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 Report on Persistent Organic Pollutants in Bangladesh

Environment and Social Development Organization (ESDO)

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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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I. EXECUTIVE SUMMARY

This study describes the identification and estimation of POPs along with the overall country situation on POPs in Bangladesh. The twelve POPs which are the subject of this report either arise from industries or are used in agriculture and disease vector control. Out of these nine are pesticides used on agricultural crops or for public health vector control.

By the late 1970s, all of the nine pesticides and PCBs had been either banned or subjected to severe use restrictions in Bangladesh. Current information indicates that some of these POPs, Heptachlor, Dieldrin, DDT and Chlordane, are still in use in different parts of Bangladesh where they are considered essential for ensuring agricultural production and public health concern.

It was found that there is considerable amount of information that describes the aggregate volume of POPs used in Bangladesh; however, there is very little reliable data about their specific uses. Although this lack of specific data makes it difficult to evaluate the rationale for the continued use of the nine pesticides, the available information still allows one to discuss the use patterns and barriers to adoption of alternatives in a generic fashion. The organization findings say that most, but not all, of the nine pesticides and PCBs in question are still in use or are in existence in Bangladesh. However, the actual quantity that is currently being used is unknown.

It was also found that dioxins and furans are released in Bangladesh in large amounts. Dioxins (Polychlorinated dibenzo-para-dioxins or PCDD) and furans (Polychlorinated dibenzo-furans or PCDF) are two of the twelve Persistent Organic Pollutants (POPs) being addressed in a global treaty known as the "Stockholm Convention".

The issue of PCBs is a global concern, Bangladesh being no exception. As early as 1986, tests conducted on shellfish collected from sea bed around the Bay of Bengal showed the PCBs content to be in the range of 250 -650 ppb. The amount of PCBs detected exceeded the permitted level set by the WHO (World Health Organisation) of 300 ppb. In 1999, tests conducted on water samples taken from five major rivers in Bangladesh for PCBs residue, showed that the amount was higher in the rivers that flow through industrial or densely populated areas. The amount of PCBs detected was found to be in the range of 0.9 - 3.1 milligram per litre. This exceeds the level in the Proposed Interim National Quality Standards for Bangladesh that sets a standard of 0.067 milligram per litre of PCBs in effluents.

II. COUNTRY BACKGROUND

Historical Background:

The territory constitution of Bangladesh was under Muslim rule for over five and a half centuries from 1201 to 1757 AD. The British ruled from June 20, 1757 to 1971 and

Pakistan from 1947 to December 15, 1971. Bangladesh emerged as an independent and sovereign state on December 16, 1971 following the victory in the War of Liberation, from March 25 to December 15, 1971 against the Pakistani occupation.

Geographical Location:

Bangladesh lies in the north-eastern part of South Asia between $20^0$34´ and $26^0$38' north latitude and $88^0$01´ and $92^0$41´ east longitude. The country is bounded by India on the south. The area of the country is 56,977 sq. km. The limits of the territorial waters of Bangladesh are 12 nautical miles and the area of the seas extending to 200 nautical miles measured from the base lines constitutes the economic zone of the country. The reserve forest area is 8.5% of the land area.

Climate Characteristics:

Bangladesh enjoys generally a sub-tropical monsoon climate. The average annual rainfall varies from 1429 to 4338 millimetres. In summer, the maximum temperature is 35^0 Celsius although in some places this occasionally rises up to 40^0 Celsius or more. In winter the minimum temperature ranges from 7^0-12^0 Celsius.

Occupation:

Agriculture is the main occupation of the people employing 65.5% of the labour force. This sector directly contributes around 25% to the gross domestic product.

Population:

The population of the country was 114.4 million in 2004. The urban population is 28.1 million while the rural population is 71.9 million. The incremental growth rate of population is estimated by using the adjusted population of the 1991 census which is 2.1 percent per annum. Assuming a medium variant of declining fertility and mortality the country is expected to reach a population of 129.6 million by 2026 A.D. The density of population was approximately 755 per sq. km. in 1991. It has increased to 761 per sq. km. in 2001. The sex ratio of the population is 106 males per 100 females. The literacy rate of the country was 36.4 percent in 2001 while it has now attained 52 percent. The percentage of Muslim population is 88.3 while that of Hindu, Buddhist and Christian are 10.5, 0.6 and 0.3 respectively. There are 19.9 million households in the country distributed over 59,990 mauzas (revenue villages).

Administrative Settings:

Bangladesh is governed by Parliamentary form of Government. The Prime Minister is the Chief Executive of the country. President selects him/her from the majority party leader. He/she has a council of Ministers that assists him/her in the discharge of his/her duties. For the convenience of administration, the country is divided into six administrative divisions, each placed under a Divisional Commissioner. Each division is sub divided into zillas. After the administrative re-organization carried-out in 1984, the country has been divided into 64 zillas. A Deputy Commissioner who is assisted by the other officials heads the administration of each zilla. Zilla is divided into a number of Thanas, each headed by Thana Nirbahi Officer. Currently there are 496 thanas of which 36 are in Metropolitan cities. Dhaka is the capital of Bangladesh.

Natural Resources:

Bangladesh has a few proven mineral resources. The country has enormous deposits of natural gas. Coal deposits have been found and efforts are under way to exploit them with international assistance. Electricity is produced by both thermal and hydroelectric process. The total generation of electricity amounted to 13,204 million kilowatt in 2000. Limestone, the basic raw material for the production of cement, has been found in some places and cement factories are being set up for their utilization. Other minerals that are found include hard rock, lignite, silica sand, white clay, etc. There is a possibility of oil deposit in the country and efforts are being made for its exploration. Salt is not mined but manufactured on small scale at several thousand evaporation sites in the coastal areas of Chittagong and Cox's Bazaar.

Industries:
Among the industries jute and cotton textile, pulp and paper, sugar, cement, chemicals, fertilizers and tanneries are important. Other notable industries are engineering and ship building, iron and steel including re-rolling mills, refinery, paints, colours and varnishes; electric cables and wires, electric lamps, fluorescent tube lights, other electrical goods and accessories, matches, cigarette, etc. Among the cottage industries, handlooms, carpet making, shoe making, bamboo and cane products, earthenware, brass and bell metal products, bidi, etc. are important. The industrial sector contributes about 15.40% of the GDP, which is dominated by Jute processing followed by cotton textile, cigarettes and garment industry. Total GDP growth was 5.33 (BBS, 2004)

III. WHAT ARE POPs?

As we know persistent organic pollutants (POPs) including polychlorinated dibenzo-p-dioxins, dibenzofurans, PCBs, and organochlorine insecticides are lipophilic stable contaminants. They have been detected in a wide range of environmental media and biota, and have been of great concern on their toxic effect on humans and wildlife.

By definition, POPs are likely to be more persistent, mobile, and bio-available than other substances. These properties are conferred by the structural makeup of the molecules and are often associated with greater degrees of halogenation. Included in this group of substances are some older chlorinated pesticides like DDT and the chlordanes, along with polychlorinated biphenyls, and polychlorinated dioxins and furans. The physico-chemical properties of these compounds are such that they favour sufficiently high atmospheric concentrations that result in global redistribution by evaporation and atmospheric transport.

IV. USES AND SOURCES OF POPs IN BANGLADESH

The main sources of the POPs in the country are pesticides; dye in the textile and food industries and tanneries; dioxin in the food and plastic industry, solid waste and PCBs in power generators.

POPs Pesticides
Most of the nine pesticides in question are still in use or are in existence in Bangladesh. However, the actual quantity that is currently being used is unknown. Bangladesh has not produced any other intentional POPs, other than DDT. Most of the intentional POPs were imported. Although at present all POPs import and production has been banned, at least five POPs pesticides and DDT are still in use under a different name or label. The PCB carrier (Power generator) is still allowed to be imported in the power sector.

There are no central registers or lists in Bangladesh, though some intergovernmental organizations like the Food and Agricultural Organization (FAO) and the World Bank have begun to assemble aggregate use data. Since country-specific data were not found this does not tell enough about usage to know specifically where and how much of these compounds are being used. It does show that the compounds are in fact still in use and aids in forming a general picture of use patterns.

PCBs

In Bangladesh PCBs are largely used in power and industrial sectors, especially the downstream and more delicate petrochemical products, ceramic industries, dying industries, high-end electronic components manufacturing, pesticide formulation, leather processing or in the tannery industry etc. They are also used in a wide variety of products such as in electrical equipment, (in the form of transformers and capacitors), paints, plastics, and carbonless copying paper to name a few. Since PCBs, have good insulating properties they are also used as dielectric liquids and in heat exchangers. However there has not been much concern given to the disposal of either electrical equipment or products, which are likely to contain PCBs in Bangladesh. PCB carriers (power generators) are still allowed for import in the electrical power sector.

The use of PCBs are still at large even though they are prohibited in the country as their identity is usually hidden under different names.

In Bangladesh, the disposal of solid waste (which may constitute products and equipment containing PCBs) is done almost solely through the landfill method. There are about 61 disposal sites in Bangladesh. In most cases, open dumping is not practiced and takes places at about 90% of the total landfills.

