



**Rotterdam Convention on the Prior
Informed Consent Procedure for
Certain Hazardous Chemicals and
Pesticides in International Trade**

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Item 4 (c) (ii) of the provisional agenda*

**Technical work: review of notifications of final
regulatory action: carbaryl**

Carbaryl: supporting documentation provided by Mozambique

Note by the Secretariat

As is mentioned in the note by the Secretariat on carbaryl: notification of final regulatory action (UNEP/FAO/RC/CRC.20/6), the annex to the present note sets out documentation provided by Mozambique to support its notification of final regulatory action for carbaryl in the pesticide category. The present note, including its annex, has not been formally edited.

* UNEP/FAO/RC/CRC.20/1/Rev.1.

Annex

Carbaryl: supporting documentation provided by Mozambique

List of documents:

1. Deliberacao Nr. 001/DNSA/2014 - National Directorate of Agriculture and Agrarian Services (The Pesticide Register Authority) in Portuguese and English.
2. Come A.M. & van der Valk H., 2014. Reducing Risks of Highly Hazardous Pesticides in Mozambique: Step 1 – Shortlisting highly hazardous pesticides, Consultancy report undertaken under the Project EP/MOZ/101/UEP.
3. Come A.M., Cassam K., Dona L.L., Mancini F. & van der Valk H., 2014. Reducing Risks of Highly Hazardous Pesticides in Mozambique: Step 2 – Survey of pesticide use practices in selected cropping systems.
4. FAO/WHO (2008) Report of the 2nd Joint Meeting on Pesticide Management and the 4th Session of the FAO Panel of Experts on Pesticide Management. 6-8 October 2008, Geneva. Food and Agriculture Organization of the United Nations, Rome & World Health Organization, Geneva.
http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/Code/Report.pdf (p.14 – 18).
5. Lahr J., Kruijne R. & Groenwold J., 2014. Hazards of pesticides imported into Mozambique, 2002-2011. Wageningen, Alterra Wageningen UR (University & Research centre).
6. EFSA Scientific Report (2006) 80, 1-71, Conclusion on the peer review of carbaryl.
7. U.S. Environmental Protection Agency (2006), p. 18, Chemicals Evaluated for Carcinogenic Potential:
<http://www.fluoridealert.org/wpcontent/pesticides/pesticides.cancer.potential.2006.pdf>.
8. U.S. Environmental Protection Agency (2019), p. 13, Chemicals Evaluated for Carcinogenic Potential Annual Cancer Report: http://npic.orst.edu/chemicals_evaluated.pdf.
9. Pesticide residues in food report of the 1996 Joint FAO/WHO meeting of experts, p. 30 - 35
http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/JMPR/Reports_1991-2006/Report1996.pdf.
10. Pesticides Properties Database (PPDB): <https://sitem.herts.ac.uk/aeru/ppdb/en/Reports/115.htm> (abstract).
11. IPCS-INCHEM International Programme on Chemical Safety:
<http://www.inchem.org/documents/icsc/icsc/eics0121.htm> (abstract).



República de Moçambique

**MINISTÉRIO DA AGRICULTURA
DIRECÇÃO NACIONAL DE SERVIÇOS AGRÁRIOS**

Deliberação Nº 001/DNSA/2014

OS pesticidas são produtos usados para a preservação das culturas e seus produtos contra diferentes pragas. Estes produtos, são por sua natureza tóxica e o uso indevido do mesmo pode perigar a saúde Humana, Animal e danificar o meio ambiente. Deste grupo de químicos, existem alguns que são considerados Altamente Perigoso. O Projecto de Redução dos de Riscos de Pesticidas Altamente Perigosos identificou os Pesticidas Altamente Perigosos que estão registados em Moçambique e depois de auscultar diferentes intervenientes (sector público, sector privado, sociedade civil e outros) conclui-se que para alguns deles dever-se-ia fazer o cancelamento imediato do registo e consequente não aprovação do seu uso em Moçambique e para outros o registo deveria ser cancelado no final do ano. Existe um outro grupo que carece de maior análise antes da tomada de decisão.

Desta forma e usando das competências atribuídas no artigo 3, coadjuvado com o artigo 1 e 4 de Decreto 6/2009 de 31 de Março a DNSA determina:

1. O Cancelamento imediato de todos os pesticidas que contenham as seguintes substâncias activas:

- a. Alachlor
- b. Aldicarb
- c. Carbendazim
- d. Carbofuran
- e. Diafenthion
- f. Diazinon (> 300 g/L)
- g. Diclofop-methyl
- h. Difenacoum
- i. Ethion
- j. Fenamiphos
- k. Iprodione
- l. Furfural
- m. Methidathion
- n. Methiocarb
- o. Monocrotophos
- p. Terbufos

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- q. Thiodicarb
 - r. Zinc phosphide
 - s. Brodifacoum (formulações líquidas – 0.75 & 2.5 g/L)
 - t. Difethialone
 - u. Methamidophos
 - v. Benomyl
 - w. Methomyl 900 g/kg
 - x. Chlorfenvinphos
 - y. Carbaryl
 - z. Oxyfluorfen
2. Cancelamento à 31 de Dezembro de 2014 de todos os produtos que contenham as substâncias activas:
- a. 2,4-D dimethylamine
 - b. Paraquat
 - c. Endosulfão
 - d. Diuron
3. Os produtos que contenham as substâncias activas listadas nos números 1 e 2 importados antes do cancelamento dos mesmos podem continuar a ser usados estando dentro do prazo de validade.

Maputo aos 15 de Julho de 2014

O Director Nacional

Mahomed Rafik Valá
(Tecnico Superior Agro-Pec de N1)

KC/19/10/2014

Republic de Mozambique

MINISTRY OF AGRICULTURE

N N. 00I / DNSA / 2014

National Directorate of Agrarian Services

Deliberation N. 00I / DNSA / 2014

Pesticides are products used for the protection of crops and their products against different pests.

These products are by their nature toxic and their improper use can damage human health, animal health and damage the environment. among this group of chemicals, there are some that are considered Highly Hazardous. The project of Risk Reduction of Highly Hazardous Pesticides identified Highly Hazardous Pesticides that are registered in Mozambique and after consulting with different actors (public sector, private sector, civil society and others) it has been concluded that: for some of them the immediate cancellation of registration and consequent non-approval of their use in Mozambique should be done while for others the registration should be cancelled at the end of the year. There is another group for which further analysis is needed before taking the decision

In this way and using the competences assigned by article 3, in conjunction with article I and 4 of Decree 6/2009 of March 31, DNSA determines:

I. The immediate cancellation of all pesticides containing the following active substances:

Alachlor
Aldicarb
Carbendazim
Carbofuran
Diafenthiuron
Diazinon 300 g / L)
Diclofop-methyl
Difenacoum
Ethion
Fenamiphos
Iprodione
Furfural
Methidathion
Methiocarb
Monocrotophos
Terbufos
Thiodicarb
Zinc phosphide
Brodifacoum (liquid formulations -0.75 & 2.5 g/L)
Difethialone
Methamidophos
Benomyl
Methomyl 900 g/kg
Chlorfenvinphos
Carbaryl
Oxyfluorfen

II. Cancellation as of 31 December 2014 of all the products containing the active substances:

2,4-D dimethylamine

Paraquat

Endosulfan

Diuron

III. Products containing the active substances listed in N. 1 and 2 imported before their cancellation can continue to be used as long as they are within the validity period.

Maputo on July 15, 2014

The National Director

Dahomgd Rafikö



Reducing Risks of Highly Hazardous Pesticides in Mozambique

Step 1 – Shortlisting highly hazardous pesticides

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Harold van der Valk

[final – 5 May 2014]

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With financial support from the SAICM Quick Start Programme



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The authors would like to gratefully acknowledge the information provided and the contributions made to this study by Ida Chongo and Marcelina Xavier (Ministry of Agriculture), Khalid Cassam and Francesca Mancini (FAO), Kimberly Nesci and Cathleen Barnes (US Environmental Protection Agency),

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Table of contents

Table of contents	3
1. Introduction	4
1.1 Project background.....	4
1.2 National and international policy framework.....	5
1.2.1 National framework.....	5
1.2.2 International framework.....	5
1.3 The project.....	7
1.3.1 Objectives.....	7
1.3.2 Approach	7
2. Methodology	9
2.1 Criteria to define HHPs	9
2.2 Data collection.....	10
2.2.1 Introduction.....	10
2.2.2 Starting data set	10
2.2.3 WHO hazard class.....	11
2.2.4 GHS carcinogenic hazard.....	11
2.2.5 GHS mutagenic hazard.....	13
2.2.6 GHS reproductive toxicity hazard.....	15
2.2.7 Stockholm Convention.....	16
2.2.8 Rotterdam Convention	18
2.2.9 Montreal Protocol.....	18
2.2.10 High incidence of severe or irreversible adverse effects.....	18
2.2.11 Import statistics	18
2.3 Data compilation	19
3. Results	20
3.1 Data availability	20
3.2 Identification of HHPs.....	21
3.3 Identification of pesticides “coming close” to HHPs	33
3.4 Registrations elsewhere	33
3.5 Import statistics	34
4 Conclusion.....	35
4.1 Methodology	35
4.2 Short-list of HHPs	35
References	39

1. Introduction

1.1 Project background

Pesticides are widely used in most areas of crop production in Mozambique to minimize infestations by pests and thus protect crops from potential yield losses and reduction of product quality. They are also widely applied for public health purposes, e.g. in malaria control.

The average annual volume of pesticide imports into Mozambique is approximately 1800 tonnes of formulated products (Figure 1). The import value of these pesticides is estimated, over the last three years, to be at least 495 million Meticaís, or 16.6 million \$US. An almost five-fold increase in pesticide imports has occurred in Mozambique since the 2003, well above world averages.

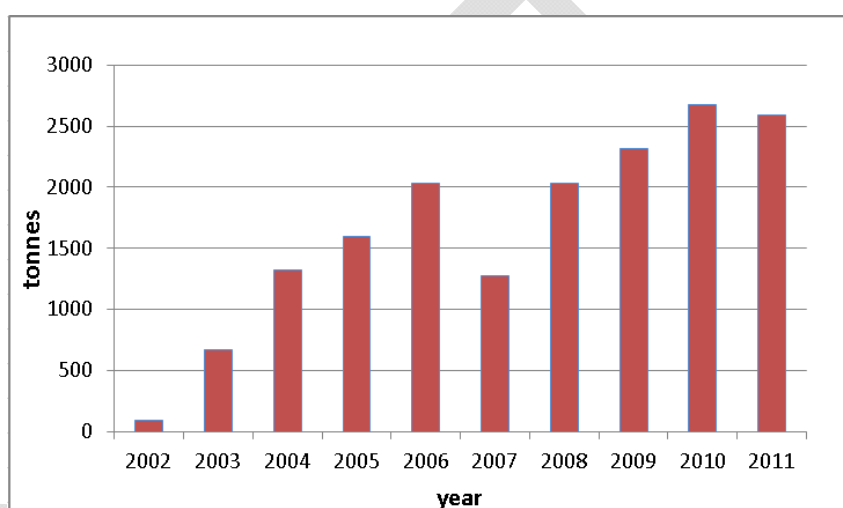


Figure 1. Annual imports of formulated pesticides into Mozambique between 2002 and 2011 (metric tons). Note that the data for 2002 are incomplete. (source: Lahr et al., 2014 based on Ministry of Agriculture statistics)

The large majority of pesticides, about 85%, are imported into Mozambique by private sector distributors and retailers, reflecting major change since the 1980s when pesticides were imported by a single state-run company. The remaining 15% of pesticides are imported directly by commercial farms, by commodity companies, and by various smaller importers. Direct pesticide imports by the state are now virtually non-existent, and state-funded imports are mainly limited to pesticides bought by the Ministry of Health for vector control and by INCAJU for cashew production.

A large part of pesticide distribution to end-users is conducted by private sector distributors and retailers, although exact figures are not available. Furthermore, private distributors deliver the pesticides they import to commodity companies which in turn will distribute the products to end-user farmers. This occurs mostly in cotton and to a smaller extent in tobacco. The private sector may also deliver pesticides to government structures who then distribute them to end-users. This is the case for INCAJU, which distributes pesticides to cashew farmers, and for the Ministry of Health, which distributes a part of the pesticides it orders to community groups to carry out mosquito control. In total, distribution by government structures represented less than 8% of the total pesticides imports.

Pesticide use may have benefits for different stakeholders, not only of farmers or consumers, but also of the society as a whole. At the same time, there is evidence of both direct and indirect risks involved in the use of these chemical substances both for humans and the environment. These risks will vary in importance (i.e. size, duration, extent, acceptability) depending on the type of pesticide and the specific use situation. Risk mitigation measures should be developed for all risks that are considered by the national regulatory authority to be unacceptable. However, given limited human and financial resources in many countries, and also in Mozambique, it may be more cost-effective to focus first on those pesticides and use situations that pose the highest risks and which are considered unacceptable by all relevant stakeholders.

Therefore, with the goal of reducing the greatest risks associated with pesticide use in Mozambique, a project entitled *Reducing Risks of Highly Hazardous Pesticides (HHPs) in Mozambique* was initiated by the Government of Mozambique, with the technical support of FAO's Pesticides Management Unit, and funded by SAICM Quick Start Programme Trust Fund. Its ultimate goal is to develop and implement an "HHP Risk Reduction Action Plan" in Mozambique for the most dangerous pesticides and use situations, resulting over time in the implementation of a variety of risk reduction measures based on a review of use conditions. These could include the cancellation of specific registrations of HHPs, implementation of risk mitigation measures, appropriate use restrictions, development of alternative pest management strategies, promotion of good agricultural practices, and possible phase-out of specific pesticides.

1.2 National and international policy framework

1.2.1 National framework

The major national legislative basis for pesticide distribution use in Mozambique is the Pesticide Management Regulation published under Decree 6/2009 of 31 March 2009 (RepMoz, 2009). The main objective of this Regulation, as laid out in its Article 2.1, is "*to ensure that all processes that involve working with or handling pesticides are executed without prejudice to public, animal and environmental health*". The Regulation further stipulates, in its Article 14, that pesticides will not be approved for use in Mozambique if, among others:

- the pesticide has unacceptable effects on organisms that are intended to be protected;
- the normal and recommended use of the pesticide has the potential to affect negatively human and/or animal health;
- the pesticide causes an unacceptable negative impact on the environment, particularly soil and water contamination, or affects organisms that are not targeted.

This clearly sets the boundaries within which the regulatory authorities in Mozambique can authorize a pesticide for use in the country.

In addition to the Pesticides Management Regulation, environmental, public health and labour legislation further defines the acceptability of risks of chemicals in general, and pesticides in particular, in Mozambique.

1.2.2 International framework

The International Code of Conduct on the Distribution and Use of Pesticides (FAO, 2002) describes the shared responsibility of many sectors of society to work together so that the

benefits to be derived from the necessary and acceptable use of pesticides are achieved without significant adverse effects on human health or the environment.

With respect to the availability and use of pesticides in a country, the Code stipulates in its Article 7, among others, that:

- Responsible authorities should give special attention to drafting rules and regulations on the availability of pesticides. These should be compatible with existing levels of user training and expertise. The parameters on which such decisions on availability are based vary widely and must be left to the discretion of each government.
- Two methods of restricting availability can be exercised by the responsible authority: not registering a product or, as a condition of registration, restricting the availability to certain groups of users in accordance with a national assessment of the hazards involved in the use of the product.
- Prohibition of the importation, sale and purchase of highly toxic and hazardous products, such as those included in WHO classes Ia and Ib, may be desirable if other control measures or good marketing practices are insufficient to ensure that the product can be handled with acceptable risk to the user.

For these reasons, pesticide risk reduction is one of the priority areas of FAO's pesticide management program.

At the request of the Committee on Agriculture (COAG), one of the governing bodies of FAO, the FAO/WHO Joint Meeting on Pesticide Management (JMPM) was asked in 2007 to provide guidance to FAO on the options to define highly hazardous pesticides (HHPs), beyond the definition provided in Article 7 of the Code, as well as on activities that could be initiated to reduce their risks. The JMPM defined on which basis HHPs could be identified (see Chapter 2.1 and FAO/WHO, 2008). The JMPM also recommended, as a general principle, that HHPs should not be registered for use unless:

- i. governments establish a clear need;
- ii. no alternatives, based on a risk–benefit analysis, are available; and
- iii. control measures as well as good marketing practices are sufficient to ensure that the product can be handled with acceptable risk to human health and the environment.

In conjunction with these considerations, the Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam, 2009) demonstrates the commitment of FAO and UNEP to address challenges associate with highly hazardous and other pesticide use in Mozambique and other developing countries. Information available on banned or severely restricted pesticides under PIC helps strengthen national decision making on pesticides. The PIC procedure assists countries like Mozambique in avoiding imports of hazardous chemicals that they cannot manage safely under national conditions of use. As such, the Convention helps to prevent incidents before they occur, serving as an early warning system or first line of defence, internationally, that helps keep countries apprised of actions that are being taken by other countries in dealing with problematic chemicals.

These and other efforts, internationally, provide a framework for strengthened pesticide management actions on the ground, in countries such as Mozambique. And in return, as projects such as this one go forward, they contribute to achieving the overall objective of the Strategic Approach to International Chemicals Management (SAICM), which is the sound management of chemicals throughout their life cycle so that, by 2020, chemicals are used and produced in ways that lead to the minimization of significant adverse effects on human health and the environment.

1.3 The project

1.3.1 Objectives

The main objectives of the project are to:

- Identify pesticides and pesticide use situations which can be considered highly hazardous under Mozambican conditions.
- Elaborate a plan of action to reduce the risks posed by these highly hazardous pesticides.
- Initiate implementation of priority risk reduction activities.
- Review the results of priority risk reduction activities.
- Develop mid- and longer-term policies, programmes and projects to reduce the risk of highly hazardous pesticides.

1.3.2 Approach

The project is organized in five key steps, which are:

- **Step 1** will develop a database of pesticide products presently registered and legally imported to the country in the last 3 years, review Mozambique's registered pesticides against the JMPM criteria for HHPs, identify a list of HHPs being used within the country and development of survey methodology to be used in step 2.
- **Step 2** will conduct field surveys for the identified HHPs, to assess actual use and exposure under local conditions in Mozambique, as well as additional hazard and risk assessments as appropriate.

On the basis of Steps 1 and 2, HHPs and cropping systems (or use situations) that require risk reduction measures will be identified.

- **Step 3** will develop Risk Reduction Action Plans, with the government and other relevant stakeholders, for HHPs and cropping systems or use situations where risks to human health and/or the environment are likely to be unacceptable.
- **Step 4** will focus on initial implementation of the Action Plans, with the national government, local communities, private/corporate sector, farmers, NGOs/CSOs, academia, scientific and technical community, and other relevant stakeholders carrying out a variety of risk activities both within the scope of this project, as well as in the longer term; and
- **Step 5** will review the Action Plan results achieved, make recommendations going forward, and evaluate the project.

This report specifically covers Step 1 of the project. Its main objective is to provide a short-list of HHPs on which to focus field surveys and hazard/risk assessments in Step 2.

The different activities in Steps 1 and 2 are outlined in Figure 2. They include:

- i. Evaluation of all pesticides registered in Mozambique against the JMPM criteria.
- ii. Elaboration of a list of HHPs and of pesticides “coming close” to HHPs (see Chapter 2 for more information).
- iii. Evaluation of pesticide import statistics for Mozambique to assess which HHPs are presently being used in the country.

- iv. Elaboration of a short-list of HHPs which will be further assessed through field surveys and hazard/risk assessments

The ultimate goal of Steps 1 and 2 is to define a list of HHPs, cropping systems and pesticide use situations which would require risk reduction, and for which Risk Reduction Action Plans will be developed under Step 3 of the project.

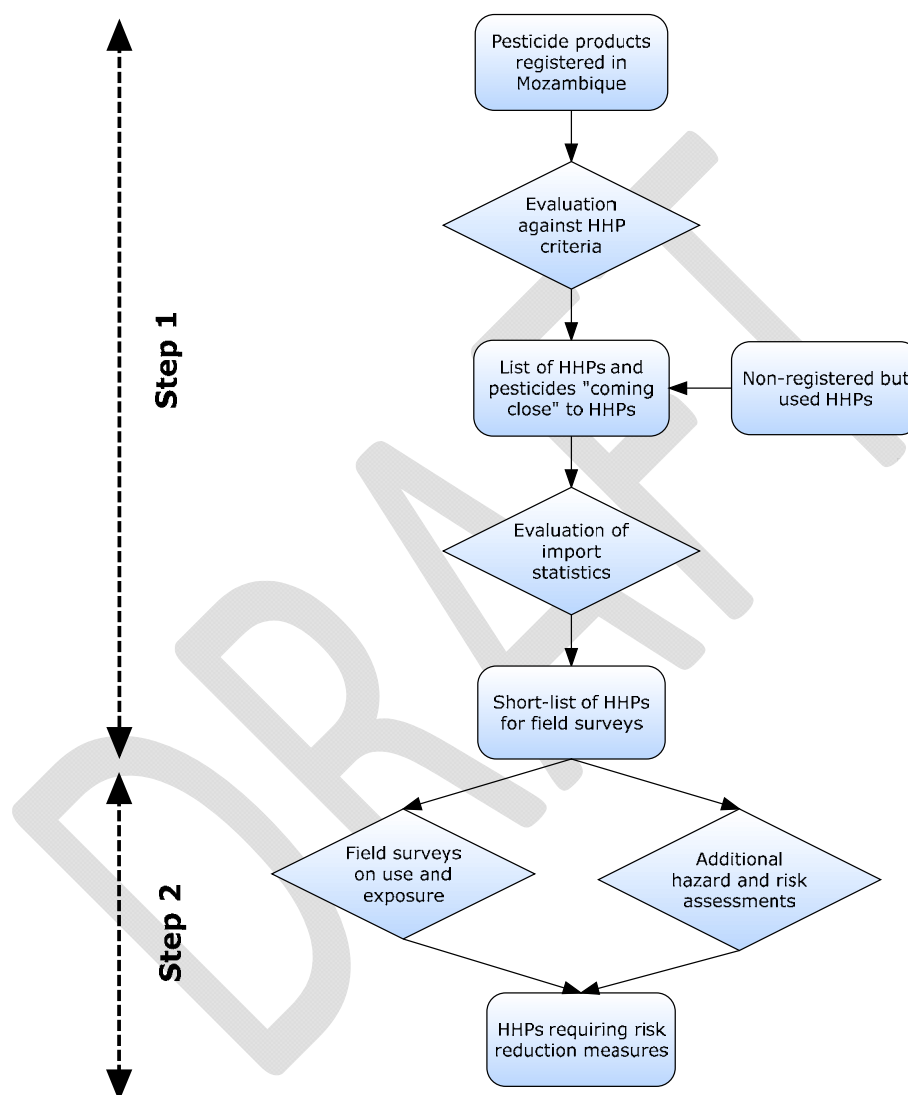


Figure 2. Schematic outline of the various activities in Steps 1 and 2 of the project. This report primarily covers Step 1.

2. Methodology

2.1 Criteria to define HHPs

The criteria that were used in this study to identify highly hazardous pesticides (HHPs) were those established by the FAO/WHO Joint Meeting on Pesticide Management (JMPM) (FAO/WHO, 2008). The JMPM recommended that HHPs should be defined as having one or more of the following characteristics:

- pesticide formulations that meet the criteria of classes Ia or Ib of the *WHO Recommended Classification of Pesticides by Hazard*;
- or
- pesticide active ingredients and their formulations that meet the criteria of carcinogenicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
- or
- pesticide active ingredients and their formulations that meet the criteria of mutagenicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
- or
- pesticide active ingredients and their formulations that meet the criteria of reproductive toxicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
- or
- pesticide active ingredients listed by the *Stockholm Convention* in its Annexes A and B, and those meeting all the criteria in paragraph 1 of annex D of the Convention;
- or
- pesticide active ingredients and formulations listed by the *Rotterdam Convention* in its Annex III;
- or
- pesticides listed under the *Montreal Protocol*;
- or
- pesticide active ingredients and formulations that have shown a high incidence of severe or irreversible adverse effects on human health or the environment.

The JMPM criteria above were used to establish a list of HHPs registered in Mozambique.

Added to this list were:

- Pesticides that are not registered in Mozambique anymore, but for which limited (left-over) quantities are still used in the country.
- Pesticides with characteristics which “come close” to the HHP criteria. A number of pesticides did not meet the WHO class criteria defined by the JMPM, but their acute or chronic toxicity “comes close” to the criteria limits, or they have been marked in the WHO classification as of particular concern with respect to their toxicity.

The following criteria were applied to identify such pesticides “coming close” to HHPs:

- For liquid formulations: pesticide products with an acute oral $LD_{50} < 200$ mg/kg or an acute dermal $LD_{50} < 400$ mg/kg (note that these are the Class Ib limits in the previous version of the WHO Classification (WHO, 2005)).
- For solid formulations: pesticide products with an acute oral $LD_{50} < 100$ mg/kg or an acute dermal $LD_{50} < 200$ mg/kg.
- Pesticides marked in the WHO classification as of particular concern with respect to chronic toxicity other than the CMR-criteria (*carcinogenicity-mutagenicity-reproductive toxicity*) listed in sections 2.2.4 to 2.2.6 below.
- Pesticides for which carcinogenicity evaluations by different registration/assessment authorities did not lead to consistent classification as GHS Category 1A or 1B, but which were, based on the evidence of one of these authorities, considered of particular concern for use in Mozambique.

2.2 Data collection

2.2.1 Introduction

In principle, the pesticide registration dossier should contain the information that is required for a responsible authority to identify whether a pesticide may be considered an HHP. However, in many developing countries, registration dossiers do not contain sufficient information for such an evaluation. And even if the information is provided in the dossier, the registration authority will often not have the technical capacity to assess the accuracy of the information or to evaluate submitted studies against all the JMPM criteria.

No international or national databases exist which list highly hazardous pesticides (HHPs) based on all the criteria listed by the JMPM. However, various databases are available for individual criteria. These include international databases, e.g. for the criteria linked to the Rotterdam and Stockholm Conventions, or for the *WHO Classification of pesticides by hazard*; others are national or regional, such as the classification and labelling of chemicals databases of the European Union.

In this study, registration dossiers submitted to the registration authority of Mozambique were used to assess pesticides against some of the HHP criteria. International databases or assessments, as well as national or regional databases of various reputable pesticide registration authorities, were accessed to review pesticides against other HHP criteria. The exact procedures for each of the HHP criteria are further described in the chapters below.

2.2.2 Starting data set

The initial dataset used for this study was the list of pesticides registered for use in Mozambique in June 2012, as provided by the Ministry of Agriculture of Mozambique (Minag, 2012). At that date, 646 formulated pesticide products were registered in the country.

The 646 registered products contained 192 active substances, of which six were synergists or other additives, and nine others were microbial pesticides.

2.2.3 WHO hazard class

HHPs

The JMPM considers as HHP all “Pesticide formulations that meet the criteria of classes Ia or Ib of the WHO Recommended Classification of Pesticides by Hazard”. The latest version of the WHO Classification (WHO, 2010) is shown in Table 1.

Table 1. WHO classification of pesticides by hazard (WHO, 2010)

WHO Class		LD ₅₀ for the rat (mg/kg body weight)	
		Oral	Dermal
Ia	Extremely hazardous	< 5	< 50
Ib	Highly hazardous	5–50	50–200
II	Moderately hazardous	50–2000	200–2000
III	Slightly hazardous	> 2000	> 2000
U	Unlikely to present acute hazard	≥5000	

To evaluate this criterion, all pesticide formulations registered in Mozambique were classified against the WHO Classification. The oral and dermal LD₅₀ value of the formulation, as provided in the registration dossier, was used as the basis for the classification.

In addition, for all formulations a theoretical LD₅₀ was calculated, based on the LD₅₀ value of the active ingredient(s) and its concentration(s) in the formulated product. LD₅₀ values for the active ingredient were obtained from the WHO Classification or, if not listed, from the FootPrint Pesticides Properties Database (PPDB, 2012). This theoretical LD₅₀ of the formulation was used in case there were no values in the registration dossier, or to check whether the LD₅₀ values provided in the dossier appeared reasonable given the active ingredient content. LD₅₀ values from the registration dossier which deviated greatly from the theoretical values were omitted from the analysis.

Whenever there were more products registered for the same active ingredient and concentration, and different LD₅₀ values were reported for these pesticide formulations, the lowest LD₅₀ value was used for final classification. If oral and dermal LD₅₀ values resulted in different classifications, the more hazardous classification was retained for the pesticide product.

