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Technical work: assessment of alternatives to endosulfan; assessment of alternatives to DDT

Report on the assessment of chemical alternatives to endosulfan and DDT

Note by the Secretariat

As referred to in documents UNEP/POPS/POPRC.8/8 and UNEP/POPS/POPRC.8/9, the report on the assessment of chemical alternatives to endosulfan and DDT is set out in the annex to the present note; it has not been formally edited.

* UNEP/POPS/POPRC.8/1.

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Annex

Report on the assessment of chemical alternatives to endosulfan and DDT

Draft prepared by the ad hoc working group on
assessment of alternatives to endosulfan and DDT
under the POPs Review Committee
of the Stockholm Convention

July 2012

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I. Disclaimer

1. This report provides hazard-based information on the alternatives with respect to the POP criteria in Annex D of the Stockholm Convention and other relevant hazard criteria. It is important to note that the assessment should not be seen as a comprehensive and in depth assessment of all available information as only a limited number of databases have been consulted (as indicated in section IV of the report).

2. The fact sheets (compiled in the background document), on which this report is based, provide an analysis on a screening level as to whether or not an insecticide meets the numerical thresholds in Annex D, but does not analyze monitoring data or other evidence as provided for in Annex D. So failure to meet the thresholds should be considered as a likelihood rather than as evidence that the insecticide is not a POP.

3. Parties may use this report when choosing alternatives to Endosulfan or to DDT as a primary source of information. It is strongly recommended that further assessment is carried out within their national framework of authorization. In addition, substances which have been identified here as not likely to be a POP, may still exhibit hazardous characteristics that should be assessed by Parties before considering such substances as a suitable alternative.

II. Background and proposed results

4. By its decision SC-5/3, the Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants (COP) decided to amend part I of Annex A to the Convention to list therein technical endosulfan and its related isomers, with specific exemptions.

5. To support the development and deployment of alternatives to endosulfan, the COP decided to undertake a work programme as set out in the annex to decision SC-5/4. Accordingly, Parties were requested and observers were invited to submit information on chemical and non-chemical alternatives to endosulfan. The Persistent Organic Pollutants Review Committee (POPRC), beginning at its seventh meeting, was requested to assess the alternatives to endosulfan in accordance with the general guidance on considerations related to alternatives and substitutes to listed persistent organic pollutants and candidate chemicals[1].

6. By its decision SC-5/6 on DDT, the COP also requested the POPRC, beginning at its eighth meeting, to assess the alternatives to DDT in accordance with the general guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals on the basis of factual information provided by parties and observers.

7. At its seventh meeting, the POPRC reviewed the information provided by the Parties and observers on alternatives to endosulfan[2]and adopted decision POPRC-7/4 which set out a workplan and terms of reference for the intersessional work related to the assessment of alternatives to endosulfan. The POPRC also reviewed the information on insecticides recommended by the World Health Organization (WHO) for disease vector control in in-door residual spraying as alternatives to DDT[3] and adopted decision POPRC-7/8 which set out a workplan and terms of reference for the intersessional work related to the assessment of alternatives to DDT. Both workplans and the present status of the subsequent steps within these two workplans are provided in Annex I, as well as the relationships between the identified steps and the chapters of this report.

8. This report addresses the various items identified in the agreed workplans with the aim to:

a) Prioritize the chemical alternatives to endosulfan relevant to the most important crop-pest complexes against the POP screening criteria,

[1]UNEP/POPS/POPRC.5/10/Add.1.

[2] UNEP/POPS/POPRC.7/INF/11/Rev.1 and UNEP/POPS/POPRC.7/INF/12.

[3] UNEP/POPS/POPRC.7/INF19.

b) Assess the POP characteristics and other hazard indicators of the prioritized chemical alternatives to endosulfan,

c) Assess the POP characteristics and other hazard indicators of the insecticides recommended by WHO for disease vector control in in-door residual spraying as alternatives to DDT.

9. This report for the consideration of the POPRC at its eighth meeting provides information on the likelihood of substances to be a POP or not to be a POP.

10. It is important to note that the assessment of the POP characteristics and other hazard indicators of the alternatives should not be seen as a comprehensive and in depth assessment of all available information as only a limited number of databases have been consulted as indicated in section III of the report.

11. Parties may use this report when choosing alternatives to endosulfan or to DDT as a primary source of information. This report provides hazard-based information on the alternatives with respect to the POP criteria in Annex D of the Stockholm Convention and other relevant hazard criteria. The fact sheets, on which this report is based, provide an analysis on a screening level as to whether or not an insecticide meets the numerical thresholds in Annex D of the Stockholm Convention, but does not analyze monitoring data or other evidence as provided for in Annex D. So failure to meet the thresholds should not be taken as evidence that the insecticide is not a POP. In addition, substances which in this report are not likely to be a POP based on the numerical criteria in Annex D, may still exhibit hazardous characteristics that should be assessed by Parties before considering such substances as a suitable alternative.

12. In summary Parties and observers submitted 110 alternative substances for Endosulfan. Out of this number the initial screening found 2 chemicals of high POPs potential, 18 that could be POPs substances, 6 that are difficult to assess because of lack of data, and 84 that are unlikely to be POPS. A further screening assessment including the 11 WHO recommended alternatives for DDT identified Dicofol as chemicals that meet all the POPs criteria, and Bifenthrin, Chlorpyrifos, Flufenoxuron, Lufenuron, Pyridalyl, Pyridaben, Chlorfluazuron, Tolfenpyrad and Prothiofos as substances that may meet all the POPs criteria but have equivocal or insufficient data.

III. Prioritization of Chemical Alternatives for Endosulfan with respect to the Persistent Organic Pollutant (POP) Characteristics (Annex D)

3.1 Introduction

13. At its seventh meeting, the POPRC decided to gather further information on alternatives to endosulfan for the exemptions listed in Part IV of Decision SC 5/3. Therefore Decision POPRC-7/4 set out a workplan and terms of reference for the intersessional work related to the assessment of alternatives to endosulfan.

14. This chapter addresses item 6 of the agreed workplan (cf. Annex I): Prioritize the chemical alternatives relevant to the most important crop-pest complexes against the POP screening criteria.

15. The Secretariat collected additional information from Parties and Observers and compiled a list by 1th May 2012 of 114 alternative substances for endosulfan that are applied for crop-pest complexes specified in Part IV of Decision SC 5/3 (cf. Annex II). Of these 114 substances 1 entry (Chromafenozide) was mentioned twice and entry 110 Tricloprid was considered to be equal to entry 103 Thiacloprid.. Of the remaining 112 entries DDT was not considered as legal alternative and entry 101, Sulphur was not considered for screening since it is not possible to apply all Annex D criteria to an inorganic chemical. 110 substances were considered further in the screening process (cf. Annex III).

16. The screening process ranked the 110 chemical alternative substances with respect to their POP characteristics.

3.2 Endpoint and data selection for prioritisation

17. To obtain a reliable database for prioritisation, experimental as well as QSARs/modelled information were collected for each substance to address in a first step bioaccumulation (B) and persistence (P) (*i.e.*, criteria (b) and (c) of Annex D of the Stockholm Convention). The two criteria were selected as their suitability for ranking was considered prior to toxicity, since all reported substances act as insecticides implying high toxicity.

18. Substances for which monitoring data (AMAP, 2009)[4] are available and which are present in remote areas are highlighted and depending on their profile considered as candidates for further assessment (cf. section 4).

19. The advantage of this combined approach is that several information sources are used such as monitoring data, QSAR and experimental data with the aim to reduce the uncertainty for the selection of alternatives to endosulfan that display POPs characteristics.

20. In addition information compiled in UNEP/POPS/POPRC.6/INF12[5] (addressing the ranking according to the risk indicators of adverse effects and bee toxicity) were also added to the list. However 46 substances were new nominees and add to the additional 8 substances for which no data were reported in document UNEP/POPS/POPRC.6/INF12, Annex III.

3.3 Experimental information

21. Experimental data on persistence (P) (DT_{50} in soil, water and sediment) and bioaccumulation (B) (aquatic BCF/BAF and log K_{ow}) were compiled from publicly available databases.

22. For persistency, the screening test on ready biodegradability are not considered to be a good indicator because in many cases higher tier studies yielding DT_{50} values (lab, field) are available for pesticides. In general experimentally derived endpoints were taken from the PPDB (Pesticides Properties Database)[6]. In cases where data were not available in the PPDB, ChemSpider[7] was used or QSAR estimates were relied upon (using EPIWEB 4.1)[8].

23. In cases where specific endpoints were not available in these databases the "List of Endpoints" of the EU pesticides assessment reports[9] were used.

24. It is proposed to use mean values for DT_{50} in soil/water and sediment since the values given in the available databases are in general geometric mean values and it is important to ensure comparable data for all substances as far as possible. Field data for DT_{50} in soil are also listed since according to Boethling et al. (2009)[10] higher-tier studies should be given more weight, though persistence depends on environmental conditions. Because environmental conditions vary in field studies the results are not strictly comparable within the data matrix.

25. As regards the DT_{50} in sediment a lot of data gaps are expected to be identified, therefore the DT_{50} for the whole water-sediment system have been collected. For 35 substances it was not possible to get a value from the above listed information sources.

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[4] AMAP Assessment 2009 - Persistent Organic Pollutants (POPs) in the Arctic. Science of the Total Environment Special Issue. 408:2851-3051. Elsevier, 2010

[5] http://chm.pops.int/Convention/POPsReviewCommittee/POPRCMeetings/POPRC6/POPRC6 Documents/tabid/783/Default.aspx

[6] PPDB (2009). The Pesticide Properties Database (PPDB) developed by the Agriculture & Environment Research Unit (AERU), University of Hertfordshire, http://sitem.herts.ac.uk/aeru/footprint/index2.htm

[7] http://www.chemspider.com/

[8] EPIWB 4.1 (US EPA, 2011). Estimation Programs Interface Suite™ for Microsoft® Windows, v 4.10 or insert version used]. United States Environmental Protection Agency, Washington, DC, USA.

[9] http://ec.europa.eu/sanco_pesticides/public/index.cfm

[10] Boethling R, Fenner K, Howard P, Klečka G, Madsen T, Snape RJ, Whelan W. (2009): Environmental Persistence of Organic Pollutants: Guidance for Development and Review of POP Risk Profiles. Integr Environ Assess Manag, 5: 539–556. doi: 10.1897/IEAM_2008-090.1

26. With regards to experimental BCF/BAF values data gaps for 28 substances (especially for those with a low log Kow) were identified. For 6 substances only estimated BCF values were available in the indicated databases. For 22 substances no BCF values were available and "no data" was entered into column BCF (exp). However, at least information on $\log K_{OW}$ was compiled as B descriptor for all substances, (except for one, Lepimectin log Kow was not available in the data sources, cf. section 5) and entered in the column log Kow (exp).

3.4 QSAR information

27. The PB-Score was developed by RIVM[11] as a tool to quickly screen substances for their potential environmental persistence and bioaccumulation in the food chain. This score is seen as a step towards selection of substances which have inherent chemical properties that potentially make them a long-term hazard for the environment. It is based completely on theoretical properties of the substances derived from the chemical structure, so no experimental data are needed as input. In addition, this tool uses the overall persistence Pov from the OECD tool[12] for the descriptor of persistence that is believed to provide a better representation of the hazard associated with P (Gouin, 2010)[13].

28. Bioaccumulation potential was estimated using log Kow and taking into account degradation (based on calculations).

29. The overall PB-score varies between 0 and 2. Cut-off values complying with the formal screening criteria in Annex D are ≥0.5 for the P-score as well as the B-score. Thus substances with a PB score of ≥1.5 will have individual P or B-scores of 0.5 or higher and comply with both criteria, whereas substances with a PB-score between 1 and 1.5 might fulfil both criteria or not.

3.5 Description of the data sources

30. The PPDB (Pesticide Properties Data Base) is a comprehensive relational database of pesticide physicochemical, toxicological, ecotoxicological and other related data. Reliable sources of information for pesticide properties are monographs produced as part of the EU review process and published by EFSA (European Food Safety Agency). These documents have been used in priority for putting together the data in the PPDB. Where EFSA documents are not available, alternative sources are used (e.g. data published by national government departments, peer-reviewed scientific publications, other databases). Such data may be based on less data material and no international peer-review has taken place for data selection.

31. The PPDB was preferred to other databases (e.g. PAN Pesticides database, US EPA Pesticide Chemical Search, ARS Pesticides Properties Database) due to its user friendly interface. Furthermore, using one single database increases the comparability of the data. Also, the PPDB is updated on a regular basis. The data are presented on a single sheet and sources have been given a confidence score allowing a quick overview of the quality of the cited data. For further details please refer to "Background and Support Information"[14] of the PPDB. In contrast to other databases, the PPDB is rather extensive in the number of compounds it covers (ca. 1600 records).

32. The second database that was used is ChemSpider. ChemSpider is a free chemical database, owned by the Royal Society of Chemistry. This database is a useful instrument to find physical and chemical properties of substances and to find the valid SMILES for further calculating parameters by EPIWEB 4.1.

