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Report of the Persistent Organic Pollutants Review Committee on the work of its sixth meeting

Addendum

Risk management evaluation on endosulfan

At its sixth meeting, the Persistent Organic Pollutants Review Committee adopted a risk management evaluation on endosulfan on the basis of the draft contained in document UNEP/POPS/POPRC.6/9, as amended. The text of the risk management evaluation is set out in the annex to the present addendum. It has not been formally edited.

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Annex

ENDOSULFAN

RISK MANAGEMENT EVALUATION

15 October 2010

Contents

Executive Summary

1. At its fifth meeting the POPRC reviewed and adopted a revised draft risk profile on endosulfan. The POPRC decided, in accordance with paragraph 7 (a) of article 8 of the Convention, and taking into account that a lack of full scientific certainty should not prevent a proposal from proceeding, that endosulfan is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted. A risk management evaluation should be prepared. Parties and observers were invited to submit the information specified in Annex F for endosulfan before 8 January 2010.

2. The current production of endosulfan worldwide is estimated to range between 18,000 and 20,000 tonnes per year. Production takes place in India, China, Israel, Brazil and the Republic of Korea. Endosulfan is used in varying amounts in Argentina, Australia, Brazil, Canada, China, India, the USA and some other countries. Its use as a plant protection product is the most relevant emission source for endosulfan.

3. Currently a broad spectrum of control measures are being applied to endosulfan. In countries where endosulfan is still applied, use is restricted to specific authorised uses and specific use conditions and restrictions are usually established in order to control health and environmental risks in the country concerned. Considering that at least 60 countries have banned or are phasing out the use of endosulfan, it can be assumed that there are viable alternatives (e.g. chemical alternatives, semio-chemicals, biological control, organic farming, IPM) available in both developed and developing countries. There seem to be no or only small amounts of obsolete endosulfan containing pesticides in most countries. However, countries that still manufacture endosulfan may have considerable stocks to manage and there may be a need to clean-up contaminated sites. The destruction of endosulfan does not pose a technical problem. In some countries access to appropriate destruction facilities is limited but these countries seem to have no or low stockpiles.

4. Alternatives to endosulfan include not only alternative substances that can be used without major changes in the process design, but also innovative changes such as agricultural processes or other practices that do not require the use of endosulfan or chemical substitutes. A number of chemical alternatives were mentioned by Parties and observers. A screening assessment has been undertaken by the intersessional working group according to the guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals. A considerable number of biological control measures and semio-chemicals have been identified for a very wide range of applications and geographical situations. Alternatives exist for a wide range of crop-pest complexes and it may be that for each specific crop-pest complex an appropriate combination of chemical, biological and cultural control action may be taken.

5. Endosulfan can be replaced in most cases by equally or more efficient alternatives. However, some information indicates that it may be difficult to replace endosulfan for specific crop-pest complexes in some countries or due to specific properties of endosulfan such as appropriateness for pollinator management, IPM systems, insecticide resistance management and its broad spectrum of targeted pests.

6. Several countries expect increased costs for agricultural production and price increases for agricultural products. Some information on costs of chemical alternatives indicates that these are significantly higher than costs of endosulfan. However, examples concerning production of cotton and other crops where the use of endosulfan was banned indicate that alternatives are economically comparable or can even lead to reduced costs for farmers and increased incomes. For countries manufacturing endosulfan, there may be significant losses in profit related to manufacture, as well as impacts on society related to lost employment. At a global level, profits and job losses will be outweighed by sales of chemical alternatives and the implementation of non-chemical alternatives and non-monetarized long term benefits for environment and health would be achieved.

7. An analysis of possible control measures demonstrates that listing of endosulfan in Annex A of the Stockholm Convention without specific exemptions would eliminate the manufacture, use, import and export of endosulfan. Such a listing would send a clear signal that production and use of endosulfan must be phased out by the time the obligation comes into force. Considering that at least 60 countries have banned or are phasing out the use of endosulfan, it can be assumed that there are viable alternatives (e.g. chemical alternatives, semio-chemicals, biological control, organic farming, IPM) available in many different geographical situations both in developed and developing countries. The chemical alternatives will need to be effective, less hazardous than endosulfan to human health or the environment, and not possess POP-like characteristics. However, replacing endosulfan with chemical and non-chemical alternatives may be difficult and/or costly for some specific crop pest complexes in some countries. Several countries that are currently phasing out endosulfan have indicated a need to continue some applications of endosulfan to allow for the phase-in of alternatives. Furthermore, taking into account that replacing endosulfan with chemical and non-chemical alternatives may be difficult and/or costly for some specific crop pest complexes in some countries, it may be necessary to address those situations through specific exemptions under Annex A. In accordance with paragraph 9 of Article 8 of the Convention, the Committee recommends that the Conference of the Parties to the Stockholm Convention considers listing technical endosulfan (CAS 115-29-7), its related isomers (CAS 959-98-8 and 33213-65-9) and endosulfan sulfate (CAS 1031-07-8) in Annex A with specific exemptions.

1 Introduction

8. In July 2007 the European Community and its Member States being parties to the Stockholm Convention proposed endosulfan to be listed in the relevant annexes of the Convention (UNEP/POPS/POPRC.4/14). The Committee “agreed to suspend consideration of the chemical” until its fourth meeting (UNEP/POPS/POPRC.4/15).

9. At its fifth meeting in October 2009 the POPRC reviewed and adopted a revised draft risk profile on endosulfan (UNEP/POPS/POPRC.5/10/Add.2). The POPRC “decided, in accordance with paragraph 7 (a) of article 8 of the Convention, and taking into account that a lack of full scientific certainty should not prevent a proposal from proceeding, that endosulfan is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted”. The Committee decided to develop for endosulfan a risk management evaluation document that includes an analysis of possible control measures for consideration at its next meeting and final recommendation to the COP for its listing in the Annexes of the Convention.[1]

10. Relevant additional information is provided as a supporting document (see UNEP/POPS/POPRC.6/INF/12).

11. Parties and observers have been invited to submit to the Secretariat information specified in Annex F information by 8 January 2010.[2] The submitted information is considered in this document. The information submitted is compiled in supporting document UNEP/POPS/POPRC.6/INF/24.

1.1 Chemical identity of Endosulfan

1.1.1 Chemical Identity

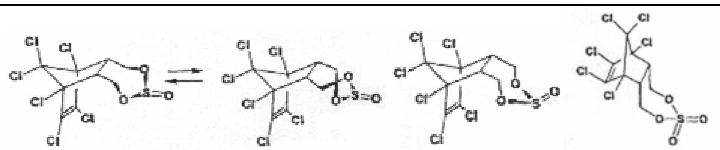
Names and registry numbers

Common name	Endosulfan	
IUPAC Chem. Abstracts	6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide 6,9-methano-2,4,3-benzodioxathiepin-6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9-hexahydro-3-oxide	
CAS registry numbers	alpha (α) endosulfan	959-98-8
	beta (β) endosulfan	33213-65-9
	technical endosulfan *	115-29-7
	endosulfan sulfate: * stereochemically unspecified	1031-07-8
Trade name	Thiodan®, Thionex, Endosan, Farmoz, Endosulfan, Callisulfan	

* Technical endosulfan is a 2:1 to 7:3 mixture of α- and β-isomer.

12. Technical grade endosulfan is a diastereomeric mixture of two biologically active isomers (α- and β-) in approximately 2:1 to 7:3 ratio, along with impurities and degradation products. The technical product must contain at least 94% endosulfan in accord with specifications of the Food and Agricultural Organization of the United Nations (FAO Specification 89/TC/S) with content of the α-isomer in the range of 64-67% and the β-isomer of 29-32%. The α-isomer is asymmetric and exists in two twist chair forms while the β-form is symmetric. The β-isomer is easily converted to α-endosulfan, but not vice versa (UNEP/POPS/POPRC.5.3).

Structures

Molecular formula	$C_9H_6Cl_6O_3S$	$C_9H_6Cl_6O_4S$
Molecular mass	406.96 g·mol^{-1}	422.96 g·mol^{-1}
Structural formulas of the isomers and the main transformation product	 α-endosulfan β-endosulfan endosulfan sulphate	

[1] http://chm.pops.int/tabid/588/Default.aspx
[2] http://chm.pops.int/tabid/655//Default.aspx

1.1.2 Production and uses

Production, trade, stockpiles

13. Endosulfan is synthesized via the following steps: Diels-Alder addition of hexachloro-cyclopentadiene and cis-butene-1,4-diol in xylene. Reaction of this cis-diol with thionyl chloride forms the final product.