It is also a practice in Bangladesh to salvage scrap metal from equipment and household electrical products. Metals such as fabricated iron, copper, brass and lead are separated and sold to be used by other industries. In this respect, this equipment is stripped of its metal components and whatever materials do not have commercial value are thrown into the regular garbage.

Dumping Sites

Large scale dumping of municipal wastes is common in the urban regions of Bangladesh. A variety of wastes including plastics, metals, papers, woods, medical waste and raw materials are dumped in large open land areas. The major problem here is burning of wastes which generate dioxins besides other poisonous gases.

Dumping sites of municipal wastes in major cities in Bangladesh are the expected sites of secondary formation of dioxins and related compounds, because huge amounts of various wastes are dumped daily and continuously burnt under low temperature by spontaneous combustion or intentional incineration.

Also, the usage of organochlorine insecticides at these sites for public health purposes is common, because of serious hygienic problems in dumping sites.

Therefore, it is suspected that pollution sources are present in dumping sites, and many residents around there might be exposed to these contaminants

Municipal Waste

The municipal and solid waste (MSW) problem in Dhaka city is very acute in comparison to many cities in developing countries. Daily production of solid waste in Dhaka City is more than 4000 Metric Tons, of which 200 Metric Tons is hospital and clinical waste, which is a mixture of toxic chemicals, radioactive elements and pathological substances. Approximately 15 to 20 percent of medical wastes are highly dangerous for human lives. When dumped with other municipal wastes in the open land, this waste poses a serious health threat to city dwellers.

The nature of solid waste has changed over time and with urban development. Of the solid wastes, plastic and polyethylene goods also cause problems with human health, the environment and drainage system. These goods are cheaply and easily available in the markets and are not reused. An Inception Report on Control & Management of Polyethylene bags in Bangladesh show that people of Dhaka City alone use 600 million bags a day. During floods, floodwater does not drain quickly and one of the major reasons is due to polyethylene in the draining system. Polyethylene and plastic materials are not biodegradable and remain intact in the soil, disturbing the flow of nutrients to the soil and hindering the entrance of sunlight. It destroys the beneficial bacteria of soil compaction. In the long run it affects the foundation of physical infrastructure, if there is any on the plastic dumpsite.

There is no independent law in Bangladesh to address the problems of solid waste. In Bangladesh, solid waste management is entrusted to the local government bodies. The responsibility of removing MSW and disposing it lies with the City Corporation. The Dhaka City Corporation Ordinance 1983 is the only local law that gives some idea on the disposal of municipal waste. Dhaka Municipal Ordinance 1983 has a provision for the removal and disposal of refuse from all public streets, public latrines, urinal drains, and dustbins.

The National Policy for Safe Water Supply and Sanitation 1998 refers to the empowerment of setting tariffs, by-laws and other needs concerning waste management and lays emphasis on organic waste recycling such as compost and bio-gas. The policy also suggests the transfer of the collection, removal and management of solid waste to the private sector where feasible.

However, the implementation of regulations is weak and public awareness level is low. No initiative has been taken to inform people about rules and regulations. Enforcement mechanisms are slow and bureaucratic.

Table 1: Composition of Solid Waste in Residential and Industrial Areas

Component (%age by dry wt.):	Mixed waste	Industrial waste	Residential waste	Commercial waste
Food and veg. waste	70.12	26.37	59.91	62.05
Paper products	4.29	7.59	11.21	6.28
Plastic, rubber &leather	4.71	6.01	17.67	4.62
Metals	0.13	-	0.15	0.28
Glass & Ceramics	0.25	-	-	0.37
Wood	0.16	-	-	-
Garden wastes, tree trimmings, & straw	10.76	4.32	8.76	2.86
Cloths	4.57	46.20	-	18.93
Rock, dirt & Misc.	5.01	9.49	2.30	4.62
Moisture Content (per cent)	65.00		50.00	54.00

Source: GOB and World Bank, 4

Constituents (per cent by wt)	Residential waste	Commercial waste	Industrial waste	Mixed waste
Moisture	50.00	54.00	60.00	59.00
Carbon (C)	26.06	17.81	9.90	12.70
Hydrogen (H)	3.53	1.92	2.00	2.25
Nitrogen (N)	1.62	0.46	0.58	0.62
Sulfur (S)	0.01	0.02	Negligible	Negligible
Ash	18.00	22.00	25.00	22.00
Oxygen (O)	0.78	3.79	2.52	3.43
Calorific value, Btu/lb	2600.00	2254.00	1680.00	1968.00

Source: BCSIR

V. BACKGROUND INFORMATION

1. Pesticides in Bangladesh

Historical Background:

The use of POP pesticides, in fact, started in Bangladesh (the erstwhile East Pakistan) with the application of endrin in modern rice cultivation in around 1957/58. But unfortunately, no systematic record of pesticides' use particularly the initial stage of pesticide use is available. The information was collected through interactions and consultation with different personnel during this study and supplemented with those presented by Rahman (2004) on the chronological development of registration system, procurement, use, storage and distribution of pesticides in Bangladesh which is presented below.

Period 1955-73:

Deputy Director (DD), Plant Protection (PP), Directorate of Agriculture (DoA), Ministry of Agriculture (MoA), was the single authority, which, based on literature review and manufacturers' information, used to list down the pesticides for use in agriculture. There was no standardization committee as such and no registration formalities since the manufacturers' local agencies maintained liaison and promotional activities.

The pesticides were procured from abroad through supply credit, grant, loan, barter etc. provided by USAID, FAO, Danish, FRG etc. Up to 1965, Pakistan Central Plant Protection Department used to procure all pesticides, which were distributed to provincial directorate of agriculture (PP, DoA in erstwhile East Pakistan). But after 1965, BADC (the erstwhile EPADC) used to procure the pesticides based on requirement and list provided by DD, PP of DOA. Endrin was the first pesticide, 3 MT of which was received in 1955. Subsequently other pesticides were received. Meanwhile in 1971 the Pesticide Ordinance was promulgated but its actual enactment in Bangladesh was in 1985, when the Pesticide Rules, 1985 was made.

Period 1973-79:
During this period also the DD, PP of DOA remained the single authority in respect of listing and standardization of pesticides but a new system of standardization called "Score Card System" which used the efficacy trial report and information from other published literature and manufacturers.

During this period a good number of private agencies of the foreign manufacturers were involved as catalyst to the government in pesticide distribution and promotion. The Pesticide Association of Bangladesh (PAB) now named as Bangladesh Crop Protection Association (BCPA) was formed in 1975, which played an important role in catalysing the pesticide related activities including negotiation with the government for privatisation of pesticides business.

Meanwhile in April 1975, 50% subsidy was withdrawn from pesticides, and thus the pesticides were sold to the farmers at 50% of the price.

In 1979, the pesticides business was privatised, when 100% price was imposed. The respective brand of pesticide was given to the respective local agency for its import, marketing and promotion.

Period 1980–85:
During this period the pesticide Standardization Committee was responsible for standardization of pesticides based on efficacy trial report, data from literature and companies. The list of pesticides approved by the Standardization Committee was prepared based on allocations against each private company's procurements.

Period 1985 onward:
The Pesticides Rules 1985 was made by the Government in consultation with the Pesticide Technical Advisory Committee (PTAC), in exercise of the Power given to it as per Clause 29 of the Pesticide Ordinance of 1971. As per the Pesticide Rules 1985, the Director, Plant Protection Wing (PPW) of Department of Agriculture Extension (DAE) became the registration authority. In exercise of the Clause 4 and 5 of the Pesticide Ordinance of 1971, the registration of pesticides started in 1986. Since then the pesticides were registered following subsequent approval of PTAC based on the report of the sub-pesticides technical advisory committee (Sub-PTAC), which evaluates several aspects of pesticides according to the prescribed format. Thus formal registration of pesticides started from 1986. However, initially all the pesticides listed by the Standardization

Committee and procured/ imported/ marketed prior to it were registered post-facto in the name of their respective private agency/company.

Pesticide Distribution Network, Buffer Stock and Storage Godowns (warehouses):

The pesticides procured were stored in Central Stores at Shyambazar (a wholesale market located in old Dhaka) and then were distributed to the districts, where they were received by Plant Protection Inspector (PPI) of Directorate of Plant Protection (DPP) and stored in District Stores and then were distributed to thanas, where they were received by Plant Protection Assistant (PPA) and stored in Thana Stores. From Thana the pesticides were distributed to the farmers free of cost until 1975 and then at 50% subsidy up to 1979. The PPI in the previously greater districts used to maintain buffer stock of pesticides received from BADC and distribute them down to the Thana under the privatisation of pesticide trade in 1979. Even after privatisation of pesticide trade in 1979, PPI used to receive buffer stock of pesticides from the DPP till 1982. Following the mergence of DPP with DAE in 1983, Deputy Director/Assistant Director of Agriculture in the Districts used to receive and distribute buffer stock of pesticides.