3.6 Uncertainties

[11] http://www.rivm.nl/bibliotheek/rapporten/601356001.html.

[12] http://www.oecd.org/LongAbstract/0,3425,en_2649_34379_40718985_119669_1_1_1,00.html

[13] Gouin, T. (2010) The precautionary principle and environmental persistence: prioritizing the decision-making process. Environ. Sci&Pol 13, 175-178

[14] http://sitem.herts.ac.uk/aeru/footprint/en/index.htm

33. Though the presented data are mostly of high quality, some data are either limited (e.g. single value) or contain some uncertainties. Data in the PPDB are weighted 1 (low) to 5 (high) according to the confidence in that data. A low score does not necessarily indicate incorrect data but indicates lower reliability. Score 1 was marked by # in the compiled list (cf. Annex III). When data from databases are used, however, in some cases no detailed specifications are given (e.g. whole fish, kinetic or steady state BCF) and this leads to uncertainties regarding the comparability of data from different substances. Furthermore the derivation of a BCF is not a standard requirement (e.g. in the EU it is required for substances with log $K_{OW} \geq 3$). For substances where no experimental BCF is available, the use of calculated values (QSAR) is considered adequate. This was performed only for 6 substances.

34. Substances not used in the EU are frequently poorly covered by the PPDB, whereas data from not approved substances may not be up to date or may be missing from the PPDB. In these cases the use of modelled data is considered more adequate compared to "no data".

35. Degradation products and metabolites were not considered in the prioritization analyses, even though they might be relevant for certain substances.

36. Considering the advantages and the disadvantages mentioned above it can be concluded that the overall high quality of the collected data provides a suitable instrument for the screening and the categorization of the chemical alternatives

3.7 Data analysis

37. In the next step, the collected numerical data were compared to benchmarks/cut off values set up by the working group in order to classify the substances within four categories (see below). The four categories allowed a ranking from a higher likelihood to be a POP (category 1: red) to a lower likelihood to be a POP (category IV: white). The benchmarks/cut off values, in particular for categories 2 and 3, were set up in a conservative manner to minimize false negatives.

38. The following categories were established:

a) Category 1: High potential to be POPs substances

Cut-offs: Annex D criteria i.e. Bioaccumulation: BCF >5000, Persistence: DT50 for whole water-sediment system >60 days was applied as conservative approach since no individual values for water or sediment were collected (cf. section 2.1). The substances identified in this category fulfill two criteria.

b) Category 2: Candidates that could be POPs substances (subject to further assessment)

Cut-offs: Bioaccumulation: BCF >1000, Persistence: DT_{50} soil or whole water-sediment system >60 days and/or a PB-score >1 (P-score >0.5). No data for a DT50 and for the PB-scores were regarded to comply with the cut-offs to minimize false negatives.

The reason for the selection of the BCFs >1000 is that the listed alternative insecticides may display high toxicity to aquatic organisms and terrestrial invertebrates. Annex D criterion on bioaccumulation allows other concerns such as high toxicity. In addition the described uncertainties (cf. section 5.1) of this exercise justified more stringent screening criteria than stated in Annex D. The DT_{50} >60 days for soil was chosen as conservative approach and because compiled degradation data do not account for metabolites.

c) Category 3: Candidates that are difficult for prioritization (subject to further assessment)

Cut-offs: log Kow >3.5 (in absence of an experimental BCF), DT_{50} soil or whole water-sediment system >60 days and/or a PB-score >1 (P-score >0.5). If no data for DT50 and BP-Scores were available, such substances were regarded as complying with the cut-off limits to avoid false negatives

d) Category 4: Unlikely to be POP substances based on persistence and bioaccumulation characteristics

Category 4 substances have according to the listed data sources a BCF <1000 or log Kow <3.5) and a DT50 water-sediment or soil <60 days. However these substances, which are not likely to be a POP, may exhibit hazardous characteristics (e.g. mutagenicity, carcinogenicity, reproductive and developmental toxicity, endocrine disruption, immune suppression or neurotoxicity) that should be assessed by Parties before considering such substances as a suitable alternative.

e) Substances which are present in remote regions indicating long-range transport

Substances for which monitoring data (AMAP, 2009) [15] in the Arctic are available are highlighted in bold letters (see section below). It should be noted that there has not been monitoring for many of the substances listed below.

3.8 Results

39. Of the 110 alternatives to endosulfan 84 are unlikely to be a POP on basis of screening against the cut-offs described in section 4. Two substances were selected as potential POP candidates, whereas 18 were selected as candidates for further assessment and 6 as candidates for further assessment with limited data. The category IV substances were not further analyzed. Substances in category I, II and III were further assessed, results of which presented in chapter IV.

40. No monitoring data or other evidence as provided for in Annex D of the Convention has been analyzed, so failure to meet the numerical criteria should not be taken as a definitive judgment that the insecticide is not a POP. However, their likelihood to be is lower than the substances that have passed. Furthermore, the substances deselected for further assessment (category IV: white) may exhibit other characteristics that should be considered in the authorization of the substance as an insecticide by Parties, such as carcinogenicity or neurotoxicity (cf. section 4). The prioritization should be seen as a screening analysis of P and B properties of the alternatives.

41. The results of the prioritization are provided below. The complete list with data for each endpoint is reported in Annex III. The 110 substances were categorised as follow:

a) Category 1: High potential to be POPs substances: 2 substances

Lufenuron, Pyridalyl

b) Category 2: Candidates that could be POPs substances: 18 substances

Alpha-cypermethrin, Bifenthrin, Chlorpyriphos, Cyhalothrin, Cypermethrin, Deltamethrin, Dicofol, Esfenvalerate, Etofenprox, Fenvalerate, Flucythrinate, Flufenoxuron, Gamma-Cyhalothrin, Hexaflumuron, Lambda-Cyhalothrin, Novaluron, Propargite, Tralomethrin

c) Category 3: Candidates that are difficult for prioritization: 6 substances

Beta-cypermethrin, Chlorfluazuron, Prothiofos, Pyridaben , Spinetoram Tolfenpyrad

d) Category 4: Unlikely to be POP substances based on persistence and bioaccumulation characteristics: 84 substances

Abamectine, Acetamiprid, Acephate, Alanycarb, Aldicarb, Azinphos-methyl, Beta-cyfluthrin, Buprofezin, Carbaryl, Carbofuran, Carbosulfan, Chlorantraniliprole, Chromafenozide, Clofentezine, Chlorpicrin, Clothianidin, Cyantraniliprole Cyfluthrin, Cyromazine,

[15] AMAP Assessment 2009 - Persistent Organic Pollutants (POPs) in the Arctic. Science of the Total Environment Special Issue. 408:2851-3051. Elsevier, 2010

Diafenthiuron, Diazinon, Dicrotophos, Diflubenzuron, Dinotefuran, Dimethoate, Emamectin benzoate, Ethion, Ethiofencarb, Ethiprole, Ethoprop, Ethylthiometon, Fenitrothion, Fenpropathrin, Fipronil, Formothion, Flonicamid, Flubendiamide, Furathiocarb, Imidacloprid, Insecticidal soap (Sodium Oleate, Sorbitan esters of fatty acids), Isoxathion, Quinalphos, Lepimectin, Malathion, Methamidophos, Methidathion, Methomyl, Methyl parathion, Milbemycin A4/Milbemycin A3, Monocrotophos, Methoxyfenozide, Naled, Napropamide, Nitenpyram, Oxamyl, Oxydemeton-methyl, Permethrin, Pirimicarb, Pirimiphos methyl, Profenofos, Phentoate, Phosalone, Phosmet, Phorate, Phosphamidon, Pymetrozine, Pyrethrin, Pyriproxifen, Pyridafenthion, Indoxacarb, Fluvalinate, Spinosad (Spinosyn D), Spirodiclofen, Spiromesifen, Spirotetramat, Teflubenzuron, Terbufos Thiacloprid, Trichlorfon, Triazophos, Triflumuron Thiamethoxam, Thiodicarb, Zeta-cypermethrin

42. The substances were further assessed depending on their category. The following describes which endpoints were chosen for the further assessment of POP characteristics and other hazard indicators (toxicity and ecotoxicity):

a) Category 1: Assessment of long-range environmental transport (LRT) and other hazard indicators.

b) Category 2: Assessment of all POP characteristics and other hazard indicators.

c) Category 3: Assessment focuses on data gaps (B and P). If outcome allows category 3 to ascend to category 2 then the substance will be subject to further assessment.

d) Category 4: No further action.

3.9 Comments on selected alternative substances

43 Chlorpyriphos, Phorate and Diazinon were detected in environmental samples in the Arctic (AMAP, 2009). However based on their BCF ≤500 and a PB-score of 0.3 and 0.8 (P and B-score <0.5) Phorate and Diazinon did not meet any benchmarks/cut off values, though the $DT50_{field}$ of Phorate was 63 days.

44 Note that for Lepimectin no data on P and B were available making further consideration difficult.

45 Emamectin benzoate, Carbosulfan and Ethion had a PB-score >1 and a B-score >0.5 but BCFs <1000. However Carbonsulfan can be regarded as borderline (high B-score and BCF of 990, log Kow 7.4). The other substances with a PB-score >1 Zeta-cypermethrin, Permethrin, Spinosad, Fipronil as well as Emamectin benzoate had a high P-score (>0.5) that corresponded well with an experimental DT50 >60 days, except for Permethrin.

46 Pyriproxifen (exp. BCF of 1379) was deselected due to low persistence (DT50). However the calculated P-value of 0.68 would suggest high environmental persistence. It should be noted that the P-value is based on an estimate of mineralization. However the findings in the EU draft assessment report (DAR 2005)[16] concerning measurements of degradation values in soil and water/sediment systems do not indicate persistence. Therefore, Pyriproxifen was not selected for further assessment.

47 Spinetoram is selected for further screening; its calculated B-score is 0.038 (Bioaccumulation Factor (BAF)~1000). In general the B-score function is very steep, a value of 0.18 is close to a BAF of 2000 (and 0.5 is close to BAF 5000), but a value of. 0.05 is still representing a calculated BAF of ~1150. So in general a low B-score should not immediately be interpreted as a substance that does not bioaccumulate at all. This applies also to e.g. Tolfenpyrad with a B-score of 0.056 (= BAF~1200).

[16] DAR (2005) Draft Assessment Report Pyriproxifen, available at http://dar.efsa.europa.eu/dar-web/provision

Permethrin has a reported BCF value of 300, however Annex III of UNEP/POPS/POPRC.6/INF/12 considered the substance as bioaccumulative.

IV. Methodology for the assessment of persistent organic pollutant characteristics and identification of other hazard indicators for the assessment of chemical alternatives to Endosulfan and DDT

4.1 Introduction

48. At its seventh meeting, the POPRC decided to gather further information on alternatives to Endosulfan and DDT. Therefore Decision POPRC-7/4 and POPRC-7/8 set out a workplan and terms of reference for the intersessional work related to the assessment of alternatives to Endosulfan and DDT (cf. Annex I).

49. This chapter addresses item 4 or item 1 of the agreed workplans for Endosulfan and DDT: Develop a methodology for the assessment of persistent organic pollutant characteristics and other hazard indicators.

4.2 Decision on properties to be considered:

50. **Substance identity:** IUPAC name, CAS No., molecular weight, chemical structure, chemical group

51. **Physical-chemical properties:** Water solubility, vapour pressure, Henry´s Law Constant, log Kow, log Kaw, log Koa

52. **Bioaccumulation:** Gather information on log Kow, BCF and additional information like modelled data (PB-score).

53. **Persistence:** Abiotic and biotic degradation, information on half-lives in water, sediment and soil, information on metabolites (if available)

54. **Long-range environmental transport (LRT):** DT50 in air (photo-oxidation, AOPWIN, EPI Suite[17]), OECD Pov and LRT Screening Tool (Characteristic Travel Distance, Transfer Efficiency)

55. The OECD "Pov and LRT Screening Tool"[18] has been developed with the aim of using multimedia models for estimating overall persistence (Pov) and long-range transport potential (LRT) of organic chemicals at a screening level in the context of PBTs/POPs assessments. The tool requires degradation half-lives in air, water and soil and partition coefficients between air and water (Kaw) and between octanol and water (Kow). The Tool calculates metrics of Pov and LRT from a multimedia chemical fate model, and provides a graphical presentation of the results. CTD (characteristic travel distance is a transport-oriented LRT indicator and quantifies the distance from the point of release to the point at which the concentration has dropped to 1/e or about 37% it its initial value. TE (transfer efficiency) is target oriented and focused on how much chemical reaches a certain distant target (Wegmann, 2009) [19].

56. The results are also displayed graphically (x=Pov, y= CTD or TE) and the calculations for the substance are located in one of the four quadrants. The substance can be compared to reference chemicals (POPs). The criteria lines for the quadrants were not modified and take as proposed in the tool (Pov limit: 195 days, CTD limit: 5096 km, TE limit: 2.25%). According to Wegmann (2009) compounds that are less problematic from an environmental exposure point of view are in the bottom-

[17] http://www.epa.gov/oppt/exposure/pubs/episuite.htm

[18] http://www.oecd.org/document/24/0,3343,en_2649_34379_45373336_1_1_1_1,00.html

[19] Wegmann F. Cavin L, MacLeod M, Scheringer M, Hungerbühler K. (2009) Environmental Modeling & Software 24, 228-237

left corner (low Pov, low LRT), while substances of environmental concern are found in the upper right region (high Pov, high LRT).