14. Endosulfan was developed in the early 1950s. Global production of endosulfan was estimated to be 10,000 tonnes annually in 1984. Current production is judged to be significantly higher than in 1984 and is estimated to range between 18,000 to 20,000 tonnes per year (India 2010 Annexure I). India is regarded as being the world's largest producer (9,900 tonnes per year (Government of India 2001-2007)) and exporter (4,104 tonnes in 2007-08 to 31 countries (Government of India)) (according to (UNEP/POPS/POPRC.5/10/Add.2)). Current production in India ranges between 9,500 tonnes (according to (India 2010 Annexure I)) and 10,500 tonnes in the states Gujarat, Kerala and Maharashtra (according to (India 2010)). India, accounts for 50% -60% of global production of endosulfan (India 2010 Annexure-I). In China, the output of endosulfan was 4,602 tonnes for 2006, 5,003 tons for 2007, and 5,177 tons for 2008 (China 2010). Production in Germany stopped at 2007 (approximately 4,000 tonnes per year)[3] but export could continue until the end of 2010 (UNEP/POPS/POPRC.5/10/Add.2). Other producers with unknown production quantities are located in Israel, Brazil and the Republic of Korea (UNEP/POPS/POPRC.5/10/Add.2).

15. To conclude, current annual production amounts to 18,000 to 20,000 tonnes worldwide. Roughly 10,000 tonnes are produced in India, 5,000 tonnes in China and 3,000 to 5,000 tonnes in Israel, Brazil and the Republic of Korea.

16. Historic production in Europe amounted to 10,000 to 50,000 tonnes per year (Germany 2010). Endosulfan production stopped in the Czech Republic, Germany, the Netherland and in Italy in 2006/2007. It has never been produced in Croatia, Cyprus, Estonia, Ireland, Norway, Slovenia, Sweden and Ukraine (UNECE 2010: CR, CY, DE, EE, HR, IE, NL, NOR, IT, SE, SI).

17. Endosulfan has never been produced in Canada; in the USA production stopped in the 1980s (UNECE 2010: CA, USA).

18. Prior to its ban in Colombia endosulfan was produced until 2001 (production quantities from 1994 to 2001 were: 1994, 198.5 t; 1995, 268.8 t; 1996, 216 t; 1997, 181.9 t; 1998, 382.6 t; 1999, 279.0 thousand litres; 2000 and 2001, 505.4 thousand litres) (Colombia 2010).

Uses

19. Endosulfan is an insecticide which has been used for over 50 years to effectively control several pests, e.g. chewing, sucking and boring insects, including aphids, thrips, beetles, foliar feeding caterpillars, mites, borers, cutworms, bollworms, bugs, white flies, leafhoppers, snails in rice paddies, and tsetse flies.

20. Endosulfan is used on a very wide range of crops. Major crops to which it is applied include soy, cotton, rice, and tea. Other crops include vegetables, fruits, nuts, berries, grapes, cereals, pulses, corn, oilseeds, potatoes, coffee, mushrooms, olives, hops, sorghum, tobacco, and cacao. It is used on ornamentals and forest trees, and has been used in the past as an industrial and domestic wood preservative, and for controlling earthworms in turf.

21. The use of endosulfan is now banned or is being phased out in at least 60 countries[4] with former uses replaced with alternative products and methods. More detailed information on current uses as informed by Parties and observers is provided in the supporting document to the endosulfan risk profile (see UNEP/POPS/POPRC.5/INF/24). The countries that are reported to have banned endosulfan cumulatively account for less than 2,000 metric tons of endosulfan usage, which is approximately 12% of present global use. Once endosulfan is completely banned in countries where it is being phased out, this figure will increase to 8,000 metric tons, i.e. 45% of present global use.

[3] A huge majority of this volume is exported for use in tropical and subtropical regions such as Latin America, Caribbean and southeast Asia (UNECE 2007)
[4] Austria, Australia, Bahrain, Belgium, Belize, Benin, Brazil, Bulgaria, Burkina Faso, Cambodia, Canada, Cape Verde, Chad, Colombia, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Gambia, Germany, Greece, Guinea Bissau, Hungary, Indonesia, Ireland, Italy, Jamaica, Japan, Jordan, Kuwait, Latvia, Lithuania, Liechtenstein, Luxembourg, Malaysia, Mali, Malta, Mauritania, Mauritius, Morocco, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Poland, Portugal, Qatar, Republic of Korea, Romania, Saudi Arabia, Senegal, Singapore, Slovakia, Slovenia, Spain, Sri Lanka, St Lucia, Sweden, Switzerland, Syria, the United Arab Emirates, United Kingdom, United States of America. In Morocco, the Pesticides Committee decided at its last meeting that pesticide preparations containing endosulfan will be withdrawn from the Moroccan market. The deadline is December 31, 2010. See http://www.onssa.gov.ma/onssa/fr/doc_pdf/PV_CPUA_GLOBAL_22_AVRIL_2010.pdf. In USA, the Environmental Protection Agency has withdrawn approval for all uses of endosulfan.

22. Some countries or regions which have recently banned endosulfan, have needed to permit temporary use of endosulfan for specific applications (e.g. Italy and Romania). More information is provided in the supporting document (UNEP/POPS/POPRC.6/INF/23). Countries that are in the process of phasing out endosulfan (see paragraphs below and section 1.5) have indicated that they will allow some continued uses of endosulfan for a specified period of time or until the most appropriate alternatives are accessible.

23. In 2006, the US EPA registered the use of endosulfan as a veterinary insecticide to control ectoparasites on beef and lactating cattle. It is used as an ear tag in cattle and accounts for almost 25% of the US market share of cattle ear tags (KMG Bernuth 2009). The USA completed a re-evaluation of endosulfan in June 2010 and has signed a formal Memorandum of Agreement with manufacturers of the agricultural insecticide endosulfan that will result in voluntary cancellation and phase-out of all existing endosulfan uses in the United States.[5] The phase-out period will be six years with the vast majority of endosulfan's current use sites being phased out by the end of 2014. The phase out period takes into consideration the time needed for growers to transition to lower-risk pest control practices. EPA is also requiring additional mitigation measures during the phase-out period to minimize worker risks associated with endosulfan use on these crops (USA 2010).

24. Brazil completed a re-evaluation of endosulfan in July 2010 and decided to ban all uses of endosulfan by 31 July 2013. The determination is based on toxicological studies involving the use of pesticides, indicating reproductive and endocrine problems in farm workers. The ban is being phased in and has already come into force in 16 states out of 27 states in Brazil and is valid for all types of crops (except coffee, cotton, soy bean and sugar cane) and for ant control and wood preservation. By 31 July 2013 the commercialization of formulated products based on endosulfan will be forbidden in the whole country for all types of crops and its use will be forbidden (law RDC 28; www.anvisa.gov.br).

25. In the Indian State of Kerala the use of endosulfan has been put on hold vide Gazette notification No. S.O.1874 (E) dt 31-10-2006 by the Government of India. Use of endosulfan in the State of Kerala accounts for less than 2% of the domestic consumption of endosulfan in India.

26. Countries using varying amounts of endosulfan, include Australia, Argentina, Brazil, Cameroon, Canada, Chile, China, Costa Rica, Ghana, Guatemala, India, Israel, Japan, Kenya, Madagascar, Mexico, Mozambique, Paraguay, Pakistan, Republic of Korea, Sierra Leone, South Africa, Sudan, Tanzania, Uganda, USA, Zambia, Zimbabwe.

27. According to the International Stewardship Centre (ISC), the total average annual use of endosulfan is estimated at approximately 15,000 metric tonnes of active ingredient with Brazil, India, China, Argentina, the USA, Pakistan, Australia and Mexico representing the major markets. According to ISC, the use in Latin America and Asia has been growing consistently (ISC 2010). Endosulfan is one of the most used insecticides in India. Out of an estimated annual production of 9,500 tonnes, 4,500 to 5,000 tonnes are consumed domestically (India 2010 Annexure-I).

28. Further details are given in the supporting document UNEP/POPS/POPRC.6/INF/12.

1.2 Conclusions of the Review Committee regarding Annex E information

29. At its fifth meeting in Geneva from 12 to 16 October 2009 the POPRC reviewed and adopted a revised draft risk profile on endosulfan prepared in accordance with Annex E by which it agrees that the POP characteristics of the chemical warrant global action.

