Toxics Link
Factsheet
Number 18 / Oct 2003

POPs

Fighting the menace of Persistent Organic Pollutants

Of all the pollutants released into the environment every year by human activity, Persistent Organic Pollutants (POPs) are among the most dangerous.They are ubiquitous: found in the most remote areas, far from any industrial activities. Even though they are present in the environment at extremely low levels, they have been linked to many health and environmental effects. With the evidence of their long-range transport to regions where they have never been used or produced, and the consequent threats they pose to the environment of the entire planet, the international community has at several occasions called for urgent global action to reduce and eliminate releases of these POPs.

POPs: The 'dirty dozen'

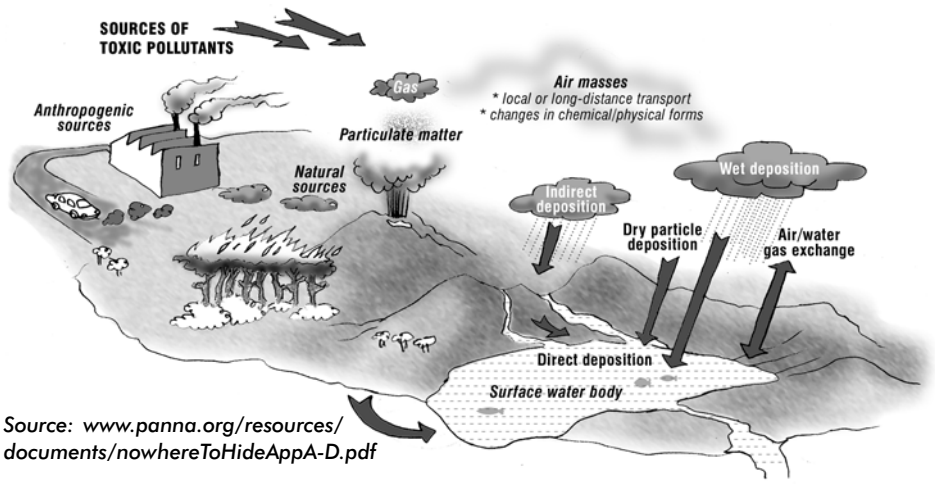
The 12 POPs (commonly known as the 'dirty dozen') identified in the Stockholm Convention are DDT, aldrin, dieldrin, endrin, chlordane, heptachlor, mirex, toxaphene, hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs), dioxins and furans. Of these, nine are organochlorine pesticides. PCBs are compounds with varied industrial applications, while HCB, PCBs, dioxins and furans are produced unintentionally, industrially as well as otherwise.

Global action against POPs

Because of the global risks posed by the long range transport of POPs, the international community is calling for global action to reduce and eliminate releases of these chemicals.

In 1997, efforts were made on a global level to deal with the problem of POPS under the aegis of United Nations Environmental Programme (UNEP). The first Inter-governmental Negotiating

Long-range transport and deposition of POPs



Source: www.panna.org/resources/documents/nowhereToHideAppA-D.pdf

AT A GLANCE

- **POPs are among the most dangerous of all pollutants released into the environment every year by humans.**
- **Among these, dioxins and furans are unintentionally produced by processes such as incineration and are of most concern because of their significant toxicity.**
- **POPs travel globally on wind and marine currents to regions far from where they are produced.**
- **Collective global action is the only way to stop the spread of POPs. The Stockholm Treaty lays guidelines for their phase-out.**
- **POPs are transported via convection currents to colder regions, where they persist for longer periods. The Himalayas could possibly be a major sink for POPs to re-enter the ecosystem through rivers.**

Pesticides, though intended for the target pest species, end up in the food chain, water and air