57. **Ecotoxicity hazards**: Focus on classification (UN-GHS system) and (chronic) limit values, pollinator toxicity (relevant only for endosulfan alternatives). As regards pollinator toxicity, the following data on the intrinsic toxicity (hazard criteria) of the substances to adult honeybees was collected: LD50 contact and LD50 oral [µg a.s./bee, usually 48 h]. They are the standard toxicity figures for bees and are available for the vast majority of insecticides and are the basic requirement for all pesticides in the EU (see e.g. EPPO 170 2010[20]). The disadvantage of these data is that they reflect intrinsic toxicity and not effects seen under more realistic conditions. Furthermore some insecticides, like insect growth regulators and substances with a similar mode of action, pose a risk to the larval development of bees (and consequently to the development of the bee hive) but are not toxic to adults – the overall bee toxicity of these substances will be underestimated if only toxicity to adults is considered. The advantage is that hazard data are comparable among substances and independent of the conditions of use of a substance. The classification of bee toxicity in the "screening risk assessment" of document UNEP/POPS/POPRC.6/INF/12 is based on an IOBC classification[21] that obviously took into account higher-tier results (semi-field and/or field data) and therefore is a risk indicator. The disadvantage of this classification is that it is dependent on the dosage applied and crop type. This may be the reason that contradictory information was found for several substances. Furthermore, probably for many of the substances no IOBC classification is available. It may reflect more realistic conditions (i.e. some substances are of high toxicity to bees, however, under (semi-)field conditions no significant effects are recognised). However, under field conditions some substances are more toxic than expected because of their synergistic interaction with other stressors such as parasites and diseases. In summary, because some pesticides can potentially tip the balance for bees though their sublethal neurological and immune effects, and because the effects on larvae are not taken into account, it is likely that the hazard information on bees underestimates the real effect. Note: In the Footprint database only one LD50 value for bees is given – either oral or contact.

58. **Toxicity hazards:** Focus on classification (GHS system) and long term limit values and consider other hazards as indicated below:

a) Acute systemic toxicity, sensitization, dermal / respiratory STOT RE or SE, mutagenicity, carcinogenicity, reproductive toxicity, developmental toxicity, endocrine disruptor, immune suppression, neuro-toxicity, acceptable exposure level (AEL) long term.

4.3 Databases consulted

59. In order to assess the selected alternative substances for endosulfan and DDT within the given time frame and resources preference to governmental reports and evaluated, peer reviewed data were given. Therefore databases were split into first line and second line references, the later were consulted if first line references yielded insufficient information.

4.3.1 First line references:

a) EU Biocides Review: http://ec.europa.eu/environment/biocides/annexi_and_ia.htm

b) ESIS: http://esis.jrc.ec.europa.eu/index.php?PGM=cla

BPD (Biocidal Products Directive) active substances listed in Annex I or IA of Directive 98/8/EC or listed in the so-called list of non-inclusions.

C&L (Classification and Labelling, Annex VI to EU CLP Regulation 1272/2008)

[20] http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2338.2010.02418.x/abstract

[21] [IOBC 2005] IOBC wprs Working Group "Pesticides and Beneficial Organisms & IOBCwprs Commission "IP Guidelines and Endorsement" (05.12.2005 Comm.)

Risk Assessment Reports (RAR)

c) EFSA

http://ec.europa.eu/food/plant/protection/evaluation/exist_subs_rep_en.htm

http://dar.efsa.europa.eu/dar-web/provision

d) EU Endocrine Disruption Database

http://ec.europa.eu/environment/endocrine/strategy/short_en.htm

e) US-EPA: RED, Factsheets

http://www.epa.gov/pesticides/chemicalsearch

http://www.epa.gov/pesticides/factsheets/npic.htm

f) WHO/EPS

http://www.who.int/whopes/quality/en/

g) EPI SUITE:

http://www.epa.gov/oppt/exposure/pubs/episuitedl.htm

h) IARC:

http://monographs.iarc.fr/ENG/Monographs/PDFs/index.php

i) International limit values (working place)

http://www.dguv.de/ifa/de/gestis/limit_values/index.jsp

j) PPDB

http://sitem.herts.ac.uk/aeru/footprint/index2.htm

4.3.2 Second line references:

a) CLP inventory (for endpoints not covered by ESIS)

http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

b) ECETOC

http://www.ecetoc.org/jacc-reports

c) ECOTOX

http://cfpub.epa.gov/ecotox/

d) EXTOXNET

http://extoxnet.orst.edu/

e) HSDB

http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

f) OECD eChemPortal

http://www.echemportal.org/echemportal/page.action?pageID=9

g) OECD Pov and LRTP Tool

http://www.oecd.org/LongAbstract/0,3425,en_2649_34379_40718985_119669_1_1_1,00.html

h) PAN

http://www.pesticideinfo.org/Index.html

i) WHO/EHC

http://www.who.int/ipcs/publications/ehc/en/index.html

4.4 Decision on the representation of the information on the endpoints, handling of conflicting results and integration of the data

60. For each substance a POP summary document was compiled. The summary document is a concise summary of qualitative information on the endpoints indicated above and has been mainly derived from governmental and international reports (substance evaluation). Data sources are differentiated into first line and second line references, the later were consulted if first line references yielded insufficient information. Conflicting results were not sorted out, but are presented as such, eventually with some explaining words indicating the overall line of evidence.

61. The summary documents provides an indication as to whether or not the insecticide meets the numerical thresholds in Annex D of the Stockholm Convention, but does not analyze monitoring data or other evidence as provided for in Annex D, so failure to meet the thresholds should not be taken as a determination that the insecticide is not a POP.

62. As an overview one large table with summary of endpoints of all alternative substances (Word document) and its comparison against the Annex D criteria is compiled. Conflicting results will be presented without explanation. Data presentation in the table is explained in a footnote to that Table.

63. An additional free text summary explaining the overall uncertainties and conclusions is provided as well.

V. Assessment of the persistent organic pollutant characteristics and other hazard indicators of the chemical alternatives of DDT and selected chemical alternatives to Endosulfan.

5.1 Introduction

64. The POP characteristics of the category 1, category 2 and category 3 substances, as distinguished in chapter III, were further analyzed. Also the alternative chemicals for DDT as recommended by WHO according to UNEP/POPS/POPRC.7/INF/19[22] were included (see Table V-1).

65. For each of these substances a detailed POP factsheet was compiled, in the case of the category 3 substances for alternatives to endosulfan this was only performed when important data gaps were identified.

66. It was decided not to further analyze the P- and B-characteristics of the category 1 substances as the data delivered for the screening already provides a profound indication of their P- and B-status. For more information it is recommended to consult the profound data set from EU pesticides or US EPA evaluations. For these two substances the factsheet contains mainly information related to human

[22] http://chm.pops.int/Convention/POPsReviewCommittee/POPRCMeetings/POPRC7/POPRC7Documents/tabid/2267/Default.aspx

health hazards and LRT.

67. The datasheets of the category 2 substances were the most extensively worked on as for those substances the fulfillment of the P- and B criteria were less clear than for the category 1 substances. Furthermore, they seemed to be more likely to fulfill the P- and B criteria than the category 3 and 4 substances.

68. Category 3 substances were characterized because of the limited data for some of the criteria. These summaries focused on the data gaps identified for each substance. E.g. for Pyridaben, the factsheet was confined to bioaccumulation, whereas for Chlorfluarzon bioaccumulation and persistence was addressed.

Table V-1: Alternatives subject to assessment

No.	Insecticide	Group	Endosulfan alternative	DDT alternative
Alternatives to Endosulfan (Category 2 substances) and DDT				
1	Alpha-Cypermethrin	Pyrethroid	x	x
2	Cypermethrin	Pyrethroid	x	
3	Bendiocarb	Carbamate		x
4	Bifenthrin	Pyrethroid	x	x
5	Chlorpyriphos	Organophosphate	x	
6	Cyfluthrin	Pyrethroid	x	x
7	Cyhalothrin	Pyrethroid	x	
8	Gamma-Cyhalothrin	Pyrethroid	x	
9	Lambda-cyhalothrin	Pyrethroid	x	x
10	Deltamethrin	Pyrethroid	x	x
11	Dicofol	Organochlorine	x	
12	Esfenvalerate	Pyrethroid	x	
13	Etofenprox	Pyrethroid	x	x
14	Fenitrothion	Organophosphate	x	x
15	Fenvalerate	Pyrethroid	x	
16	Flucythrinate	Pyrethroid	x	
17	Flufenoxuron	Benzoylurea	x	
18	Hexaflumuron	Benzoylurea	x	
19	Malathion	Organophosphate	x	x
20	Novaluron	Benzoylurea	x	

No.	Insecticide	Group	Endosulfan alternative	DDT alternative
21	Primiphos-methyl	Organophosphate	x	x
22	Propargite	Sulfite ester	x	
23	Propoxur	Carbamate		x
24	Tralomethrin	Pyrethroid	x	
Alternatives to Endosulfan (Category 1)				
25	Lufenuron	Benzoylurea	x	
26	Pyridalyl	Unclassified	x	
Alternatives to Endosulfan (Category 3)				
27	Beta-cypermethrin	Pyrethroid	x	
28	Chlorfluazuron,	Benzoylurea	x	
29	Prothiofos	Organophosphate	x	
30	Pyridaben	Pyridazinone	x	
31	Spinetoram	Unclassified	x	
32	Tolfenpyrad	Pyrazole	x	

5.2 Data availability and uncertainties

69. The task provided to the working group by POPRC decision 7/4 and 7/8 was to carry out an assessment of the POP characteristics of the alternatives identified. For endosulfan 110 alternatives were identified and for DDT 11. Such numbers oblige a stepwise approach due to limitations of time and information. Therefore, no comprehensive assessment, such as applied in risk profiles, could be carried out here and most attention was paid to the substances which seemed to be most relevant based on the available data.

70. In general the assessment of the alternative substances was based on evaluated data and governmental reports. However, for some substances particular endpoints were covered with limited data and only one report as indicated in the reference section of the individual POP factsheets. Also, the phase out/ban of certain substances was one reason for the smaller (evaluated) data set. If limited data were available that were reviewed in one report only this may be considered as substantial uncertainty. Evaluation from different bodies often used the same data set/studies but we assumed that the evaluation of the data was independent, giving some reassurance to the conclusions. However it is uncertain if or to which extent evaluations were definitely independent. In some cases metabolites have been included however the data set was not homogenous.

71. Concerning the assessment of LRT not all pesticides justified a full evaluation including the OECD tool. Only if the calculated half-life in air was greater than 24 hours or persistence in the environment indicated stability the multimedia fate model was performed.

72. However, there are several uncertainties associated with the LRT assessment: uncertainties of

the input parameters, overestimation of photo-oxidative degradation in air (see Scheringer 2009[23]) as well as CTD and TE might not be in all cases a relevant LRT descriptor (see AMAP, 2009[24]).

73. Also concerning persistence, some chemicals had single DT50 values that exceed the threshold of Annex D. The conclusion based on only one value must be seen with caution.

74. Concerning the toxicity assessment for human health, no human data have been reviewed, the assessment focused on results from laboratory animals submitted for regulatory purposes. Independent, i.e. non-regulatory studies were not included. In addition, it needs to be mentioned that practically no explicit assessment was available for adverse effects on the immune system; and the assessment of endocrine disruption was limited to several substances. It may be expected that substances within one category (organophosphates, carbamates, pyrethroids, benzylurea) show the same toxicological mode of action and therefore a similar toxicological profile. However for several substances within one category different conclusions were drawn with regard to carcinogenicity, developmental toxicity and endocrine disruption. It may well be that the slightly different chemical structures of the substances within one category lead to different effects; for example, experimental data do show differing effects of organophosphates on the nervous system. However it may also well be that the different conclusions were a consequence of different data packages available for the individual substances or simply reproducibility of the study results.

75. Finally, efficacy data determining the application rates and consequent exposure estimates were not considered.

5.3 Results

76. The results of the assessment of the substances listed in Table V-1 (substance no. 1 to 26) are displayed in Annex IV. Specific information (factsheets) on all substances listed in Table V-1 is compiled in a separate background document.

77. As explained above and as can be seen from the listing in Annex IV, not all aspects of the Annex D screening criteria have been considered. The specific Annex D item is listed in Annex IV. Thus, considering also other Annex D items might change the conclusions on certain substances.

78. Substances identified as alternatives to Endosulfan only (no. 27 to 32 listed in Table V-1, category 3) are subject to a specific evaluation concerning bioaccumulation and/or persistence. First line data sources as indicated in chapter IV were used. Data availability was very limited due to phase out or ban or restricted uses. Please refer to the background document for detailed information and the individual substances (summary). Beta-cypermethrin and Spinetoram clearly did not meet the requirements for further assessment.