30. Having completed the risk profile for endosulfan in accordance with paragraph 6 of Article 8 of the Convention, the POPRC adopted the risk profile for endosulfan contained in Addendum 2 to the report of the POPRC on the work of its fifth meeting and:

a) Decided, in accordance with paragraph 7 (a) of article 8 of the Convention, and taking into account that a lack of full scientific certainty should not prevent a proposal from proceeding, that endosulfan is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects such that global action is warranted;

b) Also decided, in accordance with paragraph 7 (a) of article 8 of the Convention and paragraph 29 of the annex to decision SC-1/7 of the Conference of the Parties to the Stockholm Convention, to establish an ad hoc working group to prepare a risk management evaluation that includes an analysis of possible control measures for endosulfan in accordance with Annex F to the Convention;

c) Invited, in accordance with paragraph 7 (a) of article 8 of the Convention, Parties and observers to submit to the Secretariat the information specified in Annex F for endosulfan before 8 January 2010.

[5] See http://www.epa.gov/pesticides/reregistration/endosulfan/endosulfan-agreement.html

1.3 Data sources

1.3.1 Overview of data submitted by Parties and observers

31. The Risk Management evaluation is primarily based on information that has been provided by Parties to the Convention and observers. Responses regarding the information specified in Annex F of the Stockholm Convention (risk management) have been provided by the following 27 Parties and observers:

a) Parties: Australia, Brazil, Bulgaria, Burundi, Canada, Colombia, Costa Rica, Croatia, Germany, India, Japan, Lithuania, Madagascar, Mexico, Monaco, Norway, Poland, Romania, Sri Lanka, Switzerland, Togo, Ukraine.

b) Observers: PAN[6], IPEN[7], ISC[8], USA, Malaysia

32. The Annex F information provided by these Parties and observers is presented in a supporting document "Compilation of information on endosulfan provided according to Annex F" (UNEP/POPS/POPRC.6/INF/24).

33. A questionnaire related to production, use and alternatives of endosulfan was sent to the Parties to the UNECE LRTAP Convention and to a group of stakeholders from industry. Relevant results from the survey are used in the present report (see UNECE 2010). Other information sources are listed under "References".

1.3.2 Information on national and international management reports

34. National risk management plans are or will be established on the basis of re-evaluations of risks from endosulfan in Australia, Brazil, Canada and the USA (see chapters 1.5 and 2.1).

1.4 Status of endosulfan under International Conventions

35. Endosulfan is subject to a number of agreements, regulations and action plans:

a) In March 2007 the Chemical Review Committee (CRC) of the Rotterdam Convention on the Prior Informed Consent Procedure (PIC) for Certain Hazardous Chemicals and Pesticides in International Trade decided to forward to the conference of the parties of the Convention (COP) a recommendation for inclusion of endosulfan in Annex III. Annex III is the list of chemicals that are subject to the PIC procedure. Listing in Annex III is based on two notifications from different regions of regulatory action banning or severely restricting the use for health or environmental reasons that were found to meet the criteria listed in Annex II of the Convention. The COP in 2008 was not able to reach consensus on inclusion of endosulfan due to the opposition of some Parties (UNEP/FAO/RC/COP.4/240, and decided to further consider the draft decision at the next COP. Meanwhile, the CRC has been evaluating further notifications of endosulfan, and has agreed to forward to the next COP a recommendation to list endosulfan in Annex III based on notifications of final regulatory action by the European Union and 8 of the 9 West African countries that take joint regulatory action through the Sahelian Pesticides Committee (Burkina Faso, Cape Verde, Gambia, Guinea Bissau, Mali, Mauritania, Niger and Senegal) (UNEP/FAO/RC/CRC.6/7).

b) Endosulfan has been proposed and is currently considered as a candidate for inclusion in the Annex I to the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants of the United Nations Economic Commission for Europe (UNECE LRTAP Convention).

c) Endosulfan is recognized as one of the twenty-one high-priority compounds identified by UNEP-GEF (United Nations Environment Programme – Global Environment Facility) during the Regional Evaluation of Persistent Toxic Substances (STP), 2002. These reports have taken into account the magnitude of usage, environmental levels and effects for human beings and for the environment of this compound.

d) The UNECE has included endosulfan in Annex II of the Draft Protocol on Pollutant Release and Transfer Registers to the AARHUS Convention on access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters.

e) The Helsinki Commission, or HELCOM, works to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental co-operation between Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. The contracting parties have agreed that by 2010 in the whole Baltic Sea catchment area of the Contracting States to ban the use, production and marketing of endosulfan (Lithuania 2010).

f) The OSPAR Commission has included endosulfan in the List of Chemicals for Priority Action (update 2002)

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[6] Pesticides Action Network International (PAN)
[7] International POPs Elimination Network (IPEN)
[8] International Stewardship Centre, Inc.

g) In the Third North Sea Conference (Hague Declaration, 8th March 1990), endosulfan was agreed on the list of priority substances.

1.5 Any national or regional control actions taken

36. Specific national or regional control actions for endosulfan have been provided under Annex F (g) by several parties.

37. Burundi reports on regulations concerning imports and storage of endosulfan (Burundi 2010).

38. The CILSS countries that are members of the Economic Community of West African States (ECOWAS) have already phased out endosulfan (Togo 2010).

39. The Sahelian Pesticides Committee (CSP) has banned all formulations containing endosulfan. The CSP is the structure for the approval of pesticides for CILSS Member States (Burkina Faso, Cape Verde, Chad, Gambia, Guinea Bissau, Mali, Mauritania, Niger and Senegal). The deadline set for termination of the use of existing stocks of endosulfan was 12 December 2008.

40. In Australia, in the course of a review of endosulfan which was completed in 2005[9], a number of measures and restrictions were implemented that have been put in place in order to reduce environmental and health impacts and trade risks. These measures include withholding periods and livestock feeding restraints; mandatory buffer zones for spraying; removal of specific uses (beans, sweet corn and peas); specific label instructions; mandatory neighbour notification; record keeping requirements; restricted availability to persons with appropriate training (Australia 2010). However, these measures were not designed to prevent long-range transport of endosulfan to the Arctic or Antarctic regions[10]. On 12 October 2010, Australia cancelled the registrations of all endosulfan products with a phase out of all uses by 12 October 2012. This action was taken on the basis of a risk assessment that concluded that endosulfan is likely, because of its potential for off-site movement (spray drift and run-off), to lead to significant adverse chronic and sub-chronic environmental effects from continued and prolonged use. These risks cannot be mitigated through restrictions on use of products or variations to label instructions. (http://www.apvma.gov.au/news_media/media_releases/2010/mr2010-12.php)

41. In the 27 EU Member States the use of endosulfan as plant protection product is banned. The authorisation of endosulfan as active substance in plant protection products has been withdrawn (Commission Decision 2005/864/EC of 2 December 2005, concerning the non-inclusion of endosulfan in Annex I to Council Directive 91/414/EEC).

42. National actions in Canada are described in the re-evaluation by Health Canada's Pest Management Regulatory Agency (see chapter 1.3.2). Label changes which will affect the allowed use, will be implemented by the 2012 growing season (Canada 2010). In August 2010, Canada announced that continued registration and use of endosulfan can no longer be supported. Canada is currently working on phase-out details and schedule.

43. USA EPA's Re-registration Eligibility Decision (RED) was completed in 2002. In 2010, following a post-re-registration evaluation of risks and benefits, the US EPA determined that endosulfan posed unacceptable risks to agricultural workers and wildlife. US EPA has signed a formal Memorandum of Agreement with manufacturers of the agricultural insecticide endosulfan that will result in voluntary cancellation and phase-out of all existing endosulfan uses in the United States. The phase-out period will be six years with the vast majority of endosulfan's current use sites being phased out by the end of 2014. The phase out period takes into consideration the time needed for growers to transition to lower-risk practices where there are fewer alternatives to endosulfan. EPA is also requiring additional mitigation measures during the phase-out period to minimize worker risks associated with endosulfan use on these crops. [11]

44. Endosulfan is designated as an agricultural chemical causing water pollution under Japan's Order for Enforcement of the Agricultural Chemicals Regulation Law. Local governments can restrict use of the agricultural chemicals causing water pollution (Japan 2010). Production, processing and import of agricultural chemicals containing endosulfan as an active substance have not been allowed since the registration expired on 29 September 2010).