2.2.4 GHS carcinogenic hazard

The JMPM considers as HHP all “Pesticide active ingredients and their formulations that meet the criteria of carcinogenicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS)”.

The carcinogenicity categories 1A and 1B are defined as by the GHS(2011) as shown in Table 2.

Table 2. Hazard categories for carcinogens, according to the GHS. See GHS (2011) for further details.

Category	Description
1	Known or presumed human carcinogen.
1A	Known to have carcinogenic potential for humans; the placing of a substance is large based on human evidence.
1B	Presumed to have carcinogenic potential for humans; the placing of a substance is largely based on animal evidence.
2	Suspected human carcinogen.

The GHS itself does not provide lists of pesticides and their classifications. Therefore, the following data sources were used to check whether a pesticide would meet GHS Class 1A or 1B for carcinogenicity:

- i. The **WHO Classification of Pesticides by Hazard** (WHO, 2010)
The footnotes to the various tables were checked for references to carcinogenicity. If a pesticide was listed as carcinogenic in the WHO Classification, it was considered, for this assessment, to meet GHS carcinogenicity Category 1A or 1B.
- ii. The **IARC Monographs on the evaluation of carcinogenic risks to humans** (IARC, 2012).
Pesticides classified as IARC Group 1 (*carcinogenic to humans*) and Group 2A (*probably carcinogenic to humans*) were considered, for this assessment, to meet GHS carcinogenicity Category 1A or 1B.
- iii. The **European Union Pesticides Database** (EU, 2012)
This database provides information on plant protection products, but not on other pesticides (biocides). EU hazard classifications follow the GHS. Therefore, pesticides listed in this database as “*carc. 1A*” are GHS Category 1A, and those listed as “*carc. 1B*” are GHS Category 1B.
- iv. The **European Chemical Substances Information System (ESIS)– Database of Harmonized Classification and Labelling Elements (CLP/GHS)** (ESIS, 2012)
In addition to plant protection products, this database provides hazard classification information on biocides. EU hazard classifications follow the GHS. Therefore, pesticides listed in this database as “*carc. 1A*” are GHS Category 1A, and those listed as “*carc. 1B*” are GHS Category 1B.
- v. The US EPA evaluations of carcinogenic potential, as provided in the **Integrated Risk Information System (IRIS)** (IRIS, 2012).
For this assessment, the following correlations were assumed between the various EPA carcinogenicity classifications and the GHS carcinogenicity categories:
 - 1986 guidelines: “*EPA class A (human carcinogen)*” were assumed to be GHS Category 1A, and “*EPA class B1 or B2 (probable human carcinogen)*” to be GHS Category 1B.
 - 1996 guidelines: “*EPA known/likely carcinogen*” was assumed to be GHS Category 1A or 1B.

- 1999 guidelines: “*EPA carcinogenic*” was assumed to be GHS Category 1A and *EPA “likely carcinogenic*” was assumed to be GHS Category 1B.
- 2005 guidelines: “*EPA carcinogenic*” was assumed for this assessment to be GHS Category 1A and “*EPA likely carcinogenic*” was assumed to be GHS Category 1B.

- vi. The list of **Chemicals Evaluated for Carcinogenic Potential**, compiled by the Office of Pesticide Programs of the US EPA (US-EPA, 2012a).

The same correlations were assumed as listed above (section v.) between the various EPA carcinogenicity classifications and the GHS carcinogenicity categories.

If pesticides were not covered by one or more of the previous sources, the data reviews mentioned below were verified:

- vii. Pesticides evaluated by the FAO/WHO *Joint Meeting on Pesticide Residues* (JMPR, 2012).

The JMPR toxicology reviews were accessed for selected pesticides to check whether the pesticide is considered to be carcinogenic. Since no standardised carcinogenicity classification is used in these reviews, pesticides were assessed on a case-by-case basis.

- viii. US EPA *Pesticide Chemical Search* (US-EPA, 2012b)

This database was accessed to obtain reviews for selected pesticides, generally *Pesticide Fact Sheets* or *Re-registration Eligibility Documents* (REDs). Since no standardised carcinogenicity classification is used in these reviews, pesticides were assessed on a case-by-case basis.

- ix. WHO *Specifications for pesticides used in public health* (WHO, 2012)

For a limited number of pesticides, the *WHO Specifications for pesticides used in public health* (new procedure) were accessed. Since no standardised carcinogenicity classification is used in these reviews, pesticides were assessed on a case-by-case basis.

In principle, if one of these data sources classified a pesticide as (equivalent to) GHS Categories 1A or 1B, the pesticide was considered a HHP. Only if the positive classification appeared outdated, and more recent comprehensive reviews or classifications were available showing that the pesticide was not carcinogenic, the pesticide was not considered a HHP based on this criterion.

2.2.5 GHS mutagenic hazard

The JMPM considers as HHP all “*Pesticide active ingredients and their formulations that meet the criteria of mutagenicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS)*”

The mutagenicity categories 1A and 1B are defined as by the GHS (2011) as shown in Table 3.

Table 3. Hazard categories for mutagens, according to the GHS. See GHS (2011) for further details.

Category	Description
1	Substances known to induce heritable mutations or to be regarded as if they induce heritable mutations in the germ cells of humans.
1A	Substances known to induce heritable mutations in germ cells of humans.
1B	Substances which should be regarded as if they induce heritable mutations in the germ cells of humans.
2	Substances which cause concern for humans owing to the possibility that they may induce heritable mutations in the germ cells of humans.

The GHS itself does not provide lists of pesticides and their classifications. Therefore, the following data sources were used to check whether a pesticide would meet GHS Class 1A or 1B for germ cell mutagenicity.

i. The **WHO Classification of Pesticides by Hazard** (WHO, 2010)

The footnotes to the various tables were checked for references to mutagenicity. If a pesticide was listed as mutagenic in the WHO Classification, it was considered, for this assessment, to meet GHS mutagenicity Category 1A or 1B.

ii. The **European Union Pesticides Database** (EU, 2012)

This database provides information on plant protection products, but not on other pesticides (biocides). EU hazard classifications follow the GHS. Therefore, pesticides listed in this database as “*muta. 1A*” are GHS Category 1A, and those listed as “*muta. 1B*” are GHS Category 1B.

iii. The **European Chemical Substances Information System (ESIS) – Database of Harmonized Classification and Labelling Elements (CLP/GHS)** (ESIS, 2012)

In addition to plant protection products, this database provides hazard classification information on biocides. EU hazard classifications follow the GHS. Therefore, pesticides listed in this database as “*muta. 1A*” are GHS Category 1A, and those listed as “*muta. 1B*” are GHS Category 1B.

If pesticides were not covered by one or more of the previous sources, the data reviews mentioned below were verified:

iv. Pesticides evaluated by the FAO/WHO **Joint Meeting on Pesticide Residues** (JMPR, 2012).

The JMPR toxicology reviews were accessed for selected pesticides to check whether the pesticide is considered to be germ cell mutagens. Since no standardised mutagenicity classification is used in these reviews, pesticides were assessed on a case-by-case basis.

v. US EPA **Pesticide Chemical Search** (US-EPA, 2012b)

This database was accessed to obtain reviews for selected pesticides, generally *Pesticide Fact Sheets* or *Re-registration Eligibility Documents* (REDs). Since no standardised mutagenicity classification is used in these reviews, pesticides were assessed on a case-by-case basis.

vi.. WHO *Specifications for pesticides used in public health* (WHO, 2012)

For a limited number of pesticides, the *WHO Specifications for pesticides used in public health* (new procedure) were accessed. Since no standardised mutagenicity classification is used in these reviews, pesticides were assessed on a case-by-case basis.

In principle, if one of these data sources classified a pesticide as (equivalent to) GHS Categories 1A or 1B, the pesticide was considered a HHP. Only if the positive classification appeared outdated, and more recent comprehensive reviews or classifications were available showing that the pesticide was not a germ cell mutagen, the pesticide was not considered a HHP based on this criterion.

2.2.6 GHS reproductive toxicity hazard

The JMPM considers as HHP all “*Pesticide active ingredients and their formulations that meet the criteria of reproductive toxicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS)*”

The reproductive toxicity categories 1A and 1B are defined as by the GHS (2011) as shown in Table 4.

Table 4. Hazard categories for reproductive toxicants, according to the GHS. See GHS (2011) for further details.

Category	Description
1	Known or presumed human reproductive toxicant
1A	Known human reproductive toxicant
1B	Presumed human reproductive toxicant
2	Suspected human reproductive toxicant

The GHS itself does not provide lists of pesticides and their classifications. Therefore, the following data sources were used to check whether a pesticide would meet GHS Class 1A or 1B for reproductive toxicity.

i. The *WHO Classification of Pesticides by Hazard* (WHO, 2010)

The footnotes to the various tables were checked for references to reproductive toxicity. If a pesticide was listed as a reproductive toxicant in the WHO Classification, it was considered, for this assessment, to meet GHS reproductive toxicity Category 1A or 1B.

ii. The *European Union Pesticides Database* (EU, 2012)

This database provides information on plant protection products, but not on other pesticides (biocides). EU hazard classifications follow the GHS. Therefore, pesticides listed in this database as “*repro. 1A*” are GHS Category 1A, and those listed as “*repro. 1B*” are GHS Category 1B.

iii. The *European Chemical Substances Information System (ESIS) – Database of Harmonized Classification and Labelling Elements (CLP/GHS)* (ESIS, 2012)

In addition to plant protection products, this database provides hazard classification information on biocides. EU hazard classifications follow the GHS. Therefore, pesticides listed in this database as “*repro. 1A*” are GHS Category 1A, and those listed as “*repro. 1B*” are GHS Category 1B.

If pesticides were not covered by one or more of the previous sources, the data reviews mentioned below were verified:

- iv. Pesticides evaluated by the FAO/WHO *Joint Meeting on Pesticide Residues* (JMPR, 2012).

The JMPR toxicology reviews were accessed for selected pesticides to check whether the pesticide is considered to be a reproductive toxicant. Since no standardised reproduction toxicity classification is used in these reviews, pesticides were assessed on a case-by-case basis.

- v. US EPA *Pesticide Chemical Search* (US-EPA, 2012b)

This database was accessed to obtain reviews for selected pesticides, generally *Pesticide Fact Sheets* or *Re-registration Eligibility Documents* (REDs). Since no standardised reproduction toxicity classification is used in these reviews, pesticides were assessed on a case-by-case basis.

- vi. WHO *Specifications for pesticides used in public health* (WHO, 2012)

For a limited number of pesticides, the *WHO Specifications for pesticides used in public health* (new procedure) were accessed. Since no standardised classification for reproductive toxicants is used in these reviews, pesticides were assessed on a case-by-case basis.

In principle, if one of these data sources classified a pesticide as (equivalent to) GHS Categories 1A or 1B, the pesticide was considered a HHP. Only if the positive classification appeared outdated, and more recent comprehensive reviews or classifications were available showing that the pesticide was not a reproductive toxicant, the pesticide was not considered a HHP based on this criterion.

2.2.7 Stockholm Convention

The JMPM considers as HHP all “*Pesticide active ingredients listed by the Stockholm Convention in its Annexes A and B, and those meeting all the criteria in paragraph 1 of Annex D of the Convention*”

Pesticides listed in Annex A and B were obtained directly from the Convention web site (Stockholm, 2012).

Annex D of the Stockholm Convention lists the screening criteria for inclusion of a pesticide in Annex A, B and/or C of the Convention (Stockholm, 2009). With respect to Annex D, the Stockholm Convention stipulates in its Article 3, that :

3. *Each Party that has one or more regulatory and assessment schemes for new pesticides or new industrial chemicals shall take measures to regulate with the aim of preventing the production and use of new pesticides or new industrial chemicals which, taking into consideration the criteria in paragraph 1 of Annex D, exhibit the characteristics of persistent organic pollutants.*

4. *Each Party that has one or more regulatory and assessment schemes for pesticides or industrial chemicals shall, where appropriate, take into consideration within these schemes the criteria in paragraph 1 of Annex D when conducting assessments of pesticides or industrial chemicals currently in use.*

Therefore, and in particular to meet Article 3.4 above, all pesticides registered in Mozambique were reviewed against the criteria listed in Annex D. The screening criteria that identify a POP, as defined in paragraph 1 of Annex D are listed in Table 5.

For each of the registered pesticides, the data were compiled using the FootPrint Pesticide Properties Database (PPDB, 2012), as follows:

Persistence

- Half-life (DT₅₀) in water: aqueous photolysis DT₅₀; aqueous hydrolysis DT₅₀, and water phase only DT₅₀ of the water-sediment study. The latter parameter, or any listed field data, had preference in the assessment of persistence in water. The range of relevant values was noted in the evaluation spreadsheet.
- Half-life (DT₅₀) in soil: DT₅₀ (typical), DT₅₀ (lab), DT₅₀ (field), any DT₅₀ values (lab or field) given in the “note” to this section in FootPrint. Any listed field data had preference in the assessment of persistence in soil. The range of relevant values was noted in the evaluation spreadsheet.
- Half-life (DT₅₀) in sediment: Water-Sediment DT₅₀

Table 5. Screening criteria to identify a Persistent Organic Pollutant (POP) according to the Stockholm Convention (Annex D) (Stockholm, 2009)

Characteristic	Criteria
b. Persistence	<p>(i) Evidence that the half-life of the chemical in water is greater than two months, or that its half-life in soil is greater than six months, or that its half-life in sediment is greater than six months; or</p> <p>(ii) Evidence that the chemical is otherwise sufficiently persistent to justify its consideration within the scope of this Convention;</p>
c. Bio-accumulation	<p>(i) Evidence that the bio-concentration factor or bio-accumulation factor in aquatic species for the chemical is greater than 5,000 or, in the absence of such data, that the log K_{ow} is greater than 5;</p> <p>(ii) Evidence that a chemical presents other reasons for concern, such as high bio-accumulation in other species, high toxicity or ecotoxicity; or</p> <p>(iii) Monitoring data in biota indicating that the bio-accumulation potential of the chemical is sufficient to justify its consideration within the scope of this Convention;</p>
d. Potential for long-range environmental transport	<p>(i) Measured levels of the chemical in locations distant from the sources of its release that are of potential concern;</p> <p>(ii) Monitoring data showing that long-range environmental transport of the chemical, with the potential for transfer to a receiving environment, may have occurred via air, water or migratory species; or</p> <p>(iii) Environmental fate properties and/or model results that demonstrate that the chemical has a potential for long-range environmental transport through air, water or migratory species, with the potential for transfer to a receiving environment in locations distant from the sources of its release. For a chemical that migrates significantly through the air, its half-life in air should be greater than two days; and</p>
e. Adverse effects	<p>(i) Evidence of adverse effects to human health or to the environment that justifies consideration of the chemical within the scope of this Convention; or</p> <p>(ii) Toxicity or ecotoxicity data that indicate the potential for damage to human health or to the environment.</p>

Bioaccumulation

- Octanol–water partition coefficient – log K_{ow} (= log P in FootPrint).
- Bioconcentration factor in aquatic species (BCF).
- Bioaccumulation factor in aquatic species (BAF) (if listed).
- Bioaccumulation factor in other species (BAF) (if listed).

Potential for long-range transport

- This characteristic was not assessed, as it was not considered relevant for the identification of HHPs in Mozambique itself.

Adverse effects

- This characteristic was only assessed for pesticides which were both persistent and bioaccumulative according to the criteria listed above. For this study, such pesticides were considered HHPs if they fell in WHO hazard class II or higher.
- No other toxicity or ecotoxicity assessments were conducted to assess whether there was “potential for damage to human health or to the environment”.

2.2.8 Rotterdam Convention

The JMPM considers as HHP all “*Pesticide active ingredients and formulations listed by the Rotterdam Convention in its Annex III*”.

Pesticides listed in Annex III were obtained directly from the Convention web site (Rotterdam, 2012)

2.2.9 Montreal Protocol

The JMPM considers as HHP all “*Pesticides listed under the Montreal Protocol*”.

The only pesticide presently listed under the Montreal Protocol is methyl bromide (Montreal, 2012)

2.2.10 High incidence of severe or irreversible adverse effects

The JMPM considers as HHP all “*Pesticide active ingredients and formulations that have shown a high incidence of severe or irreversible adverse effects on human health or the environment*”.

This parameter was not assessed in Step 1 of the project, as it requires information from actual use in Mozambique, or from similar use situations. Pesticide use surveys have been programmed for Step 2 of the project, however.

2.2.11 Import statistics

Import statistics were obtained from the Pesticide Registration Section of the Ministry of Agriculture. Mozambique applies an import permit system and all official pesticide imports are registration by the Ministry of Agriculture. While such a system does not allow for records of illegal imports, the import register in Mozambique is generally considered to represent a large fraction of pesticides entering the country. No local pesticide manufacturing or formulation takes place in Mozambique.

For this study, the import statistics of 2010, 2011 and the first half of 2012 were reviewed. Total quantities imported during that period for all products with the same active ingredient(s) were considered a proxy for the present use of that active ingredient in the country. Implicitly, it was assumed that pesticides imported before 2010 would have been used up by the time of the study and not be used anymore.

2.3 Data compilation

All assessments made and data compiled as described in the sections above were compiled in a spreadsheet. This was done to allow full transparency with respect to the identification process of the HHPs, but also to allow updating of the list of HHPs would new information become available. The latest version of the spreadsheet is available on request. This version does not contain the detailed import statistics, however, as these are considered confidential.

DRAFT

3. Results

3.1 Data availability

Using the data sources laid out in Chapter 2, it was possible to review all HHP criteria defined by the JMPM for most of the pesticides registered in Mozambique, except for the last criterion, which refers to pesticides that have shown a high incidence of severe or irreversible adverse effects – see Section 2.2.10).

Acute toxicity

LD₅₀ values for the pesticide formulations were provided in the registration dossier for 97% (oral LD₅₀) and 93% (dermal LD₅₀) of the registered products. However, in some cases the LD₅₀ values of the formulation appeared erroneous when compared to the theoretical values calculated on the basis of the a.i.; in others, the LD₅₀ of the formulation provided by the registrar was identical to the a.i. In total, 12% of the oral LD₅₀ values for the formulations were either not reported in the dossier or were considered erroneous; this was the case for 10% of the dermal LD₅₀ values. However, in many cases, LD₅₀ values of the formulation could be estimated based on the LD₅₀ values of the a.i.

As a result, LD₅₀ values for the formulation were available or could be estimated for all registered pesticide products except for three microbial pesticides and one citronella oil (i.e. > 99% of the total).

Overall, data availability for acute toxicity, which is at the basis of the WHO Class criterion of the JMPM, can be considered satisfactory.

Carcinogenicity, mutagenicity, reproductive toxicity (CMR)

Evaluations on carcinogenic potential were available for 93% of the active ingredients registered in Mozambique, representing 96% of the number of registered formulated products. Of the 11 a.i.'s lacking carcinogenicity evaluations, four were adjuvants/synergists, one a repellent, one a microbial pesticide and one a pheromone; the remaining four were “regular” chemical pesticides.

Evaluations on germ cell mutagenicity were available for 90% of the active ingredients registered in Mozambique, representing 95% of the number of registered formulated products. Of the 20 a.i.'s lacking carcinogenicity evaluations, four were adjuvants/synergists, three repellents, one a microbial pesticide and one a pheromone; the remaining 11 were “regular” chemical pesticides.

Evaluations on reproductive toxicity were available also for 90% of the active ingredients registered in Mozambique, representing 94% of the number of registered formulated products. Of the 20 a.i.'s lacking reproductive toxicity evaluations, four were adjuvants/synergists, two repellents, one a microbial pesticide and one a pheromone; the remaining 12 were “regular” chemical pesticides.

Overall, data to evaluate the CMR criteria of the JMPM were available for >90% of the a.i. and >94% of registered formulations. Eight to twelve active ingredients of “regular” chemical pesticide a.i.'s had not been evaluated and/or classified for CMR criteria by any of the used sources. It can certainly not be excluded that evaluation of other data sources would result in proper classification of these a.i.'s, but that was not further attempted in this study.

Rotterdam and Stockholm Conventions, and Montreal Protocol

Inclusion in the lists of regulated chemicals of these three international instruments was obviously complete and did not show any data gaps.

On the other hand, there were data gaps in the parameters needed to classify a pesticide as a POP according to Annex D of the Stockholm Convention. Only one data source was used to obtain this information, the FootPrint Pesticide Properties Database. However, since the FootPrint database compiles its data from various reputable reviews and databases, it is generally considered to be rather complete.

In spite of the extensiveness of the FootPrint database, for 36 a.i.'s (19% of the total) half-lives in water were not available. In many cases this absence was understandable (e.g. for microbial pesticides, repellents, pheromones), but for 17 a.i.'s of "regular" chemical pesticides registered in Mozambique, this information was not present either.

Half-lives in soil were available for more pesticides in the FootPrint database. Data were lacking for 27 a.i.'s (15% of the total), of which eight were "regular" chemical pesticides registered in Mozambique.

In contrast, half-life data for sediments (water-sediment studies) were not available for 42% of the a.i.'s. This included 58 "regular" chemical pesticide a.i.'s for which data were lacking. This is not entirely surprising, as water-sediment studies are fairly recent requirements in pesticide registration in Europe and the U.S.

Bioaccumulation potential is assessed using the bioconcentration factor (BCF) for aquatic organisms, or the bioaccumulation factor (BAF) for aquatic or terrestrial organisms. BAFs were not available in FootPrint for any of the registered a.i.'s. BCFs were not available for 76 a.i.'s (40% of the total).

In the absence of BCFs, the octanol-water partition coefficient (K_{ow} or P) of the pesticide is used to evaluate bioaccumulation potential. K_{ow} -values were available for most pesticides, with data absent for only 21 a.i.'s (10% of the total), most of which were microbial pesticides, synergists or adjuvants, and pheromones.

Based on the above, it may be concluded that for the majority of pesticides registered in Mozambique it was possible to assess whether a pesticide is persistent or bioaccumulative according to the Stockholm Convention, but that there were still considerable data gaps.

3.2 Identification of HHPs

Taking into account the limitations due to data gaps described above, in total 57 registered pesticide formulations, containing 24 active ingredients, were identified as HHPs. In addition, two pesticides were also listed as HHP: DDT and methyl-bromide (Figure 3). The latter two pesticides are not registered in Mozambique anymore, but remaining stocks are still being used (for DDT) or their use is still temporarily being allowed (for methyl bromide). Further details for all identified HHPs are provided in Table 6.

The majority of HHPs were identified on the basis of their acute toxicity. Thirty-seven out of 59 formulated products were WHO class Ia or Ib (based on acute toxicity; not on chronic), or highly toxic by inhalation (Figure 4).

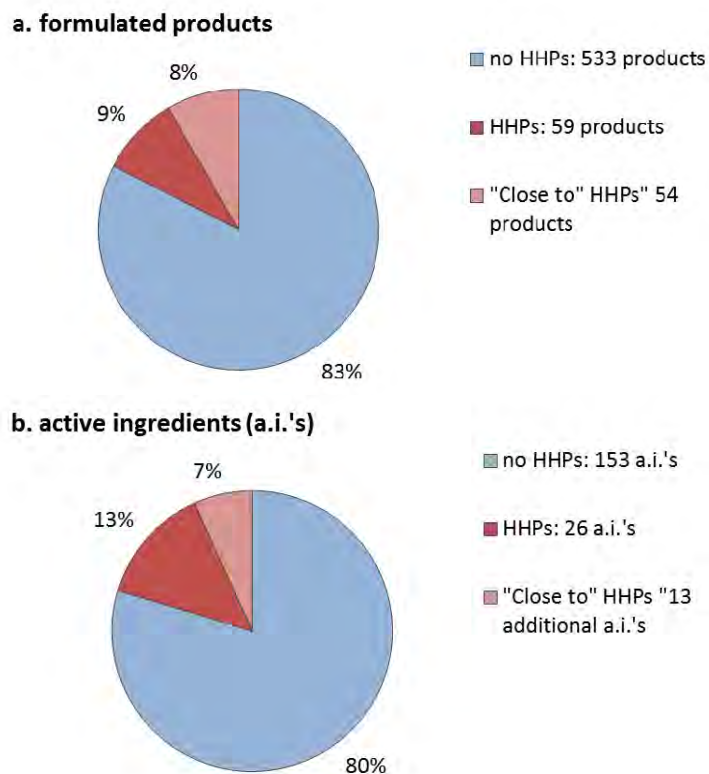


Figure 3. The number and percentage of identified highly hazardous pesticides (HHPs), pesticides "close to HHPs" in Mozambique. a. formulated products (total = 646), and b. active ingredients (a.i.'s) (total = 192).

The second most important criterion was listing in Annex III of the Rotterdam Convention (Figure 4). This was the case for 17 out of 59 formulated products, or 6 out of 26 active ingredients identified as HHP.

Two active ingredients, representing 5 pesticide products, were listed in Annex A or B of the Stockholm Convention. Three other pesticide active ingredients were both persistent and bioaccumulative according to Annex D criteria (diafenthiuron, difenacoum and difethialone), but only diafenthiuron is moderately toxic to humans. Furthermore, the insecticide diafenthiuron is considered hazardous to aquatic organisms while difenacoum and difethialone, both rodenticides, are considered hazardous to aquatic organisms as well as to birds and mammals. While this does not mean that these organisms will be unacceptably affected when the pesticides are applied, the "potential for damage to the environment" exists (as indicated in Annex D of the Stockholm Convention), and these pesticides were therefore identified as HHPs in Table 6.

One pesticide was listed under the Montreal Protocol.

Two active ingredients were classified as GHS Category 1A & 1B carcinogen, three a.i.'s as mutagen and three a.i.'s as reproductive toxicant. For 14 active ingredients, carcinogenicity evaluations by the EU and the US-EPA did not lead to the same conclusion with respect to classification; these were further evaluated under Section 3.3.

In total, seven active ingredients met more than one JMPM HHP criterion (Table 6).

Table 6. Highly hazardous pesticides (HHPs) identified among the pesticide products registered in Mozambique, and pesticide products “coming close” to being considered HHPs. For the selection criteria and the applied methodology see Chapter 2 of this report.

