Toxics *Link*
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POPs

Fighting the menace of Persistent Organic Pollutants

They are found everywhere, including the most remote areas, far from any industrial activities. Though present in the environment at very low levels, they have been linked to many health and environmental effects. With the evidence of long-range transport of these substances to regions where they have never been used or produced and the consequent threats they pose to the environment of the whole globe, the international community has now, at several occasions called for urgent global actions to reduce and eliminate releases of these chemicals. They are known as POPs, or persistent organic pollutants. Of all the pollutants released into the environment every year by human activity, POPs are among the most dangerous.

POPs the twelve dirty brothers

The 12 POPs (commonly known as the dirty dozen) identified in the Stockholm Convention are – DDT, Aldrin, Dieldrin, Endrin, Chordane, Heptachlor, Mirex, Toxaphene, Hexachlorobenzene (HCB), Polychlorinated biphenyls (PCBs), Dioxins and Furans. Out of these, 9 are organochlorine pesticides. PCBs are compounds with varied industrial application, 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

For the first time, in 1997, efforts were taken undertaken on a global level to deal with the problems POPS posed under the United Nations Environmental Programme (UNEP) The first Intergovernmental Negotiating Committee (INC) for POPs held its first meeting in Montreal in June 1998, and agreed upon 12 chemicals as target for immediate action. This was followed by INCs in Nairobi, Geneva, Bonn and Johannesburg. A multilateral, internationally legally binding treaty was finally signed on 23rd May 2001 at Stockholm by 87 countries to ban POPs, and has now 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 will draw up national legislation and develop

AT A GLANCE

- **POPs are among the most dangerous of all pollutatnts released into the environment every year by humans.**
- **Among these, doxins and furans are of most concern because of their significant toxicity.**
- **POPs travel on wind and marine currents to regions far from where they were produced.**
- **Collective global action is the only way to stop the spread of POPs. The Stockholm Treaty lays guidelines to their decrease.**

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.

Sources of POPs

Sources of POPs can be classified according to 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 kinds of sources and release mechanisms.

Pesticides

Pesticides sources 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 obselete, 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

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

Toxic Pathways

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

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. The use DDT as part of the malaria program, also constitutes a non-point source.

Production

Given the fact that all POPs pesticides excepting DDT are banned for production in India, potential hotspots might exist in closed factory premises, which might still house stocks of manufactured chemicals. It is expected that the environment around such sites might also wear the scars of 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 (HIL) where DDT is manufactured[2].

Unintentional releases

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 furan releases are accompanied with PCBs and HCB releases as well.

POPs pervade the environment through a variety of media. Pesticides, though intended 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 determine and evaluate POPs' impact on the environment, human habitats and the economy.

Pesticide POPs exposure to humans 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 like 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 production, transport, storage and application. In terms of environmental management, there are

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 aluminium 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
- Smoldering of copper cables
- Waste oil refineries

Humans are at the top of the food chain. At the time of human dietary intake, POPs have bioaccumulated to significant levels

many stages in the product life cycle of pesticide POPs where care needs to be taken to prevent the contamination of the environment.

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 runoffs 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 with certain amount of POPs remaining in the water. Contamination of POPs in the fresh water systems enter the food chain through consumption of fish raised in contaminated water bodies and to a certain extent by the direct consumption or secondary consumption of 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 air dust particles with adsorbed POPs. The persistence of POPs in soil/sediments may result in their re- suspension and re-mobilization back to the atmosphere under favourable high temperature conditions through volatilization and to the surface waters through runoffs during monsoon / flood periods.[3]

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.

Environmental contamination

Residues of POPs have been measured in various environmental media like water, soil and air. Biological sampling might not always be feasible, but water, air and soil samples give a ready method to estimate the base levels of POPs in the environment.

Source: U.S. Environmental Protection Agency, 1994

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 stages of bioaccumulation to reach significant levels. This rule of primary exposure by dietary pathways is however not applicable in certain specific situations like occupational

The continuing trade of POPs even after its 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) gave some hints how to reduce individual risk of 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 byproducts.

Did you know?

◆ POPs are highly stable compounds and can circulate globally through a process known as the "grasshopper effect"[1]. 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.

