UNITED NATIONS

UNEP

SC

UNEP/POPS/POPRC.6/INF/22

Distr.: General
8 October 2010

English only

Stockholm Convention on Persistent Organic Pollutants

Persistent Organic Pollutants Review Committee
Sixth meeting
Geneva, 11–15 October 2010
Item 5 of the provisional agenda*

Consideration of the draft risk management evaluation on endosulfan

Updated draft risk management evaluation: endosulfan

Note by the Secretariat

1. The draft risk management evaluation on endosulfan prepared by the intersessional working group in accordance with the standard workplan adopted by the Committee at its fifth meeting is contained in the annex to document UNEP/POPS/POPRC.6/9. After the final period for comments indicated in the standard workplan, additional comments were provided by a party and an observer to the chair and the drafter of the intersessional working group. The chair and the drafter responded to these comments and prepared an updated draft, which is contained in the annex to the present note. The changes made to the original draft set out in document UNEP/POPS/POPRC.6/9 are indicated in tracking mode. The annex has not been formally edited by the Secretariat.

2. The supporting document has also been updated and made available in the annex to document UNEP/POPS/POPRC.6/INF/23. A compilation of comments and responses in relation to the draft risk management evaluation, including the additional comments, can be found in document UNEP/POPS/POPRC.6/INF/13/Rev.1.

* UNEP/POPS/POPRC.6/1/Rev.1.

K1062418 081010

Annex

ENDOSULFAN

DRAFT RISK MANAGEMENT EVALUATION

17 September 2010

Contents

Executive Summary

1. At its fifth meeting the POPRC reviewed and adopted a revised draft risk profile on endosulfan. The POPRC decided 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 South 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 applied control measures cover the whole spectrum of possible control measures. 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. The ban of endosulfan in more than 60 countries demonstrates that economically viable alternatives are likely available in many different geographical situations and in developed and developing countries. There seem to be no or only small stocks 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. In total information on almost 100 chemical alternatives (including plant extracts) and 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. 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. However, some information indicates that it may be difficult to substitute endosulfan for specific crop-pest complexes in some countries or in general 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. According to the results of a screening risk assessment alternatives are generally considered safer than endosulfan. However, for some of the alternatives a clear conclusion whether they are more or less toxic to bees than endosulfan is not possible on the basis of the present information. Non-chemical alternatives generally have no or lower risk.

7. 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. 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. It can be estimated that a ban of endosulfan could cause one time costs to governments to implement the ban and facilitate access to alternatives, annual costs for agriculture and corresponding impacts on society (up to 40 million USD) and one time costs for waste management (range from approximately 0.10 to 0.23 million USD). These costs 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.

8. An analysis of possible control measures demonstrates that the most complete control measure would be the prohibition of all production and uses of endosulfan, i.e. listing it in Annex A of the Stockholm Convention. Available information indicates that alternatives are technically feasible, efficient and potentially safer and that they could be available for all current applications of endosulfan. However, as noted above substitution may be difficult and/or costly for some specific crop pest complexes. Exemptions may be required for several years for some crop-pest complexes to permit the development of feasible and efficient alternatives. A harmonised ban on production and use would contribute to balanced agricultural markets.

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

1 Introduction

10. At the fourth meeting of the POPRC in October 2008 the European Community and its Member States being parties to the Stockholm Convention have proposed endosulfan to be listed in Annex A, B or C of the Convention (UNEP/POPS/POPRC.4/14).

11. 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, 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]

12. Relevant additional information is provided as a supporting document (see [UNEP/POPS/POPRC.6/INF/12~~RME Endosulfan 2010, Supporting document 1~~]).

13. 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 a supporting document (see [~~RME Endosulfan 2010, Supporting document 2~~UNEP/POPS/POPRC.6/INF/24]).

1.1 Chemical identity of Endosulfan

1.1.1 Chemical Identity

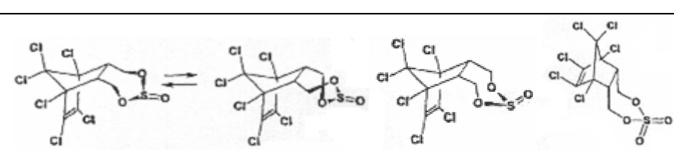
Names and registry numbers

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.

