Guidance for POP pesticides

1. Background on POP pesticides

POPs Pesticides originate almost entirely from anthropogenic sources and are associated largely with the manufacture, use and disposition of certain organic chemicals. Of the initial 12 POPs chemicals, eight are POPs pesticide. In the new POP list, five chemicals may be categorised as pesticides. These are alpha hexachlorocyclohexane (alpha-HCH), beta hexachlorocyclohexane (beta-HCH), Chlordecone, Lindane (gamma, 1,2,3,4,5,6-hexaclorocyclohexane) and Pentachlorobenzene.

This module addresses baseline data gathering and assessment of POPs pesticides. Particular care is required to address DDT due to its use for vector control and Lindane due to its use for control of ecto-parasites in veterinary and human application, which may be under the responsibility of authorities other than those responsible for primarily agricultural chemicals. In addition, it is important that all uses of HCB, alpha hexachorocyclohexane, beta hexachlorocyclohexane and pentachlorobenzene (industrial as well as pesticide) be properly addressed. Specialists with knowledge of each of these areas might be included in the task teams.

2. Objective

To review and summarize the production, use, import and export of the chemicals listed in Annex A and Annex B of the Convention (excluding other chemicals listed under Annex A and B which are not considered as pesticides).

To gather information on stockpiles and wastes containing, or thought to contain, POPs pesticides.

To assess the legal and institutional framework for control of the production, use, import, export and disposal of the chemicals listed in Annex A and Annex B (excluding other chemicals which are not classed as pesticides) of the Convention.

To identify gaps in information required to complete the assessment.

To identify whether the current situation meets the requirements of the Stockholm Convention and detail areas where it does not.

3. The obligations for Pesticides in the Stockholm Convention

At its fourth meeting in 2009, the Conference of Parties (COP) took decision to amend Annexes A,B and C of the Convention by adding 9 chemicals viz. alpha hexachlorocyclohexane (alpha-HCH), beta hexachlorocyclohexane (beta-HCH), Chlordecone, Hexabromobiphenyl, Hexabromodiphenyl ether and heptabromodiphenyl ether, Lindane (gamma, 1,2,3,4,5,6-hexaclorocyclohexane), Pentachlorobenzene, Perfluorooctane sulfonate (PFOS) and Tetrabromodiphenyl ether and pentabromodiphenyl ether. All chemicals except Perfluorooctane sulfonate (PFOS) has been kept under Annex A. Hence all pesticide chemicals under Annex A have not been given any specific exemption/acceptable purposes for production and use except lindane where it is allowed to be used in human health pharmaceutical for control of head lice and scabies as second line treatment.

On list these pesticides in the Convention, Parties are obliged to:

- Implement control measures for each chemical (Article 3 and 4);
- Develop and implement action plans for unintentionally produced chemicals (Article 5);
- Develop inventories of the chemicals' stockpiles (Article 6);
- Review and update the National Implementation Plan (Article 7);
- Include the new chemicals in the reporting (Article 15);
- Include the new chemicals in the programme for the effectiveness evaluation (Article 16).

4. Outcome

Report detailing knowledge on historical and current production, import, export, use, stockpiles and waste disposal for POP pesticides

Assessment of the legal, institutional, regulatory and enforcement systems for POP pesticides

Assessment of the data gaps and deficiencies in the knowledge on POP pesticides

5. Primary responsibility

It is likely that a focused task team would be assigned the responsibility to carry out this assessment. This team would report back to the PCU as agreed.

The task team for this assignment should be made up of people in the country responsible for work on pesticides and in particular any initiative to address the process of moving from a chemical-based approach to a more integrated pest management system and also any initiatives to improve chemicals management, licensing, control, use and waste disposal.

It is particularly important that officials with responsibility for public health and vector control be included in the assessment of DDT. It is also important that links be made between the authorities responsible for vector control and those responsible for agricultural use of pesticides since DDT can become a valuable commodity for the agricultural sector and unauthorized "leakage" might occur from authorized use for vector control to other areas.

Similarly, it is important that officials with responsibility for public health and veterinary control be included in the assessment Lindane. It is also important that efforts be made to move away from Lindane based approach to a more integrated pest management focused initiative. Emphasis to be placed on the management of Lindane stocks due to potential leakage into the agricultural sector. Special note needs to be taken with respect to the alpha and beta isomers of hexachlorocyclohexane related to the identification of sites where it was produced during Lindane production. The reader is directed to the special guidance note for hexachlorocyclohexane. Information on lindane including its Production, trade, stockpiles, Uses, Status of the chemical under international conventions, POPs characteristics, rreleases to the environment, exposure, hazard assessment for endpoints of concern, clean up and alternatives is annexed to this document.

Experience from on-going programmes in identifying and dealing with obsolete stocks of pesticides should be used and built upon where possible.

6. Tasks

Establish a mechanism for making the assessment on POPs pesticides, develop a plan for the process to assign responsibilities and set time lines.

Review and summarize the existing legal and institutional framework that covers production, import, export, use, licensing, storage, handling and disposal of pesticides, formulated products, containers and residuals. Compare the legal framework to the requirements of the Stockholm Convention. Compare the existing system against the requirements of the Stockholm Convention and identify any deficiencies in policy, implementation and enforcement.

Carry out a preliminary inventory:

- For each chemical, summarize information, to the extent possible, on production, import, export, uses in the country, presence in stockpiles and data on wastes. Special attention related to the alpha and beta isomers of hexachlorocyclohexane (see above).

- It is valuable to record the availability of data and effectiveness of relevant information systems and to make some assessment of the reliability and quality of the data. This can help to identify and classify gaps and needs for additional data gathering and generation.