45. Brazil reports on labelling requirements for endosulfan with specific information about harmful effects on the environment, equipment requirements, application, dosage, cleaning and disposal of containers and aircraft application buffer zones (Brazil 2010). Brazil has also decided to ban all uses of endosulfan by 31 July 2013 (see section 1.1.2).

[9] http://www.apvma.gov.au/products/review/completed/endosulfan.php
[10] Comment by PAN and IPEN on the second draft risk management evaluation.
[11] More information can be found at
http://www.epa.gov/pesticides/reregistration/endosulfan/endosulfan-cancl-fs.html
http://www.epa.gov/pesticides/reregistration/endosulfan/endosulfan-agreement.html
http://www.epa.gov/pesticides/reregistration/endosulfan/endosulfan-cancl-fs.html#decision
http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/44c035d59d5e6d8f8525773c0072f26b!OpenDocument

46. In Colombia the import, production and placing on the market of endosulfan was severely restricted in 1997. The only exempted use for endosulfan containing products was for the coffee pest organism *Hypothenemus Hampei*. In 2001 the exemption was abrogated and the authorisations for plant protection products containing endosulfan were cancelled (Colombia 2010).

47. In Costa Rica specific legal restrictions for endosulfan have beene in place since 2009. These are sales restrictions, use restrictions, prohibition of use for the rice cultivation, respect of protected areas and provisions for worker protection (Costa Rica 2010).

48. The National Institute of Ecology of Mexico has planned to carry out an analysis of the situation of endosulfan in order to improve the knowledge about this substance (Mexico 2010).

2 Summary information relevant to the risk management evaluation

2.1 Identification of possible control measures

49. The following control measures are potentially available for endosulfan: (1) prohibition or restriction of production, use, import and export; (2) replacement of the chemical by chemical and/or non-chemical alternatives; (3) termination of processes which could lead to unintentional release of the chemical (such as specific use conditions and restrictions, through trainings, and better labelling); (4) clean-up of contaminated sites; (5) environmentally sound management of obsolete stockpiles; (6) establishment of exposure limits in workplaces; and, (7) establishment of maximum residue limits in water, soil, sediment or food.

50. Currently applied control measures cover the whole spectrum of possible control measures. The use of endosulfan is currently banned or being phased out in at least 60 countries and replaced by alternatives. In some of the endosulfan using countries, use of endosulfan is restricted to specific authorised uses and specific use conditions and restrictions are usually established in order to control health and environmental risks in the country concerned. Clean up of contaminated sites and management of obsolete pesticides may particularly become a relevant issue in countries where endosulfan is manufactured. In many countries workplace exposure limits and maximum residue limits for different matrices are established (see UNEP/POPS/POPRC.3/INF/9). However, despite existing control measures it has to be noted that in other countries endosulfan is used under inappropriate use conditions (e.g., without personal protection equipment or appropriate training) (see e.g. PAN and IPEN 2010 Add 1).

51. Currently applied control measures by Parties include prohibition of production, use, import and export and replacement by alternatives, supply and use restriction, environmentally sound management of prohibited and obsolete pesticides. Specific control measures include: limits on frequency of spraying; introduction of mandatory buffer zones during spraying to reduce off-target spray drift; revised labels; record keeping; withholding periods; neighbour notification; consideration of downwind surrounding; time restrictions; user training and certification; maximum residue limits of endosulfan in the environment and in food; specific prescriptions for classification and labelling; reporting of release and transfer; personal protective equipment; precautions and packaging of wettable powder formulations in water soluble bags to protect mixers, loaders and applicators; restricted-entry intervals to protect those re-entering treated sites; reduced rates and numbers of applications for some crops; and removal of several crops from product labels. For details see supporting document (UNEP/POPS/POPRC.6/INF/12).

2.2 Efficacy and efficiency of possible control measures in meeting risk reduction goals

2.2.1 Technical feasibility

52. General technical feasibility is demonstrated for all possible control measures as they are already applied in many countries. The control measure “prohibition or restriction of production, use, import and export” has as a consequence the need to substitute endosulfan by chemical and/or non-chemical alternatives. Therefore the information provided by parties and observers and the discussion of technical feasibility concentrates on the technical feasibility of the substitution. Another relevant aspect is the feasibility of cleaning-up of contaminated sites and the management of obsolete stockpiles.

53. Many countries, including both developed and developing countries, have banned the use of endosulfan. It is likely that viable alternatives are available in many different geographical situations. However, the efficacy and efficiency of possible control measures is country-dependent. The technical feasibility of the substitution of endosulfan by alternatives is discussed in chapter 2.3.2.

54. The technical feasibility related to waste and disposal implications is given. There seem to be no or only small stocks of obsolete endosulfan containing pesticide products in most countries. However, the countries that still manufacture endosulfan may have considerable stocks to manage and there may be a need to clean-up contaminated sites. The destruction of endosulfan does not pose a technical problem. In some countries access to appropriate destruction facilities is limited but these countries seem to have no or low stockpiles.

55. Information was provided by parties and observers according to Annex F. For details see supporting document (UNEP/POPS/POPRC.6/INF/12).

2.2.2 Identification of critical uses

56. Possible critical uses for which there may not be accessible chemical and/or non-chemical alternatives in a country include: (a) specific crop-pest combinations; or, (b) situations where such alternatives are not appropriate because of specific advantages of endosulfan or specific disadvantages of accessible alternatives. According to some parties and observers it could be difficult to substitute endosulfan currently for specific crop-pest complexes e.g. in soybean, cotton, coffee, cane sugar and sunflower in Brazil and Argentina (Brazil 2010, ISC 2010) or due to properties of endosulfan such as appropriateness for pollinator management, IPM systems, insecticide resistance management and its broad spectrum of targeted pests (Brazil 2010, China 2010, India 2010, ISC 2010, US EPA 2010[12]). Other information indicates endosulfan is not appropriate for pollinator management or IPM (see chapter 2.3.4).

Critical uses related to specific crop-pest combinations

57. Australia, Canada, Malaysia and the USA[13] provided information on specific crop-pest combinations for which a chemical alternative is currently not registered. This does not mean that they are not available and the problem could be overcome in foreseeable time if alternative chemicals could be registered or non-chemical alternatives could be implemented for the relevant crop-pest combinations.

58. According to member companies of ISC, endosulfan is important in some major applications, i.e. in cotton, cane sugar, soybeans, sunflower and coffee in South America and hazelnuts in Europe (ISC 2010).

59. According to Australia, implementing control measures on endosulfan would have a negative impact on cashew nuts (production 25 tonnes/year)[14], cucurbits, guava, kiwi fruit, longans, loquats, mango, rambutans and tamarillo, as currently, endosulfan is the only chemical registered on these crops to control the fruit spotting bug (*Amblypelta lutescens*). Loss of endosulfan could mean loss of control and economic loss for growers until alternatives are adequately in place (Australia 2010). There are actives registered for fruit spotting bug in other tropical fruit and nut crops that could potentially be registered for other crops after significant research. The Rural Industries Research and Development Corporation also undertook research into IPM for rambutans.[15] Sixteen insecticides were screened where beta-cyfluthrin was identified as an “effective alternative” to endosulfan. However, synthetic pyrethroids such as beta-cyfluthrin are recognised as being highly disruptive to beneficial insects.[16] A number of potential options for fruit spotting bug management have been identified, e.g., sex pheromones, plant attractants and biopesticides, carrying the caveat that solutions will only come from considerable research investment. Such research is occurring but unlikely to provide the needed solutions in the short-term.[17]

60. Canada has provided a list of alternative registered active ingredients to endosulfan for those site-pest combinations of commercial class products that are not supported by the technical registrant or for which risk concerns have been identified (Canada 2010 Ref 2) (see Annex I of the supporting document UNEP/POPS/POPRC.6/INF/12).

61. For three crop pest complexes there are currently no alternatives registered in Malaysia (Malaysia 2010).

62. Currently India uses endosulfan on 20 crops for pest control. Endosulfan is considered in India to be a critical tool for Insecticide Resistance Management. Endosulfan is used for controlling pests such as boll worms and white fly on cotton, stem borer and BPH of paddy, pod borer of pulses and various sucking and chewing insect pests of fruits and vegetables in which insecticide resistance has previously occurred. Because it is a broad spectrum pesticide and because of the difficult climatic conditions (hot and humid) that lead to complex crop pest situations, endosulfan is recommended in IPM modules for major crops such as cotton, rice, tea, soybeans, mustard and sunflower. It is important in India for bee

[12] The US EPA has also identified a limited number of situations where endosulfan has advantages over available alternatives for pollinator management and insecticide resistance management. See, for example, information on vegetable seed production and cattle ear tags at http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EPA-HQ-OPP-2002-0262, documents 156 and 161.