Except for very few, most of the thana and district godowns of pesticides of the then PPW have been converted with renovation into thana/ upazilla/ zilla/ regional office and auditorium of the DAE.

2. Dioxin and Furans

General information

"Dioxin" is the general term for the polychlorinated dibenzo-para-dioxins and polychlorinated dibenzofurans. They are two persistent organic pollutants classified as a group of tricyclic aromatic hydrocarbons substituted with one to eight chlorine atoms. In molecular structure, a dioxin is composed by the combination of two benzene rings linked centrally with six member carbon rings containing two oxygen atoms at para position. This molecule belongs to the family of dibenzo-para-dioxins. A furan consists of two benzene rings connected centrally with five member carbon rings containing one oxygen atom. This molecule belongs to the family of dibenzo furans.

These compounds, commonly known as 'dioxins and furans', are found virtually everywhere on earth, with the main transport mechanism being atmospheric dispersion and deposition. As a concession to mainstream terminology, PCDDs and PCDFs are collectively referred to as "dioxins". They may contain between 1 and 8 chlorine atoms; dioxins have 75 possible positional isomers and furans have 135 positional isomers. The chemical properties of each of the isomers have not been elucidated; these properties vary with the number of chlorine atoms present. These two groups of planar tricyclic compounds have very similar chemical structures and properties. They travel together. **Table 1** shows the number of possible molecules that can be formed, depending on the number and arrangement of chlorines.

Table 1: Number of possible congeners of dioxins and furans

Level of chlorine substitution	Dioxins congeners	Furans congeners
Mono-	2	4
Di-	10	16
Tri-	14	28
Tetra-	22	38
Penta-	14	28
Hexa-	10	16
Hepta-	2	4
Octa-	1	1
Total congener=	75	135

Bromine, an element closely related to chlorine, can also replace hydrogen to form similar compounds. Chloro- and bromo- congeners can exist together. Both chlorinated and brominated chemicals are toxic, but the chlorinated ones are more common. Very little is known about the ruminated congeners. Among the dioxin congeners, 2, 3, 7, 8-tetrachlorodibenzo-para-dioxin is considered the most toxic congener of this family.

Properties of Dioxins and Furans

Dioxins and furans share the various characteristics of POPs, some of them being:

Persistent in the environment

Dioxins and furans are considered to be very stable and persistent. They are capable enough to persist in the environment for months and even decades, as illustrated by the half-life of TCDD in soil of 10-12 years.

Semi-volatile

They are semi-volatile and evaporate relatively slowly. They tend to enter the air, travel long distances on air currents, and then return to earth. They may repeat this process many times. However, colder the climate, lesser is their rate of evaporation which results in their accumulation in the colder-regions, thousands of kilometres away from their original sources. This means that once they are released into the environment, they represent a potential global threat.

Lipophilic

These chemicals are not readily soluble in water, but they are highly soluble in lipids (fats & Oils); hence their penetration through the cell membrane is very common.

Bioaccumulation and bio-magnification

Due to persistent characteristics of these molecules in living tissues, these chemicals show the phenomenon of bioaccumulation and bio-magnification. Dioxins and furans emitted from combustion and industrial sources, or re-entrained from environmental reservoirs, are transported to distant locations through atmospheric or aquatic pathways. These chemicals are deposited on agricultural crops, taken up in the food supply, and then bio-accumulated and bio-magnified through the food chain.

Posses Toxic effect

These chemicals are toxic, and have the potential to injure human and other organisms even at low concentrations. These substances at extraordinarily low concentrations can attach to intercellular receptor sites in the body and trigger a cascade of potentially harmful effects. These have been linked to adverse effects on human health and animals, such as cancer, damage to the nervous system, reproductive disorders, disruption of the immune system etc.

Human Exposure Routes:

Human exposure to background contamination with PCDD/PCDF is possible via several routes:

- Inhalation of air and intake of particles from air
- Ingestion of contaminated soils
- Dermal absorption
- Food consumption

Exposure also occurs in utero and during breast feeding.

Toxic Equivalent Factors:

Of the 210 dioxins and furans, 17 contribute most significantly to the toxicity of complex mixtures. These congeners have a common, receptor-mediated mechanism of action but don't have the same toxic effects. Since dioxins are always present as mixtures of different molecules and in order to facilitate a comparison mixture, each congener is given toxicity equivalence factor (TEF) based on its specific ability to elicit dioxin-like effects. The congener 2, 3, 7, 8- tetrachlorodibenzo-p-dioxin is the most toxic congener and is given a TEF of 1. Other congeners are given TEFs that are fractions of 1. TEFs are regarded as risk management tools and they do not necessarily represent actual toxicity with respect to all endpoints. The sum of the measured concentration of each congener multiplied by its TEF gives the total toxic equivalent (TEQ).

$$TEQ = \Sigma(\text{congener } n^* \text{ TEF}n)$$

Tolerable Daily Intake for Adult:

Internationally, the FAO and WHO Expert Committee on Food Additives decided to express the tolerable intake of dioxins as a monthly value, the Provisional Tolerable Monthly Intake (PTMI) is 70 pg dioxin toxic equivalent (TEQ)/kg body weight. The WHO working group concluded that 90% of the daily intake (from background contamination) results from ingestion. Especially, the daily intake of foodstuffs of animal origin is approximately 2 pg TEQ/kg bw/day. All other foodstuffs, especially, the non-fatty ones, are of minor importance in terms of PCDD/PCDF intake. The average daily intake proposed by WHO is 1-4 pg TEQ/kg bw/day **(Table 2**).

Table 2: Average of dioxin daily intake for adult proposed by different countries and Organizations

Sl No.	Countries	Tolerable Daily Intake (pg-TEQ/kg bw*/day)
1	FDA	0.06
2	WHO	1-4
3	Netherlands	2-4
4	USA	2
5	Canada	10
6	Japan	1-4

*bw = body weight

Daily Intake of Nursing Infants from Breast Milk:

Nursing infants comparatively ingest more dioxins each day than adults. A study conducted in Netherlands on nursing infants showed that nursing infants typically consume about 112-118 pg TEQ/kg body weight per day from breast milk (US-EPA, 2000), and adults typically take in only about 2.2 pg TEQ/kg/ bw/day. Thus nursing infants consume about 50 times more dioxin per day than adults do.

Accumulation of Dioxins and Furans:

In a survey of 253 subjects in Japan, the accumulation of dioxins and furans in human internal organs show that the median toxicity equivalency quantity (TEQ) per weight of fat in adipose tissue, liver, testes and in the brain was 2.0 pg-TEQ/g fat. The normal environmental regions showed a mean value of 18 pg-TEQ/g fats (234), a median value of 17 pg-TEQ/g fat, and a range of 1.3-53 pg-TEQ/g fat. The region located in the vicinity of waste incineration facilities showed a mean value of 17 pg-TEQ/a fats (19), a median value of 14 pg-TEQ/g fats and a range of 5.9-38 pg-TEQ/g fat. Thus no significant difference was detected between the region located in the vicinity of waste incineration facilities and the normal environmental regions. For reference purposes, the corresponding figures for the total of 253 subjects were a mean value of 18 pg-TEQ/g fats, a median value of 17 pg-TEQ/g fats, and a range of 1.3-53 pg-TEQ/g fats. The mean value in blood was 18 pg-TEQ/g fats.

Dioxin accumulates in breast milk because it readily dissolves in the milk's rich fat content. During nursing, about 95% of dioxins are transferred from the mother to her baby. According to WHO the mean value of dioxin accumulation worldwide is about 20 ng/kg TEQ (fat), with values ranging from 3.1 to 110 ng/kg TEQ (fat).

Brominated dioxins were at levels below the lower limit of determination in all samples analysed. The total daily intake of dioxins had a mean value of 0.88 pg-TEQ/kg body weight, the median value was 0.65 pg-TEQ/kg body weights, and the range was 0.0070-4.8 pg-TEQ/kg body weight.

Dioxin accumulated in human bodies causes various diseases. In an American survey, the concentration of TCDD in different foods and average dioxin intake is shown in **Table 3.**

Table 3: Dioxin concentrations in different foods

Food Sources	Concentration of Dioxin (pg/g)
Marine fish	500
Meat	35
Cheese	16
Milk	1.8
Ice cream	5.5
Cream	7.2
Coffee	0.1
Orange juice	0.2

As an environmental indicator of pollution the accumulation of dioxins in wildlife (fish, amphibians, birds, marine mammals, and land mammals) was studied in Japan (Ueda et al., 1999). The results show that predators higher in the food chain in the ecosystem tend to have greater accumulations of dioxins than predators lower in the food chain.

Terrestrial organisms have relatively high accumulations of PCDDs and PCDFs, while marine organisms tend to have higher accumulations of co-planar PCBs. The mean and range value of dioxin accumulation in some wildlife indicators are shown in **Table 4**.