- The resulting information should show for each chemical whether it is now or was previously produced, imported, exported and formulated in the country, and if so, where and in what quantities. It should also reveal any past or current uses and the characteristics of the use (i.e., the scale and nature of the operation – individual farmers, pattern of use for vector control, etc.), conditions of storage and handling for stockpiles and stores and known or suspected presence in wastes or abandoned stores.

7. Elements in the inventory

Inventory means a list compiled for some formal purpose. The preparation of an inventory of POP pesticides stocks is the first step to address and assess the problem of stocks of pesticides, its associated contaminated materials and their management.

Scope of inventory

The reliable inventory would cover information and data on production, import, export, stockpiles of the POPs pesticides. Therefore, a reliable inventory provides a firm basis for:

i. prioritizing pesticides sites according to the level of risk that they pose to public health and
ii. the environment;
iii. planning safeguarding activities;
iv. identifying the manufacturers, suppliers and donors of obsolete pesticides who may be
v. willing to provide resources for their disposal and remediation;
vi. planning campaigns for the private sector to surrender obsolete stocks;
vii. planning the subsequent disposal of obsolete stocks;
viii. planning the remediation of contaminated sites;
ix. developing a programme to avoid the reoccurrence of obsolete pesticides.

Methodologies of data/information collection

The stakeholders involve in the process of collecting information and making of inventory must be clear about the methodologies of the information collection. A thorough discussion amongst stakeholders are required to work out what exactly would be covered under the inventory.

Different methodologies could be applied in collecting information/data on pesticides. Each one has its merits and demerits. The following are some of the methods used in the data collections:

- Desk research/literature survey of existing information;
- Meetings and interviews;
- Survey through questionnaire through :
    - sending letters by post
    - telephone
    - e-mails
    - supply chain
    - NGO

- Statistical methods.
- Site inspection for stock checking and data collection

To initiate an inventory process, literature survey through desk research is the first step. The information could be sources from reports of surveys and inventories undertaken previously;

- reports of ministry officials on routine inspections of pesticide stores;
- storekeepers' records – records of purchases;
- records of donations;
- reports from NGOs; reports from manufacturers and importers; and
- customs import records.

Meetings and interviews give more flexibility to explore responses in greater depth.

Survey through questionnaires would be more focused and information flow would be specific to the questions asked in the questionnaires. Questionnaire survey methodology has been used successfully in many inventory projects. However, questionnaire preparation requires meticulous planning in identifying the sectors to be covered in the data collection. Designing of the questionnaires, conducting awareness amongst the relevant sectors from where information would flow and the distribution of questionnaires so as to ensure that it reaches at right place and at right time. However, response to the questionnaire is rather low. Motivating the holder to complete the questionnaire is likely to be difficult. There are many reasons why holders may not want to complete the questionnaire viz. not knowing about the survey; not being able to afford the time; not perceiving pesticide issues as a priority; having problems reading and understanding the questionnaire; concerns that they will face legal or financial liabilities if they admit to having obsolete pesticides; wanting to retain the obsolete pesticides, which they perceive to be more effective than the modern alternative products. There are number of ways these can be overcome like organise awareness campaigns to ensure that all holders are informed of the survey, provide assistance of NGOs, data collection experts to the holders to complete the questionnaires, undertake random inspection for a sample of completed questionnaires to check its accuracy

Statistical method for surveying is another tool to collect information through a representative sample in the selected area and then extrapolated statistically to arrive at a meaningful information/data. Statistical methods can be applied to any of the surveying methodologies, questionnaires or site inspections.

Sites inspection- This is more reliable method to get the quantitative information/data on pesticides. It is also the preferred methodology of the FAO for pesticides.

Inventory activities that require physical inspection of pesticides in storage, use, stockpiles or wastes should only be carried out by staff with adequate training and protective equipment. The FAO series of manuals on pesticide disposal should be consulted for guidance. For example, the "FAO Disposal Series 12, 13, 14, 15 and 16 which cover the inventory, environmental risk assessment, safeguarding and environmentally sound disposal of pesticide wastes. These documents contain information on issues including pesticide inventory taking and management, proper protective equipment and necessary health and safety measures.

Gather information on sites that may have been used or are being used to manufacture, formulate or handle POPs (including wastes) in a manner that may have caused site contamination.

Identify programmes or initiatives in the country that are relevant to POPs pesticide management or replacement – for example, obsolete pesticide activities, integrated pest management programmes or proposals for these.

Information to be collected

The quality of the data collected at this initial stage will have a significant impact on the implementation of all subsequent phases in the disposal programme. A thorough understanding on the following amongst the stakeholders are essentially required:

- Do we limit the inventory to obsolete and banned pesticides?
- Do we include currently available and usable pesticides and if so which ones (government owned, pesticide distribution chain)?
- Do we include associated wastes, including soils, containers and buried stocks?
- Do we limit the inventory to stocks owned by government?

- Do we include farmer-held stocks?
- Do we include old disposal sites at production and formulation plants?

Harmonization of data collection

To have a consistency in the data, it would be appropriate to harmonise the data collection process. Harmonization of the data would define the various parameters that need to be looked into while collecting the information.

Standardization of data collection format

To obtain same set information from different locations/ organizations in a more coherent manner it is essential that data collector be provided with a standardized format for collecting the information in a pre-decided sequence for easy collection, putting on to the database and interpretation. The PMU may develop standardized format based on the format developed by FAO (FAO Pesticide Disposal Series 14).