[13] The US EPA has also identified situations where specific crop-pest combinations currently lack adequate registered alternatives. See, for example, information on pineapple, strawberry, and blueberry, at http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EPA-HQ-OPP-2002-0262, documents 157, 158, and 175.

[14] http://www.fao.org/inpho/content/documents/vlibrary/ac306e/ac306e00.htm

[15] https://rirdc.infoservices.com.au/downloads/09-187.pdf

[16] Wilson L., Mensah R., Dillon M., Wade M., Parker N., Scholz B., Murrray D., Heimoana V., Lloyd R., 2005. IPM Guidelines Support Document 1: Impact of insecticides and miticides on predators in cotton, October 2005 update. Cotton Catchment Communities CRC, Australia.

[17] https://rirdc.infoservices.com.au/downloads/09-154.pdf (according to comment from Australia on the 2nd draft risk management evaluation document)

foraging crops such as paddy, certain vegetables, certain horticulture crops, pulses and sugar cane (India, personal communication).

63. According to Brazil endosulfan is a very important product for Integrated Pest Management of soybean (pests: *Anticarsia gemmatalis, Euschistus heros, Nezara viridula, Piezodorus guildinii*), sugar cane (pest: *Migdolus fryanus*), cotton (pest: *Anthonomus grandis*) and coffee (pest: *Hypothenemus hampei*) due to its efficacy and competitive properties (Brazil 2010)[18]. However a wide range of biological control organisms are being used to replace endosulfan for coffee berry borer (*Hypothenemus hampei*) in coffee cultivation in Brazil and near-by countries, including the parasitic wasps *Cephalonomis stephanotheris* and *Phymastichus coffea*, the entomopathogenic fungus *Beauvaria bassiana*, as well as neem. Biological controls are also being used to replace endosulfan in soybean, cotton and sugar cultivation in Brazil (Bejarano et al. 2009; PAN & IPEN 2010 Ref 8).

Critical uses related to advantages of endosulfan or specific disadvantages of available alternatives

64. Critical uses of endosulfan exist if the use of chemical and non-chemical alternatives is not technically feasible for specific crop-pest situations. According to some countries using endosulfan the technical feasibility of substitution is currently restricted due to specific advantages of endosulfan (see chapter 2.3.4). Other information sources contradict these arguments and bring the same arguments forward as advantages of safer alternative chemicals and practices which would be available for all known uses and geographical situations (see chapter 2.2.1). The commercial availability of an alternative could be seen as an indicator of technical feasibility (UNEP/POPS/POPRC.5/10/Add.1).

2.2.3 Costs and benefits of implementing control measures

65. Costs and benefits depend strongly on the status of control in the individual countries and the assessed control measures. An adequate social and economic assessment should not only account for the costs of switching to an alternative, but also the benefits. There should be no bias towards impacts that are quantitatively described simply because of the quantification (as impacts that cannot be described quantitatively may be of equal or greater importance) (UNEP/POPS/POPRC.5/10/Add.1).

66. Possible costs related to replacing the use of endosulfan with chemical and non-chemical alternatives include: (1) net impact on implementation costs for governments and authorities; (2) net impacts on industry (manufacturing and retailing of plant protection products); (3) net impacts on agriculture (costs for use of alternatives and costs due to altered productivity in terms of quantity or quality); (4) net impacts on society (consumer costs for agricultural products, costs for management of obsolete pesticides and remediation of contaminated sites, waste disposal costs); and, (5) net impact on environment and health (e.g. costs due to contamination of water and other natural resources including food resources and costs due to health impacts from acute (including poisoning) and chronic exposure for the whole population and specific population groups). Some of these costs and benefits can be difficult to monetarize.

67. After doing a cost-benefit analysis, there may be a need for some countries to do a trade-off analysis before coming to any conclusion (India, personal communication).

68. For the evaluation of direct cost impacts on agriculture it is considered most important to identify possible alternatives (chemicals, semio-chemicals, biological control, IPM, organic farming and specific cultural practices), related costs, their efficiency compared to endosulfan, impacts on yields and output prices of agricultural products.

69. Parties and observers have provided information that can contribute to evaluate possible costs of control measures. Several countries expect increased costs for agricultural production and price increases for agricultural products. Information on costs of some chemical alternatives indicates that these are significantly higher. However, examples concerning production of cotton and other crops where the use of endosulfan was banned indicate that alternatives are economically comparable or can even lead to reduced costs for farmers and increased incomes. Expectations for costs for the management and disposal of waste and obsolete stockpiles range from low to high. Implementation costs for governments are also possible. Endosulfan causes significant adverse effects on human health and the environment. As a consequence it can be expected that the current use of endosulfan causes significant non-quantifiable environmental and health costs. For further details see supporting document UNEP/POPS/POPRC.6/INF/12.

70. Table 1 provides an overview of the possible cost impacts. Details and assumptions for the assessment are explained in supporting document UNEP/POPS/POPRC.6/INF/12.

[18] Despite the fact that endosulfan is very important for IPM, Brazil has decided to ban the active ingredient endosulfan by 31 July 2013 through a phase out schedule. The ban is based on toxicological studies involving the use of pesticides (see section 1.1.2 of the present document).

Table 1. Overview on possible cost impacts

Type of cost impact	Quantification
Implementation costs for governments and authorities	• One time administrative costs could range from 0.82 to 4.53 million USD. Realistic estimate: below 1.65 million USD. • Non-quantified costs for the registration of suitable alternatives.
Cost impacts on industry	• In countries where endosulfan is already banned and is no longer produced, the cost impacts on industry are nil or negligible. • Annual losses for manufacturers in countries where endosulfan is still produced were estimated to be 107 to 162 million US dollars (India: $62 -$100 million, including both domestic and export sales[19]; China, $31 million; Israel, Brazil and the Republic of Korea, $14 to $31 million). • Globally the losses may be more or less outweighed by sales of chemical and non-chemical alternatives.
Cost impacts on agriculture	• Annual cost impacts due to increased plant protection if endosulfan is replaced by chemical alternatives are in a range 0 and 40 million US dollars (for Brazil, 0 to $13.87 million[20]; for India (depending on the number of applications per hectare), 0 to $24 million, for China, 0 to $8 million; for Argentina, 0 to $3 million; for the USA, 0 to $3 million; and for the rest of the world, 0 to $9 million). • Non-quantified reductions in cost in certain situations where endosulfan will be replaced by non-chemical alternatives.
Cost impacts on society	• Possible price increases of agricultural products up to 40 million US dollars. • One-time costs for the management of stockpiles have been estimated to range from $103 thousand to $228 thousand US. However, these costs could be significantly higher. These costs would particularly incur in India ($57,000 to $113,000 US), China ($28,000 to $57,000 US), Israel, Brazil and the Republic of Korea ($18,000 to $58,000 US). • Possible job losses associated with the manufacture of endosulfan, e.g., India estimates 6,000 persons are employed in endosulfan manufacture
Cost impacts on environment and health	• Significant, non-monetarised long term benefits for environment and health, but possible short-term or localized negative effects, depending on alternative pest control measure employed.

2.3 Information on alternatives (products and processes)

2.3.1 Description of alternatives

71. A number of chemical alternatives were mentioned by Parties and observers. A screening assessment has been undertaken by the intersessional working group according to the guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals (UNEP/POPS/POPRC.5/10/Add.1). For more information see UNEP/POPS/POPRC.6/INF/23.

72. Alternatives to endosulfan include not only alternative substances that can be used without major changes in the process design, but also innovative changes such as agricultural processes or other practices that do not require the use of endosulfan or chemical substitutes. Possible alternatives are: (a) chemical alternatives; (b) semio-chemicals; (c) biological control systems; and (d) agro-ecological practices such as Integrated Pest Management (IPM), organic farming and other specific agricultural practices.

73. Generally it is important that the whole range of alternatives is considered when evaluating possible alternatives. In many cases the comparison is focused on chemical alternatives and neglects non-chemical alternatives.