Table 4: Dioxins accumulation in some wildlife indicators

Indicator	Mean (pg-TEQ/g fat wet weight)	Range (pg-TEQ/g fat wet weight)
Fish (carps)	1.30	0.20-5.90
Frogs	2.7	0.20-7.5
Domestic Pigeons	4.15	0.99-10
Kites	89	9.40-390
Raptors	160	66-530
Cetaceans	88	1.30-200
Deer	0.45	0.18-1.1
Dogs	3.5	0.93-10
	28	9.7-42

Source: Ueda et al., 1999

3. PCBs:

Although the PCB-containing equipment may be covered under a number of sectors, in Bangladesh the power sector constitutes the major source. In the country there are different types of power sectors that are synchronized into the national grid. There are some isolated diesel power stations at remote places and islands, which are not connected with the National Grid. Terminal voltages of different generators are 11kV and 15.75kV.

In the Eastern Zone (eastern side of river Jamuna), electricity is generated from indigenous gas and a small percentage through hydropower. In the Western Zone, only imported liquid fuel is used for generation of electricity. After the construction of gas pipeline through the Jamuna Bridge, Bagabari Power Station consisting of two gas turbines of 71,100 MW capacities and the IPP Westmont Barge mounted plant of 96 MW are running with natural gas. The fuel cost per unit generation in the Western Zone is much higher than that of the Eastern Zone as it is transferred to the western Zone through the 230 kV East-West Inter-Connector transmission line.

At present, BPDB has a total installed capacity of 3603 MW at 57 units of power plants located at different parts of the country. The main fuel used for power generation is indigenous gas. The maximum demand served during peak hours was 3500 MW in June 2003. The transmission network of PGCB is 6493 km long comprising 230 and 132/66 kV lines. The total number of grid sub-stations is 75 and the total capacity is 8682 MVA operated in 157 transformers.

According to BPDB, in June 2003, with the new addition of 108-route km (216 circuit km), the total length of 230 kV transmission line was 682.5-route km (1365 circuit km). As of the fiscal year 2002-2003, total length of 132 kV transmission line was 2635 route km and 4611 km as circuit km. By now, Comilla North to Chandpur 132 kV single circuit lines have been converted to double lines and kowkhali to Bhandaria 132 kV transmission lines have been shifted from pole to tower along with up-gradation of line capacity.

Thus the 230 KV transmission lines are located in 13 locations, 132 kV lines in 37 locations and 66 kV lines in 1 location. In addition, for the rural areas, REB has covered a progressive total of 14543 km transmission line.

The 230 KV grid sub-stations are located in 10 locations including both east zones and west zones. In the east zone 132 kV grid sub-stations are in 33 locations and in the west zone 132 kV grid sub-stations are in 29 locations. The details of the grid sub-stations are given along with the transformer capacity (MVA).

As per recent data, PGCB owns and operates the high voltage transmission network throughout Bangladesh. Salient features of PGCB's transmission are: Grid Sub-stations Capacity: 8662 MVA; Total Transformers: 1571 and Total Sub-stations: 75 (7 no. 230 kV and 63 no. 132 kV 5 no. 66 kV) 3150 MVA, 5507 MVA, 25 MVA.

BPDB is responsible for distribution of electricity in most of the areas in Bangladesh except Dhaka Metropolitan City and its adjoining areas and most of the rural areas. Responsibility of distribution in and around Dhaka Metropolitan area lies with Dhaka Electric Supply Authority (DESA) and Dhaka Electric Supply Company (DESKO) and the remaining countryside to Rural Electrification Board (REB). Presently BPDB's distribution network comprises of 33 kV, 11 kV and 11/0.4 kV lines. Total distribution line in the country is about 143000 km and the total number of consumers of different category is about 42, 61, 241 (1998-99).

Power Sector: Historical Background:

At the time of partition of India in the year 1947, power generation and distribution of power in this part of the country were in the hands of some private companies. The power supply of 17 Districts was within the township in a limited way. Power used to be supplied to most of the district during the night time only, the supply voltage was 6.6 kV, and this was the highest distribution voltage.

Power used to be generated by some industries and railway workshops too. With all these the total power generation capacity in the country was 21 MW and there was no transmission system.

The electricity directorate was created in 1948 in order to plan and develop the power supply situation of the country. Water and Power Development Authority (WAPDA) was created in 1959 and subsequently the Electricity Directorate merged with it in 1960, and started working as a statuary organization. The basic philosophy was to give more autonomy to an organization for development of the basic infrastructure. At that time, relatively higher capacity plants were built at Sidddirgonj, Chittagong and Khulna (Highest plant size was only 10MW steam turbine at Siddirgonj). At the same time Kaptai Dam was under construction under irrigation department. The unit size of Kaptai was 40 MW, which at that time, was considered to be a large power plant. Side by side, construction of the Dhaka-Chittagong 132 kV transmission line was in progress. Construction of Kaptai Dam and commissioning of Dhaka- Chittagong 32 kV transmission line in the year 1962 were the milestones of the power development. Thus before 1962, when the integrated supply started in the eastern zone of the country through commissioning of Karnafuli Hydro- power station and the 132 transmission line from Kaptai (Chittagong Hill tracts) to Siddirgong (near Dhaka),there was no integrated supply (Grid) of power.

In mid sixties, natural gas was discovered at a place named Titas and thus the generation of electricity by using local/cheap energy came up. Following this Ashugong/ Shahjibajar power stations were commissioned with capacity of 64+64 and 105 MW. As power generation increased, the possibility of transmission and subsequent distribution of electricity got momentum. From only 42 MW generations in 1960 the generation in 1970-71 reached 224 MW. Thus 2x64 MW Steam power Stations at Ashuganj and 3x14.7, 4x15 MW Gas turbine power stations at Shahji Bazar was commissioned in the year 1970. Consequently different transmission and distribution lines established during this time were 827 km, 132 km, 167 km of 66 kV, 2357 km of 33 kV, 6653 km of 11.4 kV lines.

In 1972, after the emergence of Bangladesh through a bloody war of liberation as an independent state, the Bangladesh Power Development Board (BPDB) was created as a public sector organization to boost the power sector.

During the mid-1970s the government emphasized rural electrification for achieving social progress in the country. A different approach and a new model were considered for undertaking a comprehensive scheme. Thus the government created Rural Electrification Board (REB) in October 1977. REB by this time had become a giant in power sector forming 67 Polly Biduyt Somity, 272 substations covering 35672 villages out of 68000 villages of the country.

Later in 1990 Dhaka Electric Supply Authority (DESA) was created to operate and develop a distribution system in and around Dhaka (Including the metropolitan city) and bring about improvement of customer service, collection of revenue and lessen the administrative burden of BPDB. Later on another Private company Dhaka Electric Supply Company Limited (DESCO) was given the responsibility of Mirpur area of Dhaka city sharing with DESA. It is now working with Mirpur, Gulshan, Banani, Baridhara and Uttra areas.

In 1996, power Grid Company of Bangladesh (PGCB) was formed to takeover transmission job and it started functioning from the beginning with lines handed over to it and by 31 December 2002, all the transmission lines with Grid substations were handed over to them.

The involvement of Independent Power Producer (IPP) was made effective after October 1996. The negotiations with IPPs to finalize different packages required considerable time. In spite of this BPDB finalized and signed contract with IPPs for installation of three Barge mounted power plants to meet the server power crisis. In about two years, Khulna power company limited (KPCL), the first IPP, started its commercial operation from October 1998 and started contributing 110 MW of power to the national grid. From June, 2003 all IPPs are supplying a total of 260 MW of power.

Public investments and state ownerships have been the traditional means to exercise control over the electricity sector. Government regulated the national monopoly of power supply primarily to protect the consumers' interest. The situation is fast changing. Structural changes are taking place and new corporate characters are emerging. The expansion of the infrastructure has also been justified by the need for realizing social goods relating to rural electrification and low cost electricity supply to the public.

VI. IMPORT, DISTRIBUTION, CONSUMPTION, USE AND STOCK OF POP PESTICIDES: PAST AND PRESENT STATUS

Generally pesticides come into Bangladesh through import and smuggling from the neighbouring countries.

1. Registration and Formal Import

Although the procurement of POP pesticides started long before, some of them were registered only from 1986 onward with post-facto effect of their previous uses. Thus, as per PPW source, chlordane and heptachlor were registered in 1986 and dieldrin was registered in 1987. Accordingly, their formal first import was recorded in 1987 and the import was closed in 1997 with the banning of heptachlor 40WP **(Table 1).** Surprisingly, DDT, the most commonly used POPs pesticide in Bangladesh particularly in public health was never registered.

Table 1: Data on Registration Status of POP Pesticides in Bangladesh

POP Pesticides	Year of Registration	Date of 1st Import	Year of Banning	Date of last Import
Chlordane	14-12-86	06-05-87	01-06-97	06-05-97
Dieldrin (20 EC)	21-6-87	06-05-87	4-6-97	07-05-93
Heptachlor (40 WP)	14-12-86	06-05-87	04-096-97????	07-05-97

Source: Official Register of PPW

Therefore, to speak documentarily, at present there is no legal use of any POP pesticides in Bangladesh. But some old stocks may be available as well as some might be available through other unknown source(s).

