covers and netting.
- Use electronic repellents.
- Install fences to keep out deer and rabbits. Extend the fence below ground to deter rodents.

Biological Controls

These include:

- Attract beneficial insects and birds.
- Attract insect eating critters such as bats, toads and lizards.

The World Bank is presently supporting the Diversified Agricultural Support Project (DASP) in Uttar Pradesh and the National Agricultural Technology Project (NATP). Agricultural development projects in Tamil Nadu and Rajasthan preceded these projects[46]. The overarching objective of DASP is to increase agricultural productivity in a sustainable manner through intensification and diversification of production systems. One of the principal components of this project is enhancing environmental sustainability and conserving biodiversity and this is being addressed through the support of IPM practices. The NATP project, on the other hand, aims to build the institutional and technical capacities of the Indian Council of Agricultural Research (the apex research organization in India) in areas including IPM. The World Bank supported monitoring activities under the DASP project found high levels of pesticides (Lindane and endosulfan) on vegetables and fruits and in soil. In areas where IPM was not being used, almost 70 per cent of the samples had elevated levels of hazardous pesticides pointing to the need for further strengthening environment management practices[47].

Botanical and Organic Alternatives to Synthetic Chemicals

Though organic pesticide options are available yet its use is not popularised. Some are of the opinion that organic pesticides are slow to act. For certain pests like locusts, which multiply very fast, organic pesticides are unsuitable for use[48]. Unlike chemicals, where the bugs fall away after spraying, some organics are slow acting and does not always bring instant gratification. Again, as compared to chemicals organics are more expensive and, because of the absence of chemicals, may require more frequent applications. More research needs to be done with respect to the efficacy or organic pesticides and its use should be promoted. The following is a brief list of the most common organic pesticides:

- Bacillus Thuringiensis: Also called Bt, it's a bacteria that kills insects in their larval stage (such as caterpillars). There are several strains to choose from, depending on the pest you wish to control. It must be ingested by the pest to work.
- Bordeaux Mix: A mixture or copper sulfate and hydrated lime, Bordeaux mix can be applied as a wettable powder or dust to control disease.
- Botanical Extracts: Oils are extracted from spices and fruits, then combined to deal with pests. They pose no danger to people or pets.
- Diatomaceous Earth: The crushed exoskeletons of microscopic marine and freshwater organisms are harmless to almost all living creatures. The exceptions are soft-bodied pests. The particles of earth are like microscopic bits of broken glass that scratch, tear and destroy the bodies of the pests. Although this product is very safe, the dust can be hazardous so use a mask when applying.
- Horticultural Oil Sprays: These are light petroleum based oils used to control fungus and pests. The target plant must be soaked for effective treatment. Toxicity is low, but may irritate skin or eyes.
- Insecticidal Soap: A virtually non-toxic mixture of soap, oil and water used to deal with soft-bodied insects. Plants must be thoroughly soaked in order for soaps to be effective. Do not use household soaps on plants.
- Milky Spore: A bacteria that attacks Japanese beetles in their larval stage, milky spore is non-toxic to other organisms. Once established in the soil, it lasts for years.
- Neem: An oil extracted from the tropical neem tree. It has low toxicity. Mixed with water, neem is used as an insecticide, fungicide and miticide.

[46] World Bank. DASP, is a US$145 million World Bank-supported program
[47] World Bank report
[48] Bhatnagar, 2005

- Pyrethins: Extracted from a variety of chrysanthemums, this compound can be used on a large variety of insects. Don't confuse these with pyrethoids, which are powerful synthetic versions - leave the pyrethoids for the commercial user.
- Sulfur and Lime-Sulfur: Inorganic, non-chemical elements that are used to control mites and some foliar diseases.

In India, the alternative pesticides and methods (such as IPM) have not been successful due to higher costs as compared to chemicals. There is limited awareness on the issue and requirement of additional investment in research and creating awareness about botanical and organic alternatives to synthetic chemicals[49]. Training of extension workers and farmers in IPM is also necessary.

13. NEW POPs

The Stockholm Convention (global treaty to protect human health and the environment) initially targets 12 persistent organic pollutants (POPs) across the globe. However, under Article 8, Convention Parties can submit proposals for adding harmful chemicals for listing on Annexes A, B, and/or C. The Convention calls for the establishment of a POPs Review Committee (POPRC) to examine proposals. There are several POPs like chemicals that need to be added to the existing list. New POPs will be added to the Convention through application of scientific criteria and an agreed process for evaluation of proposed candidates. The POPs Review Committee will advise the COP on proposals submitted by Parties that must address criteria (Annex D) of the convention. Parties must also include a statement of reasons for concern and need for global control.