14. 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		

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

	α-endosulfan	β-endosulfan	endosulfan sulphate

1.1.2 Production and uses

Production, trade, stockpiles

15. 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.

16. 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 South Korea [UNEP/POPS/POPRC.5/10/Add.2].

17. 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 South Korea.

18. 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].

19. Endosulfan has never been produced in Canada; in the USA production stopped in the 1980s [UNECE 2010, CA, USA].

20. 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

21. Endosulfan is an insecticide used to control 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.

22. 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.

23. In 2006, the US EPA registered the use of endosulfan as a veterinary insecticide to control ectoparasites on beef and lactating cattle. It ~~was~~ is used as an ear tag in cattle and ~~occupied less than~~accounts for almost 25% of the US market share of cattle ear tags [KMG Bernuth 2009]. ~~However that use~~ The USA completed a re-evaluation of endosulfan in June 2010 and has ~~now been disallowed, along~~signed a formal Memorandum of Agreement with manufacturers of the agricultural insecticide endosulfan that will result in voluntary cancellation and phase-out of all ~~other~~existing endosulfan uses in the United States.[4] 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. The production and use of endosulfan is now banned in at least 60 countries[5] with former uses replaced by products and methods which are considered less hazardous on the basis of a screening risk assessment[6]. More detailed information

---

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

[5] Austria, Bahrain, Belgium, Belize, Benin, Bulgaria, Burkina Faso, Cambodia, Cape Verde, Chad, Colombia, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Gambia, Germany, Greece,

on current uses as informed by countries is provided in an informal document to the endosulfan risk profile (see UNEP/POPS/POPRC.5/INF/9).

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

26. According, to the International Stewardship Centre (ISC) the total average annual use quantity 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 largest 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].

27. Further details are given in the supporting document [RME Endosulfan 2010, Supporting document 1UNEP/POPS/POPRC.6/INF/12].

1.2 Conclusions of the Review Committee regarding Annex E information

28. 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.

29. Having completed the risk profile for endosulfan, the POPRC:

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) Decided furthermore, in accordance with paragraph 7 (a) of Article 8 of the Convention and paragraph 29 of 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.

1.3 Data sources

1.3.1 Overview of data submitted by Parties and observers

30. 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 countries and observers:

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

b) Observers: PAN & IPEN[7], ISC[8]

Guinea Bissau, Hungary, Indonesia, Ireland, Italy, Jordan, Kuwait, Latvia, Lithuania, Liechtenstein, Luxembourg, Malaysia, Mali, Malta, Mauritania, Mauritius, Morocco, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Poland, Portugal, Qatar, 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.

[6] See chapter 2.3.5 of the present document and of the supporting document

[7] Pesticides Action Network International (PAN) and International POPs Elimination Network (IPEN)

[8] International Stewardship Centre, Inc.

31. 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" [RME Endosulfan 2010, Supporting document 2UNEP/POPS/POPRC.6/INF/24].

32. 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 (reference: [UNECE 2010]).

33. 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.4/24], 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 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 31/12/2008.

e) 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.

f) 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].

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

h) 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 nine (9) CILSS country members of the Economic Community of West African States (ECOWAS) have already phased out endosulfan [Togo 2010].

39. 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].

40. 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).

41. 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]. The re-evaluation of the health and environmental risks of existing older chemicals which could be possible alternatives to endosulfan is targeted for completion in 2010 [Canada 2010].

42. USA EPA's Reregistration Eligibility Decision (RED) was completed in 2002. In 2010, following a post-reregistration evaluation of risks and benefits, the US EPA ~~decided to withdraw approval for all uses of~~ determined that endosulfan.[6] 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. EPA is also requiring additional mitigation measures during the phase-out period to minimize worker risks associated with endosulfan use on these crops.[11]

43. Endosulfan is designated as an agricultural chemical causing water pollution under Order for Enforcement of the Agricultural Chemicals Regulation Law of Japan. Local governments can restrict use of the agricultural chemicals causing water pollution. Japan will prohibit production, import, distribution and use of endosulfan [Japan 2010].