2. Stock of POP pesticides at DAE offices/stores

The information collected through questionnaire survey on pesticides lying in DAE at their different offices/stores reveal that at present there is no stock of POP pesticides at any level of DAE, although DAE stores/offices in each division, except Sylhet, contain a significant quantity of obsolete non-POP pesticides as shown in **Table 2**. Moreover, there are many containers and remnants of unidentified pesticides, some of which could be of POPs pesticides. Details of such containers and remnants including the stocks of obsolete non-POP pesticides at different levels are given below.

Table 2. *Quantity of Pesticides at DAE Offices in 2004*

Sl #	xiii. Division	POP Pesticides (Kg)	Non-POP Pesticides (Kg)
1	Dhaka	0	7605
2	Chittagong	0	2165
3	Rajshahi	0	1974
4	Khulna	0	962
5	Barisal	0	962
6	Sylhet	0	0
All		0	13668

Source: Information Collected through Questionnaire by PPW, DAE

3. Consumption of Pesticides by Type: 1998 to 2003

The trend of different types of pesticide consumption during 1998 to 2003 as may be seen in **Table 3** are increasing considerably with the consumption of a total of 18611 MT in 2003 as against only 11743 MT in 1998. The consumption in all years was the highest in case of agriculture pesticides, which include insecticides (13741 MT) followed by fungicides (3465 MT) while it was the lowest in case of rodenticides (19 MT) in 2003. But the most noticeable point is that the consumption of pesticides did not include any sale of chlorinated hydrocarbon i.e. POPs pesticides during the whole period.

Table 3: Procurement & Sales of POP pesticides and Non-POP Pesticides by Pesticide Companies during 1998 – 2003

Category	POPs Pesticides	Non-POPs Pesticides						
		Quantity (MT) in Year						
		1998	1999	2000	2001	2002	2003	Total
A. Agricultural Pesticides (AP)								
Insecticides	0	10514	12814	13753	12301	13977	13741	77100
Fungicides	0	867	1228	1648	2457	2791	3465	12456
Herbicides	0	239	315	271	839	964	1344	3972
Rodenticides	0	92	120	122	70	36	19	459
Sub-total	0	11712	14477	15794	15667	17768	18569	93987
B. Public Health Pesticides (PHP)	0	0	0	7	24	0	10	41
Total	0	11743	14503	15827	15709	17796	18611	94188

Source: (BCPA) Bangladesh Crop Protection Association, 2004

Findings from Farmers' Survey

Farmers' survey both by questionnaires and personal interview also revealed findings, which, with some exceptions, are in conformity with the Whole-sellers/Retailers Survey. According to this survey, as shown in **Table 4**, the farmers used POPs pesticides such as endrin, heptachlor, DDT, dieldrin and chlordane before 1980 and still use heptachlor, dieldrin, DDT and chlordane. Heptachlor and dieldrin were used by farmers up to 2000, when there was no sale of these pesticides by the Retailers/Whole-sellers. This raises the question of their availability although the percentage of such users is less (21%). Upon personal interview, such farmers indicated cross-boundary sources of availability of those pesticides. However, during case studies, there was no evidence of the use of POPs Pesticides.

Before 1979 as shown in **Table 4** the majority of the farmers (31.13%) used endrin followed by DDT (24.56%), heptachlor (16.17%) and dieldrin (10.77%), and these were used mostly in cultivation of rice, sugarcane, and potato respectively. But after 1980 the majority of the sample farmers used POPs pesticides such as DDT (34.69%) followed by heptachlor (21.44%), endrin (19.38), chlordane (13.26%) dieldrin (11.23%), and they used heptachlor, dieldrin, DDT and chlordane mostly for cultivation of sugarcane, rice and vegetables respectively. The figures shown in the table reveal that the numbers of farmers that use most POPs pesticides were more in the past. However, in recent years the use of DDT and heptachlor uses have increased in number.

Table 4. Use of POP pesticides before and after 1980 by sample farmers

Pesticides	Farmers (NO. & %) by Year							
	Before 1980		After 1980					
			1980-1990		1991-2000		2000-Onward All	
	No.	%	No.	%	No.	%	No.	%
Heptachlor 40 WP	27	16.17	21	21.44	27	22.68	31	24.60
DDT	41	24.56	34	34.69	37	31.10	48	38.10
Endrin	52	31.13	19	19.38	5	4.2	7	5.56
Chlordane 40 WP	29	17.37	13	13.26	19	15.97	15	11.90
Dieldrin/Aerodril 20 EC	18	10.77	11	11.23	31	26.05	25	19.84
Total Sample	167	100	98	100	119	100	126	100

4. DDT use in Bangladesh:

DDT was widely used in the western and north-eastern part of the then East Pakistan and then in Bangladesh during the Second World War. It was used to protect the troops and civilians from the spread of malaria, typhus and other vector borne diseases. After the war, DDT was widely used on a variety of agricultural crops and for the control of disease vectors as well. It is still being produced and used for vector control. Growing concern about adverse environmental effects, especially on wild birds, led to severe restrictions and bans in Bangladesh in the early 1980s. The largest agricultural use of DDT has been on cotton and fish. DDT is still used to control mosquito vectors of malaria and dry fish insect control in Bangladesh.

A. Production, Sale and Stock of DDT at DDT Plant: 1966 to 1992

Production and Sale:

The only pesticide produced in Bangladesh is DDT, which is a POPs pesticide. To meet the increasing requirements of DDT in public health, Bangladesh Chemical Industries Corporation (BCIC) established a DDT Plant at Barabkubndu in Sitakundu of Chittagong in 1966, and started DDT production. In 1982, this Plant was renamed as Chittagong Chemical Complex (CCC). The production of DDT by CCC was officially stopped on 1 December 1991 as per the decision of ECNEC meeting, but practically production was discontinued only after 1992. During this period (1966 to 1992) DDT plant/CCC produced a total of 7706 MT of DDT Technical, of which 7604.49 MT was formulated into 12003.17 MT of 75% DDT **(Table 5)**. Out of its total 75% DDT formulations, 11,793.27 MT was sold to Health Directorate for Malaria eradication program.

Table 5: Year wise Production, Sale and Stock of DDT at DDT Plant, BCIC

Year	Production of DDT Technical (MT)	Formulation of DDT Technical into 75% DDT (MT)	Sale	
			Technical (MT)	75% DDT Formulation (MT)
1966-67	180.71	-	-	-
1967-68	454.05	200.16	-	160.06
1968-69	357.26	552.69	-	546.91
1969-70	389.08	726.60	-	500.50
1970-71	314.01	508.91	-	702.04
1971-72	10.78	142.20	0.01	200.86
1972-73	188.86	116.60	-	0.06
1973-74	80.93	260.61	6.38	347.05
1974-75	93.91	161.35	-	189.55
1975-76	110.13	31.81	2.58	33.82
1976-77	115.65	270.23	9.40	213.00
1977-78	452.58	445.38	45.45	490.00
1978-79	360.15	460.44	29.55	439.40
1979-80	113.94	222.35	0.52	230.36
1980-81	751.17	1017.37	0.34	678.81
1981-82	600.85	780.46	0.51	514.11
1982-83	455.00	367.00	-	667.00
1983-84	691.00	1030.00	-	1175.00
1984-85	-	1252.00	-	1204.00
1985-86	-	808.00	-	907.29
1986-87	665.88	912.03	-	998.74
1987-88	526.14	706.33	-	714.86
1988-89	325.30	400.70	6.85	375.50
1989-90	182.18	131.10	0.10	201.40
1990-91	214.45	279.85	-	210.00
1991-92	72.53	219.00	-	92.95
1992-93	70.51	215.50	1.20	90.25
Total	7777.00	12218.67	102.89	1188.35

Source: Local market and govt. report (BCIC DDT Plant Stock book)

Stock:

As per the production and sale records, a total of 209.90 MT of 75% DDT formulation should be left in stock. But it is reported in the case study that at the time of closing this quantity of 75% DDT formulation has been completely distributed to DoH and thus there is no formulation of DDT in stock. However, 32.037 MT of Microcell/ Wassalom raw material of DDT production are in stock and stored in the godown, which could not be disposed of or sold even by auction.

B. Utility and Stock of DDT in VBDC, DoH

As communicated by the Director, Disease, DoH and prepared by the Deputy Project Manager (DPM), Malaria- Vector Borne Disease Control (Mal-VBDC) project of DoH, DDT are still supplied by the project from the DOH District Reserve Stores and Upazila Project Stores/Offices and are used in the Malaria prone areas of Bangladesh. Although the source of availability is not clear, those distributed to DOH is from DDT Plant, BCIC. According to their information, a total of 12.789 MT of DDT 75WP as shown in **Table 6** are still available as stocks in district reserve stores/upazila project offices of Mal-VBDC, DoH. From these stocks, the required amount of DDT is supplied to Malaria or Kalajar prone areas for their use against mosquito.