World Wildlife Fund (WWF) released a list of 20 chemicals that it recommends be added to the treaty. WWF's list of chemicals to be included for phase out includes the pesticides chlordecone and endosulfan, several brominated flame retardants, and perfluorinated compounds known as PFOS and PFOA. Perfluorinated compounds are used in the production of textiles, food packaging and non-stick coatings, while brominated flame retardants are used in fabrics, TVs, and other products. Table 25 gives the 20 additional chemicals proposed by WWF.

In 2005, five candidate chemicals were nominated to the POPs Review Committee for inclusion in the Convention. Norway nominated pentabromodiphenyl ether (a brominated flame retardant); the European Union nominated chlordecone (pesticide) and hexabromobiphenyl (flame retardant); Sweden nominated perfluorooctansulfonate (PFOS); and Mexico nominated Lindane. In November 2005, the Committee concluded that all chemicals were classifiable as POPs. The evaluation proceeded to the second stage of constructing and evaluating a risk profile for each substance.

Table 25: Additional chemicals proposed by WWF

Pesticides	Brominated flame retardants	Perfluorinated compounds	Other chlorinated chemicals or groups	Unintentionally produced chemicals
Chlordecone	Hexabromocyclododecane (HBCD)	Perfluorooctane sulfonate (PFOS)	Pentachlorobenzene (penta-CB)	Octachlorostyrene (OCS)
Hexachlorocyclohexane (HCH)	Hexabromobiphenyl (Hexa-BB)	Perfluorooctanoic acid and its salts (PFOA)	Short-chained chlorinated paraffins (SCCPs)	Polycyclic aromatic hydrocarbons (PAHs)
Pentachlorophenol (PCP)	Pentabromodiphenyl ether (pentaBDE)		Polychlorinated naphthalenes (PCNs)	
Endosulfan	Octabromodiphenyl ether (octaBDE)		Tetrachlorobenzene (tetra-CB)	
Hexachloro butadiene (HCBD)	Decabromodiphenyl ether (deca-BDE)			
Dicofol				

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Methoxychlor				

13.1. Situation in India

New POPs are a cause of grave concern in India. Most of the emerging POPs continues to be manufactured and used extensively in the country. Most of the POPs and PTS have been detected in all quarters of the environment, even in bottled water and aerated drinks.

There have been studies conducted on pesticides in soft drinks by Centre for Science and Environment (CSE) in 2003, which have detected pesticides and some new POPs in twelve brands of Indian soft drinks. For analysis, 16 organochlorine samples, 12 organophosphorus and 4 synthetic pyrethroides were analysed in bottled soft drinks for pesticides all of which are used extensively in India. The following soft drink brands were tested: Blue Pepsi, Coca-Cola, Diet Pepsi, Fanta, Limca, Mirinda Orange, Mirinda Lemon, Mountain Dew, Pepsi, Sprite, Thumbs Up and 7-Up.

Lindane the gamma isomer of HCH was found in every brand of soft drink tested. Lindane persists in the environment, contaminates surface and ground water and accumulates in fat tissues. The highest concentrations of Lindane found were 0.0042 mg/L, or 42 times the European Economic Commission (EEC) standard for drinking water. For all twelve brands, Lindane concentrations averaged 21 times the EEC standard.

The main source of such pesticides is ground water. CSE report says that India uses large quantities of ground water, which has become increasingly contaminated as levels have dropped dramatically in many parts of the country.

Lindane and endosulfan are increasingly being used in the agriculture sector.

14. OBSERVATION AND CONCLUSIONS

After doing an assessment of the country situation on POPs the following summarization is arrived at:

- ***Need for establishing dialogue with a broader set of stakeholders***

The country situation analysis also suggests that there is need for establishing dialogue with a broader set of stakeholders beyond government officials responsible for chemical management in the country. Efforts need to be made to include dialogue with leading industry associations and establishing partnerships with bilateral agencies and civil society. Civil societies could contribute with ground data and hence they become an important stakeholder. In the NIPs process NGO involvement has been totally marginalized. NGO involvement is an area where there is only limited recent experience.

- ***Role of industry***

Industries need to look at bio pesticides as an alternative to chemical pesticides. Research and Development divisions in the pesticide industries need to promote those chemicals, which are effective but environmentally safe. Company representatives have established a strong extension network with agricultural community in the hotspots in the country. This is evident from the fact that majority of farmers who were interacted with, particularly in Uttar Pradesh and Punjab, are highly dependent on company representatives or dealers for information on plant protection. This network can be used to an advantage for regular flow of pesticide stewardship information. Industry needs to intensify training of farmers about judicious use of pesticides and moving towards less toxic pesticides. Industry should also take onus of disposal of outdated pesticides.

- ***Small scale generators of POPs***

In India, there are several small scale generators of POPs like recycling of PVC units, pulp and paper industry etc. who are a major challenge in terms of compliance with POPs control. These units contribute significantly to dioxins and furans pollution. Often these generators operate in the informal sector with scarce concern for the environment and using obsolete technologies.