74. Endosulfan is used mainly on cotton, tea, coffee, soybean, sunflower, vegetables, rice, pulses and fruit. From the information provided by parties and observers a wide range of technically feasible alternatives has been identified. The identified alternatives are listed in Annex I of the supporting document (UNEP/POPS/POPRC.6/INF/12) including the chemical, semio-chemical and biological alternatives, the corresponding crop-pest combination and a reference indicating which country or observer has provided the corresponding information. In total, information on almost 100 chemical

[19] These calculations are based on the following assumptions by India; 20 million litres of endosulfan formulation ($12 million for domestic use and $8 million for export) at $5 US per litre = $100 million US.

[20] According to an estimate provided by Brazil in August 2010, the annual cost in Brazil to replace endosulfan with chemical alternatives would amount to approximately $34 million US (for details of the estimate and possible reasons for the discrepancy see chapter 2.3.3.1 of the supporting document UNEP/POPS/POPRC.6/INF/12).

alternatives (including plant extracts) and a considerable number of biological control measures and semio-chemicals and management and cultural practices have been identified for a very wide range of applications, geographical situations and level of development.

2.3.1.1 Chemical alternatives

75. According to Annex F information submitted by Parties and Observers a number of alternatives to endosulfan (including plant extracts) are available for specific crop-pest combinations (see Annex I, Table 10 of UNEP/POPS/POPRC.6/INF/12).

2.3.1.2 Semio-chemicals

76. According to Annex F information several semio-chemicals (i.e., substances which carry a chemical message) can be used as an alternative to endosulfan. For further details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.3.1.3 Biological control systems

77. According to Annex F information a wide range of biological control alternatives to endosulfan (i.e., reduction of pest populations by natural enemies) are available. For further details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.3.1.4 Integrated Pest Management (IPM) Systems

78. IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

79. According to established IPM principles (a) non-chemical alternatives must be preferred to chemical alternatives if they provide satisfactory pest control and (b) chemicals used shall be as target specific as possible and shall have the least side effects on human health, non-target organisms and the environment.[21] However, it should be noted that IPM systems accept critically selected plant protection products that should be available to the grower despite certain negative aspects (especially for reasons of resistance management or earmarked for exceptionally difficult cases). These products should have a short persistence and are permitted only for precisely identified indications with clearly defined restrictions (IOBC, 2004). As a consequence, in IPM systems endosulfan as a chemical alternative should be considered only as a last resort if all non-chemical alternatives fail. Furthermore, between chemical alternatives those with a narrow spectrum (low side effects) and with a short persistence should be preferred. For further details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.3.1.5 Organic farming

80. Organic farming is a form of agriculture that relies on cultural practices such as crop rotation, green manure, compost, biological pest control, and mechanical cultivation to maintain soil productivity and control pests. Organic farming excludes the use of synthetic pesticides. Information has been provided on organic farming in applications where endosulfan is usually used. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.3.1.6 Specific agricultural practices

81. ‘Specific agricultural practices’ mean any cultural practices to support pest management. These include mainly practices that are also used in IPM and organic farming. However, they can generally be applied in any form of agriculture. Such practices include for example varietal selection, use of certified pest free plants, selection of the appropriate planting time, crop rotation, use of flowering plants like marigold and sunflower to attract beneficial insects, use of beneficial insects such as the parasitic wasp *Trichogramma*, use of botanical pesticides, use of trap crops and attractant traps, and collection of infested plant parts (e.g. coffee beans). Information on specific agricultural practices that are appropriate to replace the use of endosulfan has been provided by several parties and observers. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

[21] See IOBC (2004) and EU Directive 2009/128/EC related to sustainable use of pesticides (General Principles of IPM; principles 4 and 5).

2.3.1.7 Chemical, biological and cultural alternatives for crops in India

82. India is the world's largest producer and user of endosulfan. India has indicated that bio-pesticides and bio-control agents such as BTK, *Baviria bassiana*, NPV, *trichogramma* are not found to be efficient in the Indian tropical climate. Nor are they widely accepted by farmers due to difficulties in application.

83. Other information obtained from PAN and IPEN state that there are available alternatives to endosulfan (chemical and biological) for all relevant pest-crop complexes (UNEP/POPS/POPRC.6/INF/23; for details see PAN and IPEN 2010).

2.3.2 Technical feasibility

84. Technical feasibility can be understood to mean whether an alternative (chemical, semio-chemical, biological control, IPM control or cultural control) exists or is expected to be developed in the foreseeable future (see UNEP/POPS/POPRC.5/6).

85. Technically feasible alternatives have been identified in both developed and developing countries where endosulfan has been banned. In addition, the previous chapter demonstrates that the use of endosulfan can be replaced by several chemical and non-chemical alternatives. These exist for a wide range of crop-pest complexes and for each specific crop-pest complex an appropriate combination of chemical, biological and cultural control action may be taken. However, for specific crop-pest complexes appropriate alternatives may not be available. Statements that alternatives do not exist for specific crop-pest complexes may be based on considerations that are focused only on chemical alternatives and may not always consider non-chemical control measures appropriately. In specific cases promising research on semio-chemicals is ongoing and may be used in the foreseeable future.

86. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.3.3 Costs, including environmental and health costs

87. For the evaluation of costs it is considered most important to identify possible alternatives (chemicals, semio-chemicals, biological control, IPM, organic farming and eventually specific cultural practices), related costs, their efficiency compared to endosulfan, impacts on yields and output prices of agricultural products as well as overarching indicators such as incomes of farmers or net cash revenues.

88. In some countries, the pest control costs per ha for chemical alternatives to endosulfan seem to be significantly higher than those for endosulfan. However if endosulfan is replaced by alternatives, reported overall cost impacts range from significant decreased net cash returns (e.g., up to 15% decrease for strawberries in Canada) to only minimal impacts (e.g., 0–1% changes in net revenue in US cotton production) or to significant positive impacts due to reduced production costs at comparable yields (e.g., cotton and other crops in India).

89. Alternatives to endosulfan will have positive economic impacts if they contribute to increased yield, higher output prices and lower production costs and vice versa. As a consequence it is possible to analyse the impacts of alternatives on the individual factors (i.e., yields, prices, and production costs) or the overarching impacts on the income (i.e., incomes of farmers, net cash return) for an assessment of possible economic impacts of the substitution of endosulfan with alternatives.

90. Table 2 shows expected cost impacts on agriculture if endosulfan is replaced by chemical and non-chemical alternatives on the basis of the available information. It has to be kept in mind that replacement by chemical and non-chemical alternatives are not two opposed options but that in practice a certain (non-quantified) share of current endosulfan use would be replaced by chemical alternatives and the remaining share would be replaced by non-chemical alternatives. Correspondingly the overall annual economic impact on agriculture would be a consequence of all chemical and non-chemical replacement strategies that would be put into practice if endosulfan were no longer available. The underlying information and the assumption for the assessment are explained in supporting document UNEP/POPS/POPRC.6/INF/12.

Table 2. Expected economic impacts on agriculture if endosulfan will be replaced by chemical and non-chemical alternatives

Chemical alternatives		
Cost impact factor	**Expected impact**	**Expected costs if endosulfan would be replaced by chemical alternatives**
Yields	Remain stable	Annual cost will increase between 0 and $40 million US Brazil: 0 to $13.87 million US[22] India: 0 to $9.63 million US China: 0 to $7.89 million US Argentina: 0 to $2.89 million US USA: 0 to $2.78 million US Rest of the world: 0 to $9.28 million US
Prices	Remain stable	
Production costs	Plant protection cost increase by 0 to 40%	
Non-chemical alternatives		
Cost impact factor	**Expected impact**	**Expected costs if endosulfan would be replaced by non-chemical alternatives**
Yields	Slight decrease to slight increase	Significant non-quantified annual economic benefit
Prices	In organic production significant price premiums	
Production costs	Significant change of plant production costs possible.	

91. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.3.4 Efficacy

92. Efficacy is how well the alternative performs in a particular functionality including any potential limitations (UNEP/POPS/POPRC.5/6). In pest control, efficacy can therefore be considered as how well the alternative performs in a particular crop-pest complex including any potential limitations. However, not only limitations but also benefits should be considered in the evaluation.

93. An important question is whether alternatives are equally efficient compared to endosulfan. A review of scientific literature related to the efficiency of 46 identified chemical alternatives to endosulfan has shown that out of 78 scientific papers the alternative was in 152 cases more efficient, in 18 cases equally efficient and in 68 cases less efficient than endosulfan. In 4 cases a conclusion was not possible. In 6 cases development of resistance was reported (pest: *Helicoverpa armigera*). In seven cases the pest developed stronger resistance against the alternatives (cypermethrin, chlorpyriphos, profenophos, methomyl, carbaryl, thiodicarb) than against endosulfan. In one case the pest developed slightly stronger resistance against endosulfan than against the alternative (quinalphos). In one case (spinosad) a conclusion was not possible. The results of the literature review are documented in Annex II of the supporting document UNEP/POPS/POPRC.6/INF/12.