Table 6: Stock of DDT 75WP in different District Reserve Stores and Upazila Project Office of DoH

Sl.	District	Location of Stock of DDT	Number of Bag	Quantity (kg)	Condition
1	Rajshahi	Godagari Upazila Health Project	69.5	2979	Good
2	Madaripur	Shibchar Upazila Health Project	44	1751	Good
3	Barisal	Gouranadi Upazila Health Project	42	1428	Good
4	Pirojpur	Bhandaria Upazila Health Project	06	240	Good
5	Noakhali	Chatkhil Upazila Health Project	05	170	Good
6	Rangamati	District Reserve Store	06	300	Good
7	Chittagong	Hathazari Upazila Health Project	10	475	Obsolete
8	Kurigram	District Reserve Store	159	5406	Obsolete
		Bhurungamari Upazila Health Project	01	40	Obsolete
Total			342.5	12789	6868 Kg Good 5921 Kg Obsolete

Source: Director, Disease Control (Mal-VBDC), DOH,

5. Import, use, cumulative stock and stockpiles of POPs Pesticides

Findings from all sources of information and studies mentioned above conclude that at present there is no import of POPs pesticides but they are still in use in Bangladesh. Many sources have mentioned that the apprehension of illegal trans-boundary entry of any POPs pesticide is a common phenomenon. Even the case studies revealed some old stocks of some POPs pesticides at different places. Cumulatively as shown in **Table 7**, a total of 548.05 MT of POPs pesticides comprising dieldrin 7,150 Lbs, heptachlor 977 Lbs, DDT 75% WP (local) 12.789 MT, DDT 75WP (imported) 500 MT, DDT 5 kg, and another 32.037 MT microcell/ Wassalom Raw materials for DDT production were left over as stock in different government godowns (warehouses) and under private traders of the country.

According to the government sources the physical verification of the godowns, and information on actual condition reveals that a total of 548.516 MT of POPs pesticides comprising DDT 75% WP (local) 12.794 MT, DDT 75 WP (imported) 482.90MT, and another 32.037 MT Microcell/ Wassalom raw materials for DDT production still exist in the stores/ godowns. Out of the actual total stock, only 6.868 MT of DDT 75WP was found in good condition in DoH district/ upazila stores, rest 488.826 MT POP pesticides were found obsolete along with some other unidentified remnants of pesticides in different stores as mentioned in **Table 7**. General information reveals that the total POP pesticides' stock and availability figures are higher in the private sector than the government.

Table: 7. Cumulative stock of POPs pesticides and their present conditions

Name of the Pesticides	Quantity in Stock as per Govt. Stock Book	Quantity physically found in stock	Quantity in Stock as per local traders & farmers opinion	Location	Reasons for reduction in Stock	Year of procurement
Heptachlor 40WP	977 Lbs (0.4430MT)	Nil	More then 1500 Lbs 0.680 MT	PP Stores at district and thana	Destroyed/ Buried	10.1.72 to 24.4.80
Dieldrin 20E	7150 Lbs (3.242 MT)		8200 Lbs 3.718	PP Stores at district and thana	Destroyed/ Buried	10.1.72 to 30.6.80
DDT formulation (local)	5 kg (0.005MT)	5 kg (0.005MT)	More then 50 Kg 0.045	PP Store, Chhagalniy, Feni		Seized from one dealer in 1987
DDT 75WP (local)	12.789 MT	12.789 MT	45.5 MT	District & Upazilla Stores of DoH	6.868 MT good 5.921 MT Obsolete	1962 to 1992
DDT 75 WP (imported)	500 MT	482.90 MT	More then 2500 MT	4 MSD godowns, DoH, Chittagong	Lost, All Obsolete	1984
Microeocell/ Wassalom DDT Raw material	32.037 MT	32.037 MT	No idea	DDT plant, BCIC	All obsolete	
Total (including Microcell)	548.516 MT	527.731 MT	2549.943			1985-2001
Total POP Pesticides (excluding Microcell)	548.05 MT	527.71 MT	2504.43		490.176 MT Obsolete 6.868 MT good+ some unidentified remnants	

Sources of Dioxins:

Dioxins sources are subdivided into two groups:

- Industrial-chemical processes and thermal processes
- Reservoirs

I a. Industrial-chemical processes:

During the production of some chlorinated aromatic molecules, called precursors, or during their combustion dioxins and furans are formed.

In fact, under temperatures between 200^0C and 500^0C, and in oxidant conditions, the precursors undergo some molecular rearrangements inducing the production of dioxins and furans. In wet-chemical processes, during the synthesis of chemical compounds the propensity to generate PCDD/ PCDF decreases in the following order:

Chlorophenols > Chlorobenzene > Aliphatic chlorinated compounds > inorganic chemical compounds

The favourable factors for the formation of PCDD/PCDF are:

- Presence of chlorine
- Low temperature
- Alkaline media
- Presence of UV light
- Presence of radicals in the reaction mixture.

A very good example of this is what happened in Seveso-Italy in 1976, during the synthesis of a defoliant phenoxy-herbicide. The optimal temperature for the reaction is 125^0C, if it exceeds this limit; a very exothermic reaction will occur, leading to the formation of tetrachlorodibenzodioxin which is known to be very toxic. The exothermicity of the reaction had induced the explosion of the reactor and the spread of dioxin. Though no significant acute human health hazards occurred immediately after the accident, yet the rate of cancer increased among the people who were exposed to dioxin for a long time.

1 b Thermal processes:

Thermal processes constitute an important source of dioxin emissions these days. For example, incineration is a process of emission that depends on the process used.

During combustion the chemical bonds of original molecules breakdown which destroys the molecules and produce carbonic gas, water vapour, hydrochloric acid etc., at the beginning of the PCDD/PCDF formation process.

During incineration the combustion is not complete. In complete combustion the material is totally transformed into CO_2 and H_2O, etc. In incomplete combustion the burning material is not totally transformed into CO_2 and H_2O and therefore the chemical composition of the gases is very complex. It contains molecules, atoms, radicals, etc.

No doubt, dioxins can be reformed through the reaction with different elements such as carbon, oxygen, hydrogen and chlorine present as atoms or radicals. The destruction and reformation of dioxins are illustrated in the following chemical equilibrium:

$$12C + (10-n)\,H + 2O + n\,Cl <=> C_{12}H(10-n)O_2Cl_n$$

PCDD/PCDF is formed when substances containing chlorine are burnt with carbon in the presence of oxygen with a convenient catalyst such as copper at temperature exceeding 300^0C.

Preferably the formation of PCDD/PCDF takes place in the zone where the combustion gases are cooled from 450^0C to 250^0C.

2 Reservoir Sources

Dioxin reservoirs are those matrices where PCDD/PCDF is already present, either in the environment or as products. The PCDD/PCDF found in these reservoirs are not newly generated but concentrated from other sources. A characteristic of reservoir sources is that they have the potential to allow re-entrainment of PCDD/PCDF into the environment. Potential release routes of PCDD/PCDF as a by-product into the three environmental media air, water and land and/or to product and waste.

Release of PCDD/PCDF:

Releases of PCDD/PCDF into the atmosphere occur either from stationary sources, which are mostly associated with industrial activities such as production and manufacturing or from diffused or dispersed sources, which are mostly related to the use and application of CDD/PCDF containing products. PCDD/PCDF emitted from either of these two source categories can undergo long-range transport and thus, PCDD/PCDF can be detected in air at location far from the origin of its release.

Examples of processes releasing PCDD/PCDF into air include off-gases from:

- Combustion processes
- Metal processing operations, e.g. sintering metal smelters, etc.
- Drying and baking operations, smoke houses, *etc.*
- Other thermal processes e.g. pyrolysis, ash recycling, cracking, *etc.*

Four conditions, present either individually or in combination, that potentially causes the generation of PCDD/PCDF releases to the air:

- High temperatures (above 200^0 C) processes and/or incomplete combustion
- Organic carbon
- Elemental chlorine
- PCDD/PCDF containing products

Actual dioxin formation potential and actual release depends on the presence of chlorine, process conditions, and air pollution controls applied; technologies have been developed to help reduce formation of PCDD/PCDF and to control emissions to very low levels for many processes, however caution must be exercised to ensure that emissions are not simply shifted to other media.

Release to water:

PCDD/PCDF releases to water can occur with the discharge of wastewater, run-off from contaminated sites or application of dioxin contaminated chemicals/ products, e.g. direct application of pesticides, dumping of wastes, etc. PCDD/PCDF may be present in a discharge if the PCDD/PCDF formed in the industrial production process, enters the industrial process with the feed material, or leached from a repository. Consequently, the criteria used to identify potential releases of PCDD/PCDF to water include:

- Wastewater discharge from processes involving chlorine and/or PCDD/PCDF contaminated products or combustion, incineration and other thermal processes where wet scrubbers are used to clean fuel gases; use of PCDD/PCDF contaminated pesticides (especially PCB) and
- Leachate from storage and/ or disposal sites of PCDD/PCDF contaminated materials.