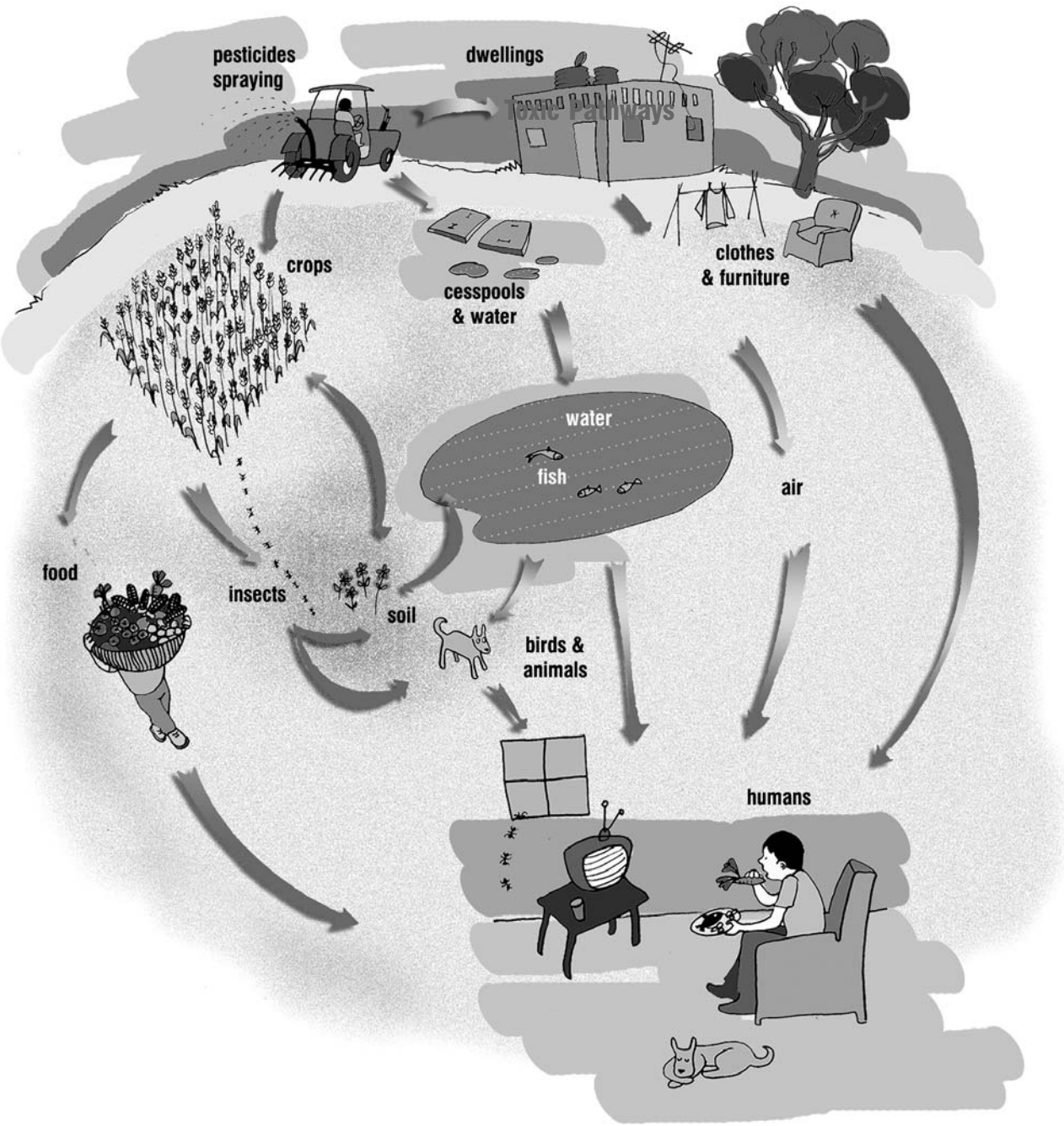
Committee (INC) for POPs held its first meeting in Montreal in June 1998 and agreed to target 12 chemicals for immediate action. This was followed by INCs in Nairobi, Geneva, Bonn and Johannesburg. A multilateral, internationally legally binding treaty to ban POPs was finally signed on May 23, 2001, in Stockholm by 87 countries. It has come to be known as the Stockholm Convention.

The Stockholm Convention sets out control measures covering the production, import, export, disposal and use of POPs. Governments are to promote the best available technologies and practices for replacing existing POPs while preventing the development of new POPs. They are expected to draw up national legislation and develop action plans for carrying out their commitments.