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
Pesticides meeting the HHP criteria							
455	Controler 48% SE	Alachlor 336 g/l (+ Atrazine 144 g/l)	Rott. Annex III	Maize, sunflower, soybean, groundnut, vegetables	0		EU: No (H ² & E ³) USA: Yes
666	Volcano alachlor 48% EC	Alachlor 480 g/l	Rott. Annex III				
509	Seter 48% EC	Alachlor 480 g/l	Rott. Annex III				
644	Volcano Aldicarb 15% GR	Aldicarb 150 g/kg	WHO Ib; Rott. Annex III	Citrus (nurseries)	0		EU: No (E) USA: Yes, but being phased out (H & E)
1172	Fumate 56% FT	Aluminium Phosphide 560 g/kg	Highly toxic by inhalation	Storage insect pests of: tobacco, cereals, groundnut, oilseeds	29844 kg (2010) 14690 kg (2011) 1311 kg (2012) 705 (2013)		EU: Yes USA: Yes
1054	Moz Aluminium Phosphide Pellets	Aluminium Phosphide 560 g/kg	Highly toxic by inhalation				
581	Phosgard 56% FT	Aluminium phosphide 560 g/kg	Highly toxic by inhalation				
773	Falfume 57% FT	Aluminium Phosphide 570 g/kg	Highly toxic by inhalation				
1071	Moz Aluminium Phosphide Tablets	Aluminium Phosphide 570 g/kg	Highly toxic by inhalation				
1129	Quickphos 57% FT	Aluminium Phosphide 570 g/kg	Highly toxic by inhalation				
1080	Biophos 57% FW	Aluminium phosphide 570 g/kg	Highly toxic by inhalation				
1028	Celphos 57% FT	Aluminium phosphide 570 g/kg	Highly toxic by inhalation				
664	Volcano Aluminium Phosphide 57% FT	Aluminium phosphide 570 g/kg	Highly toxic by inhalation				
467	Benopec 50% WP	Benomyl 500 g/kg	Mutagen; reproductive toxicant	Apple, pineapple	5600 kg (2010)		EU: No (H & E) USA: No; voluntary

¹ EU (2012) and US-EPA (2012b), checked on 26 October 2012

² H = not registered due to unacceptable risk to human health

³ E = not registered due to unacceptable risk to the environment

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
772	Volcano Demeter 50% WP	Benomyl 500 g/kg	Mutagen; reproductive toxicant		2000 kg (2012)		cancellation (H)
793	Supa-Kill Líquid Rat and Mouse Bait	Brodifacoum 0,75 g/L	WHO class Ib				
952	Brokir 0,075% CB	Brodifacoum 0,75 g/L	WHO class Ib	Rodents	40 L (2011) 28 L (2012)	Also formulation with lower concentration registered	EU: No (NS ⁴) USA: Yes
837	Rodex Profissional Líquid Concentrate	Brodifacoum 2,5 g/kg	WHO class Ib				
681	Duett 25% SC	Carbendazim 125 g/l (+ Epoxiconazole 125 g/l)	Mutagen; reproductive toxicant	Cereals, groundnut	5 L (2011)		EU: Yes USA: Yes
126	Curaterr 10% GR	Carbofuran 100 g/kg	WHO class Ib				EU: No (H & E)
504	Carbofurão 5% GR	Carbofuran 50 g/kg	WHO class Ib	Maize, sugarcane	0		USA: No; cancellation in progress (H & E)
254	Polo 50% SC	Diafenthiuron 500 g/l	Stockh. Annex D (persistent, bioaccumulative and potential for damage to the humans or the environment)	Beans, cucumber, pepper, tomato, potato	0		EU: No (NS) USA: No
1202	Divos 100% EC	Dichlorvos 1000 g/l	WHO class Ib		448 L (2010)		
984	Nuvan 100% EC	Dichlorvos 1000 g/l	WHO class Ib	Flowers, vegetables, stored cereals, domestic uses, veterinary uses	3000 L (2011)		EU: No (H)
774	Falcovos 100% EC	Dichlorvos 1000 g/l	WHO class Ib		2400 L (2012)		USA: Yes
984	Nuam 100% EC	Dichlorvos 1000 g/l	WHO class Ib		2584 (2013)		
1220	Diclofop-methyl 37,8% EC	Diclofop-methyl 378 g/l	carcinogen	Wheat, barley, triticale, peas	0		EU: Yes USA: Yes
1055	Moz Tornado 0,01% BB	Difenacoum 0,1 g/kg	Stockh. Annex D (persistent, bioaccumulative and potential for damage to the environment)	Rodents	48 (2013)		EU: Yes USA: Yes

⁴ NS = not registered because no (complete) dossier was submitted

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
944	Finale Rat And Mouse Grain Bait	Difethialone 0,025 g/kg	Stockh. Annex D (persistent, bioaccumulative and potential for damage to the environment)	Rodents	0		EU: No (NS) USA: Yes
969	Finale Rat And Mouse Pellets	Difethialone 0,025 g/kg	Stockh. Annex D (persistent, bioaccumulative and potential for damage to the environment)				
943	Finale Rat And Mouse Wax Bait	Difethialone 0,025 g/kg	Stockh. Annex D (persistent, bioaccumulative and potential for damage to the environment)				
719	Ratex Pellets	Difethialone 0,025 g/kg	Stockh. Annex D (persistent, bioaccumulative and potential for damage to the environment)				
1027	Endocel 35% EC	Endosulfan 350 g/l	Stockh. Annex A; Rott. Annex III	Cotton, cocoa, cereals, vegetables, flowers,	2585 L (2010) 7280 L (2011) 9150 L (2012)		EU: No (H & E) USA: Yes, but phase out in progress
447	Endopecc 35% EC	Endosulfan 350 g/l	Stockh. Annex A; Rott. Annex III				
825	Enticer 35% EC	Endosulfan 350 g/l	Stockh. Annex A; Rott. Annex III				
605	Volcano Endosulfão 35% EC	Endosulfan 350 g/l	Stockh. Annex A; Rott. Annex III				
518	Eticide 101% EC	Ethion 1010 g/l	WHO class Ib	Veterinary use	0		EU: No (NS) USA: No; voluntary cancellation (H)
483	Nemacur 40% EC	Fenamiphos 400 g/l	WHO class Ib	Tobacco, citrus, vegetables, potato, groundnut, grape, peach, pineapple	30 L (2013)	Also a granular formulation with lower hazard registered	EU: Yes USA: Voluntary cancellation (H & E)
715	Volamiphos 40% EC	Fenamiphos 400 g/l	WHO class Ib				
1056	Moz Fenamiphos 400 SC	Fenamiphos 400 g/l	WHO class Ib				

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
1115	Vet Fume B	Formaldehyde 370 g/l	Carcinogen	Disinfectant	1660 (2010) 4060 (2011) 1910 (2012) 3525 (2013)		EU: No (NS) USA: Yes
746	Crop Guard 90% EC	Furfural 900 g/l	WHO class Ib	Vegetables, tobacco, flowers, maize, groundnut	200 (2013)		EU: No (NS) USA: Yes
1163	Chemaron 58% SL	Methamidophos 585 g/l	WHO Ib; Rott. Annex III	Cotton, tobacco, vegetables	34760 L (2010)		EU: No (RE) ⁵ USA: No; voluntary cancellation
1163	Chemaron 58% SL	Methamidophos 585 g/l	WHO Ib; Rott. Annex III		13050 L (2011)		
1199	Sniper 58.5% SL	Methamidophos 585 g/l	WHO Ib; Rott. Annex III		37832 L (2012)		
639	Volmet 58,5% SL	Methamidophos 585 g/l	WHO Ib; Rott. Annex III		28556 L (2013)		
361	Mesurol 80 WP	Methiocarb 800 g/kg	WHO class Ib	Maize, groundnut, potato, vegetables, citrus	0	Also formulation with lower concentration registered	EU: Yes USA: Yes
1198	Methomex 90% SP	Methomyl 900 g/kg	WHO class Ib	Vegetables, tobacco, cereals, flowers	500 kg (2012) 1000 kg (2013)	Also formulation with lower concentration registered	EU: Yes USA: Yes
480	Delta Super 25,75% EC	Monocrotophos 250 g/l (+ Deltamethrin 7,5 g/l)	Rott. Annex III	Cotton, maize, tobacco	0		EU: No (NS) USA: No (cancelled in 1991)
478	Zipper Super 28% EC	Monocrotophos 250 g/l (+ Cypermethrin 30 g/l)	Rott. Annex III				
454	Monopec 40% SL	Monocrotophos 400 g/l	WHO Ib; Rott. Annex III				
1151	Monocrotophos 40% EC	Monocrotophos 400 g/l	WHO Ib; Rott. Annex III				
1185	Oxadate 31% SL	Oxamyl 310 g/l	WHO class Ib	Tobacco, sugarcane,	500 kg (2010)		EU: Yes

⁵ RE = not registered because registration expired and was not renewed

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
810	Vydate 31% SL	Oxamyl 310 g/l	WHO class Ib	fruits, vegetables, groundnut	300 kg (2011) 400 kg (2012)		USA: Yes
1065	Moz Terbufos 15% GR	Terbufos 150 g/kg	WHO class Ia	Maize, sorghum, potato, beans	0		EU: No (NS) USA: Yes
1167	Ratikill 80% AB	Zinc phosphide 800 g/kg	WHO class Ib	Rodents	0		EU: Yes
822	Ratil 80% AB	Zinc phosphide 800 g/kg	WHO class Ib				USA: Yes
Total [57/646]		[24/225]					
Pesticides not registered, but used in Mozambique and complying with the HHP criteria							
--	DDT 50% WP	DDT	Stockh. Annex B; Rott. Annex III	Malaria mosquito control	0 (but use of existing stocks)		EU: No (P) ⁶ USA: No
--	Brometo de metilo	Methyl bromide	Montreal Protocol	Quarantine treatments (stored products)	0 (but use of existing stocks)		EU: No (H) USA: Yes
Total		[2]					
Registered pesticides not complying with the JMPM criteria, but "coming close"							
570	Volcano 2,4 D 72% SL	2,4-D dimethylamine 720 g/l	WHO class II, but dermal hazard close to Ib	Sugar cane, coffee, cocoa, rice, palm trees.	47000 L (2010) 32600 L (2011) 52000 L (2012) 19600 L (2013)		EU: No USA: Yes
1063	Moz Paraquat 20% SL	Paraquat 200 g/l	WHO Class II but chronic toxicity alert; dermal hazard close to Class Ib; very low AOEL ⁷	Forestry, fruits, vegetables, cotton, coffee, tea, flowers, banana, sugar cane,	22700 L (2010) 35100 L (2011) 17952 L (2012)		EU: No (A) ⁸ USA: Yes

⁶ P = not registered because all use is prohibited in the EU

⁷ AOEL = Acceptable Operator Exposure Level

⁸ A = not registered because registration annulled by the Court

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
1303	Paracot 20% SL	Paraquat 200 g/l	WHO Class II but chronic toxicity alert; dermal hazard close to Class Ib; very low AOEL	pasture, potato	18440 L (2013)		
1262	Para-Cure 20% SL	Paraquat 200 g/l	WHO Class II but chronic toxicity alert; dermal hazard close to Class Ib; very low AOEL				
458	Paraxone 20% SL	Paraquat 200 g/l	WHO Class II but chronic toxicity alert; dermal hazard close to Class Ib; very low AOEL				
764	Volquato 20% SL	Paraquat 200 g/l	WHO Class II but chronic toxicity alert; dermal hazard close to Class Ib; very low AOEL				
1181	Gramozat 20% SL	Paraquat 200 g/l	WHO Class II but chronic toxicity alert; dermal hazard close to Class Ib; very low AOEL				
544	Ficam 80% WP	Bendiocarb 800 g/kg	WHO class II, but oral hazard close to Class Ib	Malaria mosquito control	5810 kg (2010) 14560 kg (2011) 30000 kg (2013)		EU: No (NS) USA: No; voluntary cancellation
735	Tocaia 80% WP	Bendiocarb 800 g/kg	WHO class II, but oral hazard close to Class Ib				
884	Avisnail 5% RB	Carbaryl 20 g/kg (+metaldehyde 30 g/kg)	Carcinogen (see Annex I)	Cotton, potato, maize, sorghum, tobacco, groundnut, vegetables	400 kg (2010) 4200 kg (2011) 2200 kg (2012) 2600 kg (2013)		EU: No (H & E) USA: Yes
811	Supona 30% EC	Chlorfenvinphos 300 g/l	WHO class II, but oral hazard close to Class Ib	Veterinary uses	600 L (2012) 812 L (2013)		EU: No (NS) USA: No

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
816	Dazzel N.F 30% EC	Diazinon 300 g/l	WHO class II, but dermal hazard close to Class Ib	Veterinary uses	18 L (2010) 24 L (2011) 30 L (2012) 64 L (2013)		EU: No (H) USA: Yes
1155	Dichlorvos 10% EC	Dichlorvos (DDVP)100 g/l	WHO class II, but dermal and oral hazard close to Class Ib	Stored grains, vegetables, domestic use, veterinary use	1411 L (2010) 1462 L (2011) 2400 L (2012) 4000 L (2013)	More concentrated formulations in HHP shortlist above.	EU: No (H) USA: Yes
985	Nuvan Profi 12,4% AE	Dichlorvos 124 g/l	WHO class II, but dermal and oral hazard close to Class Ib				
986	Metrad 75% WG	Diuron 400 g/kg (+metribuzin 360 g/kg)	Carcinogen (see Annex I)	Sugarcane, cotton, macadamia nuts, coffee, banana, pineapple, wheat, tea, coconut, fruits trees, cocoa, rubber tree, industrials areas	47368 L (2010) 54140 L (2011) 58900 L (2012) 44660 L (2013)		EU: Yes USA: Yes
461	Dipec 80% WP	Diuron 800 g/kg	Carcinogen (see Annex I)				
849	Volcano Diuron 80% WG	Diuron 800 g/kg	Carcinogen (see Annex I)				
532	Volcano Diurão 800 SC	Diuron 800 g/l	Carcinogen (see Annex I)				
1061	Moz Diuron 80% SC	Diuron 800 g/l	Carcinogen (see Annex I)				
1211	Iprodione 25,5% SC	Iprodione 255 g/l	Carcinogen (see Annex I)	Vines, fruit trees, vegetables	12 L (2013)		EU: Yes USA: Yes
1101	Milthane Super 80% WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				
663	Volcano Crater MX 70% WP	Mancozeb 100 g/kg (+metalaxyl 600 g/kg)	Carcinogen (see Annex I)	Tobacco, vegetables, pineapple, ornamentals, fruit trees, potato, groundnut, vines , cereals, nuts, olive, coffee, soybean	68890 kg (2010) 77740 kg (2011) 30500 kg (2012) 59570 kg (2013)		EU: Yes USA: Yes
508	Etylit MZ 70% WP	Mancozeb 350 g/kg (+fosetyl-aluminium 350 g/kg)	Carcinogen (see Annex I)				
1236	Crater 455 SC	Mancozeb 455 g/l	Carcinogen (see Annex I)				
477	Megatop 50,5% WP	Mancozeb 465 g/kg (+cymoxanil 40 g/kg)	Carcinogen (see Annex I)				
1075	Dithane NT 60% OS	Mancozeb 600 g/kg	Carcinogen (see Annex I)				

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
875	Volcano Crater MX 72% WP	Mancozeb 640 g/kg (+ Metalaxyl 80 g/kg)	Carcinogen (see Annex I)				
546	Ridomil Gold 68% WP	Mancozeb 640 g/kg (+metalaxyl 40 g/kg)	Carcinogen (see Annex I)				
472	Ekyp MZ 72% WP	Mancozeb 640 g/kg (+metalaxyl 80 g/kg)	Carcinogen (see Annex I)				
823	Mascot 72% WP	Mancozeb 640 g/kg (+metalaxyl 80 g/kg)	Carcinogen (see Annex I)				
1136	Metaman FAE PM 72% WP	Mancozeb 640 g/kg (+metalaxyl 80 g/kg)	Carcinogen (see Annex I)				
1087	Neltylxyl 72% WP	Mancozeb 640 g/kg (+metalaxyl 80 g/kg)	Carcinogen (see Annex I)				
844	Ridomil Gold MZ 68 WG	Mancozeb 640 g/kg (+metalaxyl-M 40 g/kg)	Carcinogen (see Annex I)				
1045	Moz Controller	Mancozeb 700 g/kg (+cymoxanil 60 g/kg)	Carcinogen (see Annex I)				
1307	Cotzeb 80% WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				
1162	Curethane 80% WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				
1078	Dithane NT 80% WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				
1143	Mazole 80% WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				
1133	Policar MZ 80% WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				
1221	Ventum 80% WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				
534	Volcano mancozeb 800 WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				
457	Mancopec 80% WP	Mancozeb 800 g/kg	Carcinogen (see Annex I)				

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
466	Metacidine 40% WP	Methidathion 400 g/kg	WHO class II, but oral hazard close to Class Ib	Cotton, tobacco, sugar cane, vegetables, maize	0		EU: No (NS) USA: No; voluntary cancellation in progress
646	Mesurool Super Snail Pellets 1.5% RB	Methiocarb 5 g/kg+	WHO class II, but oral hazard close to Class Ib	Maize, groundnut, potato, vegetables, citrus	0	More concentrated formulations in HHP shortlist above.	EU: Yes USA: Yes
887	Volomyl 20% SL	Methomyl 200 g/l	WHO class II, but oral hazard close to Class Ib	Maize, groundnut, potato, vegetables, citrus, cotton, tobacco, flowers,	550 L (2012)	More concentrated formulations in HHP shortlist above.	EU: Yes USA: Yes
463	Rikki 20% SL	Methomyl 200 g/l	WHO class II, but oral hazard close to Class Ib				
1105	Volxyl 24% EC	Oxyfluorfen 240 g/l	Carcinogen (see Annex I)	Cotton, soybean, groundnut, vegetables, citrus, pine trees, eucalyptus trees	900 L (2010) 1200 L (2012)		EU: Yes USA: Yes
1131	King Insectos Voadores	Permethrin 0,4 g/kg (+d-Allethrin 0,82 g/kg +piperonyl butoxide 3,3 g/kg)	Carcinogen (see Annex I)				
974	Majestic Ultra 50% EC	Permethrin 100 g/l (+pirimiphos methyl 400 g/l)	Carcinogen (see Annex I)				
967	Cooper Aerosol Fly and Mosquito Killer	Permethrin 15 g/kg (+piperonyl butoxide 15 g/kg)	Carcinogen (see Annex I)	Stored grain, public health and domestic use	4958 L (2010) 27820 L (2011) 5000 L (2013)		EU: No (E) USA: Yes
1132	King Insectos Rastejantes	Permethrin 2,5 g/kg (+pyrethrins 1 g/kg)	Carcinogen (see Annex I)				
1123	Majestic super 2% DP	Permethrin 3 g/kg (+pirimiphos methyl 16 g/k)	Carcinogen (see Annex I)				
629	Super Guard Dust 2% DP	Permethrin 4 g/kg (+pirimiphos methyl 16 g/kg)	Carcinogen (see Annex I)				

Reg. no.	Trade name	Active ingredient (a.i.)	Reason for identification as potential HHP	Registered uses in Mozambique (summary)	Import volumes (2010 – 2013)	Notes	Registration status of a.i. elsewhere ¹
163	Larvin 37,5% SC	Thiodicarb 375 g/l	WHO class II, but very close to Class Ib	Cotton	0		EU: No (H & E) USA: Yes
Total [54]		[16] <i>(of which 3 a.i.'s already listed in HHP shortlist above)</i>					

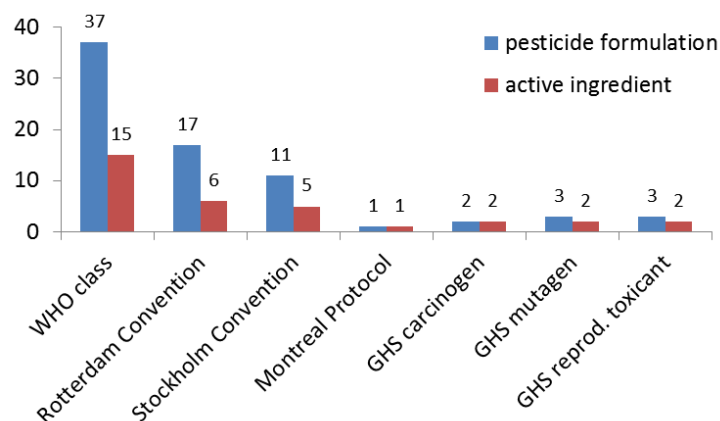


Figure 4. The number of identified highly hazardous pesticides (HHPs) in Mozambique according to the various JMPM criteria. Note that a pesticide may be identified as HHP based on more than one criterion.

3.3 Identification of pesticides “coming close” to HHPs

Using the criteria listed in Section 2.1, 54 formulated pesticide products containing 16 different active ingredients were identified as “coming close” to being an HHP (Figure 3 and Table 6). Of the 16 active ingredients, 13 were not listed under the HHPs.

Pesticide products were most often classified as being “close to” HHPs based on the acute oral or dermal toxicity of the formulations. In addition, the carcinogenicity evaluations of 16 active ingredients did not result in similar conclusions between the EU and the US-EPA. Generally, these pesticides which were evaluated as likely or probable carcinogens by the US-EPA, but not by the EU. Seven of the 16 active ingredients were considered a sufficiently great concern for Mozambique to include them under the group of pesticides “coming close” to HHPs (see Annex 1 for the justification).

In the case of paraquat, the WHO Classification notes in addition that it “*has serious delayed effects if absorbed. It is of relatively low hazard in normal use but may be fatal if the concentrated product is taken by mouth or spread on the skin*” (WHO, 2010). The occupational hazard of paraquat is confirmed by the very low Acceptable Operator Exposure Level defined in the EU (PPDB, 2012).

3.4 Registrations elsewhere

In national decision making on the continuation or modification of the registration of a HHP, it may be useful to review how other, reputable, registration authorities have evaluated the pesticide and what final registration decision they have taken.

In this step of the project, a quick search was conducted of the registration status in the EU and the USA of all pesticides listed in Table 6. This shows that some pesticides listed as HHP in Mozambique are not registered, or are being phased out, in both the EU and the USA (i.e. 9 active ingredients of HHPs and 3 additional ones for the “close to” HHPs). In some cases, this was for health and/or environmental reasons, but in others because the registration dossier was incomplete or because the pesticide was never submitted for registration in the first place. The

majority of the pesticides listed in Table 6, however, is still registered in either the EU or the USA, or in both.

When deciding on risk reduction measures for HHPs in Mozambique, including possible phase-out of certain products, it is therefore important to evaluate why exactly other registration authorities have decided not to register a pesticide; or if they have registered the pesticide, under which conditions it is allowed. These justifications and conditions should then be compared to the – actual or expected – use situation in Mozambique to evaluate whether the pesticide can continue to be used in the country, and with what possible restrictions.

3.5 Import statistics

The volumes of pesticides identified as HHPs and “coming close” to HHPs that were imported into Mozambique in the period 2010 – mid-2012 are listed in Table 6. The main objective of reviewing the import statistics is to identify which pesticides are likely not used (anymore) in the country, and for which no use surveys or additional hazard/risk assessments (Project Step 2) need to be conducted.

For 21 out of the listed 38 HHP-and “close to” HHPs active ingredients, no pesticide products were imported at all. For another seven active ingredients, less than 250 kg or litres were imported annually, and these would have a relatively low priority for further use surveys.

The most imported HHPs are products containing aluminium phosphide, benomyl, dichlorvos, difethialone, endosulfan, formaldehyde and metamidophos, with average annual imports greater than 2000 kg or litres; the most imported pesticides “coming close” to HHPs are 2,4-D dimethylamine, bendiocarb, diuron, mancozeb, paraquat and permethrin.

4 Conclusion

4.1 Methodology

The approach used for this first step of the project was entirely desk-based. It consisted of comparing all pesticide products registered in Mozambique against the criteria for highly hazardous pesticides (HHPs) as defined by the FAO/WHO Joint Meeting on Pesticide Management (JMPM). Since no international databases exist of HHPs, various reputable data sources were used to verify the criteria for each registered pesticide.

Overall, this approach allowed the assessment of the large majority of pesticide products registered in Mozambique. Some data gaps were identified, however, mainly for microbial pesticides, adjuvants/synergists and repellents. These pesticides could not be evaluated against all HHP criteria. But because these groups are generally of low hazard, it is not very likely that HHPs would have been missed.

On the other hand, a limited number of “regular” chemical pesticides could not be evaluated either for some criteria, using the data sources chosen for this study. Data were lacking mainly with respect to chronic toxicity (carcinogenicity, mutagenicity and reproductive toxicity) and for characteristics to identify persistent organic pollutants (POPs). Therefore, it cannot be excluded that the list of HHPs would be slightly longer if data would have been available for all pesticides.

The assessment of import volumes is very useful to distinguish between pesticides which have been registered but are not used in Mozambique, and those that are. This greatly helps to reduce the short-list of HHPs which require further use and exposure surveys and/or hazard/risk assessments.

4.2 Short-list of HHPs

The main objective of this first step of the project was to identify highly hazardous pesticides (HHPs) that are registered and used in Mozambique, and prepare a short-list of products that require further surveys on use and exposure and/or risk assessments. It is on the basis of the combined information from theoretical hazard assessments, more realistic risk assessments and actual use and exposure information that the Ministry of Agriculture can make informed decisions on further authorization of use of these HHPs.

This first step therefore results in a short-list on which to focus activities under Step 2 of the project. Based on the evaluation of HHP criteria discussed above, and the import statistics, it is recommended to focus the use and exposure surveys in the field, and further hazard and risk assessments, on the pesticide products listed in Table 7. These are all pesticides which average annual imports of more than approximately 250 kg or L. Identified HHPs that are imported in lower volumes are not given priority for Step 2 activities.

In total, Table 7 consists of 76 pesticide products containing 18 different active ingredients. These represent 10% of registered pesticide products and 8% of registered active ingredients in Mozambique.

Table 7. Short-list of highly hazardous pesticides (HHPs) and pesticides “coming close” to HHPs, prioritized for further study in Step 2 of the project.

Reg. no.	Trade name	Active ingredient
HHPs		
1172	Fumate 56% FT	Aluminium Phosphide 560 g/kg
1054	Moz Aluminium Phosphide Pellets	Aluminium Phosphide 560 g/kg
581	Phosgard 56% FT	Aluminium phosphide 560 g/kg
773	Falfume 57% FT	Aluminium Phosphide 570 g/kg
1071	Moz Aluminium Phosphide Tablets	Aluminium Phosphide 570 g/kg
1129	Quickphos 57% FT	Aluminium Phosphide 570 g/kg
1080	Biophos 57% FW	Aluminium phosphide 570 g/kg
1028	Celphos 57% FT	Aluminium phosphide 570 g/kg
664	Volcano Aluminium Phosphide 57% FT	Aluminium phosphide 570 g/kg
467	Benopep 50% WP	Benomyl 500 g/kg
772	Volcano Demeter 50% WP	Benomyl 500 g/kg
1202	Divos 100% EC	Dichlorvos 1000 g/l
774	Falcovos 100% EC	Dichlorvos 1000 g/l
984	Nuvam 100% EC	Dichlorvos 1000 g/l
944	Finale Rat And Mouse Grain Bait	Difethialone 0,025 g/kg
969	Finale Rat And Mouse Pellets	Difethialone 0,025 g/kg
943	Finale Rat And Mouse Wax Bait	Difethialone 0,025 g/kg
719	Ratex Pellets	Difethialone 0,025 g/kg
1027	Endocel 35% EC	Endosulfan 350 g/l
447	Endopep 35% EC	Endosulfan 350 g/l
825	Enticer 35% EC	Endosulfan 350 g/l
605	Volcano Endosulfão 35% EC	Endosulfan 350 g/l
1115	Vet Fume B	Formaldehyde 370 g/l
1163	Chemaron 58% SL	Methamidophos 585 g/l
1199	Sniper 58.5% SL	Methamidophos 585 g/l
639	Volmet 58,5% SL	Methamidophos 585 g/l
1198	Methomex 90% SP	Methomyl 900 g/kg
1185	Oxadate 31% SL	Oxamyl 310 g/l
810	Vydate 31% SL	Oxamyl 310 g/l
"close to" HHPs		
570	Volcano 2,4 D 72% SL	2,4-D dimethylamine 720 g/l
1063	Moz Paraquat 20% SL	Paraquat 200 g/l
1303	Paracot 20% SL	Paraquat 200 g/l
1262	Para-Cure 20% SL	Paraquat 200 g/l
458	Paraxone 20% SL	Paraquat 200 g/l
764	Volquato 20% SL	Paraquat 200 g/l
1181	Gramozat 20% SL	Paraquat 200 g/l

Reg. no.	Trade name	Active ingredient
544	Ficam 80% WP	Bendiocarb 800 g/kg
735	Tocaia 80% WP	Bendiocarb 800 g/kg
884	Avisnail 5% RB	Carbaryl 20 g/kg (+metaldehyde 30 g/kg)
811	Supona 30% EC	Chlorfenvinphos 300 g/l
1155	Dichlorvos 10% EC	Dichlorvos (DDVP)100 g/l
985	Nuvan Profi 12,4% AE	Dichlorvos 124 g/l
986	Metrad 75% WG	Diuron 400 g/kg (+metribuzin 360 g/kg)
461	Dipec 80% WP	Diuron 800 g/kg
849	Volcano Diuron 80% WG	Diuron 800 g/kg
532	Volcano Diurão 800 SC	Diuron 800 g/l
1061	Moz Diuron 80% SC	Diuron 800 g/l
1101	Milthane Super 80% WP	Mancozeb 800 g/kg
663	Volcano Crater MX 70% WP	Mancozeb 100 g/kg (+metalaxyl 600 g/kg)
508	Etylit MZ 70% WP	Mancozeb 350 g/kg (+fosetyl-aluminium 350 g/kg)
1236	Crater 455 SC	Mancozeb 455 g/l
477	Megatop 50,5% WP	Mancozeb 465 g/kg (+cymoxanil 40 g/kg)
1075	Dithane NT 60% OS	Mancozeb 600 g/kg
875	Volcano Crater MX 72% WP	Mancozeb 640 g/kg (+ Metalaxyl 80 g/kg)
546	Ridomil Gold 68% WP	Mancozeb 640 g/kg (+metalaxyl 40 g/kg)
472	Ekyp MZ 72% WP	Mancozeb 640 g/kg (+metalaxyl 80 g/kg)
823	Mascot 72% WP	Mancozeb 640 g/kg (+metalaxyl 80 g/kg)
1136	Metaman FAE PM 72% WP	Mancozeb 640 g/kg (+metalaxyl 80 g/kg)
1087	Neltylxl 72% WP	Mancozeb 640 g/kg (+metalaxyl 80 g/kg)
844	Ridomil Gold MZ 68 WG	Mancozeb 640 g/kg (+metalaxyl-M 40 g/kg)
1045	Moz Controller	Mancozeb 700 g/kg (+cymoxanil 60 g/kg)
1307	Cotzeb 80% WP	Mancozeb 800 g/kg
1162	Curethane 80% WP	Mancozeb 800 g/kg
1078	Dithane NT 80% WP	Mancozeb 800 g/kg
1143	Mazole 80% WP	Mancozeb 800 g/kg
1133	Policar MZ 80% WP	Mancozeb 800 g/kg
1221	Ventum 80% WP	Mancozeb 800 g/kg
887	Volomyl 20% SL	Methomyl 200 g/l
463	Rikki 20% SL	Methomyl 200 g/l
1105	Volxyl 24% EC	Oxyfluorfen 240 g/l
1131	King Insectos Voadores	Permethrin 0,4 g/kg (+d-Allethrin 0,82 g/kg +piperonyl butoxide 3,3 g/kg)
974	Majestic Ultra 50% EC	Permethrin 100 g/l (+pirimiphos methyl 400 g/l)
967	Cooper Aerosol Fly and Mosquito Killer	Permethrin 15 g/kg (+piperonyl butoxide 15 g/kg)

Reg. no.	Trade name	Active ingredient
1132	King Insectos Rastejantes	Permethrin 2,5 g/kg (+pyrethrins 1 g/kg)
1123	Majestic super 2% DP	Permethrin 3 g/kg (+pirimiphos methyl 16 g/k)
629	Super Guard Dust 2% DP	Permethrin 4 g/kg (+pirimiphos methyl 16 g/kg)

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Annex 1: Carcinogenicity – ambiguous cases

This annex lists the pesticides for which the carcinogenicity evaluations by WHO/IARC, EPA and the EU did not result in the same outcome. The final conclusion for the HHP assessment in Mozambique is in the last column of the table. Those considered a carcinogen equivalent to GHS class 1A and 1B are listed as “Yes” and included under the section *Registered pesticides not complying with the JMPM criteria, but “coming close”* of Table 6 of this report.