- ***Role of government***

Government plays an important role in chemical management in the country. However, there is no uniform stance in the government with respect to various chemical management processes in the country. This often sends out conflicting messages to the international community. There is need for an integrated approach within various government departments to be more effective as a stakeholder in chemical management in the country. New POPs needs to be evaluated as possible candidates for addition to the Stockholm Convention and, should they be accepted for inclusion into the Convention. Governments need to engage in conversation with their respective ministries concerned with chemicals to determine a strategy that will enable them to meet their obligations under the Convention.

Again, efforts are required to improve the pest related surveillance and forecasting systems to monitor whether banned POPs are manufactured, imported, exported or used in agriculture in the region. In order to monitor use of POPs or new POPs in agriculture only registered pesticide companies should be authorized to market the products. Through regular checks and a strict legislation, marketing of spurious or substandard chemicals can be prevented. Establishment of IPM units or cells in each “taluk” will help to monitor crop pests on day-to-day basis and also provide information about the economic threshold level. Government needs to encourage unemployed educated youths to participate in IPM activities and to produce IPM inputs at the village level by providing necessary assistance and training.

- ***Capacity building***

Capacity building is necessary both within government and civil society in order to provide appropriate approaches to many aspects of the POPs issue in India. Capacity building needs to be done in primarily in scientific, technology, research; sharing information, awareness raising; and institutional/policy capacity. It would be in the interest of all stakeholders to implement a national capacity building project, which is open and balanced directed towards priority areas identified nationally. This would not only benefit government, various department of which, have a disjointed approach towards chemical management in the country but would also strengthen the abilities of Non Governmental Organizations (NGOs) to raise awareness of POPs issues at community level.

- ***Need for documentation of pesticide related poisoning***

There are only four poison centres in India. Pesticide-related poisoning and deaths are reported in various agro-ecosystems in India and as these are medico-legal cases, the respondents or concerned authorities were not forthcoming in providing relevant information. There is also major under reporting of cases. There is need for systematic documentation of pesticide-related poisoning and deaths in agro-ecosystems. At the same time, it is extremely important to ascertain whether these incidences are intentional or accidental.

- ***Pesticide Stockpiles***

Container recycling, identification and disposal of obsolete pesticides are important issues in India. There is a need for estimation of unused POPs in the country so that steps may be taken for its proper disposal. Also, priority should be given for systematic collection and recycling of plastic or metal plant protection product containers, preparation of an inventory about obsolete pesticides and also safe disposal of these chemicals.

- ***Monitoring***

It is vital for monitoring levels of POPs in all quarters of the environment to gauge the trend in the level. Time series data needs to be generated in understand the decrease or increase in levels. This would in turn have important policy implications for India.

- ***Laboratory facilities***

In India, though many laboratories are now equipped to test for pesticide POPs, yet there is poor quality control of the equipments, which tends to affect test results. There is a paucity or lack of testing facilities in the case of POPs like dioxins and furans. Availability of standards for testing and the high cost involved in it especially in case of dioxin and furans adds to the problem.

- ***Use of Best Available Technologies***

In India many technologies are landing from the West. However these technologies are not the same as are used in the developed world and have the benefit to conforming to the much weaker standards that exist in developing countries. Examples abound. Medical waste incinerators norms are at least 100 times more rigid in Europe and the US than they are in India, yet multinationals sell them, sometimes along with foreign aid. Technology vendors sell such obsolete technologies into developing countries espousing their benefits, but hiding their polluting nature. [50]

In India, there is a need to implement Best Available Technology (BAT) and best environmental practices (BEP), while taking into consideration the general guidance on prevention and release reduction measures including the promotion of substitute materials.

- ***Public health usage***

There is a need to explore the possibility the use of safer alternatives DDT for public health purposes. In a largely populated country like India, the changeover has to address multiple issues. There is a question of effectiveness, of the alternatives, the cost as well as the willingness and capabilities of existing institutions to adapt to such new

[50] Australian and US companies made a beeline for South Asian markets as soon as medical waste became an issue in these countries in 1997. They professed ‘pollution free’ equipment ‘conforming to USEPA standards,’ even though in reality new stricter US standards were driving costs of incinerators up exponentially, which resulted in over 4000 medical waste incinerators closing down in the US alone during the past four years.

approaches. In the past, initiatives taken for promoting alternative non-chemical approaches such as through a World Bank funded project has not been adequately implemented or monitored.

- ***Inadvertent production of POPs***

In India, though HCH is banned the gamma isomer of HCH i.e. Lindane however continues to be manufactured in India and used for crop protection. It has been reported[51] that in many cases, during the process of manufacture of Lindane by separating it from the other isomers of HCH, the alpha, beta and gamma isomers of HCH are produced as waste products and often, sufficient safeguards are not taken to ensure their containment. So an important issue is the inadvertent production of POPs and documentation of existing processes to evaluate their POPs generating potential as well as remedial action. Areas like dye and dye intermediaries, textiles, pesticides and chemical process have been inadequately documented as sources of POPs.