◆ On entering the environment, POPs can alter the normal biochemical and physiological functions of plants and animals, including humans. Effects may include molecular changes (enzyme activity, DNA damage), cellular changes (tumour formations), tissue changes (eggshell thinning, 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 (e.g., subsistence fishermen), since fish have a high fat content and thus can contain high concentrations of POPs.

◆ Though most of the twelve 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.

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 as such are 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 populations such as pregnant mothers, and in young children.

No segment of the population is completely protected against exposure to pesticides and the potentially 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 the continued production, trade, use and release into the environment of POPs in India:

Extensive use of DDT for malaria control has lead to high levels of contamination of the environment

Continued production and trade in POP chemicals

It is interesting to note that chlordane has been imported in India subsequent to the date of its ban while aldrin, chlordane and heptachlor have been exported subsequent to the ban. The trade in POPs subsequent to its 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 isecticide.

Stockpiles of obsolete POPs pesticides

There is presence of stockpiles of obsolete POPs, but there is no known government program to monitor stockpiles though the State Pollution Control Boards have the responsibility to identify and notify sites storing hazardous material. Stockpiles poses a major problem to the environment.

Lack of awareness of handling and disposal of POPs

Such as PCBs in electrical equipment.

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 like the Asian Development Bank, and the World Bank.

After effects of past POPs-linked activities

Extensive use of DDT for malaria control has lead to high level of contamination of all quarters of the environment and high contamination in 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 it are as follows:

Elimination of all POPs sources

POPs elimination is a two-step process - source identification, followed by source elimination. Firstly the source of POPs must be properly identified- and then phased out, replaced or otherwise removed. This is true for POPs that are produced intentionally as well as unintentionally, such as dioxins.

Technological and other resource assistance

It is critical that the global POPs treaty include measures to discourage wealthy countries from promoting and exporting POP-generating technologies, processes and materials to newly industrialized nations. At the same time, measures must be included to encourage wealthy countries and aid programs to assist newly industrialized countries in developing and implementing non-POP technologies and materials.

No to Incineration

As a disposal route for existing POPs stockpiles since incineration itself has been identified as a major source of dioxins and furans. While so-called state of the art incinerators can greatly reduce stack emissions, they still cannot stop the formation of dioxins and other POPs, which may be present in the fly ash and bottom ash that would still require further treatment and disposal. Alternative destruction and detoxification 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. Recently, the Philippines and Costa Rica both banned incineration as a disposal method for municipal, medical and hazardous wastes.

Polluter pays

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

Precautionary principle

Taking preventative action when there is reason to believe that harm is likely to be

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

The rogue's gallery

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 – 0.2 mg/kg meat fat. 0.1 – 180 micrograms/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 – 0.2 mg/kg meat fat. Water quality criteria range from 0.1 – 1.8 micrograms per 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 varietyof 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 metabolized to DDD and DDE. It exhibits high bioconcentration 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 ranges from 0.02 mg/kg milk fat – 5 mg/kg meat fat. Mrl in drinking water is 1 microgram/l. It acts as a nonsystemic 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 lives of upto 12 years reported). Bioconcentration of upto 18000 ? 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 effectiveon 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 sedimentsand bioconcentratesin 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 1.5-6 micrograms/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.

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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 bioconcentrates 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 behavioral changes, reduced reproductive success and mortality. It is listed as a possible human carcinogen. The main exposure is through food. Mrl recommended by FAO/WHO are 0.006 mg/kg milk fat and 0.2 mg/kg meat or poultry fat. It acts as a nonsystemic 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 as also a fire retardant in plastics.

Persistence/Fate: Most stable with a half life of 10 years. Bioconcentration 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 behavior 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 upto 12 years. It has been shown to bioconcentrate 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.

HCB

Uses: Used for seed treatment of grain crops.

Persistence/Fate: 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.

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

Footnotes

[1] 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".

[2] Labunska 1999

[3] Interaction with Dr C Venkataraman, CESC IIT Bombay

[4] About 10 MT of chlordane is imported and 29MT exported in the year 1997-98 as mentioned in 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. There has been complete ban on manufacture, use, import and export of chlordane since 20th September 1996

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