44. 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].

45. In 1997 in Colombia the import, production and placing on the market of endosulfan was severely restricted. 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].

46. Since 2009 specific legal restrictions for endosulfan are in place in Costa Rica. 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].

47. 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

48. 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

[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

obsolete stockpiles; (6) Establishment of exposure limits in workplaces; and (7) Establishment of maximum residue limits in water, soil, sediment or food.

49. Currently applied control measures cover the whole spectrum of possible control measures. The use of endosulfan is currently banned in more than 60 countries and replaced by alternatives. 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. 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 & IPEN 2010 Add 1]).

50. 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 [RME Endosulfan 2010, Supporting document 1UNEP/POPS/POPRC.6/INF/12].

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

2.2.1 Technical feasibility

51. 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.

52. The ban of endosulfan in more than 60 countries, including both developed and developing countries, demonstrates that viable alternatives are likely 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.

53. 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.

54. Useful information was provided by parties and observers according to Annex F. For details see supporting document [RME Endosulfan 2010, Supporting document 1UNEP/POPS/POPRC.6/INF/12].

2.2.2 Identification of critical uses

55. Possible critical uses for which there may not be an available alternative in a country at the present time can be (a) specific crop-pest combinations where a chemical and/or non-chemical alternative does not yet exist in the country or (b) situations where such an alternative is not technically feasible because of specific advantages of endosulfan or specific disadvantages of available alternatives.

56. According to some parties and observers it could be difficult to substitute endosulfan at the present time for specific crop-pest complexes e.g. in soybean, cotton, coffee, cane sugar and sunflower in Brazil and Argentina ([Brazil 2010], [ISC 2010]) or in general 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).

[12] The US EPA has also identified a limited number of situations where endosulfan has advantages over available alternatives for pollinator management and instecticide resistance management. See, for example, information on

Critical uses related to specific crop-pest combinations

57. Australia, Canada and, 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, 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 has also undertaken research into IPM for rambutans and other exotic fruit.[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 to [RME Endosulfan 2010, Supporting document 1UNEP/POPS/POPRC.6/INF/12]).

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

62. According to Brazil endosulfan is currently regarded as an indispensable product of the IPM for 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]. 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

63. 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].

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 apple, pineapple, strawberry, and blueberry, at http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EPA-HQ-OPP-2002-0262, documents 113, 157, 158, and 175.

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

[15] https://rirdc.infoservices.com.au/downloads/09-154.pdf

[16] www.cottoncrc.org.au/files/46c4352a-b530-49be-8911.../file.pdf

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

2.2.3 Costs and benefits of implementing control measures

64. 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].

65. Possible costs related to replacing the ~~ban~~use of endosulfan ~~versus~~with chemical and non-chemical alternatives include (1) Implementation costs for governments and authorities; (2) Cost impacts on industry (manufacturing and retailing of plant protection products); (3) Cost impacts on agriculture (costs for use of alternatives and costs due to altered productivity in terms of quantity or quality); (4) Cost impacts on society (consumer costs for agricultural products, costs for management of obsolete pesticides and remediation of contaminated sites, waste disposal costs); (5) Cost impacts 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 risks for the whole population and particularly exposed population groups). Some of these costs can be difficult to monetize.

66. 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.

67. 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 environment and health costs.