8. Planning the national inventory

The task team would develop a plan which would be approved by the PCU (and, if appropriate, the NCC). The PCU should ensure adequate involvement of representatives from the Ministries of Agriculture, Public Health and Veterinary Service plus the national Customs Authority to ensure the status of POPs pesticide management issues are adequately reflected.

Existing data sources and programmes would be drawn on for baseline information. This should be supplemented where required by the collection of primary data from site investigation and survey. Advice on the data collection process can be obtained from the FAO guidance referenced above. Special attention should be given to provision of adequate training of personnel engaged in data collection. Advice on training can be obtained in the FAO guidance.

A strategy would be drawn up for information gathering suited to the resources available, including a projected time frame. The best way to generate the necessary information is likely to vary from country to country depending on the situation and the nature of chemicals management and the scale and uses of POPs.

Attention should be given to difficulties that are likely to be encountered in carrying out a complete inventory of obsolete pesticides. Innovative and imaginative methods may need to be developed, for example, to find stocks of pesticides stored by individual farmers in unofficial stores.

Field work, whether initial inventories or complete inventories and site assessments, should be carried out by properly trained and equipped staff.

Questionnaire preparation : The design of the questionnaire is crucial. Ideally, it should be simple and quick to complete and, at the same time, capture all the information that is required to evaluate the pesticides. The questionnaire should be tested with a small sample of individuals in the sector to ensure that it is easy to understand and that they can complete it. Mechanisms for distributing and facilitating the completion of the questionnaire, and receiving the completed questionnaires are also as important as designing of the questionnaire.

Survey and Data collection: Using questionnaires to survey pesticide stocks is a preferred methodology in the inventory preparation. Data collectors would be trained on the methodology of conducting survey and in data collection from different stakeholders at different location, many of them would be in remote places,

Validation of the data collection : The data collected by the experts need to be validated and confirmed before putting on to the database. This task has to be performed by specialists cross check the data for any inaccuracy and authenticity

Reporting: For a meaningful inventory, it is essential that reporting be done regularly and updated at least annually.

Interpretation of the results: Inventory data collected need to be processed in a manner that useful information may be presented for easy understanding for the policy makers, government agencies and the stakeholders.

9. Selection of the relevant stakeholders

Stakeholders vary from country to country. Any organization or person connected with or holder of pesticides could be a stakeholder. The probable stakeholders include:

- the ministries of agriculture, veterinary services, forestry, environment, health, roads and
- highways, national parks; customs authorities, etc.

- state/provincial and local ministries
- the national focal point for the Stockholm Convention (responsible for completion ofan indicative inventory of all POPs under the National Implementation Plan – NIP of the Convention);
- farmers associations, crop production boards and farmers cooperatives and unions;
- NGOs and civil society groups;
- universities and other academic institutions;
- commercial pesticide users;
- pesticides industry (manufacturers, formulators, distributors, retailers);
- trade unions;

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10. Awareness raising of the stakeholders

The PMU would organise series of awareness raising programes for the stakeholders to understand the need of collecting information and developing an inventory and/or update of the POPs pesticides.

11. Training of the data collectors

The PMU would develop training manuals and organise training programmes for the data collectors to train them methodology of the data collection. A reliable and validated inventory could be generated provided the data collectors know what , how and where to collect the information .

12. Types of information/data to be collected

For each chemical, collect information/data, to the extent possible, on the following:

- Production
- Import
- Export
- Consumption
- Stocks
- Wastes
- Contaminated areas

11. **Monitoring POPs pesticides**

The PMU would look into the monitoring of the pesticides in different matrix namely soil, air and water to completely understand the life cycle management of the POP pesticides. The relevant information/data would be collected to form the part of POP pesticides. The inventory of residue pesticides aims to know existence of POPs pesticides in the environment especially in/on soil and water. This information collection is important because the POPs generate the negative impact on the health of the human being and environment. Standardized methodologies for sampling would be adopted for drawing soil samples from agriculture area, in/or around warehouse, pesticides stores/shops. For residues in water, sampling would have to conducted in rivers, pool and/or well. Water sample should be a composite sample taken from three sampling point (for river or pool) and for well only one sample is enough.

12. **Legal enforcement**

The PMU should take closer look on the legal provisions, acts , rules and their enforcement with respect to manufacture, transport, storage, trade, usage and disposal of the pesticides in the country.

13. **Institutional capacity**

Lack of institutional capacity in the central/state/ province level would escalate problems of collecting useful data on pesticides. Strengthening the capacity would build confidence to prepare a reliable inventory with meaningful purpose.

14. **Socio-economic consideration**

Assess impact on society with respect to health including public, environmental and occupational health; agriculture including aquaculture and forestry; biota (biodiversity), economic aspects, social costs and movement towards sustainable development.

15. **Prevention measures**

The PMU should discuss the preventive measure for the POPs pesticides. This could include awareness, education, site identification, preparedness for emergencies, risk assessment including human health and environment.

16. **Risk reduction measures**

This may include information on the development and production of user and environmentally friendly newer formulations of presides, practices of waste management, effective treatment of effluents, proper monitoring and ecotoxicology of pollutants and alternative to POP chemicals.

17. **Alternative to POP pesticides**

Alternatives to the listed chemicals should be selected based on local studies taking into consideration on the factors viz. adoption of integrated pesticide/vector management approaches (IPM/IVM), promotion of environmental and user friendly economically viable alternatives, results of local field testing, adaptation trials and large scale demonstration of the proposed alternative .