Active ingredient	Reviews: carcinogenic (similar to GHS 1A&1B) yes/no? [date of publication of review]				Conclusion for HHP identification. Carcinogenic (similar to GHS 1A&1B) yes/no?
	IARC	EPA carcinogenicity list	EU	WHO Classification	
Alachlor	Not evaluated	Yes: likely at high doses; not likely at low doses; [June 1997] Note: US registered	No; unlikely at doses attained in use (Carc ⁹ . = Cat. 2) [Jan 2007] Note: EU not registered	No – carcinogenicity mechanism not relevant to humans [2010]	No. US registered, and EU not registered. Most recent reviews conclude pesticide is not carcinogenic at relevant rates
Carbaryl	No [1987]	Yes: likely to be carcinogenic [Feb 2002] Note: US registered, but basic or extensive PPE required for handling and use ; wettable powders only packaged in water-soluble bags, to reduce cancer risk (amended RED ¹⁰ , 2008)	No (Carc. = Cat. 2) [Sep 2006] Note: EU not registered; potential carcinogenic properties of the active substance is noted as a concern (Review report ¹¹ , 2006)	Not evaluated	Yes. EU not registered. US registered, but with PPE other risk mitigations

⁹ Carc.: Carcinogenicity classification (EU)

¹⁰ RED: Reregistration Eligibility Document (US – Environmental Protection Agency)

¹¹ Review report: Review report on active substances (EU - Standing Committee on the Food Chain and Animal Health)

Active ingredient	Reviews: carcinogenic (similar to GHS 1A&1B) yes/no? [date of publication of review]				Conclusion for HHP identification. Carcinogenic (similar to GHS 1A&1B) yes/no?
	IARC	EPA carcinogenicity list	EU	WHO Classification	
Chlorothalonil	Not evaluated	Yes: likely to be carcinogenic [Oct 1997] Note: US registered. Dietary cancer risk due to HCB impurities in chlorothalonil; limit < 40 ppm is acceptable. (RED Factsheet ¹² 1999)	No (Carc. = Cat. 2) [Sep 2006] Note: EU registered	Not evaluated	No; unless products in Mozambique contain high levels of HCB impurities Registered in both US and EU.
Diuron	Not evaluated	Yes: known/likely to be carcinogenic [July 1997] Note: US registered. However, occupational cancer risk of concern; i.e. use of backpack sprayers prohibited (RED, 2003)	No (Carc. = Cat. 2) [Jul. 2008] Note: EU registered	Not evaluated	Yes Explicit prohibition of use with backpack sprayers in US; so a concern for Mozambique
Epoxiconazol	Not evaluated	Yes: likely to be carcinogenic [Jan 2001] Note: US only an import tolerance; dietary risk acceptable; occupational risk not evaluated	No (Carc. = Cat. 2) [sep 2010] Note: EU registered	Not evaluated	No Registered in EU and tolerance in US.

¹² Factsheet: US – EPA pesticide registration factsheets

Active ingredient	Reviews: carcinogenic (similar to GHS 1A&1B) yes/no? [date of publication of review]				Conclusion for HHP identification. Carcinogenic (similar to GHS 1A&1B) yes/no?
	IARC	EPA carcinogenicity list	EU	WHO Classification	
Iprodione	Not evaluated	Yes: likely to be carcinogenic [Feb 1998] Note: US registered. However, all residential uses cancelled due to cancer risk concerns. Also, backpack sprayers, mixers should wear double layer PPE, masks and gloves. (RED, 1998)	No (Carc. = Cat. 2) [sep 2004] Note: EU registered	Not evaluated	Yes Registered in both EU and US. However, US proposed risk mitigation measures (PPE for sprayers/handlers and cancellation of residential uses) poses significant concern for Mozambican use situation.
Isoxaflutole	Not evaluated	Yes: likely to be carcinogenic [Sep 1997] Note: US registered.	No (Carc. not classified) [oct 2003] Note: EU registered	Not evaluated	No. Registered in both EU and US.
Kresoxim-methyl	Not evaluated	Yes: likely to be carcinogenic [Aug 1999] Note: US registered. But only on ornamental crops (Factsheet 1998)	No (Carc. = Cat. 2) [jan 2012] Note: EU registered	Not evaluated	No. Registered in both EU and US.
Mancozeb (cancer risk due to ETU metabolite)	Not evaluated	Yes: probable human carcinogen [Jul 1999] Note: US registered. Cancer risk below EPA thresholds; but (at least) layer PPE required; WP formulations only as water-soluble bags (RED 2005)	No (Carc. not classified) [july 2006] Note: EU registered	Not evaluated	Yes. Registered in both EU and US. However, US proposed risk mitigation measures (full PPE for sprayers/handlers and requirement for water-soluble bags for WPs) poses significant concern for Mozambican use situation.

Active ingredient	Reviews: carcinogenic (similar to GHS 1A&1B) yes/no? [date of publication of review]				Conclusion for HHP identification. Carcinogenic (similar to GHS 1A&1B) yes/no?
	IARC	EPA carcinogenicity list	EU	WHO Classification	
Metiram	Not evaluated	Yes: probable human carcinogen [Jul 1999] Note: US registered. (RED, 2005)	No (Carc. not classified) [july 2006] Note: EU registered (review report 2005: "no evidence of carcinogenic potential")	Not evaluated	No. Registered in both EU and US. Most recent EU review concludes pesticide is not carcinogenic
Oxadiazon	Not evaluated	Yes: likely to be carcinogenic [May 2001] Note: US registered. Cancer risks for occupational handlers of wettable-powder formulations of oxadiazon are of concern. Exposure scenarios of concern include mixing/ loading/ applying wettable powder formulations. To reduce these risks, the wettable powder formulations will be packaged in water-soluble packaging (WSP) only (RED Factsheet 2008)	No Carc. not classified. [jan 2010] Note: EU registered EFSA Conclusion (2010): "humans are not responsive to this class of non-genotoxic carcinogens and therefore, oxadiazon is unlikely to present a carcinogenic risk to humans"	Not evaluated	No. Registered in both EU and US. Most recent review indicates low cancer risk.
Oxyfluorfen	Not evaluated	Yes: likely to be carcinogenic [Mar 2010] Note: US registered. Cancer risk of handlers applicators / workers: Double layer Personal Protective Equipment (PPE) for all other mixers, loaders, and applicators; closed mixing/loading/ application systems required for use in several major crops.	No (Carc. not classified) [jan 2012] Note: EU registered EFSA Conclusion (2010): ... classification as Carc Cat 3 – <i>limited evidence of a carcinogenic effect</i> – was proposed by EFSA.	Not evaluated	Yes. Registered in both EU and US. However, US proposed risk mitigation measures (double PPE and closed systems) poses significant concern for Mozambican use situation.

Active ingredient	Reviews: carcinogenic (similar to GHS 1A&1B) yes/no? [date of publication of review]				Conclusion for HHP identification. Carcinogenic (similar to GHS 1A&1B) yes/no?
	IARC	EPA carcinogenicity list	EU	WHO Classification	
Permethrin	No [1991]	Yes: likely to be carcinogenic [Oct 2002] Note: US registered. In some application scenarios, cancer risk exceeds the threshold. WP and DP formulations require double layer PPE. (Factsheet, 2009).	No (Carc. not classified) Note: EU not registered. (due to incomplete dossiers, mainly for ecotox topics).	Not evaluated	Yes. Registered in US, but not in EU. Certain uses in US require extensive PPE – to be compared with Mozambique uses of permethrin.
Tetrachlorvinphos	No	Yes: likely to be carcinogenic [Mar 2002] No: Group C: possible human carcinogen [July 2006] Note: US registered.	No (no classification because no toxicological information) Note: EU not registered.	Not evaluated	No. Latest US evaluation does not place this pesticide in the HHP category
Thiabendazole	Not evaluated	Yes: Likely human carcinogen at high doses; not likely at low doses [Mar 2002] Note: US registered. "Carcinogenic risks at expected doses not pose a concern" (Factsheet, 2002)	No (Carc. not classified) Note: EU registered.	Not evaluated	No. Registered in both EU and US.
Thiodicarb (Note: rapid degradation to methomyl)	Not evaluated	Yes: Probable human carcinogen. [Jun 1996] Note: US registered. Relatively standard PPE requirements; no specific PPE to reduce carcinogenicity risk (RED, 1998)	No (Carc. not classified) Note: EU not registered. Overall, thiodicarb does not show genotoxic or carcinogenic potential (EFSA Opinion, 2005)	Not evaluated	No. Most recent EU review concludes pesticide is not carcinogenic



Reducing Risks of Highly Hazardous Pesticides in Mozambique

Step 2 – Survey of pesticide use practices in selected cropping systems

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[9 July 2014]

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Contents

1.	Introduction	5
2.	Methodology	6
2.1	Cropping systems	6
2.2	Survey questionnaires	6
2.3	Interviewers	7
2.4	Data entry and analysis	7
3.	Results.....	8
3.1	Socio-demographic coverage	8
3.2.	Crop distribution	9
3.3.	Use of pesticides	10
3.3.1.	Use of pesticides	10
3.3.2.	Use of Highly Hazardous Pesticides (HHPs)	11
3.3.3.	Training of farmers on pesticide use.....	12
3.3.5.	Pesticide application equipment.....	13
3.3.6.	Farmer reports of undue pesticide contamination.....	13
3.3.8.	Farmer health management of the symptoms associated with pesticide use	16
3.3.9.	Use of Personal Protective Equipment by pesticide applicators including HHPs.....	17
3.3.10.	Extent of protection of pesticide applicators by body part.....	18
3.3.11.	Pesticide label reading and understanding	21
3.3.4.	Pesticide storage practices.....	24
	Preliminary discussion and conclusions	25
	References	26

1. Introduction

A project entitled *Reducing Risks of Highly Hazardous Pesticides (HHPs) in Mozambique* was initiated by the Government of Mozambique with the objective to reduce the greatest risks associated with pesticide use in the country. This project is implemented with technical support of FAO's Pesticides Management Unit and is funded by SAICM Quick Start Programme Trust Fund.

The ultimate goal is to develop and implement an “HHP Risk Reduction Action Plan” for the most dangerous pesticides and use situations, resulting over time in the implementation of a variety of risk reduction measures based on a review of use conditions. These may include the cancellation of specific registrations of HHPs, implementation of risk mitigation measures, appropriate use restrictions, development of alternative pest management strategies, promotion of good agricultural practices, or phase-out of specific pesticides.

In the first step of the project, a review of all pesticides registered in Mozambique was carried out and a shortlist of highly hazardous pesticides was established. This shortlist was based on an assessment of the hazards of the pesticides, based on criteria established by the FAO/WHO Joint Meeting on Pesticide Management (Come & Van der Valk, 2014).

During the second step of the project, a use survey was carried out in selected regions and cropping systems in Mozambique. The main goal of the survey was to identify the conditions under which pesticides are being used in the country and their contribution to potential risks for human health and the environment.

The third step of the project consisted of a stakeholder consultation to further discuss the use and risks of highly hazardous pesticides in Mozambique and fine-tune the shortlist based on the survey results and the expertise and experience of stakeholders.

2. Methodology

2.1 Cropping systems

Cropping systems were selected for the study in which pesticides are used on a regular basis and/or HHPs were known to be applied. These are vegetables, cotton and tobacco, generally managed by smaller subsistence farmers. Farmers were surveyed in eight different regions of Mozambique, which was expected to provide a broad sample of pesticide use practices in the country (Table xx). In the regions where the commodity crops cotton and tobacco are grown, limited information was also collected for other crops grown by the same farmers.

In addition, pesticide use practices were also assessed in bananas and sugar cane, both plantation crops run by larger commercial farms.

Table 1 Geographical distribution and cropping systems covered by the pesticide use survey

Region	Number of districts concerned	Crops included in the survey	Number of farmers interviewed	Survey period (2013)
Maputo Cidade	2	Vegetables	40	1–14 February
Maputo Provincia	3	Vegetables	28	31 Jan. – 8 Feb.
Gaza	2	Vegetables	30	1–19 February
Zambésia	5	Cotton	15	29 Jan. – 14 Feb.
		Tobacco	19	
		(Other crops)	(34)	
Tete	8	Cotton	23	16–25 January
		Tobacco	50	
		(Other crops)	(73)	
Nampula	4	Cotton	20	16 Jan. – 2 Feb.
		(Other crops)	(20)	
Niassa	5	Tobacco	25	17 Jan. – 1 Feb.
		Cotton	11	
		(other crops)	(36)	
Cabo Delgado	4	Cotton	64	n.a.
		(Other crops)	(64)	
Total	33		325	

Surveys were conducted in January and February 2013, during the rainy season. During this period, vegetables are grown and harvested, cotton has been sown and the plant is in early stages of development, and tobacco approaches the harvest.

2.2 Survey questionnaires

The surveys were conducted using a standard questionnaire, specific for each cropping system. The questionnaires were elaborated to obtain maximum information on pesticide use which could subsequently be used to assess the local risks of HHPs in Mozambique and evaluate the possibilities to introduce alternatives posing a lower risk. Various existing pesticide use or exposure surveys were reviewed (e.g. WHO, 2001; Amera & Abate, 2008; Rotterdam Convention, undated), as well as general guidance on development of this type of questionnaires (e.g. FAO, 1997). The first version of the questionnaire was tested among a

limited number of vegetable farmers around Maputo and various modifications were made to the final version.

The questionnaires followed a structure that was similar, though not identical, for all cropping systems:

1. Demographical socio-economic information
 - e.g.: location, sex, age, education, contact details
2. Crop information for the season 2012/2013 (vegetables, cotton, tobacco, plantation crops) and/or 2011/2012 (cotton, tobacco)
 - e.g.: type of crop, area cultivated, duration of cropping cycle
3. Pesticide application for the season 2012/2013 (vegetables, cotton, tobacco, plantation crops) and/or 2011/2012 (cotton, tobacco)
 - e.g.: name of applied pesticide(s), when applied, against which pest, application rate, number of applications per cropping cycle.
4. Pesticide product information
 - e.g.: type of formulation, type of packaging, label, where and how much purchased, costs
5. Pesticide application conditions
 - e.g.: who prepares the mixture and who applies the pesticide; source of advice on use; personal protective equipment, knowledge of label instructions; type of application equipment; management of empty containers
6. Alternative pest control methods
 - e.g.: awareness of alternative control methods; monitoring and spraying regime (for cotton)
7. Health effects
 - e.g.: if/when exposed to pesticides; decontamination; signs and symptoms of poisoning

The complete questionnaires are provided in Annex xx.

2.3 Interviewers

Interviews of farmers and pesticide distributors were performed by the plant protection officers of the Provincial Directorates of Agriculture. The interviewers were trained in a three-day session in which survey techniques and the data collection form were discussed in detail and subsequently tested in the field. Two training sessions were conducted in January 2013, in Nampula and Maputo, for five and three interviewers respectively.

2.4. Data entry and analysis

Data entry of questionnaire information was produced in Mozambique entered in excel datasets per province. The data was subsequently integrated and harmonised at FAO HQ and analysed using excel 2014.

3. Results

3.1 Socio-demographic coverage

Of the total of 325 farmer that were interviewed, 82% were male and 18% female. Most female farmers were encountered in vegetable production in Gaza and Maputo provinces (Figure xx). Only male farmers were interviewed in cotton in Tete and Zambesia provinces.

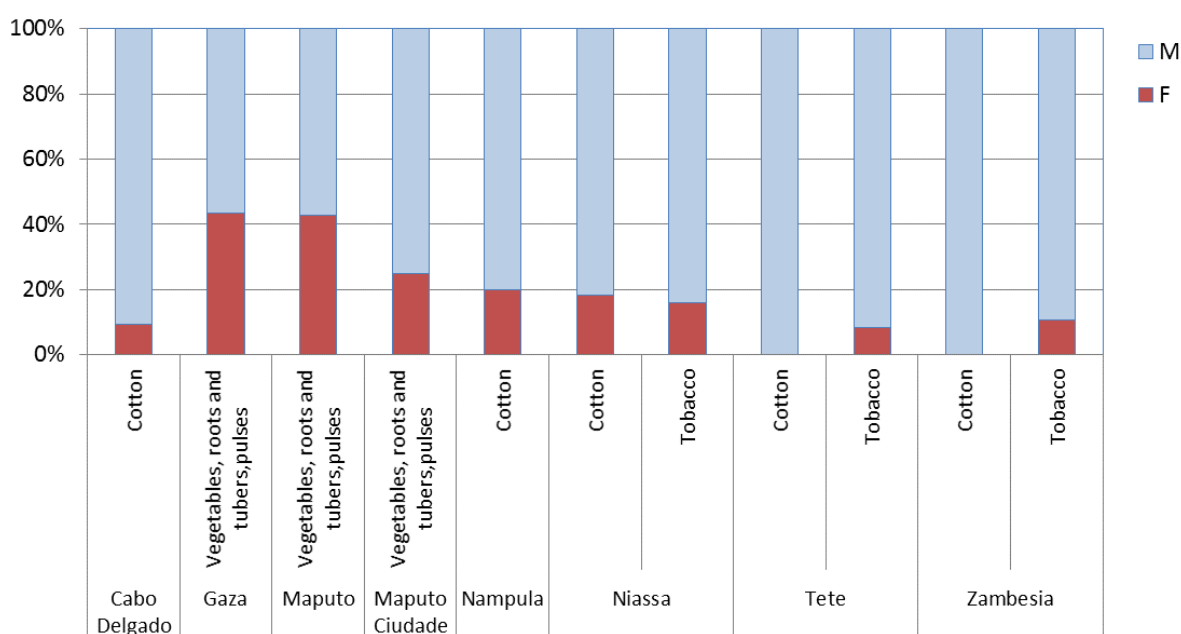


Figure 1 Gender distribution of interviewed farmers, per region and cropping system. F=female, M=male.

Overall, 68% of the interviewed farmers were between the age of 26 and 55. However, age distributions among cropping systems differed (Figure xx). Vegetable farmers were relatively older, with 60% of respondents being over 45 years of age. In contrast, cotton farmers were younger, with 35% under 35 years.

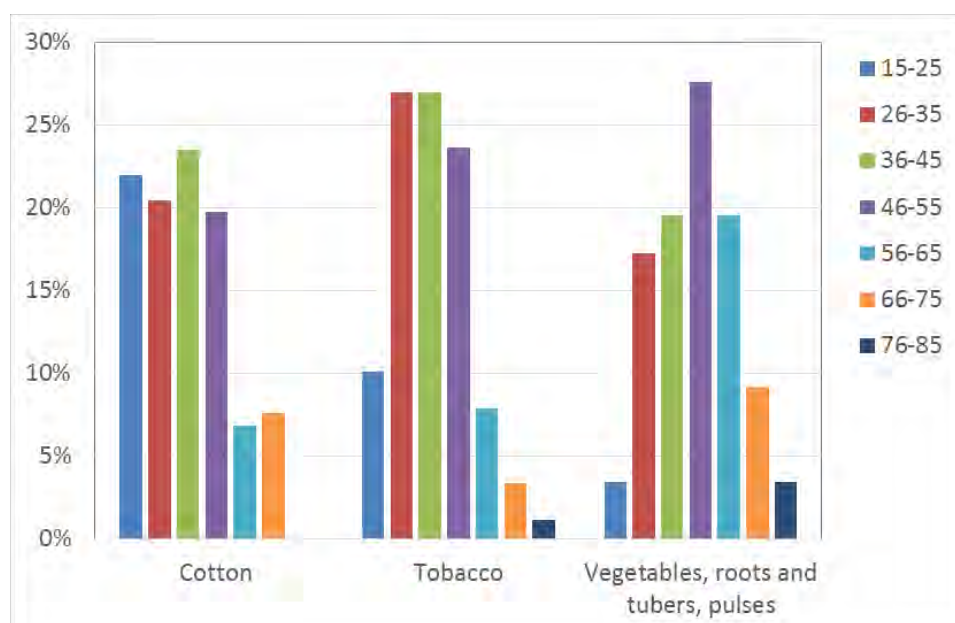


Figure 2 Gender distribution of interviewed farmers, per cropping system.

- The majority of farmers had either elementary education (33% of respondents) or had done level 5-10 (33%); 24% had no education at all. Education levels of respondents were fairly similar in Maputo, Gaza and Niassa. In Tete, Cabo Delgado and Nampula, education levels were on average slightly higher, while in Zambésia they were on average lower.

Table 2 Number of farmers interviewed

Region	Number	Gender		Education ²						
		Male	Female	None	Elementary	Level 5-10	Level 11-12	Basic agrarian level	Medium agrarian level	Higher level
Maputo Cidade	40	30	10	4	21	10	2	0	0	0
Maputo Provincia	28	16	12	7	12	7	0	0	0	0
Gaza	30	17	13	4	14	9	0	0	1	1
Zambésia	34	31 ¹	2	19	11	3	0	0	0	0
Tete	73	69	4	15	22	34	2	0	0	0
Nampula	20	16	4	3	5	12	0	0	0	0
Niassa	36	30	6	13	16	7	0	0	0	0
Cabo Delgado	64	58	6	14	24	24	1	1	0	0
<i>Total</i>	<i>325</i>	<i>267</i>	<i>57</i>	<i>79</i>	<i>125</i>	<i>106</i>	<i>5</i>	<i>1</i>	<i>1</i>	<i>1</i>
¹ One interview with a production company; gender not indicated.										
² For 7 persons education level not indicated.										

3.2. Crop distribution

Table 3 crop distribution per province in database

provinces	Cotton	Tobacco	Vegetables, roots and tubers,pulses
Cabo Delgado	100.00%	0.00%	0.00%
Gaza	0.00%	0.00%	100.00%
Maputo	0.00%	0.00%	100.00%
Maputo Cidade	0.00%	0.00%	100.00%
Nampula	100.00%	0.00%	0.00%
Niassa	30.56%	69.44%	0.00%
Tete	34.25%	65.75%	0.00%
Zambesia	44.12%	55.88%	0.00%
Grand Total	41.54%	28.31%	30.15%

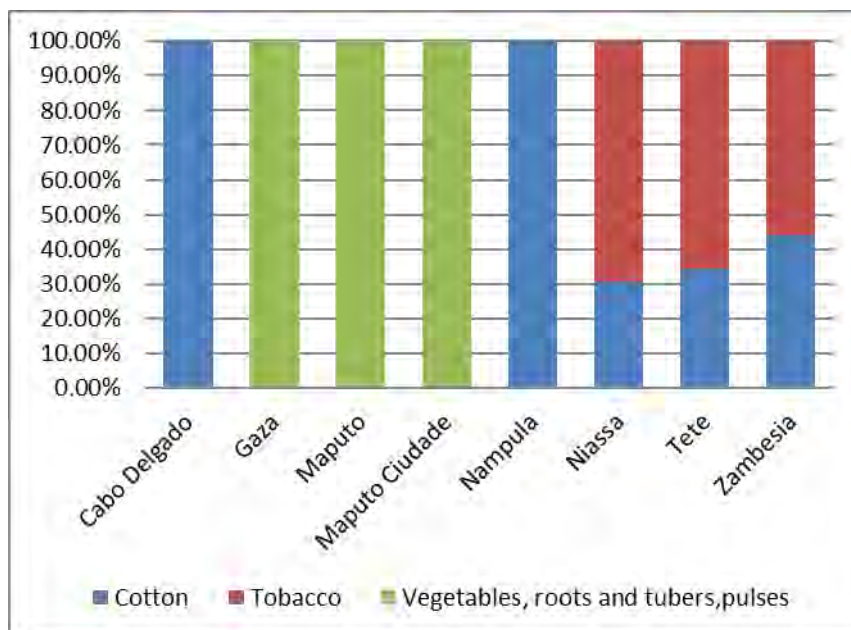


Figure 3 crop distribution per province

3.3. Use of pesticides

3.3.1. Use of pesticides

The majority of the respondents were applying themselves the pesticide, and this is true for all provinces surveyed. Therefore they were providing personal replies on their use of pesticides. The surveys revealed that most of the farmers surveyed applied pesticides- only 17 of the 325 said they did not.

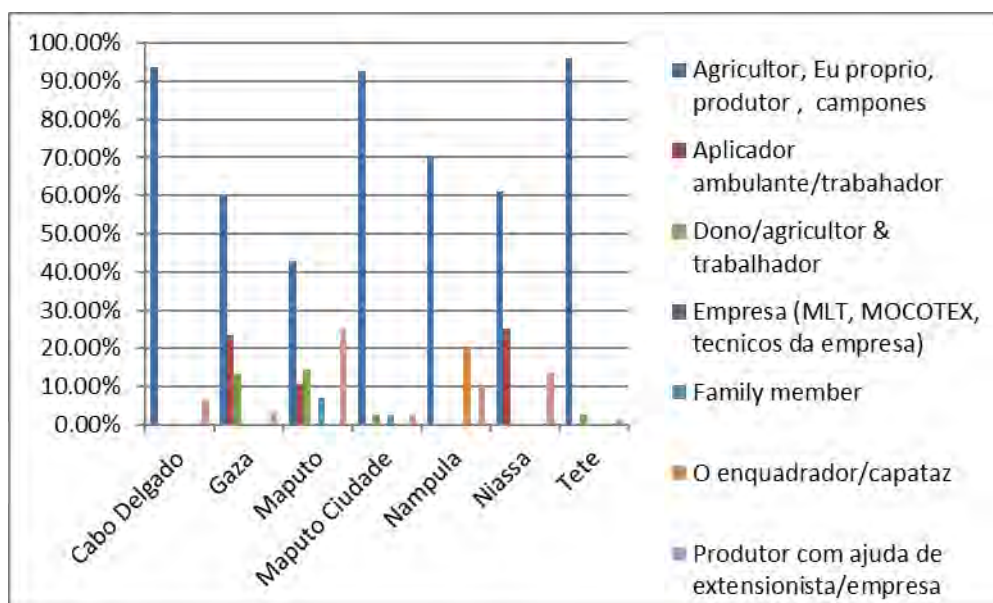


Figure 4 applicators of pesticide

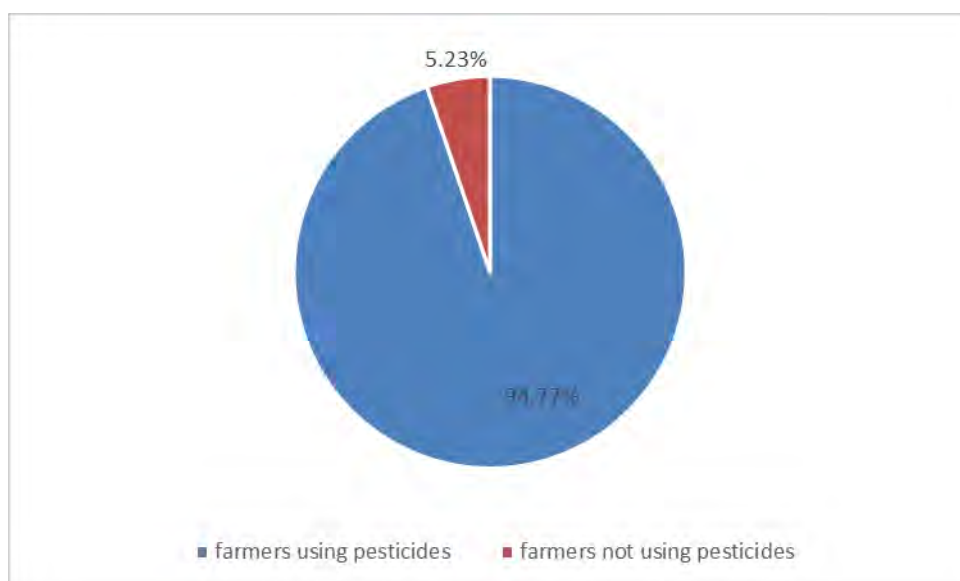


Figure 5 use of pesticide for farmer's part of the survey

3.3.2. Use of Highly Hazardous Pesticides (HHPs)

Farmers using HHPs (as per FAO-WHO 7 criteria) include almost 30% of the surveyed farmers. The HHP formulation that is most used is by far including methamidophos compound which is used by a great share of farmers particularly for vegetable crops. In addition, farmers reported overspraying vegetable crops as many as 14 times per growing season.