79. Data needs and further information concerning bioaccumulation and/or persistency were identified for Pyridaben, Chlorfluazuron, Tolfenpyrad and Prothiofos

5.4 Conclusions of the screening assessment on POPs characteristics of the chemical alternative of Endosulfan and DDT

80. Based on the results of the screening assessment the following recommendations are suggested. However, the assessment provides only an indication as to whether or not the insecticide meets the numerical thresholds in Annex D of the Stockholm Convention, and does not analyze monitoring data or other evidence as provided for in Annex D, so failure to meet the thresholds should not be taken as a determination that the insecticide is not a POP. Furthermore, this work is only a first screening indicating the likelihood and not a definite classification of the substances concerning their

[23] http://onlinelibrary.wiley.com/doi/10.1897/08-324R.1/full

[24] AMAP Assessment 2009 - Persistent Organic Pollutants (POPs) in the Arctic. Science of the Total Environment Special Issue. 408:2851-3051. Elsevier, 2010

POP characteristics.

81. Please note that only alternative substances to Endosulfan were subject to the procedure specified in chapter III (prioritization). Concerning DDT alternatives all selected pesticidal active substances were subject to the screening assessment. (The DDT alternatives are underscored below: Bendiocarb and Propoxur are DDT alternatives only, whereas Bifenthrin, Alpha-Cpermethrin, Cyfluthrin, Lamda-cyhalothrin, Deltamethrin, Etofenprox, Fenitrothion, Malathion, Primiphos-methyl are alternatives to both, DDT and Endosulfan).

82. *Substances that are likely to meet all Annex D criteria (b), (c), (d) and (e)*

a) Dicofol

83. *Substances that may meet all Annex D criteria but have equivocal or insufficient data*

a) Bifenthrin, Chlorpyriphos, Flufenoxuron, Lufenuron, Pyridalyl

b) Pyridaben, Chlorfluazuron, Tolfenpyrad and Prothiofos

84. *Substances that are not likely to meet all Annex D criteria (b), (c), (d) and (e)*

a) Alpha-Cypermethrin, Bendiocarb, Beta-cypermethrin, Cypermethrin, Cyfluthrin, Cyhalothrin, Gamma-Cyhalothrin, Lambda-cyhalothrin, Deltamethrin, Esfenvalerate, Etofenprox, Fenitrothion, Fenvalerate, Flucythrinate, Hexaflumuron, Malathion, Novaluron, Primiphos-methyl, Propargite, Propoxur, Spinetoram, Tralomethrin.

85. In addition the following substances from chapter III can be considered as "*Substances that are not likely to meet all Annex D criteria (b), (c), (d) and (e)"*

a) Abamectine, Acetamiprid, Acephate, Alanycarb, Aldicarb, Azinphos-methyl, Beta-cyfluthrin, Buprofezin, Carbaryl, Carbofuran, Carbosulfan, Chlorantraniliprole, Chromafenozide, Clofentezine, Chlorpicrin, Clothianidin, Cyantraniliprole, Cyromazine, Diafenthiuron, Diazinon, Dicrotophos, Diflubenzuron, Dinotefuran, Dimethoate, Emamectin benzoate, Ethion, Ethiofencarb, Ethiprole, Ethoprop, Ethylthiometon, Fenitrothion, Fenpropathrin, Fipronil, Formothion, Flonicamid, Flubendiamide, Furathiocarb, Imidacloprid, Insecticidal soap (Sodium Oleate, Sorbitan esters of fatty acids), Isoxathion, Quinalphos, Lepimectin, Methamidophos, Methidathion, Methomyl, Methyl parathion, Milbemycin A4/Milbemycin A3, Monocrotophos, Methoxyfenozide, Naled, Napropamide, Nitenpyram, Oxamyl, Oxydemeton-methyl, Permethrin, Pirimicarb, Profenofos, Phentoate, Phosalone, Phosmet, Phorate, Phosphamidon, Pymetrozine, Pyrethrin, Pyriproxifen, Pyridafenthion, Indoxacarb, Fluvalinate, Spinosad (Spinosyn D), Spirodiclofen, Spiromesifen, Spirotetramat, Teflubenzuron, Terbufos Thiacloprid, Trichlorfon, Triazophos, Triflumuron Thiamethoxam, Thiodicarb, Zeta-cypermethrin

86. So in summary Parties and observers submitted 110 alternative substances for Endosulfan. Out of this number the initial screening found 2 chemicals of high POPs potential, 18 that could be POPs substances, 6 that are difficult to assess because of lack of data, and 84 that are unlikely to be POPS. A further screening assessment including the 11 WHO recommended alternatives for DDT identified Dicofol as chemicals that meet all the POPs criteria, and Bifenthrin, Chlorpyrifos, Flufenoxuron, Lufenuron, Pyridalyl, Pyridaben, Chlorfluazuron, Tolfenpyrad and Prothiofos as substances that may meet all the POPs criteria but have equivocal or insufficient data.

Annex I: Workplans and status of the different items for Endosulfan and DDT

Terms of reference for the ad hoc working group

A. Intersessional work related to chemical alternatives to endosulfan

(Annex II to decision POPRC-7/4)

1. Identify chemical alternatives relevant to the crop-pest complexes in part VI of Annex A to the Stockholm Convention (decision SC-5/3) from the information provided in part A of annex I to document UNEP/POPS/POPRC.7/INF/11/Rev.2 and other information provided by parties and observers.

2. Identify information gaps relating to alternatives to the crop-pest complexes identified pursuant to the preceding paragraph.

3. Request the Secretariat to collect information related to the gaps identified pursuant to the preceding paragraph from parties and observers.

4. Develop a methodology for the assessment of persistent organic pollutant characteristics and other hazard indicators.

5. Prioritize chemical alternatives according to the most important crop-pest complexes, including those using the highest volumes of endosulfan.

6. Prioritize the chemical alternatives relevant to the most important crop-pest complexes against the persistent organic pollutant screening criteria.

7. Assess the persistent organic pollutant characteristics and other hazard indicators of the chemical alternatives prioritized.

8. Provide a report for the consideration of the Committee at its eighth meeting.

B. Intersessional work related to chemical alternatives to DDT

(Annex II to decision POPRC-7/8)

1. Develop a methodology for the assessment of persistent organic pollutant characteristics of chemical alternatives to DDT.

2. Assess the persistent organic pollutant characteristics of the chemical alternatives identified in document UNEP/POPS/POPRC.7/INF/19.

3. Provide a report for the consideration of the Committee at its eighth meeting.

Results

A. Intersessional work related to chemical alternatives to endosulfan

Ad A1: Responsible: Secretariat

Status: Done. Chemical and non chemical alternatives to endosulfan for crop-pest complex_111101 was sent to the WG members and requested additional information.

Ad A2: Responsible: WG members

Status: Done. The information received from WG members between 30 October and 30 November was compiled in Endosulfan alternatives_update Dec.2011._eun2

Ad A3 Responsible: Secretariat

Status: The request was sent on 9 December with the attached form (Form3_Endosulfan_English). So far no information received.

The information obtained from question 2 of the form could be used as a basis for prioritization of which chemicals to review.

Ad A4: Responsible WG member

Please see Chapter IV

Ad A5: For this purpose, information on the most important crop-pest complexes is necessary. The significance of the use of endosulfan has been asked in question 2 of form 3 sent to Parties and observers. This information is presented by the Secretariat.

Ad A6: Please see Chapter III

Ad A7: Please see Chapter V

B. Intersessional work related to chemical alternatives to DDT

Ad B1: Responsible WG member

Please Chapter IV

Ad B2: Please see Chapter V

Annex II

Crop	Pest	Insecticide
Apple	Aphids	Acetamiprid
		Chlorpyriphos
		Chlorpyriphos
		Clofentezine
		Cypermethrin
		Deltamethrin
		Deltamethrin
		Diazinon
		Diflubenzuron
		Dimethoate
		Fenpropathrin
		Flonicamid
		Imidacloprid
		Imidacloprid
		Indoxacarb
		Lambda-cyhalothrin
		Lambda-cyhalothrin
		Methoxyfenozide
		Phorate
		Phosalone
		Pirimicarb
		Quinalphos
		Spirodiclofen
		Spirotetramat
		Thiacloprid
		Thiacloprid
Arhar, gram	Aphids	Diazinon
		Chlorpyriphos

		Dimethoate
		Dimethoate
		Fenitrothion
		Insecticidal soap
		Lambda-cyhalothrin
		Mancozeb
		Malathion
		Naled
		Spirotetramat
		Acetamiprid
		Clothianidin
		Cyfluthrin
		Cyhalothrin
		Cypermethrin
		Ethofenprox
		Ethylthiometon
		Fenitrothion
		Flucythrinate
		Imidacloprid
		Malathion
		Permethrin
		Phenthoate
		Sorbitan esters of fatty acids
		Thiamethoxam
	Caterpillars	Carbaryl
		Carbaryl
		Chlorantraniliprole
		Diazinon
		Fenitrothion
		Lambda-cyhalothrin

		Naled
		Trichlorfon
		Chlorpicrin
		Ethofenprox
		Fenitrothion
		Malathion
		Permethrin
	Pea semilooper	Diazinon
	Pod borer	Chlorpyriphos
		Emamectin benzoate
		Quinalphos
Bean	Aphids	Acephate
		Bifenthrin
		Cyfluthrin
		Diazinon
		Dimethoate
		Dimethoate
		Esfenvalerate
		Imidacloprid
		Lambda-cyhalothrin
		Lambda-cyhalothrin
		Malathion
		Malathion
		Naled
		Spirotetramat
	Leaf miner	Imidacloprid
	Whiteflies	Acephate
		Bifenthrin
		Cyfluthrin
		Esfenvalerate

		Imidacloprid
		Lambda-cyhalothrin
		Malathion
		Carbofuran
Chilli	Aphids	Carbosulfan
		Fipronil
		Phorate
		Phosalone
		Quinalphos
	Jassids	Acephate
		Azinphos-methyl
		Carbaryl
		Carbaryl
		Chlorpyrifos-ethyl
		Diazinon
		Dimethoate
		Ethiofencarb
		Imidacloprid
		Imidacloprid
		Malathion
		Malathion
		Malathion
		Methamidophos
		Methamidophos
		Methomyl
		Methomyl
		Methyl Parathion
		Oxydemeton-methyl
		Phosphamidon
		Pirimicarb

		Trichlorfon
Coffee	Berry borer	Chlorpyrifos
		Chlorpyrifos
		Deltamethrim
		Imidacloprid
	Stem borer	Carbofuran
		Diazinon
		Fenitrothion
		Imidacloprid
Cotton	Aphids	Acetamiprid
		Buprofezin
		Carbosulfan
		Chlorpyriphos
		Diafenthiuron
		Fenvalerate
		Fipronil
		Fluvalinate
		Furathiocarb
		Imidacloprid
		Malathion
		Monocrotophos
		Oxydemeton-methyl
		Phorate
		Quinalphos
		Quinalphos
		Thiamethoxam
	Cotton bollworm	Acephate
		Beta-cyfluthrin
		Buprofezin
		Chlorantraniliprole

		Chlorfluazuron
		Chlorfluazuron
		Chlorpyriphos
		Chromafenozide
		Chromafenozide
		DDT
		Deltamethrin
		Diafenthiuron
		Emamectin benzoate
		Emamectin benzoate
		Ethofenprox
		Fenvalerate
		Fipronil
		Flubendiamide
		Flubendiamide
		Flubendiamide
		Fluvalinate
		Indoxacarb
		Indoxacarb
		Indoxacarb
		Isoxathion
		Isoxathion
		Lambda-cyhalothrin
		Lufenuron
		Lufenuron
		Lufenuron
		Malathion
		Methomyl
		Methyl Parathion
		Monocrotophos

		Novuluron
		Permethrin
		Phenthoate
		Profenofos
		Profenofos
		Profenofos
		Pyriproxyfen
		Quinalphos
		Spinosad
		Spinosad
		Spinosad
		Spirotetramat
		Thiodicarb
		Thiodicarb
		Thiodicarb
		Thiodicarb
		Triazophos
		Triazophos
		Triazophos
	Jassids	Acephate
		Acetamiprid
		Buprofezin
		Carbosulfan
		Clothianidin
		Fenvalerate
		Fipronil
		Fluvalinate
		Formothion
		Imidacloprid
		Lambda-cyhalothrin

		Malathion
		Oxydemeton-methyl
		Phorate
		Quinalphos
		Thiamethoxam
		Thiamethoxam
	Leaf rollers	Acetamiprid
		Alpha-cypermethrin
		Carbofuran
		Carbofuran
		Chlorpyrifos
		Cyhalothrin
		Cyhalothrin
		Cypermethrin
		Cypermethrin
		Furathiocarb
		Furathiocarb
	Pink bollworm	Acephate
		Acetamiprid
		Alpha-cypermethrin
		Alpha-cypermethrin
		Azinphos-methyl
		Beta-cyfluthrin
		Beta-cyfluthrin
		Beta-cyfluthrin
		Bifenthrin
		Bifenthrin
		Carbaryl
		Carbaryl
		Carbaryl