- ***Need for more research and studies***

The relationship between POPs exposure and effects are complex. International studies exist which provides some specific examples of the different effects that have been documented in different species at different levels of exposure to different POPs. It demonstrates the broad range of possible effects, and the low concentrations that may cause such effects. These studies also illustrate the difficulty in establishing minimum load levels due to the complex relationships between POP exposures and effects. There is no research in India in such areas.

It is expected that there would be synergistic effects of combination of POPs and there exists some studies giving results indicative of possible synergistic effects of combinations of POPs (e.g. Soto *et al.* 1994). The evidence however remains inconclusive. There is no study in India in this crucial area. More studies and research needs to be undertaken by research institutes Reports of synergistic effects in a yeast cell system containing the human estrogen receptor with mixtures of endosulfan, dieldrin, toxaphene, and chlordane by Arnold *et al.* (1996) have failed to be replicated by others (Ramamoorthy *et al.* 1997). Hence there is a requirement for more research by reputed research institutes in the country to develop better understanding on the issue.

[51] Interaction with Dr AT Dudani

REFERENCES

Ali Imran, Jain CK. 1998-99. Pollution potential of the pesticides in the Hindon river. National Institute of Hydrology, RoorkeeCS (AR) 7/98-99

Agarwal HC, Mittal PK, Menon KB, Pillai MKK. 1986. DDT residues in the river Jamuna in Delhi – India. Water, Air and Soil Pollution 28: 89-104

Agarwal HC, Kaushik CP, Pillai MKK. 1987. Organochlorine insecticide residues in the rain water in Delhi, India. Water, Air and Soil Pollution 32: 293-302

Agarwal Ravi. 2002. No future in DDT: A case study of India. Pesticide Safety News.4(4): 5-6

Anbu 2002. Presentation by Dr. A. Munusamy, RRL Trivandrum at Priority Setting Meeting, New Delhi, September 2002

Bhattacharya Badal, Sarkar Santosh Kumar, Mukherjee Nilanjana. 2003. Organochlorine pesticide residues in sediments of a tropical mangrove estuary, India: Implications for monitoring. Environment International 29(5): 587-592

Buccini, John. 2003. Global Pursuit of Sound Management of Chemicals. A Report for the World Bank. Canada.

Bhatnagar, V., 28 April 2005. Personal communication.

Central Pollution Control Board [2005]. *CPCB* [online]. Available from: http://www.cpcb.nic.in/ [Accessed 11 March 2005]

Chakrovorty, T., 25 March 2005. Personal communication.

CPCB. 2003. Annual Report. CPCB, MoEF: 2002-2003

CPCB. 2000. Water Quality Status of Yamuna River. Assessment and Development of River Basin. CPCB, MoEF: April, 2000

CPCB. 1995. Groundwater Quality in Flood Affected Areas of Delhi. Grounwater Quality. CPCB, MoEF

CPCB 1995a Groundwater qualities in problem areas: A Status Report. 1995. CPCB. Groundwater quality series: GWQ/2/1995-96

Dandapani, 21 April 2005. Personal communication.

Dresner, S., 2002. *The Principles of Sustainable Development*. London: Earthscan p 28

Dua, V.K., Kumari, R., Johro, R.K., Ojha, V.P., Shukla, R.P., and Sharma, V.P. 1998. "Organochlorine Insecticide Residues in Water from Five Lakes of Nainital (U.P.), India." *Bulletin of Environmental Contamination and Toxicology*. 60: 209-215.

Dua VK, Pant CS, Sharma VP, Pathak GK. 1998. HCH and DDT in surface extractable skin lipid as a measure of human exposure in India. Bull. Environ. Contam. Toxicol. 60: 238-244

Dua VK, Kumari R, Johro RK, Ojha VP, Shukla RP, Sharma VP. 1998. Organochlorine insecticide residues in water from five lakes of Nainital (U.P.), India. Bull. Environ. Contam. Toxicol. 60: 209-215

Eliminate POPs Keep the Promises [2005]. *IPEN* [online]. Available from: www.oztoxics.org/ipepweb/egg/HotspotReports/Lucknow_**eggs**report.pdf [Accessed 15 September 2005]

Final Report of the Study to facilitate the implementation of certain waste-related provisions of the Regulation on POPs [2005]. [online]. Available from: http://europa.eu.int/comm/environment/pops/index_en.htm [Accessed 12 June 2005]

Gurusamy K, Ramadoss V. 2000. Impact of DDT on Oxygen Consumption and Opercular Activity of Lepidocephalichthys Thermalis Bleeker.J. Ecotoxicol. Environ. Monitor Vol. 10 (4): 239-248

Health and Family Welfare Government of N.C.T of Delhi [2005]. [online]. Available from: http://www.health.delhigovt.nic.in/ [Accessed 5 March 2005]

Indian Ocean Regional Report. 2002. United Nations Environment Programme; Chemicals. Regionally based assessment of Persistent Toxic Substances. GEF

Joshi HC, Chakraborty U. 1996. Organochlorine pesticide residues in fish in seven beels of West Bengal, India. . *In: Souvenir and Abstracts of National symposium towards green and sustainable pesticides*. December 4-6. Society of Pesticide Science, New Delhi, India.