While the control measures will apply to an initial list of 12 chemicals, a POPs Review Committee will consider additional candidates for the POPs list on a regular basis. This will ensure that the treaty remains dynamic and responsive to new scientific findings.

Pathways of POPs

POPs always find a way to reach us. They travel on a variety of pathways to eventually land up in our bodies.



Sources of POPs

Sources of POPs can be classified according to their type. Pesticide POPs have similar source characteristics. PCBs have specific uses in different industrial sectors and have source characteristics accordingly. Similarly, unintentionally produced POPs have commonalities in terms of the kinds of sources and release mechanisms associated with them.

Pesticide POPs

Sources of pesticides can be typically characterised 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.

Non-point sources arise due to the general application of pesticides (such as in agriculture) resulting in crop run-offs or leaching into ground water reserves. Since all POPs pesticides have been banned for use in agriculture, there is no data being generated or available on this aspect though they are present in food, water, etc. The use of DDT as part of the malaria programme also constitutes a non-point source.

Production POPs

Given the fact that all POPs pesticides (except DDT) are banned for production in India, potential hotspots might exist in closed factory premises which still house stocks of manufactured chemicals. It is expected that the environment around such sites might also be contaminated due to exposure to toxics during the period of manufacture.

Such contamination of the area was indicated by a report on the effect of the Udyogamandalam plant of Hindustan Insecticides Ltd where DDT was manufactured.[1]

Unintentional POPs

A variety of industrial and non-industrial processes (typically involving high temperatures) result in the release of POP chemicals (dioxins, furans, PCBs and HCB) into the environment. Among these POPs, dioxins and furans are of most concern because of their significant toxicity. In most cases, dioxins and furans released are accompanied with PCBs and HCB as well.

POPs pervade the environment through a variety of media. Pesticides, though intended

Sources identified by the Stockholm Convention for unintentionally produced POPs

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 aluminium production, secondary zinc production, etc.

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
- Smoldering of copper cables
- Waste oil refineries.

Humans represent the top of the food chain and, at the time of human dietary intake, POPs have been through several stages of bio-accumulation and are likely to have reached significant levels

[1] *Labunska 1999*

for the target pest species, end up in the food chain, water and air and into non-target species and ecological systems. Unintentional and industrial POPs are often released in an unregulated manner and are assimilated into environmental systems owing to their properties of persistence, lipophilicity and volatility. Understanding the nature of these exposure pathways is crucial to determining and evaluating POPs' impact on the environment, human habitats and the economy.

Exposure of humans to pesticide POPs can be intentional (suicides and homicides) and unintentional (accidental, occupational and non-occupational exposure from water, air and food). Amongst unintentional exposures in the environment are the direct toxic effects during application to non-target groups such as pollinators, predators, wildlife, etc, as well as post application hazards due to pesticide residues in food, air and water.

Pesticide POPs can get into the ecosystem at various junctures such as during production, transport, storage and application. In terms of environmental management, there are many stages in the product life-cycle of pesticide POPs where care needs to be taken to prevent contamination of the environment.

The continuing trade of POPs even after their ban is an indication of the existence of possible hotspots in India in terms of production and storage facilities

Personal action on POPs to reduce risk

The World Wide Fund For Nature/World Wildlife Fund (WWF) has provided some hints on how to reduce individual risk of exposure to POPs. The task is difficult because POPs that are already in the environment will be around for decades. Still, we can reduce our exposure to POPs and help stop more POPs from getting into circulation. To reduce the risks of POPs, the following suggestions should be considered:

- **Try to eat lower on the food chain or avoid fats.** This will reduce lifetime accumulation of POPs and is especially relevant for children.
- **Choose unbleached paper products.** Chlorine bleaching processes unintentionally generate POPs by-products such as dioxins, furans and others.
- **Avoid polyvinyl chloride (PVC or vinyl) plastics.** This might be an impossible task given that there is an endless list of common vinyl items that include packaging material, utility items, wall coverings, blood and infusion bags, medical equipment, credit cards, office supplies, etc. Don't burn these items.
- **Avoid using weed killers containing POPs chemicals.** A useful hint for the customers is to check the label for the active ingredient 2,4-D; they may contain dioxins and other POPs by-products.