68. For further details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

69. The following table shows an overview of the possible cost impacts. Details and assumptions for the assessment are explained in the supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

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 where endosulfan is not produced the cost impacts on industry are nil or negligible. • Annual losses for manufacturers occur in countries where endosulfan is still produced 112.7 to 125.2 million USD (India: 61.98 million USD; China 15.03 million USD; Israel, Brazil and South Korea: 35.68 to 48.21 million USD). • Globally the losses will be more or less outweighed by sales of chemical and non-chemical alternatives.
Cost impacts on agriculture	• ~~Negative annual~~Annual cost impact due to increased plant protection costs in a range between 0 and 40 million USD (for Brazil: 0 to 13.87 mio USD[18], for India: 0 to 9.~~63~~ 63 mio USD, for China: 0 to 7.89 mio USD, for Argentina: 0 to 2.89 mio USD, for the USA: 0 to 2.78 mio USD and for the rest of the world: 0 to 9.28 mio USD) if endosulfan will be replaced by chemical alternatives ~~in contrast to~~. • Non-quantified ~~positive annual~~ reductions in cost ~~impacts if~~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 USD • One time costs for the management of stockpiles range from 101,700 to 226,000 USD. These costs would particularly incur in India (55,935 to 11,870 USD), China (13,560

[18] According to an estimate provided by Brazil in August 2010, the annual cost in Brazil to replace endosulfan with chemical alternatives would amount to ~34 mio USD (for details of the estimate and possible reasons for discrepancy see chapter 2.3.3.1 of the supporting document).

	to 27,120 USD), Israel, Brazil and South Korea (32,205 to 87,010 USD).
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

70. 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, as well as agro-ecological practices such as (d) Integrated Pest Management (IPM), (e) organic farming and other (f) specific agricultural practices.

71. 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.

72. Endosulfan is used mainly on cotton, tea, coffee, 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 to the informal document [UNEP/POPS/POPRC.6/INF/12~~RME Endosulfan 2010 long~~] 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 alternatives (including plant extracts) and a considerable number of biological control measures and semio-chemicals have been identified for a very wide range of applications, geographical situations and level of development.

73. For further details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.3.1.1 Chemical alternatives

74. According to Annex F 2010 information almost 100 chemical alternatives (including plant extracts) to endosulfan are available for specific crop-pest combinations (see Annex I, Table 10 [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12]). For further details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.3.1.2 Semio-chemicals

75. According to Annex F information several semio-chemicals (i.e., substance that carries a chemical message) can be used as an alternative to the use of endosulfan. For further details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.3.1.3 Biological control systems

76. According to Annex F information a wide range of biological control alternatives (i.e., reduction of pest populations by natural enemies) to endosulfan are available. For further details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.3.1.4 Integrated Pest Management (IPM) Systems

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

78. 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. [19] 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

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

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.

79. For further details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~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 [~~RME Endosulfan 2010, Supporting document 1~~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. The practices 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, 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 [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

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. Therefore PAN & IPEN have specifically analysed the availability of alternatives to endosulfan in India and demonstrates that for all relevant Indian pest-crop complexes alternatives to endosulfan (chemical and biological) are available and recommended by Indian government and academic sources (Alternatives recommended in India are included in the Annex to [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12]; for details see [PAN & IPEN 2010]).

2.3.2 Technical feasibility

83. Technical feasibility can be understood to consider 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).

84. The current ban of endosulfan in more than 60 countries indicates that technically feasible alternatives exist. 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.

85. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.3.3 Costs, including environmental and health costs

86. 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.

87. 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 (up to 15% decrease; 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).

88. 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.

89. Table 2 shows expected cost impacts on agriculture if endosulfan will be 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 practice if endosulfan would not be available anymore. The underlying information and the assumption for the assessment are explained in the supporting document [RME Endosulfan 2010, Supporting document 1UNEP/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 USD Brazil: 0 to 13.87 mio USD[20] India: 0 to 9.63 mio USD China: 0 to 7.89 mio USD Argentina: 0 to 2.89 mio USD USA: 0 to 2.78 mio USD Rest of the world: 0 to 9.28 mio USD
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 protection cost decreaseproduction costs possible.	

90. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document [RME Endosulfan 2010, Supporting document 1UNEP/POPS/POPRC.6/INF/12].

2.3.4 *Efficacy*

91. 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.