18. **Brief factsheet on Lindane and Endosufan covering risk profile and management evaluation**

<u>Lindane</u>

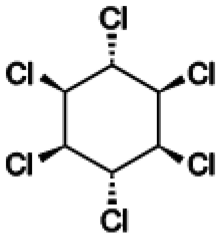
Chemical identity and properties

Lindane: gamma-hexachlorocyclohexane
Chemical formula: C6H6Cl6
CAS number: 58-89-9
Molecular weight: 290.83

Physical and chemical properties are as follows:
Physical state Crystalline solid
Melting point 112.5 °C
Boiling point at 760 mmHg 323.4 °C
Vapor pressure at 20°C 4.2x10-5 mmHg
Henry's Law constant at 25°C 3.5x10-6 atm m3/mol
Source: ATSDR, 2005

Lindane is the common name for the gamma isomer of 1,2,3,4,5,6-hexachlorocyclohexane (HCH). Technical HCH is an isomeric mixture that contains mainly five forms differing only by the chlorine atoms orientation (axial or equatorial positions) around the cyclohexane ring The five principal isomers are present in the mixture in the following proportions: alpha-hexachlorocyclohexane (53%–70%) in two enantiomeric forms ((+)alpha-HCH and (-)alpha-HCH), beta-hexachlorocyclohexane

(3%–14%), gamma-hexachlorocyclohexane (11%–18%), deltahexachlorocyclohexane (6%–10%) and epsilon-hexachlorocyclohexane (3%–5%). The gamma isomer is the only isomer showing strong insecticidal properties



Lindane (gamma-HCH)
CAS No: 58-89-9

Production, trade, stockpiles

The manufacture of technical-HCH involves the photochlorination of benzene, which yields a mixture of five main isomers. This mixture of isomers is subject to fractional crystallization and concentration to produce 99% pure lindane, with only a 10-15 percent yield. The production of lindane is therefore inefficient as for each ton of lindane (gamma isomer) obtained, approximately 6-10 tons of other isomers are also obtained (IHPA, 2006). According to the *International HCH & Pesticide Association* (IHPA) (report and Annexes), there have been variations in the production methods for HCH and lindane, as well as for HCH isomers destruction or re-use. However, most of the methods to process or re-use the waste HCH isomers have been given up over the years and consequently, most of the waste products have been dumped (IHPA, 2006).

The lindane industry claims that modern production technology processes the waste isomers into TCB (trichlorobenzene) and HCl (hydrochloric acid) thereby reducing or eliminating environmental contamination from these by-products (Crop Life, 2006).

Historical production of technical HCH and lindane occurred in many European countries, including the Czech Republic, Spain, France, Germany, United Kingdom, Italy, Romania, Bulgaria, Poland, and Turkey, and took place mainly from 1950 or earlier and stopped in 1970 to the 1990s .

According to a research by IHPA, technical HCH and lindane have also been produced in other countries including Albania, Argentina, Austria, Azerbaijan, Brazil, China, Ghana, Hungary, India, Japan, Russia, Slovakia and the United States. Exact information is difficult to obtain, as many countries do not keep records of historical pesticides production, sales and usage or the industry considers this to be proprietary information (IHPA, 2006).

Lindane has been used as a broad-spectrum insecticide The production of lindane has decreased rapidly in the last few years and only few countries are still known to produce lindane.

Uses

Lindane has been used as a broad-spectrum insecticide for both agricultural and non-agricultural purposes. Lindane has been used for seed and soil treatment, foliar applications, tree and wood treatment and against ectoparasites in both veterinary and human applications (WHO, 1991).

As a consequence of its toxic, suspected carcinogenic, persistent, bioaccumulative and suspected endocrine disrupting properties, lindane became a substance of scrutiny for countries in the European Community. All uses of HCH including lindane have been banned, but Member States may allow technical HCH for use as an intermediate in chemical manufacturing and in products with at least 99% of the isomer content in the gamma form (lindane) for public health and veterinary topical use only, until December 31st 2007 (UNECE, 2004). Currently, the only registered agricultural use for lindane in the United States is for seed treatment and for lice and scabies treatment on humans (CEC, 2005). In Canada the major use of lindane has been on canola and corn, but the only current allowable use of lindane is for public health purposes, as a lice and scabies treatment (CEC, 2005).

Information on current uses as informed by countries may be found on POPRC/LINDANE/INF.1

Status of the chemical under international conventions

Lindane is listed as a "substance scheduled for restrictions on use" in Annex II of the 1998 Protocol on Persistent Organic Pollutants of the Convention on Long-Range Transboundary Air Pollution. This means that products in which at least 99% of the HCH isomer is in the gamma form (i.e. Lindane) are restricted to the following uses: 1. Seed treatment. 2. Soil applications directly followed by incorporation into the topsoil surface layer. 3. Professional remedial and industrial treatment of lumber, timber and logs. 4. Public health and veterinary topical insecticide. 5. Non-aerial application to tree seedlings, small-scale lawn use, and indoor and outdoor use for nursery stock and ornamentals. 6. Indoor industrial and residential applications. All restricted uses of Lindane shall be reassessed under the Protocol no later than two years after the date of entry into force. The Protocol entered into force on October 23th, 2003.

Lindane, as well as the mixture of HCH isomers, is listed in Annex III of the Rotterdam Convention on the Prior Informed Consent Procedure as "chemicals subject to the prior informed consent procedure".

India has banned lindane from March 25. 2011. Though Lindane is permitted for use for locust control in China, it was not used in fact for a long period because it's high risk to environmental and public health.

POPs characteristics of Lindane

Lindane is persistent, bioaccumulates easily in the food chain and bioconcentrates rapidly. There is evidence for long-range transport and toxic effects (immunotoxic, reproductive and developmental effects) in laboratory animals and aquatic organisms.