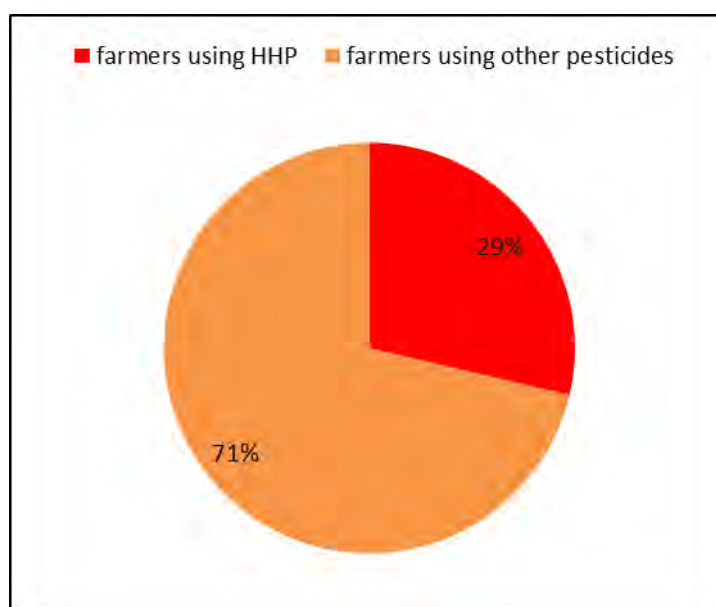


Figure 6 HHP users (out of farmers who apply pesticides)

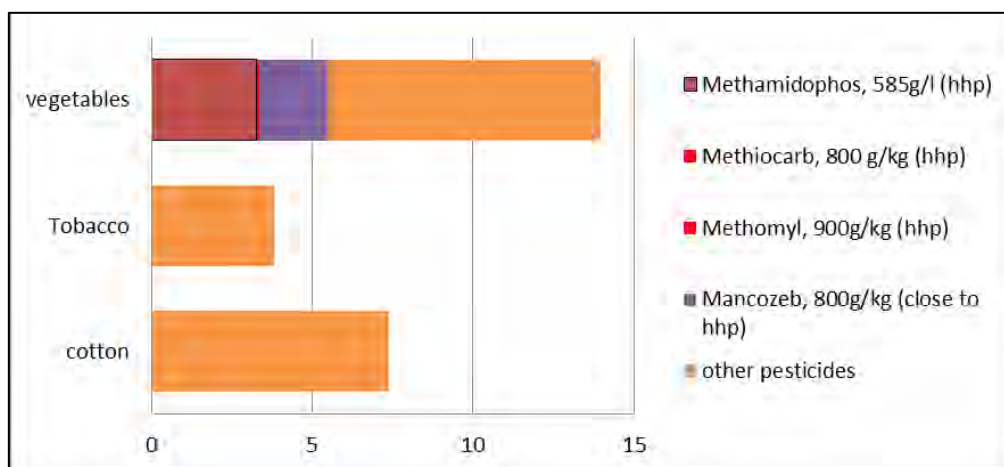


Figure 7 average applications of pesticides for farmers surveyed per crop

3.3.3. Training of farmers on pesticide use

At least half farmers did not receive training on pesticide use while making use of pesticides including HHPs.

Row Labels	Não	Sim	null	Grand Total
Cabo Delgado	60.94%	32.81%	6.25%	100.00%
Gaza	73.33%	26.67%	0.00%	100.00%
Maputo	46.43%	46.43%	7.14%	100.00%
Maputo Cidade	55.00%	42.50%	2.50%	100.00%
Nampula	80.00%	20.00%	0.00%	100.00%
Niassa	47.22%	44.44%	8.33%	100.00%
Tete	43.84%	53.42%	2.74%	100.00%
Zambesia	5.88%	88.24%	5.88%	100.00%
Grand Total	50.15%	45.54%	4.31%	100.00%

3.3.5. Pesticide application equipment

The majority of pesticide applicators used manual sprayer (36%), followed by electric sprayer (with batteries); 33% and followed by inappropriate equipment such as watering can (13.5%) or other (unknown) means (12.5%).

Table 4 Pesticide application equipment

Provinces	Balde	Outros	Pulverizador de dorso manual	Pulverizador que funcionam a pilhas (e.x. Micro-Ulva)	Regador	no data
Cabo Delgado	0.00%	0.00%	0.00%	93.75%	0.00%	6.25%
Gaza	3.33%	0.00%	96.67%	0.00%	0.00%	0.00%
Maputo	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%
Maputo Cidade	0.00%	0.00%	97.50%	0.00%	0.00%	2.50%
Nampula	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%
Niassa	0.00%	61.11%	5.56%	25.00%	0.00%	8.33%
Tete	0.00%	0.00%	24.66%	6.85%	60.27%	8.22%
Zambesia	0.00%	55.88%	2.94%	41.18%	0.00%	0.00%
Grand Total	0.31%	12.62%	36.00%	33.23%	13.54%	4.31%

3.3.6. Farmer reports of undue pesticide contamination

Farmers responses to the question: “are you receiving pesticides on clothes or skin, or in your eyes during using pesticides?” are summarised in the tables and figures below. At the national level (as sum) about half farmers surveyed reported that they noticed to receive pesticide on their clothes, bare skin or eyes when using pesticides, with some differences between provinces for different crops.

Table 5 Farmer reports of noticing of being contaminated by pesticides while using them

Provinces	Não, nunca	Sim	Sim, algumas vezes	Sim, muitas vezes	null
Cabo Delgado	20.31%	0.00%	62.50%	17.19%	0.00%
Gaza	66.67%	0.00%	23.33%	10.00%	0.00%
Maputo	28.57%	3.57%	60.71%	3.57%	3.57%
Maputo Cidade	50.00%	17.50%	32.50%	0.00%	0.00%
Nampula	25.00%	0.00%	50.00%	25.00%	0.00%
Niassa	69.44%	0.00%	25.00%	2.78%	2.78%
Tete	63.01%	0.00%	26.03%	9.59%	1.37%
Zambesia	88.24%	0.00%	11.76%	0.00%	0.00%
Grand Total	51.38%	2.46%	36.62%	8.62%	0.92%

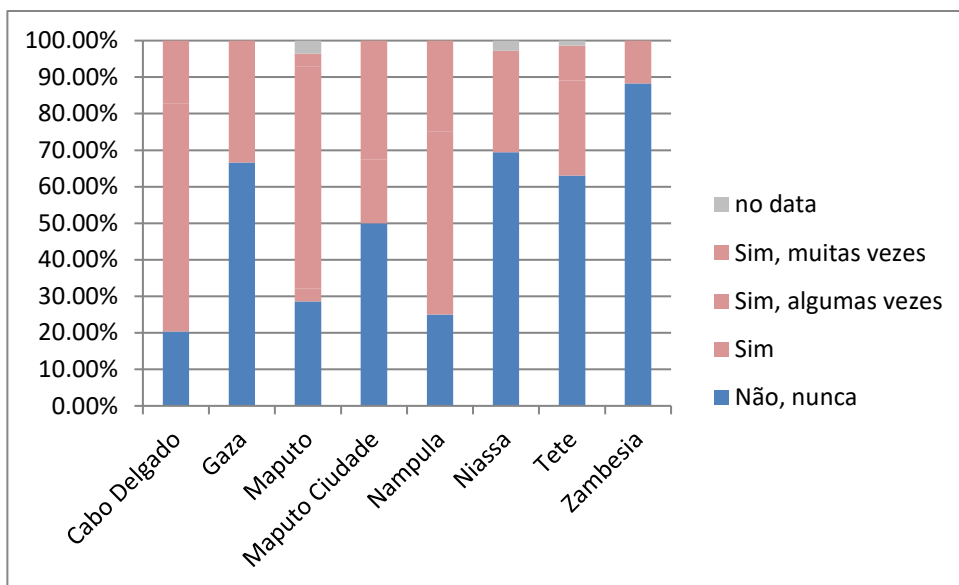


Figure 8 Farmer reports of noticing of being contaminated by pesticides while using them

3.3.7. Main health symptoms associated with pesticide use by farmers

Main health symptoms associated with pesticide use by farmers noticing symptoms were headaches, skin rashes, burning eyes, vomiting, burning nose, blurred vision, dizziness and excess sweating.

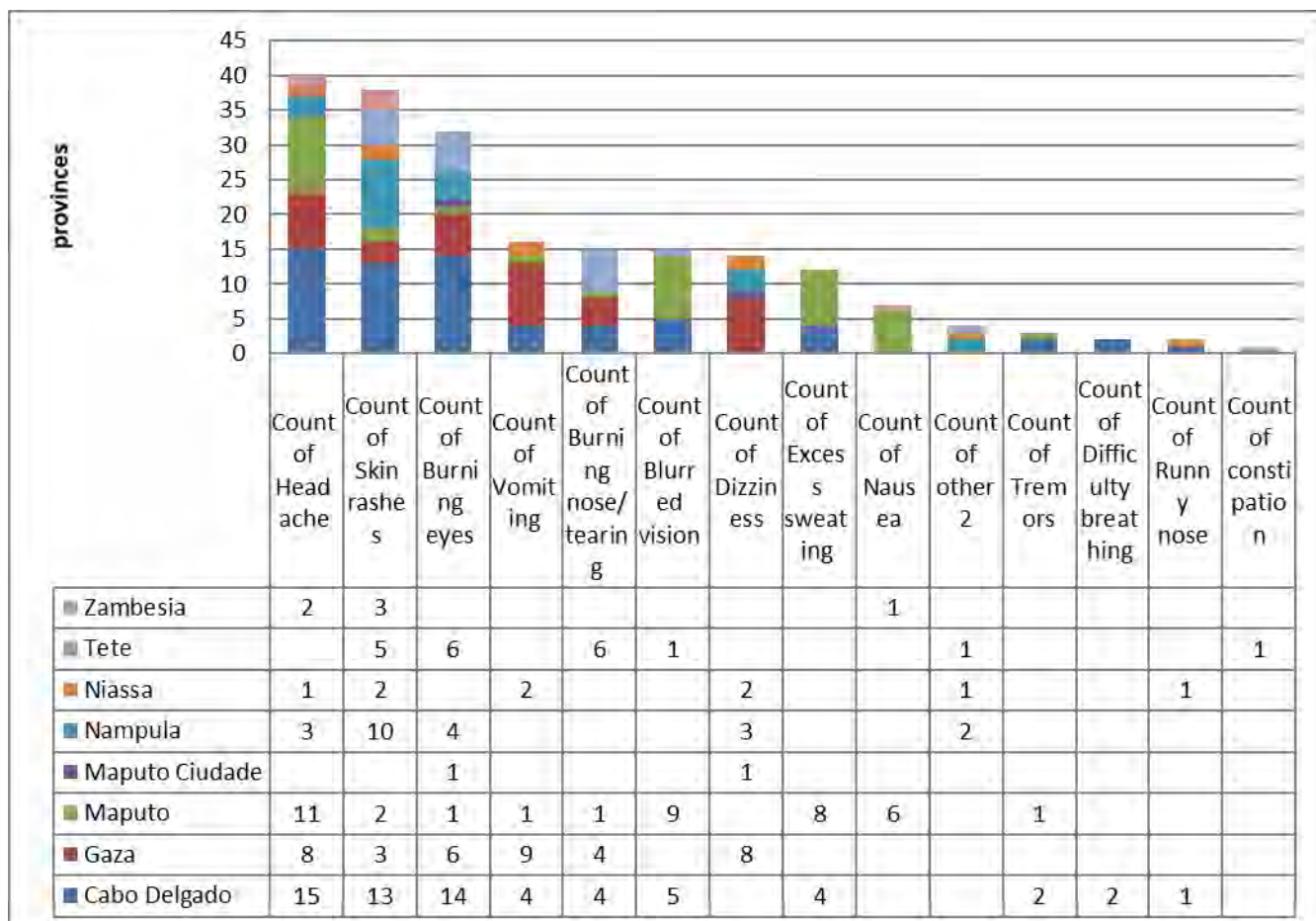


Figure 9 Reported health symptoms of farmers per province after or during having used pesticides

3.3.8. Farmer health management of the symptoms associated with pesticide use

The great majority of farmers who noticed to experience symptoms during or right after pesticide use did not see a doctor or nurse or receive any check in a health care facility.

Table 6 health care of farmers experiencing potential symptoms of pesticide poisoning when using pesticides

Provinces	Não	Sim	null
Cabo Delgado	78.13%	1.56%	20.31%
Gaza	36.67%	0.00%	63.33%
Maputo	82.14%	3.57%	14.29%
Maputo Cidade	45.00%	0.00%	55.00%
Nampula	85.00%	15.00%	0.00%
Niassa	83.33%	5.56%	11.11%
Tete	53.42%	0.00%	46.58%
Zambesia	91.18%	2.94%	5.88%
Grand Total	67.38%	2.46%	30.15%

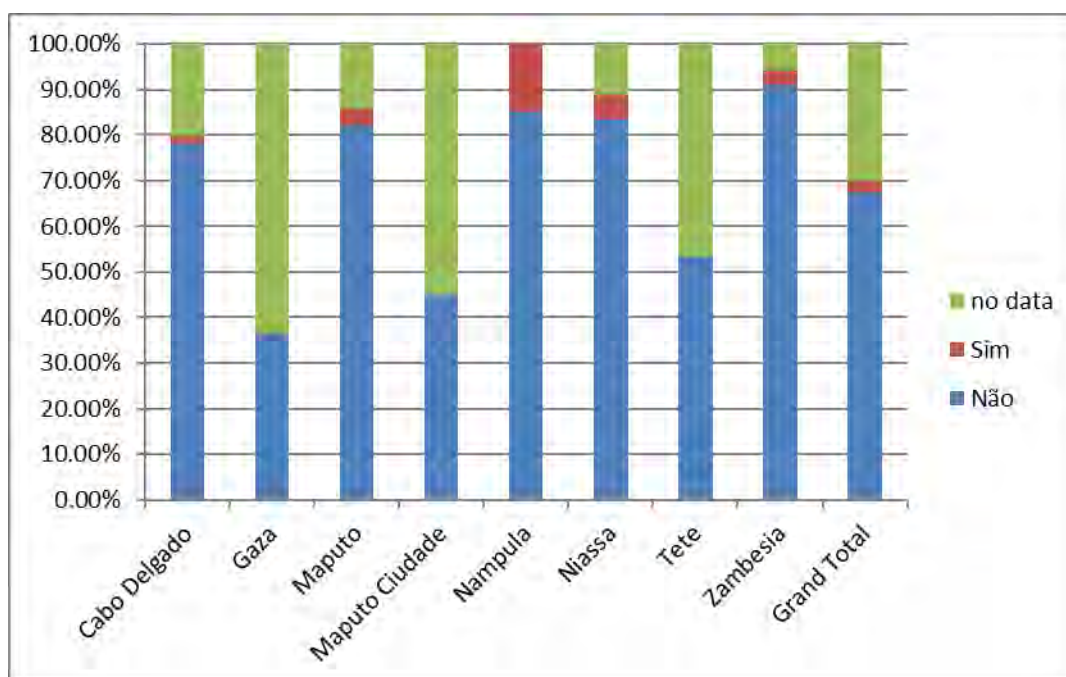


Figure 10 health care of farmers experiencing potential symptoms of pesticide poisoning when using pesticides

3.3.9. Use of Personal Protective Equipment by pesticide applicators including HHPs

Almost none of the farmers owned or wore adequate personal protective equipment. This is shown in the figures and tables below.

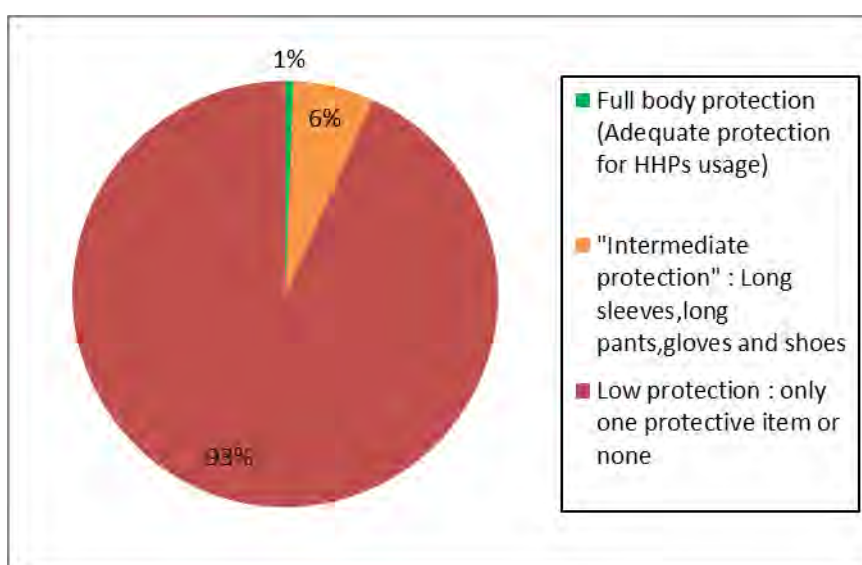


Figure 11 PPE usage for all farmers applying pesticides

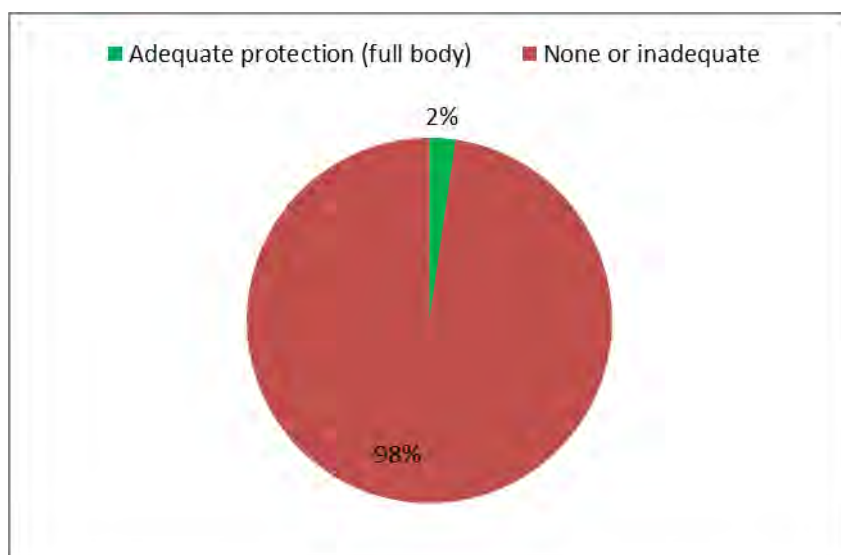


Figure 12 PPE usage for farmers applying HHPs

Table 7 Figure 14 clothes worn by pesticide applicators

Long pants	Shirt with long	Rubber boots	Gloves	bare feet or flip-flops	T-shirt	Shorts	Shoes	Rubber mask	Overalls	Dust mask	Eyes glasses or goggles	Other
63%	53%	39%	34%	34%	29%	17%	20%	15%	7%	3%	3%	2%

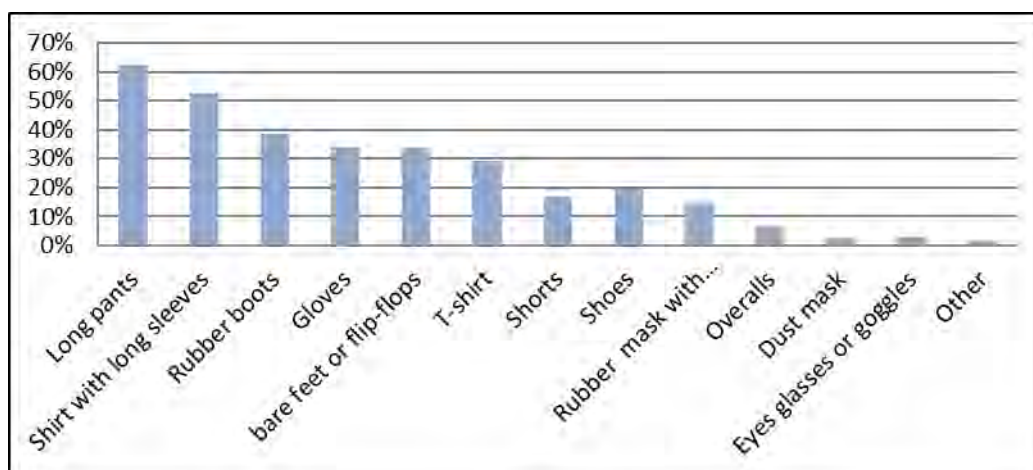


Figure 13 Clothes worn by pesticide applicators

3.3.10. Extent of protection of pesticide applicators by body part

Table 8 Protection used per body part by pesticide applicators

Row Labels	other	overalls	Rubber mask with filter	Dust mask	no mask?	Eye glasses or goggles	no eye protection?	gloves	no gloves?	t-shirt	Shirt with long sleeves	no shirt?	shorts	long pants	Rubber boots	Shoes	Bare feet
Grand Total	2	6	14	2	84	50	50	3	96	16	28	50	60	32	37	19	32

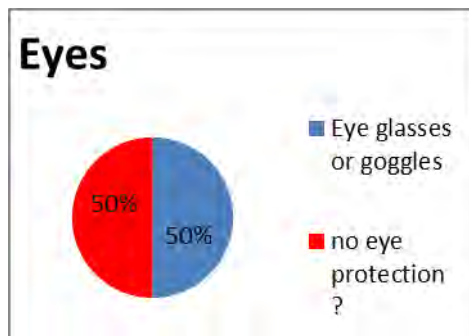


Figure 14 eye protection of pesticide applicators

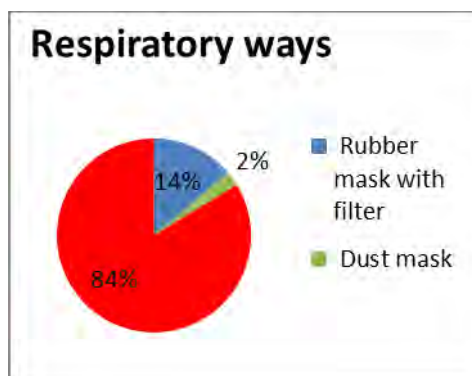


Figure 15 respiratory protection of pesticide applicators

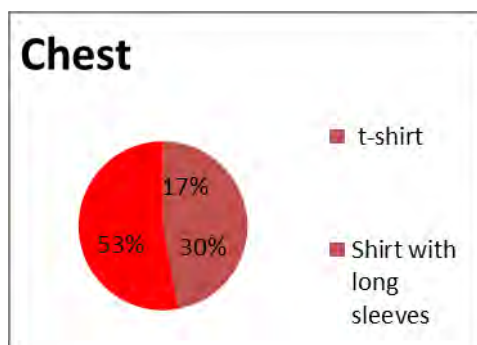


Figure 16 dermal chest protection of pesticide applicators

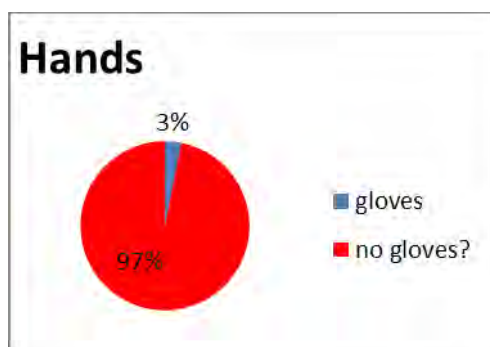


Figure 17 dermal hand protection of pesticide applicators

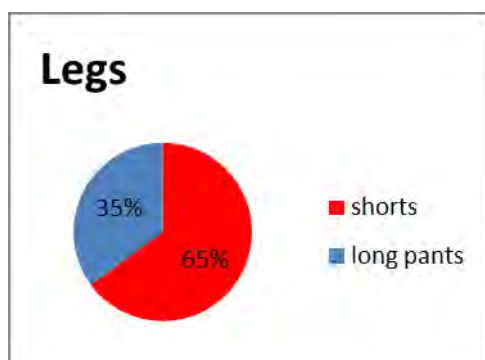


Figure 18 dermal leg protection of pesticide applicators

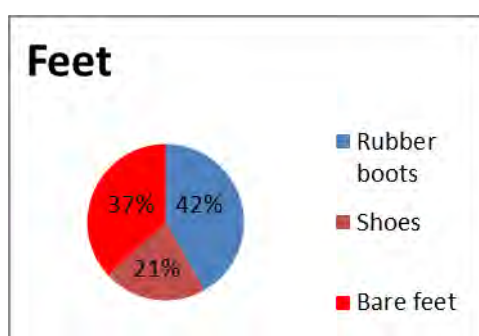


Figure 19 dermal feet protection of pesticide applicators

3.3.11. Pesticide label reading and understanding

Almost half of the farmers declared they did not read pesticide labels, including use instructions such as proper dosage and protective measures, the main reason being illiteracy. One out of four farmers poorly understood the colour band on pesticide labels that indicates acute toxicity. Tables and figures below show details by province and crops.