92. 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 7 cases the pest developed stronger resistance against the alternatives (cypermethrin, chlorpyriphos, profenophos, methomyl, carbaryl, thiodicarb) than against endosulfan. In 1 case the pest developed slightly stronger resistance against endosulfan than against the alternative (quinalphos). In 1 case (spinosad) a conclusion was not possible. The results of the literature review are documented in Annex II to [RME Endosulfan 2010, Supporting document 1UNEP/POPS/POPRC.6/INF/12].

93. 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

[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 ~34 mio USD (for details of the estimate and possible reasons for discrepancy see chapter 2.3.3.1 of the supporting document).

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.

94. 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.

95. However, according to some countries/observers the efficacy of alternatives is limited due to specific advantages of endosulfan. Advantages that are particularly brought forward as arguments for endosulfan are (a) safety to natural enemies of pests, appropriateness (b) for integrated pest management, (c) for pollinator management, (d) for insecticide resistance management. Furthermore it is stated that (e) for critical uses alternatives would not be available and (f) endosulfan may have to be replaced by several alternatives instead of one. 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.

96. Benefits and limitations related to the efficacy of alternatives are therefore briefly discussed in supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.3.5 Risk

97. 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 will be replaced by alternatives. Therefore, as additional information with particular relevance for the risk of alternatives for endosulfan 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.

98. Furthermore, the alternative should not possess hazardous properties such as mutagenicity, carcinogenicity, reproductive and developmental toxicity, endocrine disruption, immune suppression, 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].

99. 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 to the supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

100. 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[21]. 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.

101. Further details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

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

2.3.6 Availability

102. Existing alternatives are available on the market in both developed and developing countries.

2.3.7 Accessibility

103. 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 foreseeable time. 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 see informal document. Further details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

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

2.4.1 Health

104. 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. 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.

105. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.4.2 Agriculture, aquaculture and forestry

106. Several countries where endosulfan is currently used expect increased costs for agricultural production if endosulfan will not be available for use due to reduced control of pests and/or increased plant protection costs. Possible cost impacts are not quantified. According to other opinion 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.

107. 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[22], 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.

108. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.4.3 Biota (biodiversity)

109. 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.

110. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

2.4.4 Economic aspects

111. 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

[22] See chapter 2.3.3.2 of the supporting document

the savings made on health and environmental costs resulting from exposure to endosulfan, and improved incomes for those no longer using endosulfan.

112. According to the cost impact assessment one time costs for implementation (realistic estimate: below 1.65 million USD), annual costs for agriculture and corresponding impacts on society (up to 40 million USD) and one time costs for waste management (range from approximately 0.10 to 0.23 million USD) 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.

113. Useful information has been provided by parties and observers in the Annex F information submitted in 2010. For details see supporting document [RME Endosulfan 2010, Supporting document 1UNEP/POPS/POPRC.6/INF/12].

2.4.5 Movement towards sustainable development

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

115. The "Plan of Implementation of the World Summit on Sustainable Development" [23] 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,..."

116. A relevant global plan is the Strategic Approach to International Chemicals Management (SAICM)[24]. 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,[25] the definition of which includes those pesticides that are deemed to be POPs.[26]

2.4.6 Social costs (employment etc.)

117. Social impacts may occur as a consequence of positive or negative economic impacts in countries where endosulfan is currently used. For the implementation of alternatives related to particular practices such as IPM, organic farming or specific cultural measures adequate training, pest forecasting and consulting to growers are required. This may on the one hand cause corresponding 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

118. 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 and PAN & IPEN.)

119. 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

[23] http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf

[24] http://www.chem.unep.ch/saicm/

[25] 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.

[26] 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.

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

120.Control and monitoring of endosulfan is in place in several countries. For details see supporting document [~~RME Endosulfan 2010, Supporting document 1~~UNEP/POPS/POPRC.6/INF/12].

3 Synthesis of information

121.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 South Korea. Endosulfan is used as a plant protection product in varying amounts in Argentina, Australia, Brazil, Canada, China, India and the USA [27]. 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.

122.Currently applied control measures cover a broad spectrum of possible control measures. The use of endosulfan is currently banned in more than 60 countries. 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.