Lindane has been reported in seabirds, fish and mammals in the Arctic (ATSDR, 2005). Lindane concentrations in marine mammals are found at equivalent or even higher levels than some of the more hydrophobic contaminants such as polychlorinated biphenyls (PCBs) and DDT (ATSDR, 2005). In addition, lindane has been reported in human breast milk among Inuit in the Arctic and in marine mammals (Arctic Monitoring and Assessment Programme, 2002).

Releases to the environment

Considering every ton of lindane produced generates approximately 6 - 10 tons of other HCH isomers, a considerable amount of residues was generated during the manufacture of this insecticide. For decades, the waste isomers were generally disposed of in open landfills like fields and other disposal sites near the HCH manufacturing facilities. After disposal, degradation, volatilization, and run off of the waste isomers occurred (USEPA, 2006).

If the estimate of global usage of lindane of 600,000 tons between 1950 and 2000 is accurate, the total amount of possible residuals (if it is assumed that a mean value of 8 tons of waste isomers are obtained per ton of lindane produced) amounts to possibly 4.8 million tons of HCH residuals that could be present worldwide giving an idea of the extent of the environmental contamination problem (IHPA, 2006).

Between 4 and 7 million tonnes of wastes of toxic, persistent and bioaccumulative residues (largely consisting of alpha- (approx. 80%) and beta- HCH) are estimated to have been produced and discarded around the globe during 60 years of Lindane production. Most locations where HCH waste was discarded/stockpiled are not secured and that critical environmental impacts are resulting from leaching and volatilisation. To stop further POPs pollution, countries should take necessary step to identify and evaluate such sites (John Vijgen et al. 2010).

Air releases of lindane can occur during the agricultural use or aerial application of this insecticide, as well as during manufacture or disposal. Also, lindane can be released to air through volatilization after application (Shen et al., 2004). Evaporative loss to air from water is not considered significant due to lindane's relatively high water solubility (WHO/Europe, 2003).

Exposure

Lindane can be found in all environmental compartments and levels in air, water, soil, sediment, aquatic and terrestrial organisms and food have been measured worldwide.

Humans are therefore being exposed to lindane as demonstrated by detectable levels in human blood, human adipose tissue and human breast milk (WHO/Europe, 2003).

General population exposure to gamma-HCH can result from food intake, particularly from animal origin products like milk and meat, as well as water containing the pesticide. Lindane was found to be 10 times higher in adipose tissue of cattle than in the feed (ATSDR, 2005) showing that animals may be exposed to the compound through food and even through ectoparasite treatment. Lindane has been detected in cow's milk in countries that still use the chemical as a pesticide. In a study performed in Uganda, Africa, the concentrations of gamma-HCH in cow's milk was 0.006–0.036 mg/kg milk fat, respectively. Mean levels of gamma-HCH analyzed in cow's milk samples from two separate areas in India were 0.002 and 0.015 mg/kg. A monitoring study of 192 samples of cow's milk from Mexico revealed 0.002–0.187 mg/kg of gamma-HCH (ATSDR, 2005).

Hazard assessment for endpoints of concern

Lindane is the most acutely toxic HCH isomer affecting the central nervous and endocrine systems. In humans, effects from acute exposure at high concentrations to lindane may range from mild skin irritation to dizziness, headaches, diarrhea, nausea, vomiting, and even convulsions and death (CEC, 2005). Respiratory, cardiovascular, hematological, hepatic and endocrine effects have also been reported for humans, following acute or chronic lindane inhalation. Hematological alterations like leukopenia, leukocytosis, granulocytopenia, granulocytosis, eosinophilia, monocytosis, and thrombocytopenia, have been reported, following chronic human occupational exposure to gamma- HCH at production facilities (ATSDR, 2005). In India, blood levels of gamma-HCH were significantly higher in 135 breast cancer patients, 41-50 years of age, compared to a control group without the disease. However, in similar studies in other countries, a correlation between breast cancer incidence and elevated levels of gamma-HCH in blood was not observed (ATSDR, 2005).

Clean up

Methods for the clean-up of sites contaminated with Lindane include: a) Hazardous waste incinerators and rotary kilns with Gas Phase Chemical Reduction (GPCR), b) Basecatalyzed decomposition, c) Sodium dispersion (alkali metal reduction), d) Subcritical water oxidation, e) Supercritical water oxidation, f) Mechanochemical method and g) GeoMelt. According to technical proofs conducted by the Ministry of Agriculture, Forestry and Fisheries of Japan, all the methods have destruction efficiencies greater than 99.999% (Annex F information provided by Japan, 2007).

Alternatives to Lindane

Alternatives for Lindane are generally available, except for use as a human health pharmaceutical to control head lice and scabies. Regulations on the production, use and monitoring of Lindane already exist in several countries.

Chemical and non-chemical alternatives including botanical and bio-pesticides for the agricultural, veterinary and pharmaceutical uses of Lindane are recommended and available in different countries.

In the United States, at least one of the following active ingredients is registered for seed treatment for corn,barley, wheat, oat, rye and sorghum: Clothianidin, Thiamethoxam, Imidacloprid, Permethrin and Tefluthrin. For uses on livestock, Amitraz, Carbaryl, Coumaphos, Cyfluthrin, Cypermethrin, Diazinon, Dichlorvos, Fenvalerate, Lambdacyhalothrin, Malathion, Methoxychlor, Permethrin, Phosmet, Pyrethrin, Tetrachlorvinfos, and Trichlorfon are registered. Veterinary Drugs include: Eprinomectin, Ivermectin, Doramectin, Moxidectin, and Methoprene. For pharmaceutical uses, approved treatments for head lice include: Pyrethrum/Piperonyl butoxide, Permethrin, and Malathion. Lice nit combs are also recommended for use in conjunction with these treatments. For scabies, Permethrin and Crotamiton (Eurax) are approved treatments (Annex F information provided by the United States of America, 2007).