		Carbaryl
		Carbaryl
		Chlorpyrifos-ethyl
		Chlorpyriphos
		Chlorpyriphos
		Chlorpyriphos
		Chlorpyriphos
		Chlorpyriphos
		Cyfluthrin
		Cyfluthrin
		Cyhalothrin
		Cyhalothrin
		Cypermethrin
		Cypermethrin
		Cypermethrin
		Cypermethrin
		Cypermethrin
		Deltamethrin
		Deltamethrin
		Deltamethrin
		Esfenvalerate
		Esfenvalerate
		Fenpropathrin
		Fenpropathrin
		Fenpropathrin
		Fenvalerate
		Fenvalerate
		Fenvalerate
		Flufenoxoron
		Fluvalinate

		Imidacloprid
		Imidacloprid
		Lambda-cyhalothrin
		Lufenuron
		Methamidophos
		Methidathion
		Methidathion
		Methomyl
		Methomyl
		Methoxyfenozide
		Methyl Parathion
		Monocrotophos
		Permethrin
		Permethrin
		Permethrin
		Phenthoate
		Phenthoate
		Phosalone
		Profenofos
		Profenofos
		Quinalphos
		Spinosad
		Thiodicarb
		Triazophos
		Triazophos
		Triazophos
		Zeta-cypermethrin
	Thrips	Buprofezin
		Carbosulfan
		Fenvalerate

		Fipronil
		Formothion
		Lambda-cyhalothrin
		Malathion
		Methyl Parathion
		Monocrotophos
		Phorate
		Quinalphos
		Thiamethoxam
	Whiteflies	Acephate
		Acetamiprid
		Beta-cyfluthrin
		Buprofezin
		Chlorpyriphos
		Clothianidin
		Dicrotophos
		Dinotefuran
		Fipronil
		Imidacloprid
		Indoxacarb
		Lambda-cyhalothrin
		Methamidophos
		Methidathion
		Methyl Parathion
		Monocrotophos
		Novaluron
		Oxamyl
		Phorate
		Profenofos
		Pyriproxifen

		Spiromesifen
		Thiamethoxam
		Tralomethrin
		Zeta cypernethrin
Cowpea	Aphids	Acephate
		Acetamiprid
		Aldicarb
		Clothianidin
		Cyfluthrin
		Cyhalothrin
		Cypermethrin
		Cypermethrin
		Diazinon
		Diazinon
		Dimethoate
		Dimethoate
		Ethofenprox
		Ethylthiometon
		Fenitrothion
		Flucythrinate
		Imidacloprid
		Insecticidal soap
		Lambda-cyhalothrin
		Malathion
		Malathion
		Methamidophos
		Naled
		Permethrin
		Phenthoate
		Sorbitan esters of fatty acids

		Spirotetramat
		Thiamethoxam
		Thiamethoxam
	Leaf miner	Diazinon
		Carbaryl
		Chlorpyriphos
		Emamectin benzoate
		Malathion
		Methyl Parathion
		Permethrin
		Pyridalyl
		Triazophos
		Trichlorfon
	Whiteflies	Acephate
		Acetamiprid
		Aldicarb
		Carbaryl
		Cypermethrin
		Dimethoate
		Imidacloprid
		Insecticidal soap
		Methamidophos
		Pyriproxyfen
		Spirotetramat
		Thiamethoxam
Eggpant	Aphids	Flonicamid
		Spirotetramat
		Malathion
		Bifenthrin
	Diamondback moth	Chlorpyriphos

		Cypermethrin
		Deltamethrin
		Diazinon
		Dimethoate
		Lambda-cyhalothrin
		Permethrin
		Spinosad
	Jassids	Carbaryl
		Malathion
	Shoot and fruit borer	Cypermethrin
		Cypermethrin
		Deltamethrin
		Deltamethrin
		Dicofol
		Imidacloprid
		Pyridafenthion
		Chlorpyriphos
Groundnut	Aphids	Phorate
		Monocrotophos
Jute	Bihar hairy caterpillar	Dicofol (mites)
		Propargite
		Quinalphos
		Sulphur (jute mite)
		Pirimicarb
Maize	Aphids	Acetamiprid
	Pink borer	Acephate
		Beta-cyfluthrin
		Carbaryl
		Carbaryl
		Carbaryl

		Carbaryl
		Carbofuran
		Carbofuran
		Chlorfluazuron
		Chlorpyriphos
		Chlorpyriphos
		Chlorpyriphos
		Chlorpyriphos
		Cypermethrin
		Cypermethrin
		Cypermethrin
		Cypermethrin
		Deltamethrin
		Deltamethrin
		Deltamethrin
		Deltamethrin
		Deltamethrin
		Diazinon
		Diazinon
		Diflubenzuron
		Dimethoate
		Emamectin benzoate
		Gamma-cyhalothrin
		Imidacloprid
		Lambda-cyhalothrin
		Lambda-cyhalothrin
		Lufenuron
		Malathion
		Methomyl
		Methomyl

		Novaluron
		Permethrin
		Spinosad
		Teflubenzuron
		Teflubenzuron
		Terbufos
		Thiacloprid
		Trichlorfon
		Trichlorfon
		Tricloprid
		Triflumuron
		Zeta-cypermethrin
		Zeta-cypermethrin
		Carbofuran
	Stem borers	Phorate
		Chlorpyriphos
Mango	Fruit flies	Dimethoate
		Napropamide
		Spinosad
		Spinosad
		Buprofezin
	Hoppers	Deltamethrin
		Lambda-cyhalothrin
		Thiamethoxam
		Chlorpyriphos
Mustard	Aphids	Phorate
		Thiamethoxam
		Acetamiprid
	Gall midges	Chlorantraniliprole
		Cypermethrin

		Diazinon
		Imidacloprid
		Acetamiprid
Okra	Aphids	Thiamethoxam
		Deltamethrin
	Diamondback moth	Spinosad
		Deltamethrin
	Jassids	Fenvalerate
		Quinalphos
		Thiamethoxam
		Deltamethrin
	Shoot and fruit borer	Fenvalerate
		Quinalphos
		Abamectin
Onion	Aphids	Acetamiprid
		Chlorpyriphos
		Cyantraniliprole
		Cypermethrin
		Deltamethrin
		Deltamethrin
		Diazinon
		Diazinon
		Diazinon
		Dimethoate
		Dimethoate
		Dimethoate
		Ethylthiometon
		Fenitrothion
		Imidacloprid
		Insecticidal soap

		Insecticidal soap
		Lambda-cyhalothrin
		Malathion
		Malathion
		Methomyl
		Phenthoate
		Pyrethrin
		Pyrethrin
		Sodium Oleate (soap)
		Sorbitan esters of fatty acids (soap)
		Acephate
	Jassids	Deltamethrin
		Diazinon
		Ethiofencarb
		Imidacloprid
		Malathion
		Methamidophos
		Methomyl
		Phosphamidon
		Pirimicarb
		Acephate
Potato	Aphids	Bifenthrin
		Clothianidin
		Cyfluthrin
		Deltamethrin
		Diazinon
		Dimethoate
		Dimethoate
		Esfenvalerate
		Flonicamid

		Imidacloprid
		Imidacloprid
		Malathion
		Methomyl
		Methomyl
		Oxamyl
		Permethrin
		Phorate
		Phosmet
		Pymetrozine
		Spirotetramat
		Thiamethoxam
		Thiamethoxam
		Acephate
	Jassids	Carbaryl
		Carbaryl
		Cyfluthrin
		Cypermethrin
		Deltamethrin
		Diazinon
		Dimethoate
		Dimethoate
		Esfenvalerate
		Imidacloprid
		Imidacloprid
		Lambda-cyhalothrin
		Malathion
		Methomyl
		Methomyl
		Naled

		Oxamyl
		Oxamyl
		Permethrin
		Permethrin
		Phosmet
		Thiamethoxam
		Carbosulfan
Rice	Gall midges	Chlorpyriphos
		Fipronil
		Lambda-cyhalothrin
		Thiamethoxam
		Lambda-cyhalothrin
	Rice hispa	Phorate
		Quinalphos
		Acephate
	Stem borers	Carbosulfan
		Chlorantraniliprole
		Chlorpyriphos
		Deltamethrin
		Fipronil
		Lambda-cyhalothrin
		Phorate
		Quinalphos
		Thiamethoxam
		Cypermethrin
	White jassid	Acephate
		Fenitrothion
		Deltamethrin
		Fenitrothion
Tea	Aphids	Acetamiprid

		Clothianidin
		Cyhalothrin
		Dinotefuran
		Ethiprole
		Flonicamid
		Fluvalinate
		Methidathion
		Pirimiphos methyl
		Thiacloprid
		Thiamethoxiam
		Deltamethrin
	Caterpillars	Quinalphos
		Prothiofos
	Flushworm	Diazinon
		Dimethoate
	Mealybugs	Dimethoate
	Scale insects	Ethion
	Smaller green leafhopper	Carbaryl
		Pyrethrin
	Tea geometrid	Carbaryl
		Thiamethoxam
	Tea mosquito bug	Deltamethrin
	Thrips	Quinalphos
		Acephate
Tobacco	Aphids	Bifenthrin
		Imidacloprid
		Lambda-Cyhalothrin
		Methomyl
		Abamectin
	Oriental tobacco budworm	Acephate

		Acetamiprid
		Alanycarb
		Alpha-cypermethrin
		Buprofezin
		Carbaryl
		Carbaryl
		Carbaryl
		Chlorpyriphos
		Chlorpyriphos
		Cyfluthrin
		Cyhalothrin
		Cypermethrin
		Cypermethrin
		Cypermethrin
		Cypermethrin
		Deltamethrin
		Dimethoate
		Ethofenprox
		Ethoprop
		Imidacloprid
		Imidachlorprid
		Isoxathion
		Lambda-cyhalothrin
		Lambda-cyhalothrin
		Methamidophos
		Methomyl
		Thiodicarb
		Acephate
Tomato	Aphids	Acetamiprid
		Bifenthrin

		Cyfluthrin
		Diazinon
		Dimethoate
		Esfenvalerate
		Flonicamid
		Malathion
		Methomyl
		Methomyl
		Spirotetramat
		Abamectin
	Diamondback moth	Acetamiprid
		Buprofezin
		Carbaryl
		Carbofuran
		Chlorpyriphos
		Chlorpyriphos
		Clofentezine
		Cypermethrin
		Cyromazine
		Deltamethrin
		Deltamethrin
		Dimethoate
		Imidacloprid
		Methamidophos
		Methomyl
		Oxamyl
		Permethrin
		Pyridaben
		Spinosad
		Spinosad

		Trichlorfon
		Carbaryl
	Jassids	Cypermethrin
		Diazinon
		Dimethoate
		Lambda-cyhalothrin
		Malathion
		Permethrin
		Abamectin
	Leaf miner	Abamectin
		Abamectin
		Abamectin
		Acephate
		Acetamiprid
		Acetamiprid
		Alpha-cypermethrin
		Chlorantraniliprole
		Clofentezine
		Clothianidin
		Cyromazine
		Cyromazine
		Cyromazine
		Cyromazine
		Deltamethrin
		Deltamethrin
		Diazinon
		Dinotefuran
		Emamectin benzoate
		Flufenoxoron
		Imidacloprid

		Imidacloprid
		Imidacloprid
		Lepimectin
		Lufenuron
		Malathion
		Milbemycin
		Naled
		Nitenpyram
		Novaluron
		Oxamyl
		Oxamyl
		Pyridaben
		Pyridalyl
		Spinetoram
		Spinosad
		Spinosad
		Thiamethoxam
		Thiamethoxam
		Tolfenpyrad
		Trichlorfon
		Chlorantraniliprole
	Shoot and fruit borer	Lambda-Cyhalothrin
		Quinalphos
		Bifenthrin
	Whiteflies	Cyfluthrin
		Esfenvalerate
		Methomyl
		Phorate
		Thiamethoxam
		Quinalphos

Wheat	Aphids	Thiamethoxam
		Acetamiprid
	Pink borer	Chlorpyriphos
		Chlorpyriphos
		Cypermethrin
		Cypermethrin
		Deltamethrin
		Diflubenzuron
		Dimethoate
		Lambda-cyhalothrin
		Lambda-cyhalothrin
		Thiacloprid
		Thiamethoksam
		Chlorpyriphos
	Termites	Thiamethoxam

Annex III: Results of the prioritization of 110 alternatives of Endosulfan

Colour code: RED: category 1 (high potential to be POPs substances); ORANGE: category 2 (candidates that could be POPs substances); BLUE: category 3 (candidates that are difficult for prioritization); WHITE: category 4 (unlikely to be POPs substances based on P and B characteristics)