123.The most complete control measure would be the prohibition of all production and uses of endosulfan i.e. listing it in Annex A of the Stockholm Convention. As a consequence current uses of endosulfan would have to be replaced by safer alternatives. The ban of endosulfan in more than 60 countries demonstrates that economically viable alternatives are likely available in many different geographical situations and in both developed and developing countries. Available information indicates that these alternatives may be technically feasible, efficient and potentially safer and that they may be available for all current applications of endosulfan. However, substitution may be difficult and/or costly for some specific crop pest complexes in some countries. A harmonised ban of production and use would contribute to balanced agricultural markets. Listing of endosulfan would also 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. Management of waste and stockpiles of endosulfan is already included in current strategies. Stockpiles and remediation measures and related costs are expected to be low compared to other obsolete pesticides because existing stockpiles are comparatively small. Relevant costs may be incurred in countries manufacturing endosulfan. A ban of endosulfan could cause one time costs to governments to implement the ban and facilitate access to alternatives, annual costs for agriculture and corresponding impacts on society (up to 40 million USD) and one time costs for waste management (range from approximately 0.10 to 0.23 million USD). These costs 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 some farmers who experience reduced costs when they replace endosulfan.

124.Another possible control measure would be to restrict production and use of endosulfan according to specific restrictions. This would mean that emissions of endosulfan and related adverse impacts could continue. This control measure seems less appropriate considering on the one hand the properties of endosulfan and the corresponding need for global action and on the other hand the availability of economically viable, technically feasible, efficient and safer alternatives. The restricted use of endosulfan in selected countries would contribute to the distortion of agricultural markets. It is likely that endosulfan causes significant adverse effects on human health and the environment. It can therefore be expected that the current use of endosulfan causes significant non quantifiable environment and health costs and positive cost impacts such as savings for farmers.

4 Concluding statement

125.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, 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.

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

126. Having prepared a risk management evaluation and considered the management options, the POPRC recommends that the chemical be considered by the Conference of the Parties for listing in Annex A.

127. 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. 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.

References

[Australia 2010] Australia, 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Brazil 2010] Brazil, 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Bulgaria 2010] Bulgaria 2010 Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Burundi 2010] Burundi 2010 Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Canada 2010] Canada 2010 Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Canada 2010 Ref 2] Canada 2010 Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010, Additional Document submitted: Health Canada, Re-evaluation Note: Preliminary Risk and Value Assessment of Endosulfan, 2007.

[China 2010] China 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Colombia 2010] Colombia, 2010. Information submitted pursuant to Article 8 of the Stockholm Convention, March 2010.

[Costa Rica 2010] Costa Rica 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, December 2009.

[Germany 2010] Germany, 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[India 2010] India, 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[India 2010 Annexure-I] India, 2010. Annexure-I of Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[IOBC 2004] IOBC / WPRS Commission "IP-Guidelines and Endorsement", Commission "Directives de PI et Agrément" Integrated Production, Principles and Technical Guidelines, 3rd Edition, 2004.

[ISC 2010] International Stewardship Centre, Inc. Submission of Annex E and Annex F information. January 2010.

[Japan 2010] Japan, 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[KMG Bernuth 2009] KMG Bernuth, Inc. Respond to request for comments published in the federal register (Vol. 74, No. 81), dated April 29, 2009. US EPA-HQ-OPP-2008-0615. Letter from 29.06.2009 to the Office of Pesticide Programs of the US EPA

[Lithuania 2010] Lithuania 2010 Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Madagascar 2010] Madagascar 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Malaysia 2010] Malaysia 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, April 2010.