Table 9 percentage of farmers declaring to read the pesticide label per province

Provinces	Não	Sim	null	Grand Total (# of famers responding to this question)
Cabo Delgado	82.81%	10.94%	6.25%	64
Gaza	86.67%	10.00%	3.33%	30
Maputo	67.86%	32.14%	0.00%	28
Maputo Ciudade	62.50%	37.50%	0.00%	40
Nampula	95.00%	5.00%	0.00%	20
Niassa	88.89%	5.56%	5.56%	36
Tete	49.32%	46.58%	4.11%	73
Zambesia	64.71%	35.29%	0.00%	34
Grand Total	71.38%	25.54%	3.08%	325

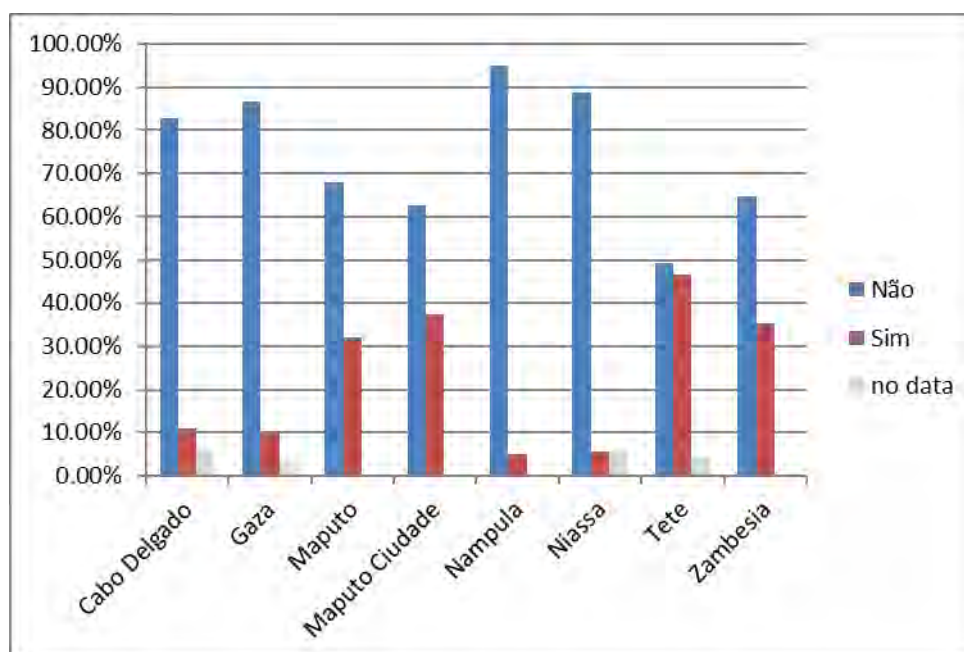


Figure 20 percentage of farmers declaring to read pesticide label per prvince

Table 10 percentage of farmers declaring to read the label per crop and province

Row Labels	Não	Sim	null
Cotton	41.48%	53.33%	5.19%
Cabo Delgado	56.25%	37.50%	6.25%
Nampula	30.00%	70.00%	0.00%
Niassa	36.36%	45.45%	18.18%
Tete	28.00%	68.00%	4.00%
Zambesia	20.00%	80.00%	0.00%
Tobacco	43.48%	55.43%	1.09%
Niassa	56.00%	44.00%	0.00%
Tete	52.08%	45.83%	2.08%
Zambesia	5.26%	94.74%	0.00%
Vegetables, roots and tubers,pulses	31.63%	66.33%	2.04%
Gaza	20.00%	80.00%	0.00%
Maputo	21.43%	75.00%	3.57%
Maputo Cidade	47.50%	50.00%	2.50%
Grand Total	39.08%	57.85%	3.08%

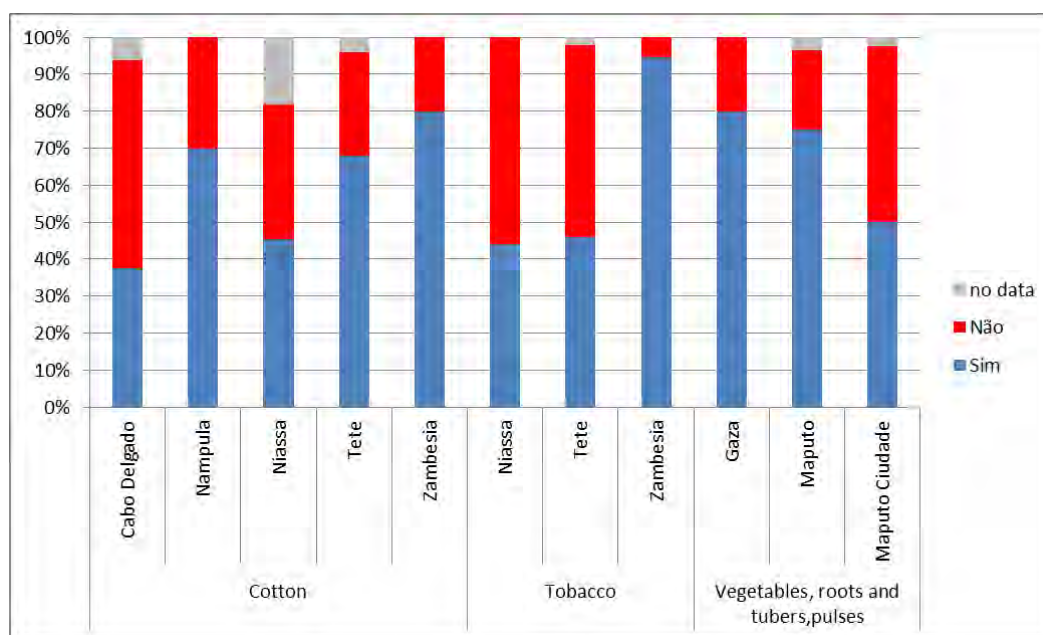


Figure 21 percentage of farmers read the label per province and crops

Table 11 farmers reporting to understand the pesticide label dosage

Row Labels	null	Não	Sim	Sim, com ajuda do técnico da empresa
Cabo Delgado	6.25%	0.00%	93.75%	0.00%
Cotton	6.25%	0.00%	93.75%	0.00%
Gaza	0.00%	26.67%	73.33%	0.00%
Vegetables, roots and tubers,pulses	0.00%	26.67%	73.33%	0.00%
Maputo	7.14%	7.14%	85.71%	0.00%
Vegetables, roots and tubers,pulses	7.14%	7.14%	85.71%	0.00%
Maputo Cidade	0.00%	37.50%	62.50%	0.00%
Vegetables, roots and tubers,pulses	0.00%	37.50%	62.50%	0.00%
Nampula	0.00%	85.00%	15.00%	0.00%
Cotton	0.00%	85.00%	15.00%	0.00%
Niassa	5.56%	83.33%	11.11%	0.00%
Cotton	18.18%	72.73%	9.09%	0.00%
Tobacco	0.00%	88.00%	12.00%	0.00%
Tete	2.74%	46.58%	50.68%	0.00%
Cotton	4.00%	48.00%	48.00%	0.00%
Tobacco	2.08%	45.83%	52.08%	0.00%
Zambesia	2.94%	5.88%	88.24%	2.94%
Cotton	6.67%	13.33%	80.00%	0.00%
Tobacco	0.00%	0.00%	94.74%	5.26%
Grand Total	3.38%	33.23%	63.08%	0.31%

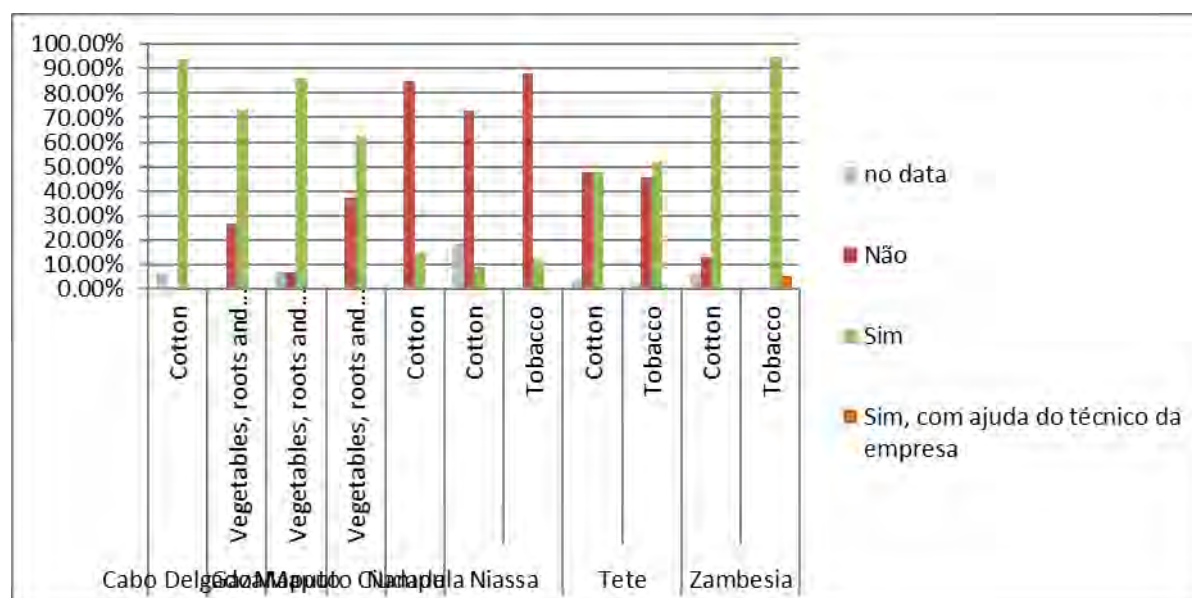


Figure 22 farmers reporting to understand the pesticide label dosage

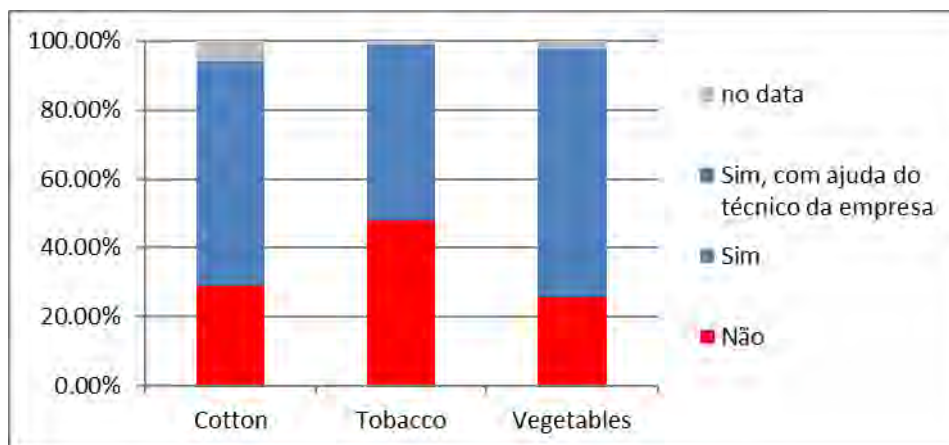


Figure 23 farmer reporting understanding the pesticide dosage instruction on the label per crop

3.3.4. Pesticide storage practices

About a third of farmers are storing pesticides inside their house

Provinces	Number of farmers storing the pesticide Inside the house	Number of farmers storing outside the house	Number of farmers
Cabo Delgado	33	21	60
Gaza	4	20	29
Maputo	1	25	28
Maputo Cidade		38	38
Nampula	3	14	20
Niassa	16	16	34
Tete	50	15	70
Zambesia		33	34
Grand Total	107	182	313

Figure 24 pesticide storage practices per province

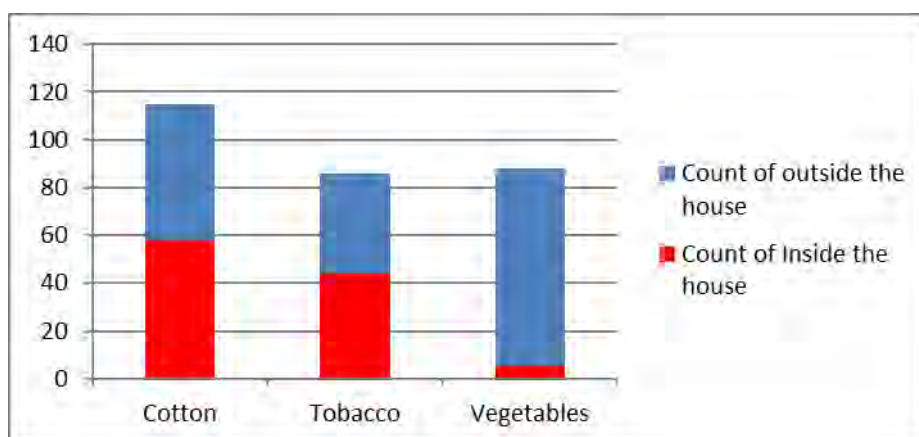


Figure 25 pesticide storage practices per crop

Preliminary discussion and conclusions

The survey results showed that the use of pesticides in general, and of HHPs in particular, was likely to result in undue exposure of farmers in the Mozambique.

Half of the farmers interviewed in the survey had not received any sort of training in using agrochemicals, and even those who had often lacked a good understanding of the risks involved through poor label reading and understanding and poor wearing of PPE. Many farmers in Mozambique do not have the required literacy and numeracy rate to even be able to understand the label. In addition PPE is often difficult to find, and expensive. As a result of all those reasons, the great majority of farmers survey (93%) did not wear appropriate protection to handle any HHPs and potentially neither a big share of the pesticides used.

For what concerns risk mitigation, it is difficult to enforce risk reduction measures that depend on wearing the appropriate PPE in these conditions. A further risk assessment is suggested by the survey and IPM programme targeting especially vegetables and cotton would improve the sustainability of the agricultural sector of Mozambique.

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REPORT

2ND FAO/WHO JOINT MEETING ON PESTICIDE MANAGEMENT

and

**4TH SESSION OF THE FAO PANEL OF EXPERTS ON PESTICIDE
MANAGEMENT**

**6 – 8 October 2008
Geneva**



**Food and Agriculture
Organization
of the United Nations**



**World Health
Organization**

Table of contents

Table of contents	3
Abbreviations	4
1. Introduction	5
2. Opening of the meeting	5
3. Election of the chairperson and rapporteurs	6
4. Adoption of the agenda	6
5. Developments since the previous session of the Panel	7
5.1 WHO	7
5.2 FAO	10
5.3 UNEP	12
5.4 Other organizations	13
6. Highly hazardous pesticides	14
6.1 Identifying highly hazardous pesticides	14
6.2 Priority activities for risk reduction	16
7. Guidelines in support of the Code of Conduct	19
8. Drafting status of guidelines under development	19
8.1 Guidelines on resistance management for pesticides	19
8.2 Guidelines on registration of microbial pest control agents	20
8.3 Guidance on pest and pesticide management policy development – agriculture	20
9. Review of outlines for new or revised guidelines	21
9.1 Guidelines on retail establishments for pesticides	21
10. Review of new and revised guidelines	22
10.1 Guidelines on the development of a reporting system for health and environmental incidents resulting from exposure to pesticides	22
10.2 Guidelines on registration of pesticides	23
10.3 Guidelines on pesticide advertising	24
11. Guidelines proposed for updating	26
11.1 Guidelines on pesticide legislation	26
11.2 Guidelines on good labelling practice for pesticides	26
12. Implementation of the Code of Conduct	27
13. Counterfeit pesticides	28
14. Review of the Code of Conduct	29
15. Recommendations	29
16. Closure of the meeting	35
Annex 1 – List of participants	36
Annex 2 – Agenda	41

Abbreviations

ADI	Acceptable Daily Intake
ASP	Africa Stockpiles Programme
CCPR	Codex Committee on Pesticide Residues
CIEN	Chemicals Information Exchange Network
CMR	Carcinogenic, Mutagenic and Reproductive toxicant
FAO	Food and Agriculture Organization of the United Nations
GCDPP	Global Collaboration for Development of Pesticides for Public Health
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GLP	Good Laboratory Practice
GMP	Global malaria Programme
HHP	Highly Hazardous Pesticide
HQ	Headquarters
IARC	International Agency for Research on Cancer
ICC	International Chamber of Commerce
ICCM	International Conference on Chemicals Management
ICSC	International Chemical Safety Card
IFCS	Inter-governmental Forum on Chemical Safety
IGO	Inter-governmental Organization
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
IPCS	International Programme on Chemical Safety
IPM	Integrated Pest Management
IVM	Integrated Vector Management
JMPR	Joint Meeting on Pesticide Residues
JMPS	Joint Meeting on Pesticide Specifications
MEA	Multilateral Environmental Agreement
MRL	Maximum Residue Limit
NGO	Non-governmental Organization
OECD	Organization for Economic Co-Operation and Development
PAN	Pesticide Action Network
PIC	Prior Informed Consent
PIM	Poisons Information Monograph
POP	Persistent Organic Pollutant
SAICM	Strategic Approach to International Chemicals Management
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNITAR	United Nations Institute for Training and Research
WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation System

1. Introduction

The 2nd FAO/WHO Joint Meeting on Pesticide Management and 4th Session of the FAO Panel of Experts on Pesticide Management, were held at WHO Headquarters in Geneva from 6 to 8 October 2008.

The FAO Panel of Experts on Pesticide Management is the official statutory body that advises the Organization on matters pertaining to pesticide regulation and management, and alerts it to new developments, problems or issues that otherwise merit attention. The Panel in particular counsels FAO on the further implementation of the revised version of the *International Code of Conduct on the Distribution and Use of Pesticides*¹ (the Code of Conduct). Members of the WHO Panel of Experts are drawn from the WHO Panel of Experts on Vector Biology and Control, or are academic or government experts invited to advise the Organization on policies, guidelines and key actions to support Member States on sound management of pesticides.

Experts invited to this meeting have been selected for their personal expertise and experience in specific aspects of pesticide management, both in agriculture and in public health, and do not represent the position of governments or institutions they may belong to. They are appointed in their personal capacity by either FAO or WHO. In addition, representatives from other Inter-Governmental Organizations (IGOs), pesticide industry and Non-Governmental Organizations (NGOs) also attended the meeting as observers.

Dr Morteza Zaim welcomed all participants on behalf of WHO and expressed his great pleasure in hosting the joint meeting for the first time in Geneva. He thanked all present for kindly having responded to the invitation to participate in the meeting.

Mr Mark Davis, of FAO, noted the absence of Dr Gero Vaagt, former Senior Officer of the FAO Pesticide Management Group, who had been called to other duties. He recalled the long involvement of Dr Vaagt in the organization of this Panel and noted that his experience would be greatly missed. Mr Davis underlined the importance of the guidance which the Panel is providing, in particular to developing countries, which are in the complicated situation of having to balance trade, health and environmental interests.

All participants in the meeting are listed in Annex 1.

2. Opening of the meeting

Dr Lorenzo Savioli, Director Control of Neglected Tropical Diseases, gave the opening address on behalf of Mr Hiroki Nakatani, Assistant Director General of WHO. He welcomed the Panel members from FAO and WHO and colleagues from other UN organizations and the World Bank to the meeting, as well as representatives of industry associations and public interest groups who attended the meeting as observers.

¹ <http://www.fao.org/agriculture/crops/core-themes/theme/pests/pm/code/en/>

Dr Savioli reminded the participants that the Panel has an advisory role to FAO and WHO on policies, guidelines and key actions to support Member States on the sound management of pesticides. He stressed that the strengthening of capacity for judicious and effective management of pesticides is a priority for WHO and that the collaboration with FAO provides an opportunity to ensure complementarity, harmonized and coordinated guidance and support to Member States and other stakeholders on this important issue.

The Director underlined that Integrated Vector Management (IVM) is being promoted by WHO as a key strategy for the sound management of pesticides. Capacity building in the field of public health pesticides is an important element of IVM, in particular given the increased use of insecticides in the health sector in many vector-borne disease endemic countries where resources and infrastructure for such activities are often inadequate.

Dr Savioli noted that important guidance documents are being prepared by the Panel and requested the meeting to ensure that these are pragmatic and useful to the main target groups, which are governments of developing countries and countries with economies in transition. He emphasized that the Code of Conduct serves as a framework and guiding document for both FAO and WHO and invited the Panel to carefully review the Code and advise whether any improvements can be made to the document to better address the specific needs of public health pesticides.

Finally, Dr Savioli, wishing the meeting success and stating he looked forward to its recommendations, declared the 2nd FAO/WHO Joint Meeting on Pesticide Management open.

3. Election of the chairperson and rapporteurs

Dr Vibeke Bernson was elected Chairperson of the meeting, and Dr Gamini Manuweera and Dr Sandhya Kulshrestha were appointed rapporteurs.

4. Adoption of the agenda

One additional issue was included under agenda item 13: counterfeiting and illegal trade in pesticides.

The definitive agenda was adopted as shown in Annex 2.

5. Developments since the previous session of the Panel

A brief summary was presented of some important developments with respect to pesticide management that had taken place since the 1st Joint Meeting in October 2007.

5.1 WHO

Chemical safety

WHO Chemical Safety is in the process of updating the Poisons Information Monographs (PIMs) on dieldrin, endosulfan, paraquat and aluminium phosphide. PIMs are concise but comprehensive, internationally peer-reviewed documents about individual agents or groups of agents to which poisoning exposures may occur. The PIMs are primarily intended to facilitate the work of poison information specialists and clinicians in dealing with poisoning cases. They summarize the physico-chemical and toxicological properties of the substance, the clinical features of poisoning and patient management. These will be available on the INTOX and INCHEM websites².

Chemical Safety has also developed International Chemical Safety Cards (ICSCs). ICSCs summarize essential product identity data and health and safety information on pure chemicals for use by workers and employers, agriculture and for the public at large. There are now approximately 150 ICSCs on pesticides, available through the WHO web page of the International Programme on Chemical Safety (IPCS)³.

Chemical Safety is undertaking a risk assessment of the use of DDT in indoor residual spraying for malaria prevention. The draft document will be released for public and peer review, followed by an expert meeting.

Food safety

The 2008 FAO/WHO Joint Meeting on Pesticide Residues (JMPR) was held in Rome, Italy, in September 2008. The meeting evaluated 26 pesticides, of which six were new compounds and six were re-evaluated within the periodic review programme of the Codex Committee on Pesticide Residues (CCPR).

JMPR consists of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group. During the Meetings, the FAO Panel of Experts is responsible for reviewing residue and analytical aspects of the pesticides under consideration, including data on their metabolism, fate in the environment and use patterns, and for estimating the maximum residue levels that might occur as a result of the use of the pesticides according to good agricultural practices. The WHO Core Assessment Group is responsible for reviewing toxicological and related data and for estimating, where possible, acceptable daily intakes (ADIs) for humans of the pesticides under consideration. Relevant information is accessible on the respective JMPR websites of FAO and WHO⁴.

² <http://www.inchem.org> and <http://www.intox.org>

³ <http://www.who.int/ipcs/publications/icsc/en/index.html>

⁴ <http://www.who.int/ipcs/food/jmpr> and <http://www.fao.org/ag/AGP/AGPP/Pesticid/JMPR>

Evidence, research and action on mental and brain disorders

Pesticide ingestion accounts for over 60 percent of suicides in many rural areas of China and South-East Asia and there is evidence of increased pesticide self-poisoning in Central and South American, as well as African countries. The WHO Team of Evidence, Research and Action on Mental and Brain Disorders of the WHO Department of Mental Health and Substance Abuse held a meeting in Nonthaburi, Thailand, in December 2007 to launch the global public health initiative *The Impact of Pesticides on Health: Preventing Intentional and Unintentional Deaths from Pesticide Poisoning*. The meeting identified actions for safer access to pesticides through community interventions.

The Team also published *Prevention of suicidal behaviours: Feasibility demonstration projects on community interventions for safer access to pesticides*⁵. The document provides draft protocols for the demonstration of feasibility of community-level interventions for safer access to pesticides and the identification of potential sites where to conduct those demonstration projects. The Team also convened a meeting on *Prevention of Suicidal Behaviours: Clinical Management of Acute Pesticide Intoxication*, in Nonthaburi, Thailand, in December 2007. The purpose of this meeting was to do an in-depth review of guidelines on the clinical management of acute pesticide intoxication and to develop clinical guidance for health care workers at different levels of the health care system (i.e., primary health care, district hospitals and specialized units) and a strategy for implementation.

Global Malaria Programme

The Global Malaria Programme (GMP) has produced an update on the WHO Position statement on DDT: *The Use of DDT for Malaria Control*, which includes increased focus on occupational and environmental safety guidance.

The GMP has been collaborating with UNEP and the Secretariat of the Stockholm Convention on Persistent Organic Pollutants (POPs), in providing technical support to countries for capacity building in the use of DDT according to the provision of the Convention. In this context, the Secretariat of the Convention has signed a memorandum of understanding with WHO to support countries in fulfilling their requirements for reporting to the Secretariat on the production and use of DDT for disease vector control.

Two national workshops on DDT reporting were held in 2008, respectively in Rabat, Morocco and in Sana'a, Yemen. Both workshops were preceded by a field visit conducted on assessment and support for safe storage of DDT. In July 2008 a three day inter-regional workshop was held in Bangkok, Thailand to improve the relevant processes for data collection, reporting systems and DDT stocks management in each of the participating countries, i.e., China, Democratic People's Republic of Korea, India, Myanmar, Papua New Guinea and Solomon Islands. As part of these regional and country workshops support was also given to countries to assess the capacities of countries for environmentally sound management of DDT stocks and wastes and discuss the introduction of alternatives to DDT and the strategies to be used to reduce the reliance on DDT.

⁵ http://www.who.int/mental_health/resources/suicide/en/index.html

WHOPES

The WHO Pesticide Evaluation Scheme (WHOPES) finalized the testing and evaluation of 5 pesticide products and developed recommendations on their use in public health⁶. The reports of the WHOPES Working Group meetings provide critical reviews of existing literature as well as of studies organized and supervised by WHOPES. These reports are widely distributed among national control programmes, registration authorities and other stakeholders and are intended to facilitate the registration and safe and effective use of such products by Member States.

The 7th FAO/WHO Joint Meeting on Pesticide Specifications (JMPS), held in Braunschweig, Germany, in June 2008, reviewed data package of 19 manufacturers of pesticides (ten for FAO specifications; two for WHO specifications; and seven for joint FAO/WHO specifications) and made recommendations for the development of quality standards for these products.

In collaboration with FAO, WHOPES developed a training manual on the development of pesticide specifications. This tool provides a step-by-step approach to acquiring the knowledge and skills for basic decision-making on the development of pesticide specifications, including the determination of equivalence, following the principles, criteria and procedures detailed in the *Manual on development and use of FAO and WHO specifications for pesticides*⁷. The planned training activities of the two Organizations are expected to support capacity building of the national programmes in the implementation of the Code of Conduct, especially as it relates to Article 6.1.4.

The sixth meeting of the Global Collaboration for Development of Pesticides for Public Health (GCDPP) was held at WHO headquarters, in April 2008. The meeting was attended by representatives of industry, national and government-supported agencies, regional and international organizations, and universities and research institutions, as well as several WHO resource persons, mainly from pesticide registration authorities. The meeting discussed the draft FAO/WHO guidelines on registration of pesticides and advised WHO on the refinement of the guidelines so that they are pragmatic and useful for the main target groups.

WHOPES is in the process of peer review of three generic risk assessment models for application of insecticides in indoor residual spraying, space spraying and mosquito larviciding, as well as three efficacy guidelines for mosquito skin repellents, ground-applied space spray products and household insecticide products. All six guidelines are expected to be published by mid-2009.

Housed in the WHO Vector Ecology and Management Unit, WHOPES has supported the activities of the Unit in supporting Member States in incorporating the principles IVM into their national policies. IVM is highly promoted by WHO for the optimal use of resources for vector and public health pest control and as a key strategy for sound management of pesticides.

WHOPES has also, in collaboration with WHO Regional Offices, initiated situation analyses and needs assessments for strengthening capacity on sound management of pesticides in 12

⁶ <http://www.who.int/whopes/recommendations/wgm/en/>

⁷ http://whqlibdoc.who.int/publications/2006/9251048576_eng_update2.pdf

priority countries in Asia, Africa and South America, through multi-sector and multi-stakeholder approaches. WHOPES also attended the WHO/EURO meeting on Sound Management of Pesticides – Risk Reduction, in Bonn, Germany, in August 2008. The meeting was attended by representatives of 18 Member States, mainly from Eastern Europe, the Caucasus and Central Asia, and recommended on actions to reduce risks associated with the use of such chemicals in agriculture and health.

5.2 FAO

Organizational changes

The Panel was informed that the Plant Production and Protection Division, which hosts the pesticide management programme at FAO, is going through a process of restructuring which should lead to closer integration of crop production and protection activities. Issues related to pesticide management used to be handled by the Pesticide Management Group, but will now be under a Programme Entity responsible for the reduction of risks associated with pesticide use in agriculture to protect human health and the environment, which has three main objectives:

- implementation of the Code of Conduct, including the progressive elimination of highly hazardous pesticides. This objective also covers the work of the JMPR and the JMPS;
- national capacity building for implementation of the Code of Conduct. This objective covers, among other activities, human health risk assessment, strengthening of laboratory capacity, the development of national action plans, implementation of IPM, the safeguarding of obsolete pesticides stocks, etc.;
- communication, knowledge management and associated capacity building services in support of pesticide risk reduction, which includes such activities as the development of guidelines in support of the Code of Conduct, the deployment of pesticide stock management systems, the publication of the joint FAO/WHO training manual on pesticide specifications, information tools on herbicide resistance, etc..

Furthermore, the departure of the Senior Officer Pesticide Management at FAO has led to a reassignment of tasks to other staff within AGP. However, it has also led to a reduction in capacity to implement some of the planned activities related to pesticide management, including some recommendations made previously by the Panel. It is expected that this post will be filled again by mid-2009.

Food safety

The Codex Committee on Pesticide Residues (CCPR) met for its 40th Session, in Hangzhou, China, in April 2008. In addition to the adoption of (draft) Maximum Residue Limits (MRLs) and the revocations of some existing MRLs, the CCPR discussed options for setting globally harmonized MRLs through Codex. This might be achieved by the definition of Codex MRLs before most national MRLs have been set. The implications of such a system on the work of the CCPR and the JMPR would be considerable, though, and these will be further evaluated before the next session. The report of the CCPR is available on the Codex web site⁸.