Substance					**POP-Indicators Bioaccumulation and Persistence**									**POP-Indicators RIVM modelled**			**UNEP/POPS/POPRC.6/INF/12-Annex III**	
CAS No	**Name**	**Source**	**Molecular weight**	**Chemical group**	**logKow (exp)**		**BCF (exp)**		**DT50soil lab [d] 20°C**		**DT50water/sediment whole system [d]**		**DT50soil (field) [d]**	**P-score**	**B-score**	**PB-score**	**Bee Toxicity**	**Ranking**
71751-41-2	Abamectine	PPDB	866,60	Micro-organism derived	4,40		69		28,7		89,0		1,0	0,930	0,265	1,195	y	2
30560-19-1	Acephate	PPDB	183,17	Organophosphate	-0,98		0		3,0		32,0		3,0	0,106	0,000	0,106	y	1
135410-20-7	Acetamiprid	PPDB	222,67	Neonicotinoid	0,80		no data		2,6		4,7		no data	0,484	0,000	0,484	n	0
83130-01-2	Alanycarb	PPDB	399,53	Carbamate	3,43		164	§	2,7	*	1,1	*	no data	0,420	0,000	0,420	no data	not screened
116-06-3	Aldicarb	PPDB	190,26	Carbamate	1,15		42		2,4		6,0		2,0	0,204	0,000	0,204	no data	not screened
67375-30-8	Alpha-cypermethrin	PPDB	416,30	Pyrethroid	5,50		1204		100,0		21,0		35,0	0,824	0,289	1,113	no data	not screened
86-50-0	Azinphos-methyl	PPDB	317,32	Organophosphate	2,96		40		31,0		3,6	*	5,0 *	0,272	0,029	0,301	y	2
68359-37-5	Beta-cyfluthrin	PPDB	434,29	Pyrethroid	5,90		506		27,8		3,0		13,0	0,923	0,010	0,933	no data	2
65731-84-2	Beta-cypermethrin	PPDB	416,30	Pyrethroid	4,70		no data		10,0	#	no data		no data	0,824	0,289	1,113	no data	1
82657-04-3	Bifenthrin	PPDB	422,88	Pyrethroid	6,60		1703		102,2		161,0		86,8	0,897	0,383	1,280	y/n	4
69327-76-0	Buprofezin	PPDB	305,44	Unclassified	4,93		509		135,4		49,0		45,6	0,522	0,000	0,522	n	1
63-25-2	Carbaryl	PPDB	201,22	Carbamate	2,36		44		16,0		5,8		nd	0,212	0,000	0,212	y	3
1563-66-2	Carbofuran	PPDB	221,26	Carbamate	1,80		12		12,8		9,7		14,0	0,447	0,000	0,447	y	2
55285-14-8	Carbosulfan	PPDB	380,50	Carbamate	7,42		990		29,2		4,8		21,0	0,334	0,867	1,201	no data	not screened
500008-45-7	Chlorantraniliprole	PPDB	483,15	Anthranilic diamide	2,86		15	*	597,0	*	170,0	*	204,0 *	0,932	0,000	0,932	no data	no data
71422-67-8	Chlorfluazuron	PPDB	540,65	Benzoylurea	5,80		no data		no data		no data		no data	0,996	0,000	0,996	no data	not screened
76-06-2	Chlorpicrin	PPDB	164,37	Unclassified	2,50		no data		7,2		no data		3,0	0,494	0,000	0,494	no data	not screened
2921-88-2	**Chlorpyriphos**	PPDB	350,89	Organophosphate	5,00		1374		76,0		36,5		21,0	0,819	0,609	1,428	y	3
143807-66-3	Chromafenozide	PPDB	394,51	Diacylhydrazine	2,70		no data		78,0	#	no data		no data	0,817	0,014	0,831	no data	not screened
74115-24-5	Clofentezine	PPDB	303,15	Tetrazine	3,10		248		62,5		9,6		35,8	0,634	0,076	0,710	n	1
210880-92-5	Clothianidin	PPDB	249,70	Neonicotinoid	0,91		no data		545,0		56,4		121,2	0,267	0,000	0,267	no data	not screened
736994-63-1	Cyantraniliprole	PPDB	473,71	Diamide	3,43	§	no data		no data		no data		no data	0,901	0,000	0,901	no data	not screened
68359-37-5	Cyfluthrin	PPDB	434,29	Pyrethroid	6,00		506		51,0		1,0		33,0	0,923	0,010	0,933	no data	2

Substance					POP-Indicators Bioaccumulation and Persistence									POP-Indicators RIVM modelled			UNEP/POPS/POPRC.6/INF/12-Annex III	
CAS No	Name	Source	Molecular weight	Chemical group	logKow (exp)		BCF (exp)		DT50soil lab [d] 20°C		DT50water/sediment whole system [d]		DT50soil (field) [d]		P-score	B-score	PB-score	Bee Toxicity	Ranking
68085-85-8	Cyhalothrin	PPDB	449,85	Pyrethroid	6,80		1950		57,0		no data		no data		0,919	0,581	1,500	no data	not screened
52315-07-8	Cypermethrin	PPDB	416,30	Pyrethroid	5,30		1204		68,0		17,0		69,0		0,824	0,289	1,113	y/n	2
66215-27-8	Cyromazine	PPDB	166,18	Triazine	0,07		1		31,8		228,0		9,7		0,000	0,174	0,170	y	1
52918-63-5	Deltamethrin	PPDB	505,20	Pyrethroid	4,60		1400		26,0		65,0		21,0		0,745	0,129	0,875	y	4
80060-09-9	Diafenthiuron	PPDB	384,58	Thiourea	5,76		no data		0,5	#	no data		no data		0,768	0,005	0,773	no data	0
333-41-5	**Diazinon**	PPDB	304,35	Organophosphate	3,69		500		9,1		10,4		18,4		0,387	0,363	0,751	y	3
115-32-2	Dicofol	PPDB	370,49	Organochlorine	4,30		10000		45,0		29,0		no data		0,954	0,940	1,893	y	4
141-66-2	Dicrotophos	PPDB	237,19	Organophosphate	-0,50		75		28,0	#	no data		no data		0,094	0,000	0,094	y	2
35367-38-5	Diflubenzuron	PPDB	310,68	Benzoylurea	3,89		320		3,2		4,5		no data		0,882	0,013	0,895	no data	not screened
60-51-5	Dimethoate	PPDB	229,26	Organophosphate	0,70		no data		2,6		15,2		7,2		0,092	0,000	0,092	y	2
165252-70-0	Dinotefuran	PPDB	202,21	Neonicotinoid	-0,55		no data		82,0	#	no data		75,0		0,106	0,000	0,106	no data	no data
155569-91-8	Emamectin benzoate	PPDB	1008,30	Micro-organism derived	5,00		80		193,4		>120	*	0,8	*	0,931	0,817	1,748	no data	no data
66230-04-4	Esfenvalerate	PPDB	419,90	Pyrethroid	6,24		3250		41,0		71,0		44,0		0,718	0,001	0,719	y	3
29973-13-5	Ethiofencarb	PPDB	225,31	Carbamate	2,04		75	§	37,0	#	52,0		no data		0,214	0,000	0,214	no data	not screened
563-12-2	Ethion	PPDB	384,48	Organophosphate	5,07		586		150,0		no data		no data		0,300	0,703	1,003	no data	not screened
181587-01-9	Ethiprole	PPDB	397,20	Phenylpyrazole	1,99		no data		50,0	#	no data		no data		0,939	0,113	1,052	no data	not screened
298-03-3	Ethylthiometon	ChemSpider	258,30	Organophosphate	3,21	§	59	§	no data		no data		no data		0,195	0,043	0,238	no data	not screened
13194-48-4	Ethoprop	PPDB	242,3	Organophosphate	2,99		225	§	17,0		83		23,0		no data	no data	no data	no data	not screened
80844-07-1	Etofenprox	PPDB	376,49	Pyrethroid	6,90		3951	*	16,6		13,3		no data		0,698	0,518	1,217	no data	1
122-14-5	Fenitrothion	PPDB	277,23	Organophosphate	3,32		29		2,7		1,6		no data		0,394	0,096	0,490	no data	not screened
39515-41-8	Fenpropathrin	PPDB	349,42	Pyrethroid	6,04		1100		31,0		28,0		28,0		0,711	0,077	0,788	n	2
51630-58-1	Fenvalerate	PPDB	419,90	Pyrethroid	5,01		1664		77,0		no data		no data		0,718	0,001	0,719	y	2
120068-37-3	Fipronil	PPDB	437,15	Phenylpyrazole	3,75		321		142,0		68,0		65,0		0,976	0,309	1,285	y	no data
158062-67-0	Flonicamid	PPDB	229,16	Pyridine	-0,24		no data		1,1		40,0		3,1		0,648	0,000	0,648	no data	no data
272451-65-7	Flubendiamide	PPDB	682,39	Benzene-dicarboxamide	4,20		66		>365	*	>365	*	12,8	*	0,993	0,000	0,993	n	0

Substance		Source	Molecular weight	Chemical group	POP-Indicators Bioaccumulation and Persistence									POP-Indicators RIVM modelled			UNEP/POPS/POPRC.6/INF/12-Annex III	
CAS No	Name				logKow (exp)		BCF (exp)		DT50soil lab [d] 20°C		DT50water/sediment whole system [d]		DT50soil (field) [d]	P-score	B-score	PB-score	Bee Toxicity	Ranking
70124-77-5	Flucythrinate	PPDB	451,46	Pyrethroid	4,70		11749		21,0		no data		no data	0,616	0,545	1,161	no data	3
101463-69-8	Flufenoxuron	PPDB	488,77	Benzoylurea	5,11		700500		72,5		42,9		53,0	0,992	0,122	1,115	no data	not screened
69409-94-5	Fluvalinate	PPDB	502,91	Pyrethroid	3,85		no data		7,0	#	no data		no data	0,929	0,005	0,935	no data	not screened
2540-82-1	Formothion	PPDB	257,27	Organothiophosphate	1,48		0		14,0	#	no data		no data	0,113	0,000	0,113	no data	not screened
65907-30-4	Furathiocarb	PPDB	382,47	Carbamate	4,60		92		1,0	#	no data		no data	0,549	0,158	0,707	no data	not screened
76703-62-3	Gamma-Cyhalothrin	PPDB	449,85	Pyrethroid	4,96		1950		24,1	*	35,0	*	no data	0,919	0,581	1,500	no data	not screened
86479-06-3	Hexaflumuron	PPDB	461,14	Benzoylurea	5,68		4700		57,0	#	no data		170,0	0,973	0,869	1,842	no data	not screened
138261-41-3	Imidacloprid	PPDB	255,66	Neonicotinoid	0,57		1		187,0		129,0		174,0	0,414	0,000	0,414	y	1
173584-44-6	Indoxacarb	PPDB	527,83	Oxadiazine	4,65		520		5,0		6,0		20,0	0,947	0,000	0,947	n	0
143-19-1	Insecticidal soap (Sodium Oleate, Sorbitan esters of fatty acids)	ChemSpider	304,50	Fatty acids	3,92	§	56,2	§	no data		no data		no data	0,020	0,803	0,823	no data	not screened
18854-01-8	Isoxathion	PPDB	313,31	Organophosphate	3,88		730		no data		no data		no data	0,278	0,312	0,590	no data	not screened
91465-08-6	Lambda-Cyhalothrin	PPDB	449,85	Pyrethroid	6,90		1950		65,0		12,0		25,0	0,919	0,581	1,500	n	4
171249-05-1	Lepimectin	ChemSpider	1424,70	Macrocyclic Lactone	no data		no data		no data		no data		no data	0,768	0,655	1,422	no data	not screened
103055-07-8	Lufenuron	PPDB	511,16	Benzoylurea	5,12		5300		20,8		112,0		265,0	0,993	0,266	1,259	no data	not screened
121-75-5	Malathion	PPDB	330,36	Organophosphate	2,75		103		0,2		0,4		1,0	0,110	0,000	0,110	no data	1
10265-92-6	Methamidophos	PPDB	141,13	Organophosphate	-0,79		75		4,0		23,5		4,0	0,057	0,000	0,057	y	2
950-37-8	Methidathion	PPDB	302,30	Organophosphate	2,57		75		10,0		70,0		7,0	0,211	0,000	0,211	y	2
16752-77-5	Methomyl	PPDB	162,21	Carbamate	0,09		no data		7,0		3,7		no data	0,074	0,000	0,074	y	2
161050-58-4	Methoxyfenozide	PPDB	368,47	Diacylhydrazine	3,72		11		718,0		208,7	*	68,0	0,970	0,243	1,210	no data	0
298-00-0	Methyl parathion	PPDB	263,21	Organophosphate	3,00		71		12,0		5,0		10,0	0,309	0,029	0,337	no data	2
51596-10-2	Milbemycin A3	LOeP	556,70	Macrolides	6,54	*	76	*	no data		no data		no data	0,798	0,686	1,484	no data	not screened
51596-11-3	Milbemycin A4	LOeP	556,70	Macrolides	7	*	114	*	43	*	86	*	10 *	0,798	0,686	1,484	no data	not screened
6923-22-4	Monocrotophos	PPDB	223,16	Organophosphate	1,16		no data		7,0	#	no data		30,0	0,082	0,000	0,082	y	3
300-76-5	Naled	PPDB	380,79	Organophosphate	2,18		598		0,5	*	0,5	*	no data	0,289	0,000	0,289	y	2