Kalra RL et al. 1999. DDT and HCH residues in dairy milk samples collected from different geographical regions of India: a multicentre study. Food Additives and Contaminants 16(10): 411-417

Kalra et al. 2001. Surveillance of DDT and HCH residues in infant formula samples and their implications on dietary exposure: a multicentre study. Pesticide Research Journal 13(2): 147-151

Kannan, Kurunthachalam, Tanabe, Shinsuke, Ramesh, Aramandla, Subramanian, Annamalai, and Tatsukawa Ryo. 1992. "Persistent Organochlorine Residues in Foodstuffs from India and Their Implications on Human Dietary Exposure." *Journal of Agriculture and Food Chemistry*. 40: 518-524.

Kannan K, Tanabe S, Tatsukawa R. 1994. Biodegradation Capacity and Residue Pattern of Organochlorines in Ganges River Dolphins from India. *Toxicological and Environmental Chemistry* 42:249 – 261

Kannan K, Tanabe S, Tatsukawa R. 1994. Biodegradation Capacity and Residue Pattern of Organochlorines in Ganges River Dolphins from India. *Toxicological and Environmental Chemistry* 42:249 – 261

Kannan Kurunthachalam, Tanabe Shinsuke, Tatsukawa Ryo. 1995. Geographical Distribution and Accumulation Features of Organochlorine Residues in Fish in Tropical Asia and Oceania. *Environmental science and Technology* 29: 2673-26

Kannan Kurunthachalam, Tanabe Shinsuke, Tatsukawa Ryo. 1995. Geographical Distribution and Accumulation Features of Organochlorine Residues in Fish in Tropical Asia and Oceania. *Environmental science and Technology* 29: 2673-2683

Kashyap Rekha, Bhatnagar Vijay K, Saiyed Habibullah N. 2002. Integrated Pest management and residue levels of dichlorodiphenyltrichloroethane (DDT) and hexachlorocyclohexane (HCH) in water samples from rural areas in Gujarat state, India. Archives of Environmental Health 57(4): 337-339

Kathpal TS, Singh G, Yadav GS, Djankar JS, Singh A. 1992. Monitoring of milk and milk products for DDT and HCH contamination. Pesticide Research Journal 4(2): 123-131

Karnik AB. 2001. Immune response to exposure to occupational and environmental agents. ICMR Bulletin. 31(6&7)
Khan S, Choudhary N, Kumar C, Ehteshamuddin S. 1998. Effect of DDT and EDTA on the LDH Activity in Cybister confuses. Journal of Physiology 1 (1): pp 29-32

Khan Ahmed Sharif Yusuf, Khan Azam Ashraful Mohammed. 1998. Study on the use of DDT as preservative practiced in stored dried fishes of Bangladesh. Poll. Res. 17(4): 363-365

Kumari Anupma, Sinha Kumar Ravindra. 2001. Quantitative estimation of DDT residues in some freshwater fishes of river Ganga at Patna, Bihar. *Environment and Ecology* 19(2): 396-399

Kumari Anupma, Sinha RK, Gopal Krishna. 2001. Organochlorine contamination in the fish of the River Ganges, India. *Aquatic Ecosystem Health and Management*. 4: 505-510

Kumari Anupma, Sinha RK, Gopal Krishna, Lata Swarn. 2002. Concentration of organochlorines in Ganges river dolphins from Patna, Bihar. *Journal of Environmental Biology*. 23(3): 279-281

Kumar, Neelima R, Nath, Amit, Bhalla, O.P. 1991. "Organochlorine Insecticide Residues in Commercial Brands of Baby Milk Powder." *Pesticide Research Journal*. 3(2): 163-166.

Kunisue, Tatsuya, Watanabe, Mafuni, Monirith, In, Subramanian, Annamalai, Tana Seang Touch, Prudente Maricar, and Tanabe Shinsuke. 2001. Dioxin Related Compounds in Human Breast Milk Collected from Asian Developing Countries. Presented in Dioxin 2001 – 21st International Symposium on Halogenated Environmental Organic Pollutants & POPs, Kyong Ju, Korea.

Loganathan B. G., and Kannan K. 1994. "Global Organochlorine Contamination Trends: An Overview." *Journal of the Human Environment*. 23(3):187-191.