Nowhere to hide, no place to go

Once in the environment, POPs are transported within the region mainly through natural media like fresh water systems (rivers and streams), atmospheric currents (usually adsorbed to suspended sediment) and marine currents.

Streams receive pesticide run-offs from agricultural fields and industrial waste. Owing to their hydrophobic nature, POPs are transported mainly by adsorption with sediment and organic matter in the streams while a certain amount of POPs remain in the water. POPs in the fresh water systems enter the food chain through fish raised in contaminated water bodies and, to a certain extent, by the direct consumption or secondary consumption of the contaminated water.

POPs represent a class of semi-volatile compounds, and the role of atmospheric transport is important for their dispersal within a region. Air transport can also occur through precipitation and the movement of dust particles with adsorbed POPs. The persistence of POPs in soil/sediments may result in their re-suspension and re-mobilisation back to the atmosphere under favourable high temperature conditions through volatilisation and to the surface waters through run-offs during monsoon/flood periods.[2]

Most inflows into the marine environment occur due to the outflows of rivers into the oceans and seas. This discharge is due to the high sediment loads in rivers and the possible presence of adsorbed POPs in them. POPs fluxes into the sea also occur due to direct discharges into the sea, ship traffic, ship scrapping and through the atmospheric route.

[2] Interaction with Dr C. Venkataraman, CESC, IIT Bombay.

Did you know?

◆ POPs are highly stable compounds and can circulate globally through a process known as the "grasshopper effect".[3] According to UN, the breast milk of the average Inuit mother has five times as much dioxins as that of her counterpart in the industrialised world. However, breast milk is still recommended for infants.

◆ On entering the environment, POPs can alter the normal bio-chemical and physiological functions of plants and animals, including humans. Effects may include molecular changes (enzyme activity, DNA damage), cellular changes (tumour formations), tissue changes (organ functioning), individual changes (behaviour, deformities), population changes (mortality, abundance, distribution), and community changes (numbers of species and their interactions).

◆ POPs concentrate in living organisms through another process called bioaccumulation. POPs are readily absorbed in fatty tissue, where concentrations can become magnified by up to 70,000 times the background levels.

◆ Fish, predatory birds, mammals and humans are high up the food chain and so absorb the greatest concentrations.

◆ Human health impacts may be felt most acutely in populations that consume large amounts of fish (for example, subsistence fishermen), since fish have a high fat content and thus can contain high concentrations of POPs.

◆ Though most of the 12 POPs have been banned or subjected to severe use restrictions in many countries for more than 20 years, many are still in use and stockpiles of obsolete POPs exist in many parts of the world.

◆ Humans can be exposed to POPs through diet, occupational accidents and the environment.

◆ Exposure to very low doses of certain POPs can lead to cancer, damage to the central and peripheral nervous systems, diseases of the immune system, reproductive disorders, and interference with infant and child development.

◆ Shifting from POPs to chemical and non-chemical alternatives is the key to reducing the impact of these hazardous substances. A high priority is finding alternatives to hazardous chemicals for insect control.

◆ There are many safer chemical and non-chemical alternatives, but their development and dissemination will require time, money and training.

◆ Many countries face barriers to identifying and controlling releases of POPs. These include high prices of some alternatives, the need for education and training on the hazardous nature of POPs, a lack of information on alternatives, a lack of reliable data about the current uses of POPs and the need for regulations/infrastructure to manage their use.

Governments should realise that people must not bear the economic cost of the clean-up and disposal of POPs pesticides

Eating POPs

Amongst the pathways that expose humans to pesticide POPs, dietary exposure takes precedence over other pathways like air, water and dermal exposure. Humans represent the top of the food chain and, at the time of human dietary intake, POPs have been through several stages of bio-accumulation and are likely to have reached significant levels.