Release to land:

Sources releasing PCDD/PCDF to land can be divided into two classes: PCDD/PCDF contaminated product "applied" to land directly or PCDD/PCDF deposited into land via environmental processes. In all cases, land serves as a sink for the PCDD/PCDF from which they can be released into the food chain through intake by plants and/or/ animals.

Release to products:

Major sources of environmental contamination with PCDD/PCDF in the past were due to production and use of chlorinated organic chemicals; there are four factors, which favour the formation of PCDD/PCDF:

- Presence of chlorine
- Elevated temperatures
- Alkaline media
- Presence of UV-light
- Presence of radicals in the reaction mixture/chemical process.

The highest concentrations of PCDD/PCDF have been found in chlorinated phenols and their derivates. Waste and residues from production are also contaminated with PCDD/PCDF. PCDD/PCDF reduction comes from modification of the problematic step of the production process. Reduction of releases can also be accomplished by restrictions on the use of a chemical, by substitution or bans in some cases. This type of source control of the PCDD/PCDF in the products life cycle includes consumer waste. Effective control of the PCDD/PCDF source to product leads to benefits in several other environmental compartments and media at the same time.

Release in residues:

An infinite number of processes can transfer PCDD/PCDF to wastes or residues. However, the most likely type of waste can be classified according to their origin, since PCDD/PCDF is always a by-product.

PCDD/PCDFs are persistent and are widely dispersed in the environment. Low concentrations of PCDD/PCDF are contained in normal municipal solid waste as well as industrial, hospital and other solid waste streams collected in normal every day activities.

These include consumer products such as plastics, paper, cloth, household chemicals and food and especially products used in industry such as solvents, oils, and paints.

PCDD/PCDFs are concentrated in solid waste streams from combustion and thermal industrial processes such as fly ash, bottom ash, and other dust. Particulate matter from combustion and thermal industrial processes contain unburned carbon which is absorbed by PCDD/PCDF. Fine fly ashes and dusts collected from thermal processes contain by-product PCDD/PCDF in a concentrated form.

Higher conservations of PCDD/PCDF in the solid residue can be achieved in low combustion process control and high particle removal efficiency of the air pollution control (APC) system. Moreover, chemical production involving elemental chlorine leads to wastes containing PCDD/PCDF. Obviously, effluents from the pulp and papermaking as well as municipal sewage waters are PCDD/PCDF contaminated waste streams.

The potential for residues to cause environmental contamination or exposure to PCDD/PCDF depends greatly on how the residue is treated and disposed.

Sources of dioxins and furans in Bangladesh

The sources of dioxins and furans in Bangladesh are: manufacturing processes of chemicals, production processes of ceramic, plastics, paper, asphalt mixing, glass, brick, lime, lead, aluminium, zinc, iron, and steel, etc. and hazardous hospital wastes and municipal wastes / domestic waste burning, biomass burning, tobacco smoking, wood combustion, landfill burning, open water dumping, waste oil disposal, and vehicle fuel combustion.

Sources of PCBs

General:

The term polychlorinated biphenyls, or PCBs, refers to a class of synthetic organic chemicals that are, to a large degree, chemically inert. PCBs have been widely used in a multitude of applications, many of which are still in use, including dielectric fluids in electrical equipment, heat-transformer fluids in mechanical operations, plasticizers, lubricants, inks and surface coating. They are used where chemical stability has been required for safety, operation, or durability. In Bangladesh, large quantities of PCB-containing electrical equipment are still in service. Besides, a large number of old ships are broken in Bangladesh, which also contain PCBs.

Power sector:

It is very difficult to have an exact estimate of PCBs used in electrical equipment in Bangladesh. But since the PCB production or use in electrical transformers have been either stopped or restricted in the electrical transformers manufacturing countries in 1980, the electrical equipment and transformers imported before 1980 must contain PCBs. Thus the particulars including the number, size, capacity, manufacturers, country of origin, time of installation etc. of electrical equipment such as transformers, capacitors etc. may be available, which would give an estimate of the PCBs presence in Bangladesh. But the information on the PCBs or the oils containing PCBs imported directly for retro-filling or fresh use in other cases is not exactly available. However, according to BPDB Deputy Director Purchase, BPDB procures 2 lakh barrels of transformer oil every year (200,000).

Ships:

There are about 70 ship-breaking yards located in the beaches of the Bay of Bengal under Sitakundu Police Station of Chittagong and 8-10 kilometres from the Chittagong city. At present 32 ship-recycling yards are operating on regular basis and at a large scale. On an average 50-60 ships are recycled annually in those yards. The principal materials of a ship (e.g. steel, aluminium) are not an overriding concern from the standpoint of human health or marine pollution. However, old ships contain many other toxic substances. There are a number of potential sources of concern that PCBs are contained in wiring insulation, electrical equipment (e.g. transformers, batteries and accumulators), heat exchangers, plastic covering of electrical cabling installed before 1975 etc. The PCB contents of the ships thus are spilled-over to the environment as well as the PCB contaminated articles of the broken ships are left to the environment, which are likely to cause serious pollution. But it is very difficult to estimate the quality of PCBs that are adding to the Bangladesh environment every year.

Preliminary assessment of POP pesticides related human and Environmental Risks

Scientific Evidence of POP Pesticides in Environmental Samples

The process of POP pesticides in environmental samples particularly in human milk, fish and water has been reported in many countries in the world. Thus in cognisance with the scope of inventory preparation, efforts were planned to have a preliminary assessment of POPs pesticides related human and environmental risks. But due to various limitations particularly due to constraints in terms of time, facilities and budget for sample analysis for the presence of POPs pesticide reduces in various samples collected at the time of the study could not be reported. Moreover, such studies in Bangladesh are very scanty, although some popular articles published in different dailies indicated hints on the possible hazards from contamination of food items and agricultural commodities. However, the information on this aspect as revealed through a review of available literatures and scientific publications are presented in the following section.

Human milk samples:

No study is reported in relation to the assessment of POPs pesticides in human milk samples in Bangladesh. However, it is suspected that since POP pesticides particularly DDT, chordane and heptachlor have been used for long time in Bangladesh, and both rural and urban women have been exposed to it, the milk samples of such exposed women are very likely to contain residues of these pesticides.

Fish Samples:

In Bangladesh both fresh water fish and sea fish are locally available and consumed by the people of Bangladesh. Although it is apprehended that those fish may contain POP pesticides residues, no comprehensive study has been conducted so far in this regard. However, very limited studies have been reported in some floodplain fish species and dried fish. Such studies reveal that the levels of total DDT (including DDE and DDD) was 0.025 mg/kg and 0.0171 mg/kg while those of dieldrin within the Codex Maximum Residue Limits (MRLs of 0.3 mg/kg) were found in the most contaminated fish (Matin et. al. 1996).

Water Samples:

Bangladesh is an intensively rice-growing area. Rice is grown in both rain-fed and irrigated habitats. Most of the pesticides are used in rice cultivation. Thus rice fields receive the highest amount of pesticides, and the water in rice fields as well as lakes and rivers, which receive run-off water, are apprehended to contain pesticides residues. But no comprehensive study has been so far conducted in this regard too. However, review of some sporadic studies conducted revealed that water of Meghna Dhonagoda Irrigation Project contained organochlorine at concentrations of 1.82, 1.91, and 2.39 ng/ml of water while the water samples from some other locations of the same habitat contained residues of DDT, DDE, aldrin, dieldrin, endrin and heptachlor at concentrations ranging from 0.20 to 6.75 ng/ml (Alam et al. 1999).

Damage caused by POPs

The impact of Dioxins and Furans on Human health and environment:

a. Impacts on human health:

The impact of dioxins and furans on human beings and ecosystems has become a matter of public concern in recent year.

a. Extremely minute quantities of dioxins and furans may have an impact on human health
b. Effects may be passed on to the next generation through the mothers body
c. Dioxins may cause lower sperm counts and other reproductive abnormalities.
d. Immune system becomes weaker
e. Causes tumours and cancer

Dioxins bio-accumulate in the body, which may affect the development of the human foetus/embryo, and cause impairment of the immune system, male reproductive system (for example reduced sperm count) and endometriosis in women over time.

The best-known and most toxic dioxin congener is 2, 3, 7, 8-tetrachlorodibenzo-*p*-dioxin, commonly referred to as TCDD. The toxicity possessed by TCDD is derived from the chemical's ability to bind very efficiently with a particular type of receptor protein inside the cytoplasm of some cells within the body. This is known as the Ah, or dioxin, receptor (Buckland et al., 2000). The resulting TCDD-receptor complex can enter the cell's nucleus and bind with its DNA, thereby disrupting the cell's mechanism for producing proteins. The wide and rather puzzling array of toxic effects induced in animals by TCDD and structurally related compounds are apparently all receptor-mediated responses to these chemicals. It appears to be the differing ability of individual congeners to bind with the Ah receptor that determines their toxic effect. The most noticeable effect of acute exposure to TCDD in humans is chloracne, although epidemiological observations suggest an increased risk of soft-tissue sarcoma and non-Hodgkin's lymphoma. Symptoms including nausea, eye and respiratory tract irritations, dehydration, weight loss and cyanosis have been reported, along with altered function of the neuromuscular system, liver, kidneys and pancreas.