Lowe's [2005]. *Finding the right pesticide* [online]. Available from: http://www.chem.unep.ch/pops/ [Accessed 11 June 2005]

Mathur HB, Johnson Sapna, Mishra Rashmi, Kumar Avinash, Singh Bhupinder. 2003. Analysis of pesticide residues in bottled water (Delhi Region). *Center for Science and Environment.* CSE/PML-6/2002

Mitra, Barun S, and Tren, Richard. 2002. The Burden of Malaria. A Research Paper of Africa Fighting Malaria, European Science and Environment Forum Publication and Liberty Institute. Occasional Paper 12. India

Muralidharan S, Regupathy A, Sundramoorthy T. 1992. Organochlorine residues in the eggs of selected colonial water birds breeding at Keoladeo national park, Bharatpur, India. Aquatic Ecosystems In Semi-Arid Regions: Implications For Resource Management. NHRI Symposium Series 7, Environment Canada, Saskatoon

Muralidharan S. 1993. Aldrin poisoning of Sarus cranes (Grus antigone) and a few granivorous birds in Keoladeo National Park, Bharatpur, India. Ecotoxicology 2: 196-202

Muralidharan S. 2000. Organochlorine residues in the waters of Keoladeo national park, Bharatpur, Rajasthan. Bull. Environ. Contam. Toxicol. 65: 35-41

Nair, Amit, Dureja, P., Pillai, M.K.K. 1992. "Aldrin and Dieldrin in Residues in Human Fat, Milk and Blood Serum Collected from Delhi." *Human and Experimental Toxicology.* 11: 43-45.

Nair, Amit, Dureja, P., and Pillai, M.K.K., 1991. Levels of aldrin and dieldrin in environmental samples from Delhi, India. *The Science of the Total Environment*. 108 : 255-259.

Naoroji Rishad. 1999. Status of diurnal raptors of Corbett national park with notes on their ecology and conservation. Journal, Bombay Natural History Society. 96(3): 387-398

Nigam U, Siddiqui MKJ. 2001. Organochlorine Insecticide Residues in Dairy Milk Samples Collected in Lucknow, India. Bull. Environ. Contam. Toxicol. 66: 678-682

North America Regional Report. 2002. United Nations Environment Programme; Chemicals. Regionally based assessment of Persistent Toxic Substances. GEF

Parivesh 2001Polychlorinated Biphenyls (PCBs): Persistent Pollutants. CPCB, MoEF. Parivesh: December 2001.
Prakash Vibhu. 1999. Status of Vultures in Keoladeo National Park, Bharatpur, Rajasthan, with special reference to population crash in GYPS species. J. Bombay Natural History Society 96(3): 365 – 378

Rathore Minakshi, Bhatnagar Pradeep, Mathur D, Saxena GN. 2002. Burden of organochlorine pesticides in blood and its effect on thyroid hormones in women. The Science of the Total Environment 295: 207-215

Radhakrishnan AG, Antony PD. 1989. Pesticide residues in marine fishes. *Fishery Technology*. 26(1): 60-61

Rahmani Asad R. 2001. The Bengal Floricans of Dudhwa. Sanctuary Asia. December 2001: 22-27

Ramesh A, Tanabe S, Tatsukawa R, Subramanian AN. 1989. Seasonal variations of organochlorine insecticides residues in air from Porto Novo, South India. *Env. Poll.* 62: 213-222

Ramesh A, Tanabe S, Kannan K, Subramanian AN, Kumaran PL, Tatsukawa R. 1992. Characteristic Trend of Persistent Organochlorine Contamination in Wildlife from a Tropical Agricultural Watershed, South India. *Archives of Environmental Contamination and Toxicology* 23: 26-36

Ramesh A, Tanabe S, Kannan K, Subramanian AN, Kumaran PL, Tatsukawa R. 1992. Characteristic Trend of Persistent Organochlorine Contamination in Wildlife from a Tropical Agricultural Watershed, South India. *Archives of Environmental Contamination and Toxicology* 23: 26-36

Rao Sreenivasa A, Rao Ramamohan P. 2000. Pesticides in the air of the Kolleru Lake. Environ Hlth. 42(2): 70-74

Rao Sreenivasa A, Rao Ramamohan P. 2000. Pesticides in the air of the Kolleru Lake. Environ Hlth. 42(2): 70-74

Rao Sreenivasa A, Rao Ramamohana P. 2000. Study on pesticide residues in vegetables. Poll. Res. 19(4) 661-664

Reddy Jagadishwar D, Rao Narasimha B, Reddy Narasimha K, Sultan Azam Mir, Babu Ramesh T. 1997. Monitoring of Pesticide Residues in river, Tank and Canal Water. Pesticide Research Journal 9 (1): 97-100

Reddy VRK, Sathyamoorthy VR. 2000. Cytotoxic Effect of Some Waste Water Effluents on somatic Chromosomes of Allium CEPA. J. Cytol. Genet. 1: 123-126

Rengam, S., 25 March 2005. Personal communication.

RFI (Resources for the Future International). 2000. Status Report and Needs Assessment: Stockholm Convention on Persistent Organic Pollutants (POPs) Implementation in India. Report prepared by RFI for the World Bank. Canada.