Canadian alternatives for pharmaceutical uses of Lindane include: Permethrin (1% cream), Bioallethrin and piperonyl butoxide, Pyrethrin and piperonyl butoxide, Permethrin (5% cream), Precipitatedisulphur 6% in petrolatum and Crotamiton 10% (Eurax). Canadian registered alternatives for agricultural uses include: for canola: Acetamiprid, Clothianidin, Thiamethoxam and Imidacloprid; for corn: Clothianidin, Imidacloprid (only for field corn grown for seed) and Tefluthrin; and for sorghum:

Thiamethoxam and Imidacloprid. Alternatives for livestock treatments include: Carbaryl, Diazinon, Dichlorvos, Malathion, Phosmet, Tetrachlorvinphos, Trichlorfon, Cyfluthrin, Cypermethrin, Fenvalerate, Permethrin, Pyrethrin, Rotenone, Eprinomectin, Evermectin, Abamectin, Doramectin, Moxidectin and Phosmet (CEC, 2006).

Alternatives for use on canola cultivation in the Republic of Zambia include: Gaucho, Helix and Primer-Z, and for head lice treatment: Nix (Annex F information provided by the Republic of Zambia, 2007).

In Germany, alternatives against Atomaria linearis include: Thiamethoxam, Imidacloprid, Imidacloprid / Tefluthrin, Clothianidin, Clothianidin / Beta-Cyfluthrin, Alpha-Cypermethrin and Deltamethrin; against Elateridae: Clothianidin, Imidacloprid and Thiamethoxam; against leaf-cutting insects: Lambda-Cyhalothrin, Acadirachtin, Pyrethrin / Rapsöl, Beta-Cyfluthrin, Alpha-Cypermethrin, Lambda-Cyhalothrin, Acadirachtin, Pyrethrin / Rapsöl and Methamidophos. Alternatives for use as a wood protection product include: 3-Iodo-2-propynyl butylcarbamate (IPBC), (E)-1-(2-Chloro-1,3-thiazol-5-ylmethyl)-3-methyl-2-nitro guanidine / Clothianidin, 1-(4-(2-Chloro-alpha,alpha,alpha-ptrifluorotolyloxy)- 2-fluorophenyl)-3-(2,6-difluorobenzolyl)urea / Flufenoxuron, Cyclopropanecarboxylic acid, 3-[(1Z)- 2-chloro-3,3,3-trifluoro-1-propenyl]-2,2-dimethyl-, (2-methyl[1,1'-biphenyl]-3-ylmethyl ester, (1R,3R)-rel- / Bifenthrin, 3-Phenoxybenzyl-2-(4-ethoxyphenyl)-2-methylpropylether / Etofenprox, m-Phenoxybenzyl 3-(2,2- dichlorovinyl)-2,2-dimethylcyclo propanecarboxylate / Permethrin, alpha.-cyano-3-phenoxybenzyl 3-(2,2- dichlorovinyl)-2,2-dimethylcyclo propanecarboxylate / Cypermethrin, Dazomet, Thiamethoxam and 4-Bromo-2-(4-chlorophenyl)-1-(ethoxymethyl)-5-(trifluoromethyl)-1H-pyrrole-3-carbonitrile/ Chlorfenapyr. The alternative used for public health and veterinary topical insecticide is: Infectopedicul solution (Permethrin) (Annex F information provided by Germany, 2007).

In Thailand, alternatives for the treatment of head lice and scabies include: Permethrin, Cabaryl, Stemona root extract and benzyl benzoate. The alternatives for use on pets are: Permethrin, Flumethrin and Cypermethrin; and for termite control: Alpha-cypermethrin, Bifenthrin, Cypermethrin and Delta-methrin (Annex F information provided by Thailand, 2007).

Though Lindane is permitted for use for locust control in China, it was not used in fact for a long period because it’s high risk to environmental and public health. Some alternatives are available, such as the organophosphorous and pyrethroid pesticides. At present, organophosphorous and pyrethroid pesticides, i.e. malathion and cypermethrin, are the dominant pesticides in locust control in China. Additionally, fipronil is applied on a limited basis. Meanwhile, biological environmentally friendly pesticides of low toxicity are being strongly promoted by the Chinese government. These include locust microsporidium, metarrhizium anisopliae and nimbin. However, based on the assessment of relevant authorities, Lindane is still the best pesticide to control Locust in the case of extensive outbreaks.

In Sweden, Malation, Permethrin and Disulfiram with bezylbenzoate have been used as alternatives against scabies and lice in humans. In veterinary applications, Flumethrin, Foxim, Fipronil, Ivermectin and Moxidectin have been used (Annex F information provided by Sweden, 2007).

Alternatives used in Brazil include: Cypermethrin for termite control in compacted wood, Cypermethrin and 3-iodo-2-propynyl butylcarbamate (IPBC) for control of insects and fungi in dry wood, Cyfluthrin for wood used in construction or furniture fabrication, Deltamethrin for control of termite and drill, Endosulfan for termite control in wood, Fipronil for termite control in manufacture of compacted agglomerated wood, and TBP for fungal control in justsawed wood (Annex F information provided by Brazil, 2007).