⁸ <http://www.codexalimentarius.net/web/archives.jsp?year=08>

In addition to the work carried out by the JMPR in 2008 referred to under section 5.1, the attention of the Panel drawn to the ongoing FAO/WHO-IPCS project to update principles and methods for the risk assessment of chemicals in food⁹.

Minor uses

A Global Minor Use Summit was organized jointly by FAO, the US Department of Agriculture (USDA), the US Environmental Protection Agency (USEPA), and IR-4 Project, at FAO headquarters in December 2007. The summit focussed on finding solution for constraints regarding the generation of data for the registration of pesticides, and other regulatory issues, for minor use or specialty crops.

The summit discussed such issues as the generation of residue data, the promotion of extrapolation of data between different uses (e.g., through zoning or crop grouping), strengthening information and data sharing, and the development of harmonized, global guidance. The final recommendations of the summit can be found on FAO's web site¹⁰.

Obsolete pesticides

Regarding the management and disposal of obsolete pesticides, the Panel was informed that a second phase of the Africa Stockpiles Programme (ASP) is being developed. Noticeably, a much greater emphasis will likely be placed on the importance of sound pesticide management for the prevention of accumulation of obsolete pesticide stocks.

In addition, FAO is in the process of setting up new projects on the management and disposal of obsolete pesticides in Eastern Europe, the Caucuses and Central Asia; the Middle East; the Andean countries and Paraguay; and India and Vietnam (with UNDP).

Rotterdam Convention

The number of Parties to the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (the Rotterdam Convention) continues to increase its scope and impact. The number of Parties increased to 126, while national implementation plans for the Convention have been developed for 52 countries, and is continuing.

The Chemical Review Committee, in March 2008, recommended the inclusion of two new pesticides into its Annex III (the PIC procedure): aldicarb and alachlor. Furthermore, the upcoming Conference of Parties of the Convention, later in October 2008, will consider the inclusion of the pesticides TBT and endosulfan into Annex III.

Trends in international agriculture

The year 2008 has seen the emergence and increased importance of a number of global issues which have a direct impact of agricultural production, such as spiralling food prices, the promotion of bio-fuels and the consequences of climate change. These trends have focused international attention on agriculture again, after a long period of relative neglect. The implications of these global trends on (increased) pesticide use are already being noted. This underlines the importance of continued efforts to ensure sound pesticide management.

⁹ <http://www.who.int/ipcs/food/principles/en/>

¹⁰ <http://www.fao.org/ag/AGP/AGPP/Pesticid/>

Monitoring implementation of the Code of Conduct

The previous session of the Joint Meeting discussed two *ad hoc* cases of monitoring observance of the Code of Conduct.

In response to the provisions of the Guidelines on Monitoring and Observance of the Code of Conduct, and in particular its Annex I, FAO sent out an invitation to provide a Regular Monitoring Report on implementation of the Code of Conduct to all its member countries, in July 2008. The deadline for receipt of reports was set at 30 October 2008.

Results of this monitoring exercise will be analysed in the course of 2009, and a report on implementation of the Code of Conduct in FAO member countries should be available at the next session of the Joint Meeting. The report should assist FAO, WHO and the Panel in identifying and/or strengthening priorities for further implementation of the Code of Conduct.

5.3 UNEP

UNEP Chemicals presented its activities for strengthening sound management of pesticides, much of which is carried out in support of SAICM and chemicals-related multilateral agreements. They include activities related risk assessment, management and communication, such as:

- facilitating development of tools for guidance and training in methods for risk assessment and management to be used in capacity building in developing countries and economies in transition;
- promoting the development, exchange and communication of information on reduction of chemicals exposures and effects of chemicals on in particular for sensitive groups and ecosystems;
- supporting activities to minimize effects of natural disasters and industrial accidents involving chemicals;
- mainstreaming of chemicals management into national development agendas.

Pesticide risks

A particular issue with respect to pesticides which UNEP intends to focus on over the next few years are the environmental risks of pesticides in the tropics. In this respect, limited funding has been programmed for the period 2009 – 2011.

Information systems

Several information systems have been put in place, which are of particular relevance for pesticide management:

- the *POPs Laboratory Databank*, a global database of laboratories capable of analyzing POPs. The database provides information, for each laboratory, of the type of analyses that are carried out, the matrices in which POPs can be detected, methods being used, and quality assurance aspects¹¹;

¹¹ <http://www.chem.unep.ch/databank/Home/Welcome.aspx>

- the *Information System on DDT in Disease Vector Control*, which is operated in collaboration with the WHO Global Malaria Programme and the Stockholm Convention¹². The system provides relevant up-to-date information and guidance on DDT and its alternatives in disease vector control. It was especially developed as a tool for exchanging data, experiences and expertise on the management and use of DDT within and between regions;
- the *Information System on POP Termiticides and Alternatives*, which aims to provide easy access to relevant information and guidance materials on termites and options for their management without POP termiticides¹³;
- the *Chemical Information Exchange Network (CIEN)*, which was set up as a mechanism to help networking and collaboration among various stakeholders responsible for the environmentally sound management of chemicals¹⁴. Twelve countries in Africa now have national CIEN web sites to facilitate national information exchange on chemicals;

5.4 Other organizations

The representative of UNITAR informed the meeting about its activities on capacity building for chemicals and waste management. UNITAR is assisting 25 countries in implementing SAICM. It also has a collaborative programme with the Rotterdam Convention, in particular to develop national action plans for its implementation.

The participants were also informed about activities related to pesticide risk reduction carried out by the OECD. A number of seminars has been organised on specific topics, in which non-OECD countries have taken part, the latest of which was the workshop on *Risk Reduction through Better Worker Safety and Training*. Its report has been published earlier in 2008¹⁵.

The Pesticide Action Network (PAN) brought to the attention of the meeting that it had taken up the issue of risk reduction from highly hazardous pesticides (HHPs). A community monitoring exercise had been started to collect information of human health effects caused by pesticides. Furthermore, a first draft of a list of HHPs is presently being elaborated by PAN.

¹² <http://www.chem.unep.ch/ddt/Default.html>

¹³ <http://www.chem.unep.ch/termite/Default.html>

¹⁴ <http://jp1.estis.net/communities/cien/>

¹⁵ http://www.oecd.org/departement/0,3355,en_2649_34383_1_1_1_1_1,00.html

6. Highly hazardous pesticides

6.1 Identifying highly hazardous pesticides

The previous session of the Panel defined a number of criteria to define HHPs. Following publication of these criteria, feedback was received with regard to the clarity of the criteria and their completeness. Therefore, a number of criteria were revisited by the Panel.

WHO classification

A presentation was made by the WHO on the *WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification*¹⁶, in particular the approach taken for the inclusion of certain chronic hazards (the “CMR” criteria: carcinogenicity, mutagenicity and reproduction toxicity). At present, pesticides classified by the International Agency for Research on Cancer (IARC) as having a high likelihood of being carcinogenic, are specifically identified in the WHO Classification. Reproductive toxicity is taken into account on a case-by-case basis, but not all pesticides listed in the classification have been evaluated against this hazard.

Concern was expressed that CMR hazards have not been, and are presently not, systematically evaluated for all pesticides listed in the WHO Classification. It therefore, contrary to acute hazards, may not provide a complete classification of CMR hazards. However, the only other global hazard classification, the *Globally Harmonized System for the Classification and Labelling of Chemicals* (GHS)¹⁷, while providing criteria for CMR hazards, does not evaluate individual pesticides against these criteria. Systematic evaluation of individual pesticides against the CMR criteria of the GHS, and inclusion of its results in the WHO Classification, would according to the Panel be extremely useful.

The Panel underlined the longstanding use and great importance of the WHO Classification for many aspects of pesticide management and regulation, in particular in developing countries. It noted its wide use in registration, classification and labelling, among others.

The Panel reiterated its previously expressed concern that the acute toxicity classifications of the WHO system and of the GHS have not yet been harmonized. It therefore recommended that WHO, as soon as possible, harmonize its criteria for acute toxicity with those of the GHS. The Panel further recommended that WHO should assess the feasibility of incorporating the GHS CMR criteria, and possibly other relevant endpoints, into its Classification. Pesticides listed in the Classification would subsequently need to be evaluated against these criteria, so that the WHO Classification can be considered comprehensive and complete, not only for acute hazards but also for the most important chronic hazards. The Panel recognized, however, that such evaluations would require considerable resources.

Endocrine disrupting pesticides

Endocrine disrupting effects were not incorporated into the list of criteria for HHPs as defined by the previous session of the Panel. A presentation was therefore made by PAN on the status of knowledge about endocrine disrupting pesticides.

¹⁶ http://www.who.int/ipcs/publications/pesticides_hazard/en/

¹⁷ http://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html

It was stressed in this presentation that endocrine disruption by chemicals should not be considered an emerging issue anymore. Much scientific work has been carried out on the effects of endocrine disruption and the toxicological and physiological explanatory mechanisms. A summary of these mechanisms, as well as the resulting adverse effects, was presented to the Panel.

PAN noted that a number of countries have started taking action in regulating endocrine disrupting chemicals, including pesticides. As a first step, several countries, such as the European Union, Japan and the United States of America have started listing potential endocrine disrupting chemicals and identifying those that require further regulation. Furthermore, the OECD has initiated a research programme which is expected to lead, shortly, to a battery of new and revised testing guidelines to detect endocrine disruptors.

It was recognized in the presentation that there still is no full understanding of all the mechanisms by which pesticides affect the endocrine system, and the adverse effects this may cause. However, PAN was of the view that there is sufficient information on endocrine disrupting pesticides, with assay guidelines well developed by OECD in conjunction with the European Union, Japan and the United States of America, to move forward and regulate at least those pesticides already identified by the European Union. As a result, PAN urged FAO and WHO to include endocrine disruption as a criterion for HHPs.

The Panel welcomed the considerable advancements in the development of harmonized testing guidelines and evaluation criteria for endocrine disrupting chemicals. However, it noted that the OECD harmonized testing guidelines had not yet been published, and the European Union list of likely endocrine disrupting chemicals requiring regulation had not yet been formally adopted. Furthermore, there is still much discussion about the variety in effects that may be caused by endocrine disruptors, questions regarding potency, and effective approaches to assess their actual risk. The Panel also noted that endocrine disruption is not a toxicity endpoint as such and often will lead to toxic effects such as cancer or reproductive effects. Such effects would be covered by the criteria for HHPs.

The Panel, therefore, felt it was premature to include specific reference to endocrine disruptors as a separate category of highly hazardous pesticides. However, the Panel recognized that endocrine disruption can be an important mechanism of pesticide hazard expression. It was recommended that this issue be closely followed, and that the Panel should review the extent to which the existing criteria address endocrine disrupting pesticides at one of its future sessions.

Criteria for HHPs

Based on its discussions, and with the aim to ensure that its criteria for HHPs are clear and unequivocal, the Panel recommended that the criteria published at its 2007 session be slightly revised, and read as follows.

Highly hazardous pesticides should be defined as having one or more of the following characteristics:

- pesticide formulations that meet the criteria of classes Ia or Ib of the *WHO Recommended Classification of Pesticides by Hazard*;

or

- pesticide active ingredients and their formulations that meet the criteria of carcinogenicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
- or
- pesticide active ingredients and their formulations that meet the criteria of mutagenicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
- or
- pesticide active ingredients and their formulations that meet the criteria of reproductive toxicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
- or
- pesticide active ingredients listed by the *Stockholm Convention* in its Annexes A and B, and those meeting all the criteria in paragraph 1 of annex D of the Convention;
- or
- pesticide active ingredients and formulations listed by the *Rotterdam Convention* in its Annex III;
- or
- pesticides listed under the *Montreal Protocol*;
- or
- pesticide active ingredients and formulations that have shown a high incidence of severe or irreversible adverse effects on human health or the environment.

With respect to the last criterion, the Panel requested WHO, FAO and UNEP to develop workable criteria on how to determine whether pesticide active ingredients and their formulations have shown a high incidence of severe or irreversible adverse effects on human health or the environment.

Pesticide industry representatives indicated that criteria to identify highly hazardous pesticides which are entirely hazard-based would not be supported by them, and risk assessment should be the basis for regulatory decision making.

6.2 Priority activities for risk reduction

The Panel recalled the recommendation made by the 131st session of the FAO Council, in 2006, with respect to FAO's contribution to SAICM, which read:

In view of the broad range of activities envisaged within SAICM, the Council suggested that the activities of FAO could include risk reduction, including the progressive ban on highly hazardous pesticides, promoting good agricultural practices, ensuring environmentally-sound disposal of stock-piles of obsolete pesticides and capacity-building in establishing national and regional laboratories.

The previous session of the Panel made a number of recommendations with respect to risk reduction of HHPs. FAO informed the meeting that regrettably little progress had been made with implementation of these recommendations, to a large extent due to limitations in personnel (see section 5.2). FAO stressed, however, that risk reduction of HHPs would remain a high priority in its programme, as recommended by the FAO Council.

The previous Panel recommendation that FAO and WHO, as a first step, prepare a list of HHPs based on the criteria identified, had not been taken up. FAO indicated it would be very hesitant to develop such a list, since its relationship to existing Multilateral Environmental Agreements (MEAs) that have more extensive identification procedures, in particular the Rotterdam Convention, might cause confusion in implementation at country level. In addition, preparing a list of individual pesticides classified as a HHP will likely result in long and complicated discussions, which may divert attention from the main task of reducing the risks posed by HHPs.

FAO therefore suggested that the first step of implementing the criteria defined by the Panel may be to develop guidance for registrars on how to apply the criteria for the national authorization of pesticides. Such guidance would also include available relevant data sources needed to use the criteria, and advice on elements and procedures for decision making, in particular with respect to viable alternatives for HHPs. As a second step, FAO and WHO could then actively engage regulators at the national level and assist them in implementing risk mitigation measures for HHPs.

The Panel stressed that registrars in many developing countries need clear guidance on what should be considered HHPs and what type of risk reduction measures can be taken. At present, most countries concerned already lack manpower and technical expertise to carry out proper hazards assessment for pesticides, let alone complete risk assessments.

The Panel revisited its previous recommendations made on priority activities for risk reduction. It noted that most of these recommendations still stand, but suggested to make a number of amendments to further clarify actions that should be taken to reduce risks that are posed by HHPs.

The Panel noted that many HHPs are currently in use, and reiterated that substituting them by less hazardous pest management options will often take time. However, as a general principle, the Panel recommended that HHPs should not be registered for use unless:

- i. governments establish a clear need;
- ii. no alternatives, based on a risk – benefit analysis, are available; and
- iii. control measures as well as good marketing practices are sufficient to ensure that the product can be handled with acceptable risk to human health and the environment.

The Panel considered that the following activities should be a priority for FAO and WHO, with the aim to reduce the risks from HHPs, which explicitly could include a progressive ban of these compounds:

- FAO and WHO, as a first step, should make available to countries information on HHPs based on the criteria above, update it periodically in cooperation with UNEP, and make it widely known;
- FAO, in collaboration with WHO, should invite governments and the pesticide industry to develop plans of action to reduce risks from HHPs by taking regulatory or technical

action, either at the national or the regional level as appropriate, taking into account the work undertaken in existing MEAs such as the Stockholm Convention, Rotterdam Convention and the Montreal Protocol;

- FAO, in collaboration with WHO, should collect information on alternatives for HHPs, both reduced risk pesticides and other pest management approaches, in cooperation with all relevant stakeholders, and share experiences among countries;
- FAO, in collaboration with WHO, should seek assistance from donors for countries which wish to act to reduce risks from HHPs with the aim of preparing, implementing and enforcing action plans and search for alternatives;
- FAO should mobilize internal and external resources in order to implement, as a priority, the recommendations of the FAO Council with respect to HHPs.

The Panel underlined that effective risk reduction from HHPs is mainly carried out at the national level, and that national governments thus have the prime responsibility in this respect. It therefore recommended that FAO, in collaboration with WHO, invite national governments to ensure that at least the following risk reduction measures for HHPs are taken into account:

- identify HHPs with help of the criteria explained above;
- review the need for the use of HHPs, while simultaneously reviewing use conditions, mitigation measures and comparative risk assessment;
- where a specific need is identified for a HHP and no viable alternatives are available, governments should be advised to take all the necessary precautions, mitigation measures and apply restrictions, that may include the use only under certain conditions or by specifically certified users, severe restrictions, or a possible phase-out;
- promote the use of alternative pest management strategies and, in case they are not available, promote research for development of alternative strategies;
- promote the substitution principle for HHPs;
- ensure the provision of sufficient advice and information to users.

Finally, the Panel noted that the Global Guide to Resources on Acute Toxic Pesticides, which had been prepared by the Intergovernmental Forum on Chemical Safety (IFCS) to assist its recommendations on acutely toxic pesticides, is still being updated regularly¹⁸. The Panel suggested that FAO and WHO, as well as national government, could also use this guide to further identify and implement priority activities for risk reduction of HHPs.

¹⁸ http://www.who.int/ifcs/champions/guide_resources/en/index.html

7. Guidelines in support of the Code of Conduct

As an introduction to the discussions on the various guidelines being developed in support of the Code of Conduct, the Panel was informed of newly published or translated guidelines since the its previous session, in October 2007:

- the publication, in May 2008, of the joint FAO/WHO *Guidelines on Management Options for Empty Pesticide Containers*.¹⁹
- the translation into French and Spanish of the FAO *Guidelines on Monitoring and Observance of the Code of Conduct*.²⁰
- the translation into Arabic of the FAO *Guidelines on Efficacy Evaluation for the Registration of Plant Protection Products*.²¹
- the publication of the FAO Legislative study No. 97 – *Designing National Pesticide Legislation*.²²

The Panel was also informed that, because of legal requirements at WHO and the wish to operate a consistent guideline drafting procedure within both organizations, FAO and WHO have decided that guidelines in support of the Code of Conduct would in the future only be drafted by independent experts. FAO and WHO underlined that this procedure would be adhered to avoid any appearance of a conflict of interest, and not because there had been any reservation with respect to the technical quality of previous guidelines. Guidelines presently in the process of being drafted are not affected by this change of policy. Pesticide industry associations and public interest groups would continue to be invited to participate in Task Groups for specific guidelines as observers, and provide inputs in the drafting process.

8. Drafting status of guidelines under development

The Panel was presented with the drafting status of a number of guidelines that are presently being developed.

8.1 Guidelines on resistance management for pesticides

The Panel reviewed a first working draft of the *Guidelines on Resistance Management for Pesticides* at its previous session. Additional comments on this draft had been received subsequently and had been incorporated into a second draft by the drafter in close collaboration with the Task Group chair. The second draft had been reformatted by FAO and was being completed by the drafter.

The Panel requested the Task Group chair and the drafter to finalize the draft by January 2009, to be circulated for review by the Task Group and by a limited number of independent

¹⁹ <http://www.fao.org/agriculture/crops/core-themes/theme/pests/pm/code/frame/implement/obsolete/en/>

²⁰ <http://www.fao.org/agriculture/crops/core-themes/theme/pests/pm/code/frame/monitor/en/>

²¹ <http://www.fao.org/agriculture/crops/core-themes/theme/pests/pm/code/frame/implement/regpes/en/>

²² <http://www.fao.org/legal/legstud/list-e.htm>

peer reviewers. External peer reviewers should be selected based on their expertise in pesticide resistance management, both in agriculture and in public health, by FAO and WHO in consultation with the Task Group chair. The Panel recommended that comments received be taken into account in finalizing this draft, and that it subsequently be circulated among Panel members and observers for review, by June 2009. A final version of the guideline should be presented to the Panel for endorsement by October 2009.

8.2 Guidelines on registration of microbial pest control agents

With respect to the *Guidelines on Registration of Microbial Pest Control Agents*, the Panel took note of the fact that a draft had been prepared based on the outline agreed during its previous session. This draft was circulated among the Task Group members and comments were incorporated by the drafter. The second draft will require reformatting, to be in line with the agreed guideline format.

The Panel requested that this draft be finalized and reviewed by the Task Group by January 2009, and subsequently be sent for external peer review. External peer reviewers should be selected based on their expertise in the registration of microbial pest control agents, both in agriculture and in public health, by FAO and WHO in consultation with the Task Group chair. The Panel recommended that the peer review be taken into account in finalizing this draft, and it be circulated subsequently among Panel members and observers for comments, by May 2009. A new version of the guideline should be presented to the Panel for endorsement, by October 2009.

8.3 Guidance on pest and pesticide management policy development – agriculture.

A draft of the *Guidance on Pest and Pesticide Management Policy Development (Agriculture)* had been discussed by the Panel at its previous session. Subsequently, additional comments were provided which differed substantially from each other and did not represent a clear consensus on the changes to be made. This resulted in a new draft of the document, which had not yet been circulated among the Task Group or full Panel.

The Panel discussed the status and process of development of this draft guideline. It requested FAO to circulate the newly revised draft among the Task Group members for review, by January 2009, to assess whether previous comments have been incorporated in an acceptable manner. Since the latest comments were all provided Task Group members, the Panel recommended that the Task Group consider calling an external independent peer review of the guidance document if certain key elements would remain unresolved. The Panel recommended that a final draft then be prepared, and circulated among Panel members for endorsement by June 2009. If no major comments were to be received on the final draft, FAO was requested to finalize the guidance document and subsequently proceed with publication prior to the Panel's next session.

9. Review of outlines for new or revised guidelines

The Panel was presented with one draft outline for a new guideline to be developed.

9.1 Guidelines on retail establishments for pesticides

A revised scope and outline was presented of the *Guidelines on Retail Establishments for Pesticides*, based on the suggestions made the Panel during its previous session. The Panel confirmed its previous recommendation that the guideline should focus on providing advice to governments on the establishment of a proper system and setting minimum requirements of pesticide distribution and sales within the country. Guidance to be provided to retailers was considered to be the main responsibility of individual governments and of the private sector itself.

The Panel underlined the very important role that retailers play in the pesticide management chain, in particular in developing countries, where they tend to be the prime source of information for pesticide users, not only on the products themselves but also on pest management in general. The effective organization and regulation of retail outlets should therefore be a priority and the guideline should provide minimum requirements in this respect.

The Panel made a number of suggestions regarding the contents of guideline, which included:

- ensuring that distribution and sales of all types of pesticides, including agricultural, public health and domestic use products are covered;
- taking into account different types of retail outlets which may cater for different groups of pesticide users (e.g., general public, farmers, professional pest control operators);
- addressing forms of retail specific to many developing countries, such as travelling salesmen and mixed retail shops (e.g., ‘one-stop shops’ selling all agricultural inputs and materials, or even other types of goods);
- including options for retailer licensing, and the problem encountered in various countries that license holders may not be the actual shopkeepers;
- addressing in sufficient detail elements on labelling, packaging, storage and disposal;
- stressing the need to avoid the risk of food contamination during storage;
- covering all articles of the Code of Conduct which are relevant of pesticide distribution and sales.

In addition, the Panel underlined the importance of training of and information provision to pesticide distributors and retailers, and of effective enforcement, and requested that this be taken into account in the guideline.

The Panel requested that FAO and WHO prepare a detailed annotated table of contents for this guideline by March 2009, and circulate it among Panel members and observers for comments. The Panel further recommended that the development of the guideline be initiated as soon as possible afterwards, so that a complete draft can be distributed for discussion at its next session.

10. Review of new and revised guidelines

The Panel was presented with three draft guidelines presently under development.

10.1 Guidelines on the development of a reporting system for health and environmental incidents resulting from exposure to pesticides

A draft version of the *Guidelines on the Development of a Reporting System for Health and Environmental Incidents Resulting from Exposure to Pesticides* had been discussed during the previous session of the Panel. Comments made by the Panel were incorporated and the draft went subsequently through an additional review round by a number of Panel members, observers and external reviewers. A final draft was then prepared and had been distributed to the Panel for endorsement.

The Panel commended the drafter for her excellent work in finalizing this guideline. The Panel recognized the importance of having a feedback system on possible adverse impact of pesticides within the country as a basis for effective interventions through policy and other options. While recognizing that the operation of a thorough and effective pesticide incident reporting and monitoring system is very complex and will require considerable resources, the Panel underlined that this guideline can provide guidance on how to initiate such a system.

The Panel endorsed in principle the present version of the guideline, but requested that a number of clarifications be made to certain sections of the text. These included:

- adding and/or amending certain definitions;
- providing a good description of the circumstances of pesticide exposure, and the addition of certain elements to the report of suspected pesticide poisoning cases;
- including a recommendation for mandatory reporting of health and environmental incidents;
- providing more guidance on the verification of incident reports.

The Panel recognized that cases of pesticide poisoning as a result of suicide attempts will have very different policy implications from occupational and accidental cases. However, it recommended that reporting and assessment of suicide cases also be included in the guideline.

The Panel noted that for the guidelines to be effective, many countries will likely need capacity building in various aspects of incident reporting and analysis. The Panel also stressed the need of field-testing this guideline and obtaining feedback about the feasibility of its recommendations and its usefulness, and noted the willingness of individual members and of UNEP to do so. It was underlined that a reporting system is only one of the building blocks in protecting human health and the environment as part of sound pesticide management.

The Panel requested that a definitive draft be circulated to its members for final endorsement by November 2008, and that FAO and WHO, after formatting and editing, proceed with publication of the guideline no later than March 2009.

10.2 Guidelines on registration of pesticides

Based on the outline agreed upon at the previous session of the Panel, a draft of the *Guidelines on Registration of Pesticides* had been prepared. This initial draft had been discussed at the 6th GCDPP Meeting in April 2008, in which most of the members of the Task Team for this guideline participated. The comments and suggestions provided during the meeting were subsequently incorporated in a revised draft, which had been circulated among Panel members and observers.

The Panel was reminded of the fact that the purpose of the guideline is to provide general advice on the principles and process as well as requirements for registration of pesticides, including institutional and administrative organization. It should be considered as an umbrella document with more detailed guidance on technical elements of the registration process (such as data requirements, testing methods or risk assessment procedures) to be provided in separate guidelines.

The Panel expressed its appreciation regarding the advanced status of development of the document. It stressed that an effective pesticide registration system is a vital element for sound management of pesticides in a country, and requires a multi-disciplinary approach in implementation.

The Panel considered that the overall scope and contents of the guideline were appropriate for its purpose, and raised a number of issues that might be considered when finalizing the document. These included:

- limiting the section on the responsibilities of various stakeholders to those that are directly involved in pesticide registration;
- considering to extend the definition of ‘pesticide’ to the one used by the JMPS, so that public health and domestic use pesticides are more clearly included;
- explaining different types of registration in more detail;
- providing more information on registration by equivalence;
- clarifying and correcting the section on data protection, by limiting it to a description of principles but avoiding to take a specific position, as this was not done in the Code of Conduct;
- ensuring that issues regarding transparency of the registration process and public information are properly covered;
- providing more guidance on the use of existing data and data exchange between registration authorities;
- including experimental permits, and providing more detail on registration options for minor uses and biopesticides;
- providing additional guidance on comparative risk assessment and the substitution principle;
- clarifying the various options and requirements for fast-track registration.

The Panel further confirmed that genetically modified organisms or natural enemies of pests would not be covered by the guideline. It requested FAO and WHO to carry out a legal review of the guideline to avoid inconsistencies or errors.

The Panel recommended to extend the commenting period until 31 December 2008, after which a new draft should be prepared and circulated among Panel members for endorsement, no later than March 2009. The Panel requested that, if no major comments are received, FAO and WHO, after formatting and editing, proceed with publication of the guideline.

10.3 Guidelines on pesticide advertising

With respect to the *Guidelines on Pesticide Advertising*, the Panel took note of the new draft which had been prepared by the Task Group chair and the written comments provided on this document.

The draft of the guidelines as presented to the Panel suggests that for certain types of advertisements, the provisions of Article 11.2 do not necessarily need to be observed. This would be the case, for instance, for small promotional items such as pens which may not have enough space to show the required wording. While recognizing that such physical constraints could exist for certain types of promotional items, the Panel underlined that no exemptions should be made in this guideline for provisions in the Code of Conduct. Therefore, the Panel recommended that the provisions of Article 11 in the Code of Conduct would need to apply to all forms of pesticide advertising, and that the guidelines reflect this clearly.

The Panel discussed the need to provide further guidance on Article 11.2.18 of the Code of Conduct which states that *Pesticide industry should ensure that advertisements and promotional activities should not include inappropriate incentives to encourage the purchase of pesticides*. The previous session of the Panel recommended that examples be given of what can be considered appropriate and inappropriate incentives or gifts, to assist regulators in the application of this article to their national situation. Examples were subsequently provided in the new draft of the guideline.