Ruparelia SG, Verma Yogendra, Hargan MC. 2001. The evaluation of Toxicity of Industrial Effluents from Pesticide Industries using Short Term Fish Bioassay. J. Environ. Res. 11 (2): 129-132

Sarkar A, Sengupta R. 1987. Chlorinated pesticide residues in sediment from the Arabian sea along the central west coast of India. Bull. Environ. Contam. Toxicol. 39: 1049-1054

Sarkar A, Sengupta R. 1988. Chlorinated pesticide residues in marine sediments. Mar. Pollut. Bull. 19: 35-37

Sarkar A, Nagarajan R, Chaphadkar S, Pal S, Singbal SYS. 1997. Contamination of organochlorine pesticides in sediments from the Arabian Sea along the west coast of India. *Water Research*. 31(2): 195-200

Sarkar A, Everaarts JM. 1998. Riverine input of chlorinated hydrocarbons in the coastal pollution. Published in Ecology of wetlands and associated systems. *The Pennsylvania Academy of Science* (eds. SK Majumdar, EW Miller and FJ Brenner)

Sarkar Guha, Ghosh SK. 2001. Pollution: alarm bells ringing in Indian agriculture. *Science and Culture*, Nov-Dec: 355-361

Sarkar UK, Basheer VS, Singh AK, Srivastava SM. 2003. Organochlorine pesticide residues in water and fish samples: first report from rivers and streams of Kumaon Himalayan region, India. Bull. *Environ. Contam. Toxicol.* 70: 485-493

Sarkar, Guha K., and Ghosh, S.K. 2001. "Pollution: Alarm Bells Ringing in Indian Agriculture." *Science and Culture*. 67(11-12). 355-361.

Saxena, S., 25 February 2005. Personal communication.

Selvarani Dravyan, Rajamanickam C. 2002. Polychlorinated biphenyls 1232 toxicity on microsome of Ariuscaelatus (Valenciennes). Indian J. Environ. Toxicol. 12 (1): 26-29

Senthilkumar, Kurunthachalam, Kannan, Kurunthachalam, Paramasivan, Odathurai N., Shanmugasundaram, Vellakovil P., Nakanishi, Junko, and Masunaga Shigeki. 2001. "Polychlorinated Dibenzo-p-dioxins, Dibenzofurans and Polychlorinated Biphenyls in Human Tissues, Meat, Fish and Wildlife Samples from India." *Environmental Science and Technology*. 35: 3448 – 3455.

Senthilkumar, Kurunthachalam, Kannan, Kurunthachalam, Subramanian, Annamalai, Tanabe, Shinsuke. 2001a. "Accumulation of Organochlorine Pesticides and Polychlorinated Biphenyls in Sediments, Aquatic Organisms, Birds, Bird Eggs and Bat Collected from South India." *Environmental Science and Pollution Research.* 8 (1): 35-47.

Senthilkumar, Kurunthachalam, Mafumi, Watanabe, Kannan Kurunthachalam, Subramanian Annamalai, and Tanabe Shinsuke. 1999. "Isomer-Specific Patterns and Toxic Assessment of Polychlorinated Biphenyls in Resident, Wintering Migrant Birds and Bat Collected from South India." *Toxicological and Environmental Chemistry.* 71: 221-239.

Senthilkumar, Kurunthachalam, Kannan, Kurunthachalam, Sinha, Ravindra K, Tanabe, Shinsuke, Giesy, John P. 1999a. "Bioaccumulation Profiles of Polychlorinated Biphenyl Congeners and Organochlorine Pesticides in Ganges River Dolphins." *Environmental Toxicology and Chemistry.* 18 (7): 1511 – 1520.

Sethi PK, Bhattacharya AK, Sarkar A. 1999. Current trends of some organochlorine pesticides in Yamuna river sediments around Delhi. *Environment Pollution Control Journal.* 72: 40-43

Singh KP. 1992. Measurement of Ganga River Quality with particular reference to heavy metals and pesticides. NRCD Funded Project conducted by ITRC

Singh KP. 1997. Assessment of the impact of wastewater contaminants (metals and pesticides) on environmental, health and agricultural quality of the receiving areas near Kanpur and Varanasi. NRCD Funded Project conducted by ITRC

Singh RP. 2001. Comparison of organochlorine pesticide levels in soil and groundwater of Agra, India. Bull. Environ. Contam. Toxicol. 67: 126-132

Siddiqui MK, Nigam U, Srivastava S, Tejeshwar DS, Chandrawati. 2002. Association of maternal blood pressure and hemoglobin level with organochlorines in human milk. Human and Experimental Toxicology 21: 1-6

Siddiqui MKJ, Srivastava S, Srivastava SP, Mehrotra PK, Mathur N, Tandon I. 2003. Persistent chlorinated pesticides and intra-uterine foetal growth retardation: a possible association. Int. Arch. Occup. Environ. Health. 76: 75-80