Substance		Source	Molecular weight	Chemical group	POP-Indicators Bioaccumulation and Persistence									POP-Indicators RIVM modelled			UNEP/POPS/POPRC.6/INF/12-Annex III	
CAS No	Name				logKow (exp)		BCF (exp)		DT50soil lab [d] 20°C		DT50water/sediment whole system [d]		DT50soil (field) [d]	P-score	B-score	PB-score	Bee Toxicity	Ranking
15299-99-7	Napropamide	PPDB	271,36	Alkanamide	3,30		98		308,0		316,0		72,0	0,412	0,034	0,446	no data	not screened
150824-47-8	Nitenpyram	PPDB	270,72	Neonicotinoid	-0,66		no data		8,0	#	no data		no data	0,580	0,000	0,580	no data	not screened
116714-46-6	Novaluron	PPDB	492,70	Benzoylurea	4,30		2091		9,0		17,5		96,5	0,989	0,250	1,239	no data	no data
23135-22-0	Oxamyl	PPDB	219,26	Carbamate	-0,44		2		6,6		0,7		11,0	0,142	0,000	0,142	y	2
301-12-2	Oxydemeton-methyl	PPDB	246,30	Organophosphate	-0,74		no data		1,0		3,0		5,0	0,081	0,000	0,081	no data	not screened
52645-53-1	Permethrin	PPDB	391,30	Pyrethroid	6,10		300		13,0		40,0		42,0	0,775	0,467	1,242	y	3
2597-03-7	Phentoate	PPDB	320,39	Organophosphate	3,69		381		35,0	#	no data		no data	0,194	0,000	0,194	no data	not screened
298-02-2	**Phorate**	PPDB	260,40	Organophosphate	3,86		483		40,0		no data		63,0	0,205	0,139	0,344	no data	not screened
2310-17-0	Phosalone	PPDB	367,80	Organophosphate	4,01		180		2,0		4,0		no data	0,560	0,411	0,971	n	3
732-11-6	Phosmet	PPDB	317,30	Organophosphate	2,96		no data		3,1		7,0		7,0	0,275	0,032	0,306	no data	2
13171-21-6	Phosphamidon	PPDB	299,69	Organophosphate	0,80		75		9,0		13,0		12,0	0,256	0,000	0,256	no data	not screened
23103-98-2	Pirimicarb	PPDB	238,39	Carbamate	1,70		24		86,0		195,0		9,0	0,443	0,000	0,443	n	2
29232-93-7	Pirimiphos methyl	PPDB	305,33	Organophosphate	3,90		741	§	12,0		no data		39,0	0,517	0,169	0,686	no data	not screened
41198-08-7	Profenofos	PPDB	373,63	Organophosphate	4,68	§	1186		7,0		no data		7,0	0,625	0,252	0,877	no data	2
2312-35-8	Propargite	PPDB	350,47	Sulfite ester	5,70		13964		72,2		18,7		16,7	0,642	0,718	1,360	no data	4
34643-46-4	Prothiofos	PPDB	345,25	Organophosphate	5,67		no data		no data		no data		45,0	0,629	0,955	1,584	no data	not screened
123312-89-0	Pymetrozine	PPDB	217,23	Pyridine	-0,19		no data		12,5		83,0		35,5	0,225	0,000	0,225	no data	1
8003-34-7	Pyrethrin	PPDB	328,40	plant derived	5,90		471	*	8,0		3,0	*	12,0	0,501	0,447	0,949	no data	no data
96489-71-3	Pyridaben	PPDB	364,9	Pyridazinone	6,4		48,0		106,0		17,5		29,0	0,804	0,906	1,709	no data	2,0
119-12-0	Pyridafenthion	PPDB	340,33	Organophosphate	3,20		no data		18,0	#	no data		no data	0,320	0,000	0,320	no data	not screened
179101-81-6	Pyridalyl	PPDB	491,12	Unclassified	8,10		16000		140,0		186,0	*	156,3	0,985	0,835	1,820	no data	not screened
95737-68-1	Pyriproxifen	PPDB	321,37	Unclassified	5,37		1379		6,7		6,5		4,2	0,661	0,008	0,669	no data	1
13593-03-8	Quinalphos	PPDB	298,30	Organophosphate	4,44		523	§	21,0	#	no data		no data	0,273	0,259	0,532	y	3
187166-40-1 / 187166-15-0	Spinetoram	PPDB	748.01 / 760.03	Unclassified	4,20		no data		17,0		no data		4,5	0,917	0,038	0,955	no data	not screened
131929-63-0	Spinosad (Spinosyn D)	PPDB	745,99	Micro-organism derived	4,53	*	115	*	41,0	*	103,0	*	3,5	* 0,909	0,348	1,256	y	1

Substance		Source	Molecular weight	Chemical group	POP-Indicators Bioaccumulation and Persistence					POP-Indicators RIVM modelled			UNEP/POPS/POPRC.6/INF/12-Annex III	
CAS No	Name				logKow (exp)	BCF (exp)	DT50soil lab [d] 20°C	DT50water/sediment whole system [d]	DT50soil (field) [d]	P-score	B-score	PB-score	Bee Toxicity	Ranking
148477-71-8	Spirodiclofen	PPDB	411,23	Tetronic acid	5,83	1	7,3	3,2	no data	0,827	0,202	1,029	y	1
283594-90-1	Spiromesifen	PPDB	370,48	Tetronic acid	4,55	545	23,5	6,0	2,1	0,717	0,001	0,719	no data	1
203313-25-1	Spirotetramat	PPDB	373,45	Tetramic acid	2,73	no data	1,0	1,0	0,7	0,025	0,000	0,025	no data	not screened
83121-18-0	Teflubenzuron	PPDB	381,11	Benzoylurea	4,30	640	92,1	16,4	13,7	0,987	0,000	0,987	no data	not screened
111988-49-9	Thiacloprid	PPDB	252,72	Neonicotinoid	1,26	no data	1,3	28,0	18,0	0,506	0,000	0,506	n	2
153719-23-4	Thiamethoxam	PPDB	291,71	Neonicotinoid	-0,13	no data	121,0	40,0	39,0	0,334	0,000	0,334	y	no data
59669-26-0	Thiodicarb	PPDB	354,47	Carbamate	1,62	6	0,4	0,1	18,0	0,273	0,000	0,273	no data	not screened
129558-76-5	Tolfenpyrad	PPDB	383,88	Pyrazole	5,61	no data	4,0 #	no data	no data	0,774	0,056	0,831	no data	not screened
66841-25-6	Tralomethrin	PPDB	665,00	Pyrethroid	5,00	1200	27,0	no data	no data	0,899	0,000	0,899	no data	2
24017-47-8	Triazophos	PPDB	313,30	Organophosphate	3,55	300	44,0	35,0	9,0	0,272	0,256	0,528	n	2
52-68-6	Trichlorfon	PPDB	257,40	Organophosphate	2,69	no data	18,0	0,7	no data	0,514	0,000	0,514	n	1
64628-44-0	Triflumuron	PPDB	358,70	Benzoylurea	4,90	612	4,3	6,4	22,0	0,856	0,067	0,923	no data	not screened
13071-79-9	Terbufos	PPDB	288,4	Organophosphate	4,51	286	5	no data	12	no data	no data	no data	no data	not screened
52315-07-8	Zeta-cypermethrin	PPDB	416,31	Pyrethroid	6,60	356	60,0	2,0	10,0	0,824	0,289	1,113	y	2

*LoEP according to EU Review process (when the inclusion in annex I is pending or the substance is not approved)

#Footprint: DT50 typical (in some cases insufficient data, single values)

§ calculated by EPIWB 4.1 (US EPA. [2011]. Estimation Programs Interface Suite™ for Microsoft® Windows, v 4.10]. United States Environmental Protection Agency, Washington, DC, USA.

Annex IV: Results of the screening assessment for 26 selected alternatives to Endosulfan and DDT

Substance	**Chemical group**	**Bioaccumulation** Annex D 1 (c) (i)	**Persistence:** Annex D 1. (b) (i).	**LRT** Annex D 1 (d) (iii)	**Classification** Regulation (EC) No 1272/2008	**Pollinator Toxicity**	**acute syst. Tox.**	**Sensit. derm./ resp.**	**STOT SE or RE**	**Muta.**	**Carc.**	**Dev. tox**	**Repro. Tox.**	**ED**	**Adv. eff. to IS**	**Del. NT**	**NT**	**long term AEL [mg/kg bw day]**
Alpha-cypermethrin	Pyrethroid	no	no	no	Aquatic acute and chronic cat. 1	LC50: oral: 0.059 µg/bee; contact: 0.033 µg/bee	o3 r?	no	SE3; RE2	no	?	no	no	II	-	no	Crit. Eff.	0.01
Bendiocarb	Carbamate	no	no	no	Aquatic acute and chronic cat. 1, M=100	-	o,r3* d4*	no	no	no	no	no	no	-	-	no	Crit. Eff.	0.0065
Bifenthrin	Pyrethroid	Yes/no Equivocal data set	yes	Yes/no DT50 air<2 days, but high Pov, intermediate concern acc. to OECD model	Proposed: Aquatic acute and chronic cat. 1	LC50: oral: 0.12 µg a.s./bee contact: 0.04-0.11 µg a.s./bee	o,r3	d1	?	no	?	no	no	I	-	no	Crit. Eff.	0.0075
Chlorpyriphos	Organophosphate	No, but log Kow close to 5 Monitoring data indicated bioaccumulation	No/yes, equivocal database; metabolite appears to be more persistent	No Annex D 1 (d) (ii): **yes**, based on monitoring data in remote regions	Aquatic acute and chronic cat. 1 M= 10 000	LC50: oral: 0.25 µg/bee contact: 0.06 µg/bee	o3	no	no	no	no	no	no	IIIa	-	no	Crit. Eff. For neurodevelopmental tox	0.0003 or 0.01
Cyfluthrin	Pyrethroid	No, But log Kow 6	no	No/yes based on DT50 air< 2 days but high transfer efficiency (OECD tool)	Aquatic acute and chronic cat. 1	-	o,r2	no	no	no	no	no	no	-	-	no	Crit. Eff.	r:0.0002 o,d: 0.002
Cypermethrin	Pyrethroid	No But log Kow 5.3-5.6	yes, based on max. DT50 in soils from field study	no	Aquatic acute and chronic cat. 1	LC50: oral: 0.035 µg/bee; contact: 0.020 µg/bee	o4 r4	no	SE3	no	?	no	no	II	yes	no	Crit. Eff.	0.025
Deltamethrin	Pyrethroid type II	No But log Kow 4.6-6.2	yes but also faster degradation rates reported	no	Aquatic acute and chronic cat. 1	LC50: 0.079µg/bee oral 0.0015µg/bee contact	o,r3	no	no	no	no	no	no	I	-	no	Crit. Eff.	0.0075

Substance	**Chemical group**	**Bioaccumulation** Annex D 1 (c) (i)	**Persistence:** Annex D 1. (b) (i).	**LRT** Annex D 1 (d) (iii)	**Classification** Regulation (EC) No 1272/2008	**Pollinator Toxicity**	**acute syst. Tox.**	**Sensit. derm./ resp.**	**STOT SE or RE**	**Muta.**	**Carc.**	**Dev. tox**	**Repro. Tox.**	**ED**	**Adv. eff. to IS**	**Del. NT**	**NT**	**long term AEL [mg/kg bw day]**
Dicofol	Organo - chlorine	yes based on BCFs	yes for dicofol residues for a.s. equivocal database	Yes Based on multimedia fate model and half-life in air >2 d	Aquatic acute and chronic cat. 1	LC50 oral/contact=57.1 and 36.3 µ a.s/bee (formulation tested)	o,d 4	d 1	no	no	?	no	?	II	-	no	Crit. Eff. for short term exp.	0.0004 or 0.002
Etofenprox	Pyrethroid - ether	no based on one single BCF value	No	No	Aquatic acute and chronic cat. 1	LC50 oral/contact=0.27 and 0.13 µ a.s/bee	no	no	RE2?	no	no	no	no	IIIb	-	no	no	0.03
Esfenvalerate	Pyrethroid type II	No But log Kow 6.24	Yes based on DT50 soil; but database equivocal	No/yes based on DT50 air <2 days but high transfer efficiency (OECD tool)	Aquatic acute and chronic cat. 1	LC50 oral/contact=0.21 and 0.06 µ a.s/bee	o,r3	d1	no	no	no	no	no	IIIb	-	no	Crit. Eff. for short term exp.	0.02
Fenitrothion	Organo - phosphate	no	no	no	Aquatic acute and chronic cat. 1	LC50: oral: 0.20 µg/bee contact: 0.163µg/bee	o4* d?	?	no	no	no	no	no	I	-	no	Crit. Eff.	0.0013
Fenvalerate	Pyrethroid	no But BCF close to 5000 Log Kow 4.6 to 6.2	Yes, based on soil DT50 $_{field}$ from the USDA Pesticide database and P-score	no	Self classification: Aquatic acute and chronic cat. 1 or no classification	LC50: oral: 0.41 µg/bee contact: 0.23 µg/bee	o,d4?	no	no	no	no	no	no	II	-	no	Crit. Eff.	0.025
Flucythrinate	Pyrethroid type II	Yes/no Equivocal data base	no	no	Self classification: Aquatic acute cat. 1 and probable chronic cat. 1	LD50 contact: 0.078 µg per bee	r1-3 o3 d4-0	no	RE 2 - 0	no	no	no	no	-	-	no	Crit. Eff.	0.02