94. Against this background it can be expected that in most cases chemical alternatives will be more efficient than endosulfan. Considering the whole spectrum of chemical and non-chemical alternatives it can be assumed that endosulfan can in most cases be substituted by equally or more efficient alternatives. In specific cases development of resistance may become a problem. However, in the case of *Helicoverpa armigera* there seems to be at least one more efficient alternative chemical substance concerning resistance (quinalphos), as well as a number of non-chemical methods of control. Generally it seems noteworthy that local producers may have important knowledge about their production systems that may not be available to analysts in other locations.

95. Furthermore, many examples under different geographical conditions and for different crops demonstrate the efficacy of the alternatives to endosulfan because yields are maintained or increased also after the widespread use of alternatives.

96. However, according to some Parties and observers the efficacy of alternatives is limited due to specific advantages of endosulfan. Advantages that are particularly brought forward as arguments for endosulfan are its safety to natural enemies of pests and its appropriateness for integrated pest management, pollinator management, and insecticide resistance management. Furthermore it is stated that for critical uses alternatives would not be available and endosulfan may have to be replaced by several alternatives instead of one. Other information sources contradict these arguments and

[22] According to an estimate provided by Brazil in August 2010, the annual cost in Brazil to replace endosulfan with chemical alternatives would amount to approximately $34 million US (for details of the estimate and possible reasons for discrepancy see chapter 2.3.3.1 of the supporting document UNEP/POPS/POPRC.6/INF/12).

bring the same arguments forward as advantages of safer alternative chemicals and practices which would be available for all known uses and geographical situations.

97. Use of narrow spectrum pesticides instead of broad spectrum pesticides may lead to multiplicity of pesticides, which may have practical problems in implementation as farmers in developing countries may be less informed. Use of non-chemical alternatives may prevent this problem in the long run.

98. Benefits and limitations related to the efficacy of alternatives are briefly discussed in supporting document UNEP/POPS/POPRC.6/INF/12.

2.3.5 Risk

99. Alternatives should be safer than the currently used endosulfan. For an evaluation of the safety of alternatives, a risk profile for the chemicals under consideration should be developed. As this might be difficult if there is a lack of information on hazard properties or exposure data, a simple analysis of risk should be performed, taking into consideration the weight of available evidence. It should first be confirmed that the alternatives do not have POPs properties and thus should not meet the screening criteria of Annex D of the Stockholm Convention (persistence, bioaccumulation, potential for long-range transport, and adverse effects). Pollinator management is a relevant issue if endosulfan is replaced by alternatives. Therefore information on the safety of the alternatives for pollinators (i.e., particularly for bees) is relevant. As a consequence bee toxicity should be considered when assessing the safety of alternatives to endosulfan.

100. Furthermore, the alternative should not possess hazardous properties such as mutagenicity, carcinogenicity, reproductive and developmental toxicity, endocrine disruption, immune suppression, and neurotoxicity. Consideration should also be given to the exposure situation under actual conditions of use by workers, farmers and consumers. For further guidance see "General guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals" (UNEP/POPS/POPRC.5/10/Add.1).

101. Given the multitude of available alternatives a comprehensive assessment of possible risks related to alternatives is difficult. Risks are possible as a result of the exposure to hazardous alternatives. For a screening assessment of the risks related to the identified chemical alternatives, available information on a set of hazard indicators (i.e. on the POP properties and the hazardous properties as mentioned above) has been compiled. On the basis of the compilation it is possible to evaluate the possible risks related to the identified alternatives and to indicate priorities for more and less appropriate alternatives (concerning their possible risks to environment and health) and to identify alternatives for which information on hazard indicators is lacking. The results of a screening assessment of the alternatives can be found in Annex III of supporting document UNEP/POPS/POPRC.6/INF/12.

102. On the basis of the results of this screening risk assessment it can be expected that if endosulfan would not be available for plant protection it would be replaceable by safer chemical alternatives. A clear conclusion whether chemical alternatives to endosulfan are more or less toxic to bees is not possible on the basis of the present information (45 of the alternatives are toxic to bees, 28 are not toxic to bees, for 13 no information on bee toxicity has been identified). However, the range of toxicity to bees among possible chemical alternatives indicates that in many situations it may be possible to replace endosulfan by chemical alternatives with no or lower bee toxicity and/or less persistence in the environment[23]. It has to be noted that the screening risk assessment only concerns chemical alternatives. Non-chemical alternatives are generally related to no or lower risks compared to endosulfan. For further details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.3.6 Availability

103. Several Parties and observers have mentioned that alternatives are available on the market in both developed and developing countries.

2.3.7 Accessibility

104. Accessibility refers to whether an alternative can be used considering geographic, legal or other limitations (UNEP/POPS/POPRC.5/6). It is vital to consider the accessibility of all (chemical and non-chemical) alternatives. Accessibility to chemical alternatives may be limited because the alternatives are currently not registered. This does not mean that they are not available and the problem could be overcome in the foreseeable future. However, the situation of registering minor uses for pesticides is complex as there could be significantly more chemicals registered for many uses only if expensive data packages were developed for those combinations. The time required to do this could be significant. Further details are provided in supporting document UNEP/POPS/POPRC.6/INF/12.

[23] see for example <http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EPA-HQ-OPP-2002-0262, document 156>

2.4 Summary of information on impacts on society of implementing possible control measures

2.4.1 Health

105. POPRC concluded that endosulfan is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects, such that global action is warranted. Several parties and observers state that the current use of endosulfan gives rise to adverse health and environmental effects and expect that the control of endosulfan will positively impact health and the environment. Others do not expect adverse effects or are in the state of evaluating the risks.

106. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.4.2 Agriculture, aquaculture and forestry

107. Several countries where endosulfan is currently used expect increased costs for agricultural production if endosulfan is no longer available for use, e.g., reduced control of pests and/or increased plant protection costs. Possible cost impacts are not quantified. According to other information the use of alternatives will have beneficial cost impacts on agricultural production particularly due to higher safety for beneficial organisms, reduced costs and improved incomes for farmers.

108. Possible annual cost impacts on agriculture are estimated to be up to 40 million USD if endosulfan will be replaced by chemical and non-chemical alternatives. The replacement with chemical alternatives could have negative impacts amounting up to 40 million USD. The replacement with non-chemical alternatives could have significant positive economic impacts[24], if combined with investment for implementation. The overall economic impact on agriculture would be a consequence of all chemical and non-chemical replacement strategies that would be put into practice if endosulfan would not be available anymore. This overall impact is not quantified.

109. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.4.3 Biota (biodiversity)

110. Some parties and observers expect positive impacts on biodiversity if the use of endosulfan is restricted. However it is noted that multiple chemical alternative insecticides may be required in certain cases which may have some associated negative impacts on biodiversity. On the other hand it needs to be stressed that non-chemical alternatives avoid these problems.

111. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

2.4.4 Economic aspects

112. Several countries where endosulfan is currently used expect negative economic impacts for agricultural production if endosulfan will not be available (see chapter 2.4.2). Time and cost required to register suitable alternatives are not quantified. Positive economic impacts can be expected because of the substitution of alternatives for endosulfan includes the savings made on health and environmental costs resulting from exposure to endosulfan, and improved incomes for those no longer using endosulfan.

113. According to the cost impact assessment one time costs for implementation (realistic estimate: below $1.65 million US), non-quantified costs for the registration of suitable alternatives, annual costs for agriculture and corresponding impacts on society (up to $40 million US) and one time costs for waste management (range from approximately $0.10 to $0.23 million US) have to be considered in contrast to high, non-monetarised long term benefits for environment and health and positive cost impacts such as savings for farmers. Cost impacts on industry are expected to be in balance.

114. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

[24] See chapter 2.3.3.2 of the supporting document UNEP/POPS/POPRC.6/INF/12

2.4.5 Movement towards sustainable development

115. Elimination of endosulfan is consistent with sustainable development plans that seek to reduce emissions of toxic chemicals.