Srivastava AK, Bihari V, Mathur N, Pangtey BS, Gupta BN. 1993. Estuarine pollution – a health perspective. Indian Journal of Environmental Protection 13(8): 561-564

Srivastava AK, Gupta BN, Bihari V, Mathur N, Pangtey BS, Bharti RS, Godbole MM. 1995. Organochlorine pesticide exposure and thyroid function: A study in human subjects. Journal of Environmental Pathology, Toxicology and Oncology. 14(2): 107-110

Srivastava LP, Gupta KP, Raizada RB. 2000. Organochlorine pesticide residues in herbal ayurvedic preparations. Bull. Environ. Contam. Toxicol. 64: 502-507

Shailaja MS, Sengupta R. 1989. DDT residues in fishes from the Eastern Arabian sea. *Marine Pollution Bulletin* 20(12): 629-630

Shailaja MS, Sengupta R. 1990. Residues of dichlorodiphenyltrichloroethane and metabolites in zooplankton from the Arabian Sea. *Current Science* 59(19): 929-931

Shailaja MS, Singhal SYS. 1994. Organochlorine pesticide compounds in organisms from the Bay of Bengal. *Estuarine Coastal and Shelf Science.* 39: 219-226

Shailaja MS, Nair Maheshwari. 1997. Seasonal differences in organochlorine pesticide concentrations of zooplankton and fish in the Arabian sea. *Marine Environmental Research* 44(3): 263-274

Simonich S. L., and Hites, R. A. 1995. "Global Distribution of Persistent Organic Pollutants." *Science.* 269:1851-1854.

Singh, R. (2005) Incinerator in Delhi- State The Biggest Polluter

Srivastava, A.K., Bihari, V., Mathur, N., Pangtey, B.S., and Gupta, B.N. 1993. "Estuarine Pollution – A Health Perspective." *Indian Journal of Environmental Protection*. 13(8): 561-564.

Stockholm Convention on Persistent Organic Pollutants (Pops) [2005]. *Persistent Organic Pollutants* [online]. Available from: http://www.pops.int/ [Accessed 11 March 2005]

Stockholm Convention on Persistent Organic Pollutants [2005]. [online]. Available from: http://www.pops.int/documents/convtext/convtext_en.pdf [Accessed 20 June 2005]

United Nations Environment Program Chemicals [2005]. *Persistent Organic Pollutants* [online]. Available from: http://www.chem.unep.ch/pops/ [Accessed 20 June 2005]

GPA [2005]. *Global Program of Action for The protection of Marine Environment from Land based activities.* [online]. Available from: http://pops.gpa.unep.org/04histo.htm [Accessed 11 April 2005]

UNEP. 2002c. Regionally Based Assessments of Toxic Substances: Indian Ocean Regional Report. UNEP Chemicals. Switzerland.

UNEP 2003. Regionally-based Assessments of Persistent Toxic Substances: Global Report. UNEP Chemicals. Switzerland.

UNEP 2003. Regionally-based Assessments of Persistent Toxic Substances: Global Report. UNEP Chemicals. Switzerland.

UNEP 2002a. The Hazardous Chemicals and Wastes Conventions. Switzerland.

UNEP 2002b. Regional Based Assessments of Toxic Substances – South East Asia and South Pacific Regional Report. UNEP Chemicals. Switzerland.

UNEP 2002c. Regionally Based Assessments of Toxic Substances: Indian Ocean Regional Report. UNEP Chemicals. Switzerland.

UNEP 2002d. Regional Based Assessments of Toxic Substances – Europe Regional Report, UNEP Chemicals. Switzerland.

UNEP 2002. http://www.unep.org/wssd/. Switzerland.

UNEP 2002f. Regional Based Assessments of Toxic Substances – North America Regional Report, UNEP Chemicals. Switzerland.

UNEP 2002g. Regional Based Assessments of Toxic Substances – Sub-Saharan Africa Regional Report, UNEP Chemicals. Switzerland.

UNEP 2002h. Regional Based Assessments of Toxic Substances – Central and North East Asia Regional Report, UNEP Chemicals. Switzerland.

Vijayan VS. 2003. Where have all the sparrows gone? Down to Earth January 31, 2003: 50-51

WHO 2002a. Global Assessment of the State-of-the-Science of Endocrine Disruptors (T. Damstra, S. Barlow, A. Bergman, R. Kavlock, and G Van Der Kraak Eds). International Programme for Chemical Safety (IPCS). Switzerland.

World Bank. 2002. Making Sustainable Commitments: An Environment Strategy for the World Bank. Washington. D.C.

World Bank (2004) Issues and Options in Addressing the Objectives of the Stockholm Convention on Persistent Organic Pollutants in India and the South Asia Region. Discussion Paper

WWF [2005]. *For the Living Planet* [online]. Available from: http://www.chem.unep.ch/pops/ [Accessed 12 June 2005]