This rule of primary exposure by dietary pathways is, however, not applicable in certain specific situations such as occupational and accidental exposure where dermal, atmospheric and water pathways can assume significance.

Exposures

POPs have been detected in various human tissue samples, animal samples and aquatic species often in higher concentrations, and their presence, as such, is a matter of concern. The presence of POPs residues in human and animal samples is probably the most effective way to confirm the exposure and magnitude of POPs in the population. It must be remembered that POPs exposures even at low doses (the timing of the exposure being as important as the dosage) can cause undesirable health effects, especially in the more vulnerable sections of the population, such as pregnant mothers and young children. No segment of

[3] POPs, when released into the environment, can be transported on air currents to places far from their point of origin. Such transport can consist of a number of "hops" from one point to another. Each "hop"consists of three stages: evaporation, transport in the atmosphere and condensation at lower temperatures. Scientists have called this phenomenon the "grasshopper effect".

the population is completely protected against exposure to pesticides and their serious health effects, though a disproportionate burden is shouldered by the people of developing countries and by high-risk groups. Factors that influence variations in levels include intensity, efficiency of absorption, species, age, nutritional status and integrity of the organs.

POPs problem in India

Despite the fact that most short-listed POPs are banned from use, production, import or export in India, a combination of factors has led to their continued production, trade, use and release into the environment.

Continued production and trade in POP chemicals

It is interesting to note that chlordane has been imported in India subsequent to its ban, while aldrin, chlordane and heptachlor have been exported subsequent to their ban. The trade in POPs after their ban is an indication of the continued existence of possible hotspots in India in terms of production and storage facilities.[4] It is suspected that DDT which is allowed for vector control but banned for agricultural purposes is pilfered and used as an insecticide.

Stockpiles of obsolete POPs pesticides

Though stockpiles of obsolete POPs exist, posing a major threat to the environment, there is no known government programme to monitor them. The State Pollution Control Boards, however, do have the responsibility to identify and notify sites storing hazardous material.

Lack of awareness of handling and disposal of POPs

Electrical equipment, such as transformers containing PCBs, are indiscriminately disposed into the waste stream.

Polluting POPs-producing technologies

Some developed nations, in partnership with local entrepreneurs, are pushing for the expansion of POPs producing technologies such as waste incinerators, waste-to-energy and PVC manufacturing plants. In some cases, the construction of these incinerators is backed by multilateral financial institutions.

While so-called state-of-the-art incinerators can greatly reduce stack emissions, they still cannot stop the formation of dioxins and other POPs

[4] About 10 MT of chlordane is imported and 29 MT exported in the year 1997-98 as mentioned in a presentation by Dr P.S. Chandurkar, Plant Protection Adviser to the Government of India, during the UNEP-GEF PTS regional priority-setting meeting, September 2002. There has been a complete ban on the manufacture, use, import and export of chlordane since September 20, 1996.

The rogue's gallery: pesticide POPs

Aldrin

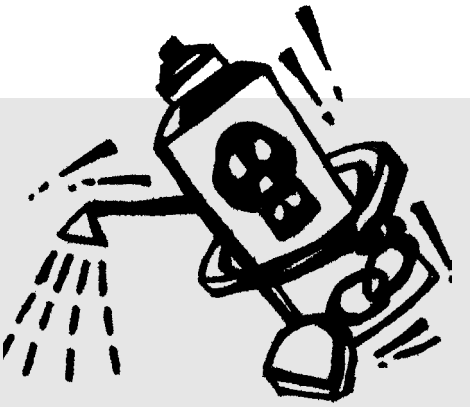
Uses: Controlling soil pests, termites, ants.
Persistence/fate: Metabolised to dieldrin by plants, animals. Half-life is soil and water ranges from 20 days to 1.6 years.
Toxicity: Lethal dose for an adult is 80 mg/kg of body weight. Most toxic to aquatic invertebrates. MRLs of FAO/WHO range from 0.006 mg/kg milk fat to 0.2 mg/kg meat fat; 0.1 to 180 μg/l for water quality. Acts as a stomach and contact poison. IARC*(1987): Group 3: Unclassifiable as to carcinogenicity in humans.
Banning status in India: Complete ban on manufacture, use, import and export.