Alternatives used in Switzerland for seed treatment are Fipronil and Thiamethoxam (Additional information provided by Switzerland, 2007) .

Besides the chemical alternatives, there are also non-chemical alternatives to agricultural seed treatment uses of Lindane. Among cultural methods currently known to effectively prevent harm to seeds and crops are: Crop rotation (alfalfa, soybeans and clover), where small grains need to be rotated with a non-host species every year to reduce the severity of infestation and maintain low levels of pests; Site selection and monitoring in order to determine if wireworms are present; Fallowing, starving wireworms by allowing the area to fallow for a few years before planting; Re-seeding with resistant crops such as buckwheat or flax; Timing of seeding and planting, trying to plant in warm, dry conditions, usually later in the season for small grains where larvae are deeper in the soil and giving seedlings a greater chance of survival; Shallow cultivation to starve hatchlings, expose eggs for predation and damage larvae; and Soil packing to impede wireworm travel (CEC, 2006).

Biological methods are also considered as non-chemical alternatives to Lindane. Current research at Pacific Agri-Food Research Centre, in Canada is examining the use of Metarhizium anisopliae, an insect fungal pathogen to control wireworm. Additional biological control methods employed in Costa Rica include *Trichoderma* spp, Piper aduncum, Trichograma wasps, and *Bacillus thuringiensis* (Annex F information provided by IPEN, 2007). Also, Alternatives to Lindane for controlling wheat midge involve agroecological practices and integrated pest management techniques that include crop rotation, altering seeding dates to reduce vulnerability, use of farming practices that promote greater crop uniformity, use of resistant wheat varieties, and biological controls such as parasitic wasps (Manitoba, 2006).

There are also non-chemical methods for the treatment of head lice and scabies. Some authors argue that the use of these methods exceed the efficacy of pediculicidal treatments. For the treatment of head lice they suggest application of hot air or mechanical removal using a wet combing method. For scabies treatment some authors suggest that essential oils have shown positive effects against mites in vitro and in field studies. Tea tree oil (*Melaleuca alternifolia*) and a paste made from extracts of neem (*Azadirachta indica*) and tumeric (*Curcuma longa*) are considered highly effective. In a clinical trial in Nigeria, bush tea (*Lippia multiflora*) essential oil showed similarly high cure rates. A randomized control study in Brazil showed a commercially available repellent containing coconut oil and jojoba was highly effective (IPEN, 2007).

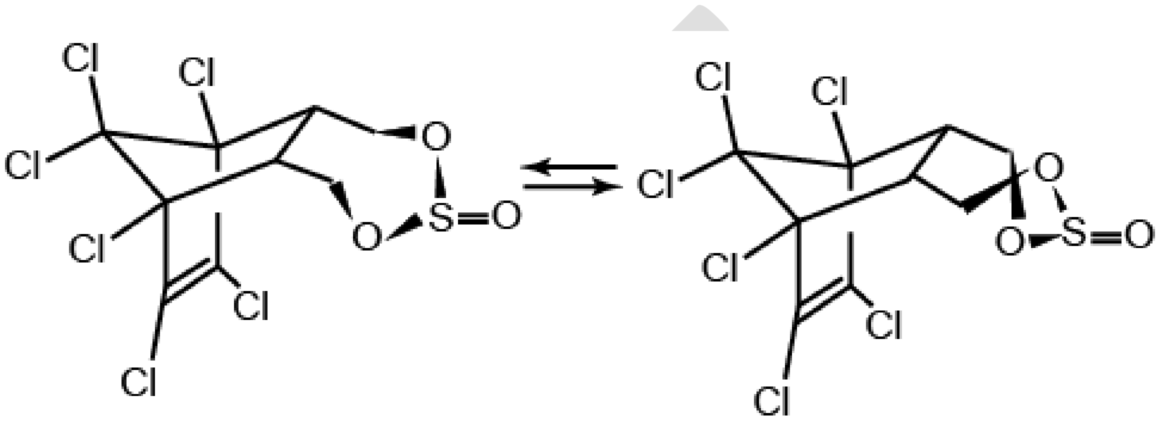
Endosulfan

Endosulfan is listed under Annex A with specific exemptions.

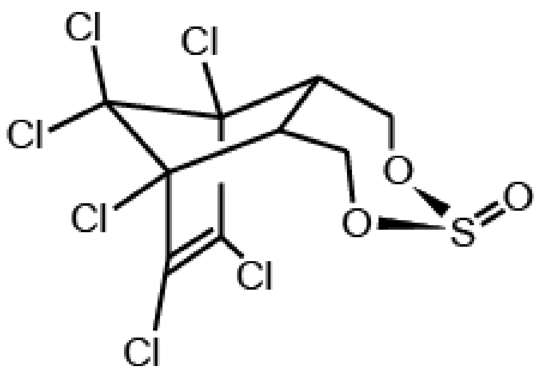
Chemical identity and properties

Endosulfan occurs as two biologically active isomers: alpha- and beta-endosulfan. Technical endosulfan (CAS No: 115-29-7) is a mixture of the two isomers along with small amounts of impurities.

alpha-endosulfan CAS No: 959-98-8,



beta-endosulfan CAS No: 33213-65-



According to the risk profile on endosulfan, adopted by the POPRC, endosulfan is persistent in the atmosphere, sediments and water. Endosulfan bioaccumulates and has the potential for long-range transport. It has been detected in air, sediments, water and in living organisms in remote areas, such as the Arctic, that are distant from areas of intensive use. . Endosulfan is highly toxic to the environment and there is evidence suggesting the relevance of some effects on humans. However, the information on its genotoxicity and potential for endocrine disruption is not fully conclusive. Endosulfan has been shown to have adverse effects on a wide range of aquatic and terrestrial organisms.