Substance	Chemical group	Bioaccumulation Annex D 1 (c) (i)	Persistence: Annex D 1. (b) (i).	LRT Annex D 1 (d) (iii)	Classification Regulation (EC) No 1272/2008	Pollinator Toxicity	acute syst. Tox.	Sensit. derm./ resp.	STOT SE or RE	Muta.	Carc.	Dev. tox	Repro. Tox.	ED	Adv. eff. to IS	Del. NT	NT	long term AEL [mg/kg bw day]
Flufenoxuron	Benzoylurea	Yes Based on exp. BCF values in fish	Yes/no Database equivocal EU ad hoc WG on PBT concluded vP!	No/yes based on DT50 air <2 days but transfer efficiency above model limit (OECD tool)	Proposed: Aquatic acute and chronic cat. 1	LC50:>100 µg/bee contact, toxicity to immature stages might be considerable higher	no	no	RE	no	no	yes	no	-	-	no	no	0.0175
Hexaflumuron	Benzoylurea	Yes Based on log Kow 5.7	Yes Based on DT50 soil and stability in water at pH<7 (but limited data)	No Based on DT50 air 6 hours	Self classification: Aquatic acute and chronic cat. 1	LC50 oral/contact:>100 µg/bee toxicity to immature stages might be considerable higher	r4?	no	no	no	no	no	no	-	-	no	no	0.02 or 0.005
Cyhalothrin, Lambda-Cyhalothrin Gamma-Cyhalothrin[1]	Pyrethroid type II	No but BCF close to 5000 log Kow 5-6.9	No but stable under anaerobic conditions	no	Aquatic acute and chronic cat. 1 (Lambda-Cyhalothrin) high toxicity also reported for the other two substances	LC50: Cyhalothrin: oral: 0.027µg/bee Lambda: oral: 0.91µg/bee, contact: 0.038µg/bee; Gamma: contact: 0.005µg/bee	r2; r1[1] o3 d4	no	no	no	no	no	no	I	-	no	Crit. Eff.	0.0025
Lufenuron	Benzoylurea	yes Based on BCF in fish	yes	No/yes based on DT50 air <2 days but transfer efficiency slightly above model limit (OECD tool)	Aquatic acute and chronic cat. 1		no	d1	RE?	no	no	no	no	no	-	no	Crit. effect	0.015
Malathion	Organophosphate	no	no	no	Aquatic acute and chronic cat. 1 (M=1000)	LC50: oral: 0.40 µg a.s./bee contact: 0.16µg a.s./bee formulation tested	o4*	skin 1	no	no	no	no	no	II	?	no	Crit. Eff.	0.03
Novaluron	Benzoylurea	yes Based on BCF in fish	no	no	Self classification: Aquatic acute and chronic cat. 1	LC50:>100 µg/bee contact toxicity to immature stages might be considerable higher	no	no	no	no	no	no	no	-	-	no	no	0.002

Substance	**Chemical group**	**Bioaccumulation** Annex D 1 (c) (i)	**Persistence:** Annex D 1. (b) (i).	**LRT** Annex D 1 (d) (iii)	**Classification** Regulation (EC) No 1272/2008	**Pollinator Toxicity**	**acute syst. Tox.**	**Sensit. derm./ resp.**	**STOT SE or RE**	**Muta.**	**Carc.**	**Dev. tox**	**Repro. Tox.**	**ED**	**Adv. eff. to IS**	**Del. NT**	**NT**	**long term AEL [mg/kg bw day]**
Pirimiphos-methyl	Organophosphate	no	no	no	Aquatic acute and chronic cat. 1	-	o4*	no	no	no	?	no	no	-	-	no	Crit. Eff.	0.004
Propargit	Sulfite ester	yes Based on log Kow and modelled BCF (BUT interpretation exp. BCF equivocal)	no	no	Aquatic acute and chronic cat. 1	LC50 oral/contact:> 100 µg a.s./bee and 47.92 µg a.s./bee.	r3	?	RE2?	no	2	?	no	-	-	no	no	0.007
Propoxur	carbamate	no	No BUT no proof of biodegradation in aquatic environments below a pH value of 7	no	Aquatic acute and chronic cat. 1	LC50: 1.35 µg/bee	o3 r4?	no	no	no	? (US EPA: yes)	no	no	-	-	no	Crit. Eff.	0.005 or 0.02
Pyridalyl	unclassified	yes	yes	No/yes based on DT50 air <2 days but transfer efficiency above model limit (OECD tool)	Aquatic acute and chronic cat. 1	NOEL of >100 µ/bee concerning acute toxicity	no	d1?	RE2?	no	no	no	no	no	no	no	no	0.028
Tralomethrin	Pyrethroid type II	no	yes based on results of deltamethrin metabolite	no	Self classification: Aquatic acute and chronic cat. 1	LC50: 0.13 µg/bee contact	o,r3	no	no	no	no	no	no	I	-	no	Crit. Eff.	0.0075

Underscore… DDT alternative insecticides for indoor residual spraying approved by World Health Organization Pesticide Evaluation Scheme

a.s. ...active substance

yellow: indicate concern

orange: no clear conclusions or limited could be drawn

no: no GHS classification and data supporting no hazard

?: no harmonised GHS classification, but data are reported to possibly support GHS classification or evaluation available with unclear conclusion for adverse effects to the immune system or neurotoxicity.

Crit. Eff.: critical effect

-: no specific data evaluation available

acute syst. Tox. - acute systemic toxicity: EU GHS categories **1**, **2** ,**3**, **4** for oral (**o**), dermal (**d**), respiratory (**r**) exposure. "*" indicates minimal classification (uncertainty from transposing Dir. 67/548/EC to GHS, Regulation (EC) No 1272/2008)

Sensit. derm./ resp.- Sensitization: EU GHS category **1** for dermal (**d**) or respiratory (**r**) exposure

STOT SE or RE - Specific Target Organ Toxicity: EU GHS categories **1** or **2** for single exposure (**SE**) or repeated exposure (**RE**) or "**no**" GHS classification and data supporting no hazard. "**?"** in case no harmonised GHS classification, but data are reported to possibly support GHS classification. In view of the low AELs for all of the substances STOT RE classification may apply to all of these substances or at least those showing specific neurotoxic effects. However this aspect seems not harmonised yet in the EU-GHS system.

Muta.- Mutagenicity: EU GHS categories **1** or **2** or "**no**" GHS classification and data supporting no hazard. "**?"** in case no harmonised GHS classification, but data are reported to possibly support GHS classification.

Carc.- Carcinogenicity: see Muta.

Dev. Tox.-Developmental Toxicity: see Muta.

Repro. Tox. -Reproductive Toxicity: see Muta

ED -endocrine disruption: EU Endocrine Disruption Database categories 1, 2, 3a or 3b, indicated as **I**, **II**, **IIIa** or **IIIb** to avoid confusion with concept of GHS categories. The European Endocrine Disruption database is considered as primary reference to cover this endpoint. The development and category definition is explained on the respective EU homepage: http://ec.europa.eu/environment/endocrine/strategy/substances_en.htm**. Category 1** - evidence of endocrine disrupting activity in at least one species using intact animals**; Category 2** - at least some in vitro evidence of biological activity related to endocrine disruption; **Category 3** - no evidence of endocrine disrupting activity (3a) or no data available (3b). In case the substance is not listed and no specific data evaluation is available this is indicated in the list with"-".In case the substance is not listed but one of the evaluations indicates a specific ED evaluation and conclusion this is indicated with "**no**". The US EPA ED screening program and respective lists are largely based on exposure considerations and data needs rather than observed effects and -together with references to other ED lists- this information is implicit in the POP factsheet under the heading "other information" where the summary of the PAN pesticides network database is reported.

Adv. Eff. to IS - Adverse effects to immune system: In principle from standard animal test endpoints (in specific heamatology, histology and organ weights) indications for adverse effects to the immune system may be apparent. If no such effects were reported in the evaluations screened for the POP factsheet it could be assumed that the substance is without concern for these endpoints. However more specific endpoints may be investigated and required. Therefore in the absence of a specific discussion of the potential for adverse to the immune system a "**-**" is indicated in the summary list as a precautionary consideration. If a discussion is available indicating the presence or absence of specific concern this is indicated with "**yes**" or "**no**", respectively. If a discussion is available with an unclear conclusion this is indicated with "**?**".

Del. NT - delayed neurotoxicity: Specific test guidelines were developed (OECD TG 418 and 419) to test the potential for delayed neurotoxicity in hen. As mentioned in the TGs this effect is recognized as potentially relevant especially for organophosphorus substances. Therefore in the summary list a "**no**" is indicated for all non-organophosphorus substances, though in most cases no specific test for delayed neurotoxicity was available. For all organophosphorous substances in the list negative data were reported for delayed neurotoxicity, therefore also for these a "**no**" is indicated in the summary table. More details may be found in the POP factsheets and the related references.

NT - neurotoxicity: Neurotoxicity may result from clinical, functional, sensory, behavioral or histological and eventually development specific endpoints. In case such endpoints were reported as critical for the derivation of limit values this was indicated in the summary table with "**crit. eff**." If they were only critical with short term exposure this is mentioned in the table, if they were not critical for AEL derivation this is indicated in the summary table with "**no**". More details may be found in the POP factsheets and the related references.

long term AEL- long term acceptable exposure level [mg/kg bw day]: (1) It may be debated if internal or external limit values should be presented in this summary list. The disadvantage of internal (systemic) limit values is that it is not in all evaluations a consistent practice to refine external limit values by oral absorption rates and that the latter may also contain further uncertainties. The advantage of internal limit values is that exposure route specificities may be reduced. In this summary list the internal limit values are presented or the external limit values in case internal values are not specified. However as far as available both values are presented in the POP factsheets. (2) As far as available in the international evaluations and the listed databases the long term internal limit dose value from the latest evaluations will be presented, if necessary specific for exposure route. In case very disparate values are provided in different reviews, the range of the values is listed.

Annex V: Abbreviations

Abbreviation	**Explanation**
AEL	Acceptable Exposure level
ADI	Acceptable daily intake
ACTH	adrenal cortical trophic hormone
ai	active ingredient
as	active substance
AR	Assessment Report
BAF	bioaccumulation factor
BCF	bioconcentration factor
CS Syndrome	?
bw	Body weight
CAS	Chemical Abstracts Service
CAR	Competent authority Report
CNS	Central Nervous System
CLP Regulation	Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures
CTD	characteristic travel distance
DAR	Draft Assessment Report
$DT_{50(lab)}$	period required for 50 percent dissipation (under laboratory conditions)
$DT_{90(lab)}$	period required for 50 percent dissipation (under laboratory conditions)
EC_{50}	median effective concentration
E_bC_{50}	Median affective concentration, growth rate
E_rC_{50}	Median effective concentration, biomass

Abbreviation	**Explanation**
LOEL	lowest observable effect level
LRT	long-range transport
K_{ow}	octanol-water partition coefficient
K_{aw}	air-water partition coefficient
K_{oa}	octanol-air partition coefficient
LLNA	Local Lymph Node Assay
NOAEL	no observed adverse effect level
NOAEC	no observed adverse effect concentration
NOEC	no observed effect concentration
NOE_rC	no observed effect concentration, growth rate
NOE_bC	No observed effect concentration, biomass
(Q)SAR	quantitative structure-activity relationship
OH	hydroxide
OECD	Organization for Economic Co-operation and Development
PBT	persistent, bioaccumulative, toxic
PPBD	Pesticide Properties DataBase
Pov	Overall Persistence
POD	point of departure
RED	Re-registration Eligibility decision
RfD	Reference Dose
RIVM	Netherlands National Institute of Public Health and Environmental

Abbreviation	**Explanation**
EPPO	European and Mediterranean Plant Protection Organization
EU	European Union
GHS	Globally Harmonized System
EFSA	European Food Safety Authority
IARC	International Agency for Research on Cancer
IOBC	International Organization for Biological Control
H	Henry's Law constant (calculated as a unit less value)
HPV chemical	High production volume chemical
HSDB	Hazardous substance database
LOAEC	lowest observable adverse effect concentration
LOAEL	lowest observable adverse effect level
LC_{50}	lethal concentration, median
LOEC	lowest observable effect concentration

Abbreviation	**Explanation**
	Protection
STOT RE or SE	Specific Target Organ Toxicity-Repeated Exposure or Single Exposure
$t_{½}$	half-life (define method of estimation)
TE	Transfer Efficiency
TC NES	Technical Committee on New and Existing Substances
US EPA	United States Environmental Protection Agency
WHO	World Health Organization