Dieldrin

Uses: Used in the wool processing industry, for soil pests, public health situations including termites.
Persistence/fate: Highly persistent in soils with a half-life of 3-4 years in temperate climates. Persistence in air is 4-40 hours.
Toxicity: MRLs recommended by FAO/WHO varies from 0.006mg/kg milk fat to 0.2 mg/kg meat fat. Water quality criteria range from 0.1 to 1.8 μg/l . It acts as a non-systemic stomach and contact poison. IARC* (1987): Group 3: Unclassifiable as to carcinogenicity in humans.
Banning status in India: Use restricted to locust control in desert areas under the direction of the Plan Protection Advisor. Complete ban on manufacture, import and export. Marketing and use permitted for two years from date of ban on manufacture, or date of expiry, whichever is earlier.

DDT

Uses: Used for vector control for diseases like malaria, dengue and kala azar. It was also widely used on a variety of agricultural crops.
Persistence/fate: Highly persistent in soils with a half-life of 15 years and 7 days in air. In the environment, it is metabolised to DDD and DDE. It



exhibits high bio-concentration factors.
Toxicity: 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 to 5 mg/kg meat fat. MRL in drinking water is 1 μg/l. It acts as a non-systemic stomach and contact poison. IARC* (1991): Group 2B: Possibly carcinogenic to humans.
Banning status in India: Banned for agricultural use, and restricted use in the public health sector (10,000 MT per annum).

Endrin

Uses: Used as an insecticide in cotton, rice, sugarcane and other crops. Also used as a rodenticide.
Persistence/fate: Highly persistent in soils (half-life of up to 12 years reported). Bio-concentration of up to 18,000 has been recorded in fish.
Toxicity: Endrin is highly toxic to fish and acute toxicity is high in laboratory animals. It is suspected to suppress the immune system in humans. It is a contact and stomach poison and may have delayed neurotoxic action. IARC* (1987): Group 3: Unclassifiable as to carcinogenicity in humans.
Banning status in India: Complete ban on manufacture, use, import and export.

Chlordane

Uses: Used as a fumigant, acaricide, and is most effective on termites. Also used on household pests.
Persistence/fate: It is highly persistent in soils with a half-life of 4 years. It binds to aquatic sediments and bio-concentrates in organisms.
Toxicity: Its most possible pathway is through the air. There is evidence of endocrine disruption in intact organisms. It is a possible carcinogen in humans and disrupts the immune system. Acute toxicity for mammals is moderate. MRLs of the FAO/WHO are 0.002 mg/kg milk fat and 0.5 mg/kg poultry fat. Water quality criteria range from 1.5 to 6 μg/l. It is a contact poison and fumigant with long residual effects. IARC* (1991): Group 2B: Possibly carcinogenic to humans.
Banning status in India: Complete ban on manufacture, use, import and export.

Heptachlor

Uses: It is primarily used against soil insects and termites. It is also used for seed treatment and against household pests.
Persistence/fate: 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.
Toxicity: Heptachlor is toxic to wildlife even 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 recommended by FAO/WHO are 0.006 mg/kg milk fat and 0.2 mg/kg meat or poultry fat. It acts as a non-systemic insecticide with stomach, contact and some respiratory action. IARC* (1991): Group 2B: Possibly carcinogenic to humans.
Banning status in India: Complete ban on manufacture, use, import and export.

Mirex

Uses: Used against control of ants, and also as a fire retardant in plastics.
Persistence/fate: Most stable with a half-life of 10 years. Bio-concentration factors of 2600 and 51400 have been recorded in pink shrimp and fathead minnows. It is capable of undergoing long range transport due to volatility.
Toxicity: 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. Humans are exposed through dietary intakes. IARC* (1979): Group 2B: Possibly carcinogenic to humans.
Banning status in India: Never registered.