116. The "Plan of Implementation of the World Summit on Sustainable Development" [25] of the Johannesburg World Summit on Sustainable Development encourages specific actions in order to change unsustainable patterns of consumption and production. Governments, relevant international organizations, the private sector and all major groups should play an active role in changing unsustainable consumption and production patterns. A specific commitment in this context is to "... sound management of chemicals throughout their life cycle and of hazardous wastes for sustainable development as well as for the protection of human health and the environment, inter alia, aiming to achieve, by 2020, that chemicals are used and produced in ways that lead to the minimization of significant adverse effects on human health and the environment, using transparent science-based risk assessment procedures and science -based risk management procedures, taking into account the precautionary approach, as set out in principle 15 of the Rio Declaration on Environment and Development,..."

117. A relevant global plan is the Strategic Approach to International Chemicals Management (SAICM)[26]. SAICM makes the essential link between chemical safety, sustainable development, and poverty reduction. The Global Plan of Action of SAICM contains specific measures to support risk reduction that include prioritising safe and effective alternatives for persistent, bioaccumulative and toxic substances. The overarching Policy Strategy of SAICM includes POPs as a class of chemicals to be prioritised for halting production and use and substitution with safer substitutes. Additionally, the FAO has agreed to facilitate the phase out of Highly Hazardous Pesticides,[27] the definition of which includes those pesticides that are deemed to be POPs.[28]

2.4.6 Social costs (employment etc.)

118. Social impacts may occur as a consequence of positive or negative economic impacts in countries where endosulfan is currently used. Possible job losses associated with manufacture of endosulfan may occur, e.g., India estimates 6,000 persons are employed in endosulfan manufacture. For the implementation of alternatives related to particular practices such as IPM, organic farming or specific cultural measures, there will need to be pest forecasting, consultation with growers and training for farmers. This may on the one hand increase costs (e.g., for governments) but may also create corresponding employment. Specific information with respect to social costs was not received.

2.5 Other considerations

2.5.1 Access to information and public education

119. Several parties and observers provided useful information related to access to information and public education (see Annex F, 2010 submission of Australia, Brazil, Bulgaria, Canada, India, Lithuania, Madagascar, Malaysia, Poland, Switzerland, Togo, Ukraine, USA, PAN, and IPEN.)

120. Access to information is available via the internet, plant protection product labels or integrated pest management programs. The information provided concerns for example information on registered plant protection products, recommendations for the treatment of crop-pest combinations, procedures for cleaning, storage, return, transport and fate of used pesticide containers and waste material of products unsuitable for use or obsolete, information on prohibited and obsolete pesticides, risk assessments, risk mitigation measures, waste treatment measures, training and education of farmers, information on POPs and information on alternatives to endosulfan. Information is usually provided by state agencies and/or plant protection product companies and universities or other training facilities.

2.5.2 Status of control and monitoring capacity

121. Control and monitoring of endosulfan is in place in several countries. For details see supporting document UNEP/POPS/POPRC.6/INF/12.

3 Synthesis of information

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[25] http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf
[26] http://www.chem.unep.ch/saicm/
[27] New Initiative for Pesticide Risk Reduction. COAG/2007/Inf.14. FAO Committee on Agriculture, Twentieth Session, Rome, 25-28 April 2007. ftp://ftp.fao.org/docrep/fao/meeting/011/j9387e.pdf.
[28] Recommendations. First Session of the FAO/WHO Meeting on Pesticide Management and 3rd Session of the FAO Panel of Experts on Pesticide Management, 22-26 October 2007, Rome, Italy. http://www.fao.org/ag/agp/agpp/pesticid/Code/expmeeting/Raccomandations07.pdf.

122. Endosulfan was developed in the early 1950s. The current production of endosulfan worldwide is estimated to range between 18,000 and 20,000 tonnes per year. Production takes place in India, China, Israel, Brazil and the Republic of Korea. Endosulfan is used as a plant protection product in varying amounts in Argentina, Australia, Brazil, Canada, China, India and the USA[29]. Its use in agriculture is the most relevant emission source for endosulfan. As a result of its long-range environmental transport and its properties, endosulfan is likely to lead to significant adverse human health and environmental effects such that global action is warranted.

123. Currently a broad spectrum of possible control measures for endosulfan are being applied. In some countries where endosulfan is still applied, use is restricted to specific authorised uses and specific use conditions and restrictions are usually established in order to control health and environmental risks in the country concerned. Clean-up of contaminated sites and management of obsolete pesticides may particularly become a relevant issue in countries where endosulfan is manufactured. In many countries workplace exposure limits and maximum residue limits for different matrices are established.

124. Option 1: Listing of endosulfan in Annex A without specific exemptions

125. Listing of endosulfan in Annex A of the Stockholm Convention without specific exemptions would eliminate the manufacture, use, import and export of endosulfan. Such a listing would send a clear signal that production and use of endosulfan must be phased out by the time the obligation comes into force. Considering that at least 60 countries have banned or are phasing out the use of endosulfan, it can be assumed that there are viable alternatives (e.g. chemical alternatives, semio-chemicals, biological control, organic farming, IPM) available in many different geographical situations both in developed and developing countries. The chemical alternatives will need to be effective, less hazardous than endosulfan to human health or the environment, and not possess POP-like characteristics. However, replacing endosulfan with chemical and non-chemical alternatives may be difficult and/or costly for some specific crop pest complexes in some countries. Listing endosulfan in Annex A of the Convention without exemptions could cause Parties to ‘opt out of’/’not opt in’ to the listing.

126. Option 2: Listing of endosulfan in Annex A with specific exemptions

127. Several countries that are currently phasing out endosulfan have indicated a need to continue some applications of endosulfan to allow for the phase-in of alternatives. Furthermore, taking into account that replacing endosulfan with chemical and non-chemical alternatives may be difficult and/or costly for some specific crop pest complexes in some countries, it may be necessary to address those situations through specific exemptions under Annex A. Depending on the nature of the specific exemptions, releases of endosulfan and related adverse impacts would continue. Listing of endosulfan in Annex A with specific exemptions would be less effective at preventing harm to human health and the environment globally.

128. Option 3: Listing of endosulfan in Annex B with specific exemptions and/or acceptable purposes

129. Listing of endosulfan in Annex B of the Convention would restrict the manufacture, use, import and export of endosulfan. In addition to the possible use of specific exemptions, this option would also allow acceptable purposes due to the present uncertainty surrounding the accessibility of alternatives for problematic crop-pest complexes in some countries. Depending on the nature of the acceptable purposes and/or specific exemptions, significant releases of endosulfan and related adverse impacts would continue. Listing of endosulfan in Annex B would be less effective at preventing harm to human health and the environment globally.

130. Regardless of where endosulfan is listed, i.e. Annex A or B, there could be one-time costs to governments to implement the ban/restrictions and to investigate and implement appropriate alternatives, annual costs for agriculture and costs associated with waste management. For countries manufacturing endosulfan, there may be significant losses in profit related to manufacture, as well as impacts on society related to lost employment. At a global level, profits and job losses will be outweighed by sales of chemical alternatives and the implementation of non-chemical alternatives and non-monetarized long-term benefits for environment and health would be achieved. Listing of endosulfan in either Annex would mean that the provisions of Article 3 on export and import and of Article 6 on identification and sound disposal of stockpiles and waste would apply. Stockpiles and remediation measures and related costs are expected to be low compared to other obsolete pesticides because existing stockpiles are comparatively small. A harmonised ban/restriction of production and use would contribute to balanced agricultural markets.

4 Concluding statement

131. The POPRC of the Stockholm Convention has decided, “in accordance with paragraph 7 (a) of article 8 of the Convention, and taking into account that a lack of full scientific certainty should not prevent a proposal from proceeding,

[29] In the USA, the EPA has withdrawn approval for all uses of endosulfan. http://www.epa.gov/pesticides/reregistration/endosulfan/endosulfan-agreement.html

that endosulfan is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects, such that global action is warranted".

132. A thorough review of control measures that have already been implemented in several countries shows that risks to health and environment from exposure to endosulfan can be significantly reduced by eliminating production and use of endosulfan. Global action on endosulfan will reduce more significantly harm to human health and the environment. In addition, control measures are also expected to support the goal agreed at the 2002 Johannesburg World Summit on Sustainable Development of ensuring that by the year 2020, chemicals are produced and used in ways that minimise significant adverse impacts on the environment and human health.

133. In accordance with paragraph 9 of Article 8 of the Convention, the Committee recommends that the Conference of the Parties to the Stockholm Convention considers listing technical endosulfan (CAS 115-29-7), its related isomers (CAS 959-98-8 and 33213-65-9) and endosulfan sulfate (CAS 1031-07-8) in Annex A with specific exemptions.

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