Use and production

According to the risk management evaluation on endosulfan, adopted by the POPRC, endosulfan is an insecticide that has been used since the 1950s to control crop pests, tsetse flies and ectoparasites of cattle and as a wood preservative. As a broad-spectrum insecticide, endosulfan is currently used to control a wide range of pests on a variety of crops including coffee, cotton, rice, sorghum and soy.

A total of between 18,000 and 20,000 tons of endosulfan are produced annually in Brazil, China, India, Israel and South Korea. Colombia, the United States of America and several countries in Europe that used to produce endosulfan have stopped its production.

The largest users of endosulfan (Argentina, Australia, Brazil, China, India, Mexico, Pakistan and the United States) use a total of about 15,000 tons of endosulfan annually.

Alternatives of endosulfan

The availability of alternative chemicals, products or processes can be determined by conducting a survey on which specific alternatives are feasible for what use; Although it may be difficult to implement fully risk assessment on alternatives, Parties should at least confirm that persistent organic pollutants are not substituted by others or by chemicals with concern of significant risk.

Both chemical and non-chemical alternatives to endosulfan are available in many developed and developing countries. Some of these alternatives have been used in countries where endosulfan has been banned or is being phased-out. However, some countries feel, it may be difficult and/or costly to replace endosulfan for specific crop-pest complexes.

Chemical alternatives include: insecticides such as malathion used in Sahelian countries and phoxim, malathion, profenofos used in China against the cotton bollworm on cotton; cyromazin against the Colorado potato beetle on potato in Canada; bifenthrin against white fly on tea in China.

Non-chemical alternatives include: the bacteria based pesticide viz. *Bacillus thuringiensis* (*Bt*) against the diamondback moth on cauliflower in Canada; the fungus *Metarhizium flavoviride* against locusts on rice and wheat in West Africa; the wasp *Phymastichus coffea* used in Mexico and Costa Rica against the coffee berry borer on coffee.

19. Status on Penta chlorobenzene

Pentachlorobenzene is a white or colourless crystals with some odour. Pentachlorobenzene is a man-made substance that is used to make another chemical, pentachloronitrobenzene. Therefore, pentachlorobenzene enters the environment when pentachloronitrobenzene is used. Pentachlorobenzene is used to make pentachloronitrobenzene, a fungicide. In addition, it has been used as a flame retardant It might still be used as a chemical intermediate. It is also produced unintentionally during combustion, thermal and industrial processes and present as impurities in products such as pesticides or solvents.

Pentachlorobenzene could enter human body by eating or drinking contaminated food and water or by breathing contaminated air.

First exposure to pentachlorobenzene is encountered in the production facility. It can be released to the air during its production as well as during the application of pentachloronitrobenzene as a fungicide. Short-term exposure to pentachlorobenzene could affect the central nervous system. Long-term exposure could affect the liver and kidneys and cause tissue lesions. Animal studies and tests show that pentachlorobenzene can possibly cause toxic effects on human reproduction.

20. Guidance

Information and programmes on obsolete pesticides is available from FAO through contacting OPGroup@fao.org. The following guidelines can be downloaded from www.fao.org

- Guidance on stakeholder engagement, FAO Disposal Series 11, Country Guidelines
- Guidance on environmental risk assessment, FAO Disposal Series 12, Environmental Management Tool Kit for Obsolete Pesticides Volume 1
- Guidance on storage and transport of pesticides, FAO Disposal Series 13, Environmental Management Tool Kit for Obsolete Pesticides Volume 2
- Guidance on inventory taking, FAO Disposal Series 14, The Preparation of Inventories of Pesticides and Associated Waste
- Guidance on environmental assessment and management plans for obsolete pesticides, FAO Disposal Series 15, Environmental Management Tool Kit Volume 3
- Guidance on safeguarding and disposal of obsolete pesticides, FAO Disposal Series 16, Environmental Management Tool Kit Volume 4

University of Cape Town post graduate diploma course on Pesticide Risk Management – Modules on International Conventions and Obsolete Pesticides available as short courses from March 2012.

Report of the Persistent Organic Pollutants Review Committee on the work of its second meeting, Risk profile on lindane UNEP/POPS/POPRC.2/17/Add.4

2005-2008 (POPRC1-POPRC4): The 9 New POPs - Risk Management Evaluations, http://chm.pops.int/Programmes/New%20POPs/Publications/tabid/695/language/en-GB/Default.aspx

Guidance on risk profiles for POPs pesticides – UNEP/POPS/POPRC.3/20/Add.4 (Lindane), UNEP/POPS/POPRC.3/20/Add.8 (alpha hexachlorocyclohexane), UNEP/POPS/POPRC.3/20/Add.9 (beta hexachlorocyclohexane), UNEP/POPS/POPRC.3/20/Add.10 (chloredecone)

Guidance on risk management evaluations - UNEP/POPS/POPRC.3/20/Add.4 (Lindane), UNEP/POPS/POPRC.4/15/Add.3 (alpha hexachlorocyclohexane), UNEP/POPS/POPRC.4/15/Add.4 (beta hexachlorocyclohexane), UNEP/POPS/POPRC.3/20/Add.2 (chloredecone)

Guidance on alternatives - UNEP/POPS/POPRC.5/10/Add.1

Startup Guidance for the 9 new POPs, Stockholm Convention on persistent organic pollutants (POPs)

Crosschecking Tool for Informed Decision Making in the Development of Action Plans on Pesticides Under The Stockholm Convention.