Chloracne generally takes the form of dermal lesions and in severs cases, pustules on the face and shoulders (US.EPA, 2000). Toxicologist initially concluded that TCDD was one of the most toxic of all man-made substances and recommended that soil levels in excess of one part per billion would constitute an unacceptable health risk to humans. This is the extrapolation of animal data to humans based on the effects of very high doses of TCDD on test animals, led to dioxins and furans being labelled as 'the most toxic chemical known to man' (Ueda, 1999). Exposure to dioxins has been implicated in a wide range of human health effects related to reproduction, immune function, growth and development, and cancer. Dioxin has strongly been related to cancer. The acute toxicity of dioxin has not been seen frequently but it has a long-term effect on human health. The long time exposure of 1 ng dioxin/kg body weight potentially causes cancer.

Maternal body burdens of these chemicals are transferred through the placenta to the developing foetus and through breast milk to the infant, and can cause injury at vulnerable stages of development that may not be diagnosed until the infant reaches puberty or adulthood.

People are affected largely through consumption of large amounts of wild food especially carnivorous fish, marine mammals and other tertiary consumers. These chemicals travel long distances through air currents, contaminating pastures where livestock graze.

b. Impacts on environment:

These chemicals cause adverse effects to wildlife. These chemicals move through the food chain to humans. Various studies conducted on laboratory animals have concluded that dioxins are highly toxic to certain species of animals at very low level of exposure (EC, 1999). Observations included teratogenic effects (malformations of the foetus), liver-damage, decreased reproduction and growth rates, cancer promotion and behavioural changes.

Dioxins are found everywhere in the world – in water, air, soil, and sediment – even in places where dioxin or dioxin-containing products have never been used. After the release of these chemicals into the environment, they travel in multiple cycles of evaporation, transport by air and condensation; this is called the grasshopper effect. This process allows these chemicals to travel great distances quickly. In the cold climate the evaporation rates of these chemicals are low and a large quantity enters into the food chain. In Canada, the level of these chemicals is higher.

Bio – transformation:

These chemicals are soluble in blood fat and attain their saturation rapidly. It is also reabsorbed by the kidney. As a consequence of saturation, these chemicals accumulate in the fatty tissues and thus are able to cause chronic poisoning.

When a pregnant woman is exposed, these chemicals cross the placental barrier and affect the foetus. Newborns are affected more by breast-feeding.

Laws Currently Regulating POPs

LAW MAKING:

The constitution provides for a unicameral legislature, which is called Jatiyo Sangsad (JS). It consists of 300 members directly elected by adult franchise. The members of parliament elect another 30 female members. The JS is the national parliament and is vested with all powers under the constitution to make laws for the country. Any rule passed by any ministry must be vetted by the Ministry of Law and Justice.

RELEVANT POLICIES AND REGULATIONS

ENVIRONMENT SECTOR:

The Bangladesh Environment conservation Act, 1995 and the Bangladesh Environment Conservation Rules, 1997

The Bangladesh Environment Conservation Act, 1995 originally published in Bangla in the Bangladesh Gazette, in regard to the extra-ordinary issue of 16-2-1995 and amended by Act Nos. 12 of 2000 and 9 of 2002, followed by the Bangladesh Environment Conservation Rules, 1997 was made for the conservation of the environment, improvement of environment standards and control and mitigation of environmental pollution. Although all the provisions are important in the context of environment conservation, the most relevant ones of the Act worth mentioning in regard to POPs are section 2 Definitions of "environment", "environment pollutant", "hazardous substances", "pollution" which are definitely applicable to POPs because of their similar nature and characteristics; section 6A (6K), which with the caption "Restrictions on manufacture, sale etc., if articles injurious to environment" states that… or any other article is injurious to the environment, the Government may, by notification in the official gazette, issue a direction imposing absolute ban on the manufacture, import, marketing, sale, demonstration for sale, stock, distribution, commercial carriage or commercial use, or allow the operation or management of such activities under conditions specified in the notification, and every person shall be bound to comply with such direction, empowers Director General of DOE to take necessary actions for putting ban on such substances or activities related to POPs or their emissions. However, slight shortfall, which may be taken care of is to specify the names of POPs substances and, where applicable their threshold levels, as hazardous. For this only a technical guideline prepared by the experts and subsequently included in the approved National Implementation Plan of POPs should be sufficient.

The Environment Court Act, 2000 (Act No. 11 of 2000):

The Environment Court Act. 2000 (Act No. 11 of 2000) published in the Bangladesh Gazette, in regard to the extra-ordinary issue of 10-4-2000 and amended by Act No. 10 of 2000 is an Act to provide for the establishment of environment courts and matters incidental thereto. Where as it is expedient and necessary to provide for the establishment of Environment Courts for the trial of offences relating to environmental pollution and matters incidental thereto; enforces that any violation of environmental law, which means as per section 2 of the Environment Court act, 2000 this Act, the Bangladesh Environment Conservation Act, 1995 (Act no. 1 of 1995), any other law specified by the Government in the official Gazette, for the purposes of this Act, and the rules made under these laws. Section 3 of this Act states that "Notwithstanding anything contained to the contrary in any other law for the time being in force, the provisions of this Act shall have effect". Therefore, for prosecuting any legal action against violation of any provisions already existing in the relevant Acts, Rules, Ordinance related to POPs, the Environment Court Act 2000 might be quite adequate in its content.

NGO and POPs

In Bangladesh so far ESDO (Environment and Social Development Organization) is the single NGO involved in the POPs activities. Under the International POPs Elimination Project of IPEN (International POPs Elimination Network), a few more NGOs have started working on POPs issues. Their capacities however are limited.

Efforts to deal with POPs

ESDO at their level and within their capacity has been taking up awareness activities on POPs in Bangladesh since 2003. Similar efforts have been taken up by others as well. These efforts are however negligible as compared to the magnitude of the problem in the country.

The government although has a positive attitude towards addressing the issue but they lack in manpower, skills and technical knowledge required for the same.

Other sectors have not contributed much. The corporate sector is still not aware of POPs issues.

The efforts have been stunted owing to lack of monitoring mechanisms within the country.

State of Stockholm Convention Ratification and the National Implementation Plan

The Government of Bangladesh signed the Stockholm Convention on POPs on 23 May 2001. As a signatory of the Convention, the Government is required to take action to generate general awareness of consequences of POPs releases and ultimate elimination.

The government has taken up the initiative to prepare the National Implementation Plan. In preparation for the same, government has completed the National Inventory on POPs. Department of Environment (DoE) of Ministry of Environment and Forest (MoEF) is the concerned authority to prepare the national implementation plan.

Public awareness Activities

Other than the inventory on POPs, DoE has not taken up any further activities with regard to POPs awareness.

There is no government initiated POPs public awareness campaign. Whatever little awareness has been created is due to the effort of civil society organizations.

Recommendation on eliminating POPs

1. To recommend to the Government to ratify the Stockholm Convention on POPs and implement its various provisions.
2. To recommend to the Government to develop a national strategy and action plan aimed at eliminating POPs.
3. To recommend to the Governments to strengthen inter departmental cooperation to effectively deal with the issue of POPs.
4. To develop an information exchange mechanism.
5. To establish and/or strengthen the analytical control.
6. To develop mechanisms to monitor POPs sources and their movements,
7. To establish national registers of POPs discharges.
8. Take measures to study technologies and promote introduction (transfer) of new technologies/ alternatives to minimize and eliminate POPs.
9. To draw attention of the international community towards specific issues concerning POPs in the developing countries with the aim of securing financial and technical assistance to solve the problem.
10. To seek intergovernmental cooperation within the region for effective monitoring and action.
11. To initiate comprehensive mass awareness campaign on POPs
12. To establish inter-sectoral (Government –NGO-Corporate and Private sectors) partnership to deal with the issue.
13. Need of financial and technical support to encourage action research activities.

Recommendations on inventories

1. Need to generate and compile the POPs information comprehensively
2. Identify the origin and transfer of POPs through global pathway

3. Establish information exchange network on POPs at regional and international levels.
4. Conduct necessary assessment of POPs with the aim of the developing strategy and introducing mechanisms to reduce and/or eliminate POPs discharges, spills and wastes.

Alternatives to POPs

A variety of chemical and non-chemical alternatives are available for POPs in Bangladesh. However their usage is not uniform throughout the country. Integrated pest management (IPM) systems, introduced by Bangladesh Agricultural Research Council in early 1980s, are being used in some parts and rely on the judicious use of newer and pest specific pesticides and biological control methods. In these areas there exists a well-developed distribution network for both pest control technologies and information. However in other parts, especially where there are fewer producers operating smaller farms, the use of older compounds, including some POPs, is common. This is largely on account of:

- Common social attitudes that foster the continued use of older products;
- Poor dissemination of both alternatives and information;
- Relative high degree of illiteracy that constrains the dissemination of any information; and
- Other production related factors that limit the practical adoption of alternatives.