Toxaphene

Uses: Used extensively for cotton pests, vegetables, fruits and cereal grains. Also used to combat livestock parasites.
Persistence/fate: It has a half-life of up to 12 years. It has been shown to bio-concentrate in aquatic organisms.
Toxicity: Toxaphene is highly toxic to fish. Strong evidence exists for the potential of endocrine disruption and it has been listed as a possible human carcinogen. It is a non-systemic contact and stomach insecticide. IARC* (1987): Group 2B: Possibly carcinogenic to humans.
Banning status in India: Never registered.

Hexachlorobenzene (HCB)

Uses: Used for seed treatment of grain crops.
Persistence/fate: Estimated half-life of 2.7 to 5.7 years in soil, and 0.5 to 4.2 years in air. High bio-accumulation potential and long half-life in biota.
Toxicity: In humans, exposure has been known to cause skin lesions, unusual hair growth, colic, severe weakness, kidney and liver damage, CNS effects, circulatory collapse and respiratory depression, debilitation, urinary, arthritic, neurological and metabolic disorders, and death. It is also listed as a possible human carcinogen and causes effects even at low concentrations. IARC* (1987): Group 2B: Possibly carcinogenic to humans.
Banning Status in India: Never registered.

After-effects of past POPs-linked activities

Extensive use of DDT for malaria control has led to a high level of contamination of all quarters of the environment and food commodities.

Collective action to be taken on POPs

The problems associated with POPs are too large, complicated and expensive for any individual nation to tackle. Hence, governments should actively participate in the UNEP process to eliminate POPs and seek safer alternatives. Suggested ways of doing so are as follows:

Governments should actively participate in the UNEP process to eliminate POPs and seek safer alternatives

❖ **Elimination of all POPs sources**

The sources of POPs must be properly identified, and then phased out, replaced or removed. This is true for POPs that are produced intentionally as well as unintentionally, such as dioxins.

❖ **Technological and other resource assistance**

The global POPs treaty includes measures to discourage wealthy countries from promoting and exporting POPs-generating technologies, processes and materials to newly industrialised nations. At the same time, measures must be included to encourage wealthy countries and aid programmes to assist newly industrialised countries in developing and implementing non-POP technologies and materials.

❖ **No incineration**

Since incineration itself has been identified as a major source of dioxins and furans, it cannot be used as a disposal route for existing POPs stockpiles. While so-called state-of-the-art incinerators can greatly reduce stack emissions, they cannot stop the formation of dioxins and other POPs which may be present in fly ash and bottom ash. Those would still require further treatment and disposal.

Alternative destruction and de-toxification methods and technologies which do not generate POPs should be used instead. In recognition of the dangers associated with incineration, countries like Australia are venturing into non-incineration destruction technologies.

❖ **Polluter pays**

Governments should realise that people must not bear the economic cost of the clean-up and disposal of POPs pesticides. Multinational chemical corporations should be made responsible for the stockpiles of their products.

❖ **Precautionary principle**

Preventive action should be taken when there is reason to believe that harm is likely to be caused by human activity.

References

- *Trojan Horses – Persistent Organic Pollutants in India*; 2000; Srishti/Toxics Link Report.
- *Toxic Legacies, Poisoned Futures: Persistent Organic Pollutants in Asia*; Hernandez, Von, and Jayaraman, Nityanand; 1998; Greenpeace International, Amsterdam.
- *UNEP: Regionally-based assessment of Persistent Toxic Substances – Workshop reports from a Global Environmental Facility project*; 1999; UNEP Chemicals.
- *Needs Report 2002: Status Report and Needs Assessment: Stockholm Convention on Persistent Organic Pollutants (POPs) Implementation in India*; 2002; The World Bank.
- www.chem.unep.ch/
- http://archive.greenpeace.org/toxics/toxfreeasia/apops.html

Compiled and written by Papiya Sarkar

For more information, please contact:

PAPIYA SARKAR
Toxics Link
H2 Jungpura Extension
Ground Floor
New Delhi 110 014
Tel: +91-(0)11-24328006/0711
E-mail: papiya@toxicslink.org

Designed and produced by Splash! Communications, *e-mail* makeasplash@vsnl.net; Illustrations by Supriya Sahai