[Mexico 2010] Mexico 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Monaco 2010] Monaco 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Norway 2010] Norway 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[PAN & IPEN 2010] PAN & IPEN 2010 Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[PAN & IPEN 2010 Add 1] Communities in Peril: Asian regional report on community monitoring of highly hazardous pesticide use, Pesticide Action Network Asia and the Pacific, 2010 (additional document provided by PAN & IPEN in the commenting period in March 2010)

[Poland 2010] Poland 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[UNEP/POPS/POPRC.6/INF/24~~RME Annex F 2010~~] Informal background document to [~~RME Endosulfan 2010, long version~~UNEP/POPS/POPRC.6/INF/12]: “Risk Management Evaluation Endosulfan – Information provided according to Annex F”, 2010

[UNEP/POPS/POPRC.6/INF/12~~RME Endosulfan 2010, long~~] ~~Informal background~~Supporting document to the present document: ~~“Risk Management Evaluation Endosulfan, Long version, March 2010”~~

[Romania 2010] Romania 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Sri Lanka 2010] Sri Lanka 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Switzerland 2010] Switzerland 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Togo 2010] Togo, 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[Ukraine 2010] Ukraine, 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.

[UNECE 2007] ENDOSULFAN, Dossier prepared in support of a proposal of endosulfan to be 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 (LRTAP Protocol on POPs) German Federal Environment Agency – Umweltbundesamt, Dessau, February 2007

[UNECE 2010] Information provided by parties and industry stakeholders for a questionnaire survey related to the proposal of endosulfan to be 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 (LRTAP Protocol on POPs), February 2010

[UNECE 2010 CA, BE, CR, CY, DE, EE, FI ,FR, HR, NL, NOR, IE, IT, SE, SI, SUI, UA, UK, USA] UNECE submission provided by Canada (CA), Belgium (BE), Czech Republic (CR), Cyprus (CY), Germany (DE), Estland (EE), Spain (ES), Finland (FI), France (FR), Croatia (HR), Netherlands (NL), Norway (NOR), Ireland (IE), Italy (IT), Sweden (SE), Slovenia (SI), Switzerland (SUI, Ukraine (UA), United Kingdom (UK) and the United States of America (USA) respectively for a questionnaire survey related to the proposal of endosulfan to be 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 (LRTAP Protocol on POPs), February 2010.

[UNEP/FAO/RC/COP.4/24] United Nations Environment Programme, Food and Agriculture Organization of the United Nations, Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, Conference of the Parties, Fourth meeting Rome, 27-31 October 2008, Report of the Conference of the Parties to the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade on the work of its fourth meeting. UNEP 31/08/2008.

[UNEP/FAO/RC/CRC.6/7] Listing of chemicals in Annex III to the Rotterdam Convention: review of notifications of final regulatory actions to ban or severely restrict a chemical: endosulfan. Chemical Review Committee Sixth meeting Geneva, 15–19 March 2010. UNEP 01/12/2009.

[UNEP/POPS/POPRC.4.14] Persistent Organic Pollutants Review Committee, Fourth meeting Geneva, 13–17 October 2008, Endosulfan proposal. UNEP 27/08/2008.

[UNEP/POPS/POPRC.5.3] Persistent Organic Pollutants Review Committee, Fifth meeting, Geneva, 12–16 October 2009, Draft risk profile: endosulfan. UNEP 29/07/2009.

[UNEP/POPS/POPRC.5.6] Persistent Organic Pollutants Review Committee, Fifth meeting, Geneva, 12–16 October 2009, Summary of intersessional work on substitution and alternatives. UNEP 20/07/2009.

[UNEP/POPS/POPRC.5/INF/9] Persistent Organic Pollutants Review Committee, Fifth meeting, Geneva, 12–16 October 2009, Supporting document for the draft risk profile on endosulfan. UNEP 11/08/2009.

[UNEP/POPS/POPRC.5/10/Add.1] Persistent Organic Pollutants Review Committee Fifth meeting, Geneva, 12–16 October 2009, Report of the Persistent Organic Pollutants Review Committee on the work of its fifth meeting, Addendum:

General guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals. UNEP 05/12/2009.

[UNEP/POPS/POPRC.5/10/Add.2] Persistent Organic Pollutants Review Committee Fifth meeting, Geneva, 12–16 October 2009, Report of the Persistent Organic Pollutants Review Committee on the work of its fifth meeting, Addendum: Risk profile on endosulfan. UNEP 13/12/2009.[USA 2010]

[USA 2010] USA, 2010. Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex F of the Convention, January 2010.