The draft guidelines provide a general definition of ‘inappropriate’ which reads: *In general terms, an incentive may be considered appropriate if it is in line with the objectives of the Code of Conduct, and inappropriate if it runs counter to these objectives, i.e. if it encourages the purchasing of a pesticide for another reason than to make the best choice to control a pest or disease*. This definition was considered by some observers as too narrow, as the ‘best choice’ could be interpreted as being limited to biological reasons, but excluding convenience of use, price, etc. Such an interpretation would then disallow advertising to encourage ‘brand change’. It was suggested to modify the latter part of the phrase into: *make the best choice for cost-effective control a pest or disease*. However, the Panel considered this an equally narrow interpretation, and suggested clarify that the best choice will need to be made for agronomic, economic, environmental and health reasons.

Concern was expressed about the use of specific examples in the guidelines, as they can never be exhaustive, and are highly dependent on social, economic, cultural and religious circumstances. A replacement text was therefore presented to the Panel of a more generic nature. The Panel discussed both the draft guideline text and the proposed replacement and concluded that inclusion in the guidelines of explicit examples of inappropriate incentives

would be helpful to national regulators. It considered that the draft guideline clearly stresses that the exact interpretation of this article is subjected to the national or local situation.

The Panel therefore concluded that a list of examples of inappropriate (but not of appropriate) incentives of gifts should be provided in the guideline, such as, but not necessarily limited to:

- incentives or gifts which are not related to the product advertised;
- incentives or gifts with a value higher than the product advertised, unless it is related to the judicious use of the product in question (e.g., personal protective equipment, sprayer maintenance equipment);
- incentives or gifts in exchange of the product label, as this leads to unlabeled products in the hands of the end-user.

The suggestion made to refer in the guidelines to the International Chamber of Commerce (ICC) Code of Advertising and Marketing Communication Practice²³ (and in particular Chapter A on Sales promotion) as minimum general provisions regarding the use of incentives, was supported by the Panel.

The guideline leaves it at the discretion of governments and other stakeholders to notify FAO or WHO of cases of non observance of the provisions of the Code of Conduct on advertising. FAO and WHO may decide to review such notifications. It was suggested that a summary of such complaints and the outcome of the review should be made publicly available by FAO or WHO. The Panel did not support this suggestion, since the *ad hoc* monitoring procedure of observance of the Code of Conduct, set up by FAO, is not a formal international complaints procedure²⁴.

CropLife International noted that, at this point in time, it could not agree with the Panel recommendations on this guideline, but would provide a definitive statement on its acceptance after having reviewed the final draft.

The Task Group was requested to incorporate the recommendations made during the meeting, as well as any editorial comments as far as appropriate. The Panel further requested that the final draft of the guidelines be reviewed again for any legal inconsistencies.

The Panel recommended that the Task Group prepare a new draft of the document by January 2009, for subsequent circulation among the Panel members for endorsement. The Panel requested that, if no major comments are received, FAO and WHO, after formatting and editing, proceed with publication of the guideline no later than June 2009.

²³ <http://www.iccwbo.org/policy/marketing/id8532/index.html>

²⁴ <http://www.fao.org/ag/AGP/AGPP/Pesticid/Code/Guidelines/Monitoring.htm>

11. Guidelines proposed for updating

The Panel discussed two guidelines which had been proposed for updating during a previous session.

11.1 Guidelines on pesticide legislation

The Panel was presented with the recently published *FAO Legislative Study on Designing National Pesticide Legislation*, and commended its quality and clarity.

The Panel underlined that the existing FAO guidelines on pesticide legislation are outdated and do not cover all pesticide uses addressed in the Code of Conduct, and reiterated its previous recommendation to develop updated guidelines on this issue. The Panel discussed in which ways the presented legislative study could be used as a basis for the elaboration of a new guideline on pesticide legislation, which would need to cover all areas of pesticide use, including public health and domestic uses.

The Panel recommended that FAO and WHO initiate the development of an outline for a new guideline on pesticide legislation, to be presented for consideration by the Panel at its next session.

11.2 Guidelines on good labelling practice for pesticides

The Panel was informed that no progress had yet been made in updating this document. The Panel stressed the importance of effective labelling of pesticides as a prime tool for communication with the user.

The Panel revisited its previous recommendation to present the WHO and GHS classifications for pesticides in a parallel manner in the guidelines, since these two systems had not yet been harmonized. It agreed, however, that clear advice on pesticide labelling needs to be provided to countries and a double-track system should be avoided. Furthermore, countries have started implementing GHS and require specific guidance on how to apply this to pesticide labelling.

The Panel noted that while the GHS is to become the global standard for classification and labelling of chemicals, the FAO guidelines and WHO classification of pesticides have long history of use in many countries, and that users have grown accustomed to this approach. The Panel therefore supported the proposal to update the guideline, taking into account the GHS but ensuring that the existing guideline is not changed more than absolutely necessary.

The Panel requested that a first draft be circulated among Panel members and observers by January 2009.

12. Implementation of the Code of Conduct

Although a large number of activities are being carried out by international organizations, national governments, the private sector and civil society organizations, which contribute to the implementation of the Code of Conduct, continued efforts to promote the sound management of pesticides are still needed, in particular in developing countries and countries with economies in transition. The Panel was therefore invited to discuss ways and means of strengthening implementation of the Code over the next few years.

A number of issues were put forward, regarding a possibly reorientation of implementation of the Code, among them:

- increased focus on national implementation, by favouring the development of national projects and programmes;
- better orientation of guidance and guidelines to the needs to developing countries and including systematic verification of their usefulness;
- closer integration of pest management, pesticide management, sustainable intensification of crop production, integrated vector management, chemicals management, environmental issues;
- mainstreaming of awareness building on the Code in the regular work of FAO, WHO and UNEP.

It was proposed to develop a programme for implementation of the Code of Conduct, which would build on a strategic approach based on four main elements: **i. normative work** at the international level (e.g., guidelines, policies, forums), which would guide to **ii. capacity building** on technical and policy issues (e.g., training, information exchange) at national and regional levels, which would lead to **iii. implementation** projects and programmes, primarily at the national level, which in turn would require **iv. feedback** mechanisms to assess effectiveness of implementation. By having the feedback direct the normative work again, a 'strategic loop' for implementation of the Code of Conduct could be developed.

The Panel welcomed the initiative to attempt to increase attention and resources for implementation of the Code of Conduct, and agreed that activities at national and regional levels are in particular required. The Panel endorsed the general concept to develop a programme for implementation of the Code of Conduct along the lines set out during the meeting.

The Panel stressed the importance of ensuring the involvement of all stakeholders, since the success of the Code of Conduct is borne by the fact that all major stakeholders have underwritten it. New stakeholders, such as the food sector, should therefore be actively engaged to participate in the programme. Furthermore, the Panel recommended that opportunities be sought to work with other organizations which are members of the Inter-organization Programme for the Sound Management of Chemicals (IOMC) to strengthen work on training, capacity building and implementation of the Code of Conduct.

The Panel stressed the importance of integration of the programme with initiatives such as the *Strategic Approach to International Chemicals Management* (SAICM) and the 2nd *International Conference on Chemicals Management* (ICCM-2), with a view to facilitating a more effective implementation of the Code of Conduct.

While FAO, WHO and UNEP are already accessing their regular budgets to fund implementation activities, this will certainly be greatly insufficient to develop an effective programme. The Panel therefore called upon FAO, WHO, UNEP and other meeting participants to identify sources and secure funds for implementation of the programme. The Panel recommended that particular attention be paid to presenting the programme in ways that are attractive to governments and potential donors.

The Panel indicated that its members could contribute to the development of a programme for implementation of the Code of Conduct by identifying important needs and gaps that require attention and key entry points that could help get such a programme started up. Furthermore, the Panel could act as ‘steering committee’ which would oversee implementation and monitor its effectiveness.

13. Counterfeit pesticides

At the request of CropLife International, the Panel discussed the problem of counterfeit and illegal pesticides.

The Panel was informed of the increasing importance of counterfeit pesticide products, which are estimated to amount to 5-7 percent of the products in Europe and 20-30 percent in developing countries. Apart from causing economic losses to the legitimate pesticide industry, forged pesticides may endanger farmers’ livelihoods and health, put the food chain and consumers at risk, and may cause damage to the environment. Counterfeiting also undermines the national regulatory systems. CropLife expressed its concern that legitimate pesticides tend to be strictly regulated but problems of illegal and counterfeit products still get relatively limited attention in many countries.

The Panel recognized the importance of the problems caused by the trade in counterfeit pesticides, and noted that it appears to be related, to a large extent, to weak inspection and control systems in many (developing) countries. Strengthening import and export controls, and developing effective systems of quality control which are also feasible in resource-poor countries, are needed to get to grips with this problem. This will require involvement of many players and stakeholders.

The Panel indicated that it would like to further discuss possible ways of reducing the trade and adverse impact of counterfeit pesticides at a next session.

14. Review of the Code of Conduct

The Panel discussed the scope and objectives of the *International Code of Conduct on the Distribution and Use of Pesticides*, in particular its coverage of public health and domestic pesticides. The Panel noted that the Code of Conduct clearly addresses all pesticides and all areas of use. However, it was recognized that its provisions, definitions and the included references appear to focus more on the management of agricultural pesticides.

The Panel recognized that an even more complete Code of Conduct, which might be jointly published by FAO, WHO and possibly UNEP, would likely increase its visibility and impact. However, concern was expressed at initiating a formal revision of the Code of Conduct, as experience has shown that this would require much time and resources, which might better be used for actual implementation of the Code of Conduct. Any possible updating of the Code of Conduct should therefore be limited in scope and not attempt to amend issues expected to generate much discussion.

The Panel recommended that FAO and WHO start the process to ensure that the Code of Conduct, and its implementation tools, adequately addresses all pesticides, and in particular public health pesticides. As a first step, WHO was requested to prepare a working document indicating which articles of the Code of Conduct might need to be amended or completed to ensure full coverage of public health and domestic pesticides.

15. Recommendations

Based on the working documents reviewed, the presentations made and the discussions held during the meeting, the Panel made the following recommendations:

Highly hazardous pesticides

1. To make further progress on the initiative for the reduction of risks posed by HHPs, the Panel reviewed the recommendations from its 2007 meeting and **agreed** that these recommendations **be adopted with the modifications** as incorporated in the following text:
2. HHPs **should be defined** as having one or more of the following characteristics:
 - pesticide formulations that meet the criteria of classes Ia or Ib of the *WHO Recommended Classification of Pesticides by Hazard*;
 - or
 - pesticide active ingredients and their formulations that meet the criteria of carcinogenicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
 - or

- pesticide active ingredients and their formulations that meet the criteria of mutagenicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
 - or
 - pesticide active ingredients and their formulations that meet the criteria of reproductive toxicity Categories 1A and 1B of the *Globally Harmonized System on Classification and Labelling of Chemicals* (GHS);
 - or
 - pesticide active ingredients listed by the *Stockholm Convention* in its Annexes A and B, and those meeting all the criteria in paragraph 1 of annex D of the Convention;
 - or
 - pesticide active ingredients and formulations listed by the *Rotterdam Convention* in its Annex III;
 - or
 - pesticides listed under the *Montreal Protocol*;
 - or
 - pesticide active ingredients and formulations that have shown a high incidence of severe or irreversible adverse effects on human health or the environment.
3. The Panel **noted** advancements in the development of harmonized testing guidelines and evaluation criteria for endocrine disrupting chemicals, but felt it was premature to include specific reference to endocrine disruptors as a separate category of highly hazardous pesticides. However, the Panel **recognized** that endocrine disruption can be an important mechanism of pesticide hazard expression. It was **recommended** that the extent to which the existing criteria address endocrine disrupting pesticides be reviewed by the Panel at one of its next sessions.
 4. The Panel further **recommended** that WHO, FAO and UNEP develop criteria for determining whether pesticide active ingredients and their formulations have shown a high incidence of severe or irreversible adverse effects on human health or the environment.
 5. The Panel discussed how to address the current use of highly hazardous pesticides, and **recommended** that these should not be registered for use unless:
 - a) governments establish a clear need;
 - b) no alternatives, based on a risk – benefit analysis, are available; and
 - c) control measures as well as good marketing practices are sufficient to ensure that the product can be handled with acceptable risk to human health and the environment.
 6. The Panel discussed priority activities related to risk reduction from HHPs, including a progressive ban, and **recommended** that:
 - a) FAO and WHO, as a first step, make available to countries information on HHPs based on the criteria above, update it periodically in cooperation with UNEP, and make it widely known;

- b) FAO, in collaboration with WHO, invite governments and the pesticide industry to develop plans of action to reduce risks from HHPs by taking regulatory or technical action, either at the national or the regional level as appropriate, taking into account the work undertaken in existing Multilateral Environmental Agreements such as the Stockholm Convention, Rotterdam Convention and the Montreal Protocol;
 - c) FAO, in collaboration with WHO, collect information on alternatives for HHPs, both reduced risk pesticides and other pest management approaches, in cooperation with all relevant stakeholders, and share experiences among countries;
 - d) FAO, in collaboration with WHO, seek assistance from donors for countries which wish to act to reduce risks from HHPs with the aim of preparing, implementing and enforcing action plans and search for alternatives;
 - e) FAO mobilize internal and external resources in order to implement, as a priority, the recommendations of the FAO Council with respect to HHPs.
7. The Panel further **recommended** that FAO, in collaboration with WHO, invite national governments to ensure that at least the following risk reduction measures for highly hazardous pesticides (HHPs) are taken into account:
- a) identify HHPs with help of the criteria explained above;
 - b) review the need for the use of HHPs, while simultaneously reviewing use conditions, mitigation measures and comparative risk assessment;
 - c) where a specific need is identified for a HHP and no viable alternatives are available, governments should be advised to take all the necessary precautions, mitigation measures and apply restrictions, that may include the use only under certain conditions or by specifically certified users, severe restrictions, or a possible phase-out;
 - d) promote the use of alternative pest management strategies and, in case they are not available, promote research for development of alternative strategies;
 - e) promote the substitution principle for HHPs;
 - f) ensure the provision of sufficient advice and information to users.

WHO Classification of pesticides by hazard

8. Given the great importance of the *WHO Recommended Classification of Pesticides by Hazard* for various aspects of pesticide management and regulation, including registration, classification and labelling, in particular in many developing countries, the Panel **expressed its concern** that the classifications of the WHO system and of the GHS have not yet been harmonized, which impedes the provision of clear guidance on classification and labelling of pesticides.
9. The Panel therefore **recommended** that WHO, as a matter of urgency, harmonize its criteria on acute toxicity with those of the GHS. The Panel further **recommended** that WHO assess the feasibility to incorporate the GHS criteria on carcinogenicity, mutagenicity and reproductive toxicity, and other relevant endpoints, into its Classification and ensure that all pesticides listed have been evaluated against these criteria.

Implementation of the Code of Conduct

10. The Panel discussed the need to strengthen the implementation of the *International Code of Conduct on the Distribution and Use of Pesticides* and **recognized** the importance of its implementation at, in particular, national and regional levels. The Panel **endorsed** the general concept to develop a programme for implementation of the Code of Conduct as presented, and **recommended** that it include a strategy to involve the food sector as an important stakeholder.
11. The Panel **stressed** the importance of integration with initiatives such as the *Strategic Approach to International Chemicals Management* (SAICM) and the 2nd *International Conference on Chemicals Management* (ICCM-2), with a view to facilitating a more effective implementation of the Code of Conduct. Furthermore, the Panel **recommended** that opportunities be sought to work with organizations which are members of the Inter-organization Programme for the Sound Management of Chemicals (IOMC) to strengthen work on training, capacity building and implementation of the Code of Conduct.
12. The Panel **called upon** FAO, WHO, UNEP and other meeting participants to identify sources and secure funds for implementation of the programme. The Panel **recommended** that particular attention be paid to presenting the programme in ways that are attractive to governments and potential donors.
13. The Panel **requested** to be kept informed of developments in the elaboration and implementation of the programme.

Guidelines in support of the Code of Conduct

14. The Panel reviewed the drafting status of a number of guidelines which are being developed in support of the Code of Conduct, and made the following recommendations.
 - a) With respect to the *Guidelines on Resistance Management for Pesticides*, the Panel took note of the ongoing work to develop a new draft of this guideline, along the lines set out during its previous session. The Panel **requested** the Task Group chair and the drafter to finalize the draft by January 2009, to be circulated for review by the full Task Group and independent peer reviewers. The Panel **recommended** that comments received be taken into account in finalizing this draft, and that it subsequently be circulated among Panel members and observers for review, by June 2009. A final version of the guideline should be presented to the Panel for endorsement by October 2009.
 - b) With respect to the *Guidelines on Registration of Microbial Pest Control Agents*, the Panel took note of the fact that a draft had been prepared for this document, based on the outline agreed during its previous session. The Panel **requested** that this draft be finalized and reviewed by the Task Group by January 2009, and subsequently be sent for external peer review. The Panel **recommended** that the peer review be taken into account in finalizing this draft, and it be circulated subsequently among Panel members and observers for comments, by May 2009. A new version of the guideline should be presented to the Panel for endorsement, by October 2009.

- c) With respect to the *Guidance on Pest and Pesticide Management Policy Development*, the Panel noted the status of development of this draft and **requested** that, after internal review by FAO, the draft be circulated and commented on by the Task Group, by January 2009, to assess whether previous comments have been incorporated in an acceptable manner. The Panel **recommended** that the Task Group consider calling an external independent peer review of the guidance document if certain elements would remain unresolved. The Panel **recommended** that a final draft be circulated among Panel members for endorsement by June 2009 and that FAO, if no major comments were received, finalize the guidance document and subsequently proceed with publication prior to its next session.
15. The Panel reviewed the draft outline of one guideline which is being developed in support of the Code of Conduct, and made the following recommendations.
 - a) With respect to the outline for the *Guidelines on Retail Establishments for Pesticides*, the Panel **underlined** the importance of proper regulation of retail outlets, and **recommended** drafting a guideline focused on providing advice to the governments in the establishment of a proper system of sale of pesticides within the country, including public health and household pesticides. The Panel **provided** several **suggestions** on its content, which included taking into account different types of retail establishments which may sell pesticides; addressing in sufficient detail elements on labelling, packaging, storage and disposal; and stressing the need to avoid food contamination during storage. The Panel **requested** that FAO and WHO prepare a detailed annotated table of contents for this guideline by March 2009, and circulate it among Panel members and observers for comments. The Panel further **recommended** that the development of the guideline be initiated as soon as possible afterwards, so that a complete draft can be distributed for discussion at its next Session.
16. The Panel reviewed a number of draft guidelines that were developed in support of the Code of Conduct, and made the following recommendations.
 - a) With respect to the *Guidelines on the Development of a Reporting System for Health and Environmental Incidents Resulting from Exposure to Pesticides*, the Panel **recognized** the importance of having a feedback system on possible adverse impact of pesticides within the country as a basis for effective interventions through policy and other options. The Panel **endorsed in principle** the present version of the guideline, but requested that a number of clarifications be made to certain sections of the text. The Panel **requested** that a definitive draft be circulated to its members for final endorsement by November 2008, and that FAO and WHO, after formatting and editing, proceed with publication of the guideline no later than March 2009.
 - b) With respect to the *Guidelines on Registration of Pesticides*, the Panel **stressed** that an effective pesticide registration system is a vital element for sound management of pesticides in a country, and requires a multi-disciplinary approach in implementation. The Panel **made suggestions** for improvements to various sections of the draft, including the responsibilities of various actors for pesticide registration; the issue of data protection, transparency and public information; registration by equivalence; comparative risk assessment and the substitution principle. The Panel **recommended** to extend the commenting period until 31 December 2008, after

which a new draft should be prepared and circulated among Panel members for endorsement, no later than March 2009. The Panel **requested** that, if no major comments are received, FAO and WHO, after formatting and editing, proceed with publication of the guideline.

- c) With respect to the *Guidelines on Pesticide Advertising*, the Panel took note of the new draft which had been prepared by the Task Group chair and the comments provided on this document. The Panel **recommended** that the provisions of Article 11 in the Code would need to apply to all forms of advertising. The Panel further discussed the issue of inappropriate incentives and **concluded** that a list of examples should be provided in the guideline, taking into account the comments made. The Panel **recommended** that the Task Group prepare a new draft of the document by January 2009, for subsequent circulation by among the Panel members for endorsement. The Panel **requested** that, if no major comments are received, FAO and WHO, after formatting and editing, proceed with publication of the guideline no later than June 2009.
17. The Panel reviewed a number of draft guidelines which had been proposed for updating, and made the following recommendations.
- a) With respect to *Guidelines on Pesticide Legislation*, the Panel took note of the *FAO Legislative Study on Designing National Pesticide Legislation* and **commended** its quality. The Panel **underlined** that existing FAO guidelines on pesticide legislation are outdated and do not cover all pesticide uses addressed in the Code of Conduct. The Panel discussed in which ways the study could be used as a basis for the elaboration of a new guideline on pesticide legislation, covering all areas of pesticide use, including public health and domestic uses. The Panel **recommended** that FAO and WHO initiate the development of an outline for a new guideline on pesticide legislation, to be presented for consideration by the Panel at its next session.
 - b) With respect to the *Guidelines on Good Labelling Practice for Pesticides*, the Panel took note of the status of updating this document. The Panel **stressed** the importance of effective labelling of pesticides as a prime tool for communication with the user. The Panel **agreed** that clear advice on labelling needs to be provided to countries, and that parallel presentations of the WHO and GHS classifications for pesticides in the same guideline should be avoided. The Panel **recommended** that the guideline be updated, taking into account the GHS but ensuring that the existing guideline is not changed more than absolutely necessary, and that a first draft be circulated among Panel members and observers by January 2009.

Review of Code of Conduct

18. The Panel discussed the scope and objectives of the *International Code of Conduct on the Distribution and Use of Pesticides* and **noted** that, while these clearly address all pesticides, the provisions of the Code of Conduct and the included references appear to lean to the management of agricultural pesticides. The Panel therefore **recommended** that FAO and WHO start the process to ensure that the Code of Conduct, and its

implementation tools, adequately addresses all pesticides, and in particular public health pesticides.

16. Closure of the meeting

The 2nd FAO/WHO Joint Meeting on Pesticide Management, and the 4th Session of the FAO Panel of Experts on Pesticide Management, was closed by Mr Mark Davis, Senior Officer a.i. of the Pesticide Management Group of FAO and by Dr Morteza Zaim, Scientist in charge of the WHO Pesticide Evaluation Scheme. They thanked all participants for their valuable inputs in the discussions and expressed their satisfaction about the progress that was made.

The meeting was informed that Dr Vibeke Bernson, who had chaired the meeting over the last few years, would be retiring at the end of 2008. Her pleasant but very efficient way of chairing the meetings has greatly contributed to their success. Her contribution to the Panel was gratefully acknowledged.

Finally, the meeting also took note of the fact that FAO Panel members will come to the end of their 4-year term in the course of 2009, but before the next session. Therefore, Mr Davis extended his sincere gratitude, on behalf of FAO, to all for having accepted to sit on the Panel and for having shared their experience and expertise. He presented an FAO memorial medal to each FAO Panel member as an expression of the appreciation of the Organization.

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Annex 2 – Agenda

1. Opening of the meeting and welcome address
2. Appointment of Chairman and Rapporteurs
3. Adoption of agenda
4. Introduction of meeting procedure, working arrangements and housekeeping matters.
5. Summary of developments and actions taken after the first joint meeting in October 2007.
6. Highly hazardous pesticides – status of implementation of recommendations made after the first joint meeting in October 2007.
7. Draft Guidelines agreed for publication in the previous meeting – status report
 - a. Guidelines on management options for empty pesticide containers.
 - b. Guidelines on pesticide advertising.
 - c. Guidance on pest and pesticide management policy development – agriculture.
8. Draft Guidelines under development – status report
 - a. Guidelines on resistance management for pesticides.
 - b. Guidelines on registration microbial pest control agents.
9. Draft outlines for Guidelines – for review
 - a. Guidelines on retail establishments of pesticides.
10. Draft Guidelines – for review.
 - a. Guidelines on the development a reporting system for health and environmental incidents resulting from exposure to pesticides.
 - b. Guidelines on registration of pesticides.
11. Guidelines proposed for updating – issues regarding content
 - a. Guidelines on pesticide legislation
 - b. Guidelines on good labelling practice for pesticides
12. Implementation of the revised version of the International Code of Conduct – future orientation of activities.
13. Any other matters.

Hazards of pesticides imported into Mozambique, 2002-2011

Joost Lahr
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Jan Groenwold

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Contents

Summary	5
1 Introduction	7
1.1 Scope of the project	7
1.2 Objectives	7
1.3 Approach	7
2 Methods	9
2.1 Datasets	9
2.1.1 Import data	9
2.1.2 Pesticide properties	9
2.2 Trends in pesticide import	10
2.3 Hazard indicators	10
2.3.1 Acute hazard to human health	10
2.3.2 Chronic hazard to human health	12
2.3.3 Acute environmental hazard	12
2.3.4 Environmental Toxic Load	13
2.3.5 Groundwater leaching potential	14
2.4 Pesticides of concern	14
3 Results	17
3.1 Agricultural statistics	17
3.2 Pesticide imports	18
3.2.1 Imported numbers of pesticides	18
3.2.2 Imported pesticide volume	21
3.2.3 Monetary value	25
3.3 Acute hazard to human health	27
3.4 Chronic hazard to human health	29
3.4.1 Carcinogenicity	30
3.4.2 Mutagenicity	31
3.4.3 Toxicity to reproduction	32
3.5 Acute environmental hazard	32
3.5.1 Fish	33
3.5.2 Aquatic invertebrates	34
3.5.3 Algae	35
3.5.4 Bees	36
3.6 Environmental Toxic Load	37
3.6.1 Fish	37
3.6.2 Aquatic invertebrates	37
3.6.3 Algae	38
3.6.4 Bees	39
3.7 Groundwater leaching potential	39
4 Discussion	41
4.1 Limitations and advantages of the methods	41
4.1.1 Use of import data	41
4.1.2 Hazard assessments	41
4.1.3 Environmental Toxic Load	42
4.1.4 GUS index	42
4.1.5 Advantages of hazard analysis	42
4.2 Trends in pesticide imports	43

4.3	Human health hazard	43
4.4	Environmental hazard	43
5	Conclusions	45
	References & sources	47
Annexes	49	
Annex 1: Compound properties		51
Annex 2 Human hazard		65
Annex 3 Environmental toxic Loads		71
Annex 4: Groundwater leaching		79
Annex 5: Imported formulated products containing active ingredients of primary concern		85

Summary

Together with the government of Mozambique, The Food and Agriculture of the United Nations (FAO) is implementing a project to identify the most Highly Hazardous Pesticides (HHPs) in Mozambique based on import data and to reduce risks of these pesticides by recommendations for mitigation measures. In the framework of this project Alterra, Wageningen UR, has conducted a desk top study to assess the hazards associated with pesticides imported in Mozambique from 2002 to 2011. The objectives of the study were (1) to conduct an evaluation of historical trends in the use of pesticides in Mozambique based on pesticide import data compiled by the Ministry of Agriculture over the period 2002 – 2011, (2) to assess trends in human health and environmental hazards and potential risks of the pesticides imported in Mozambique, and (3) to identify pesticides or pesticide use patterns (as far as feasible) contributing most to these hazards.

In order to analyse trends in potential hazards of pesticide use on human health and the environment, hazard based indicators were used for occupational health, aquatic organisms, bees and groundwater. When true exposure assessment data are not available, hazard based indicators can be used to rank pesticides relatively to each other from high to low hazard. FAO supplied data to Alterra of pesticides imported into Mozambique from the years 2002 to 2011, as well as information on pesticides with a registration in Mozambique. It is not clear if the pesticide import data for 2002 used in this study are complete.

The most important results of the study are:

- The volume of pesticides imported increased almost threefold, from 670 tonnes in 2003 to 2592 tonnes in 2011. Agricultural production increased by 40 % from 9.9 million tonnes in 2002 to 13,9 million tonnes in 2011, whereas the agricultural area increased only by 1.4%;
- The types of pesticides imported in the country are very consistent over time. The majority of products consists of insecticides, followed by the herbicides and fungicides;
- The volume of highly hazardous products imported over time decreased and the volume of products with a (very) low hazard increased;
- Only few pesticide products with a known chronic hazard to human health were imported in the country, although carcinogenic products were imported at the rate of 100 tons per year;
- A considerable number of the pesticides imported into the country are acutely toxic to fish, aquatic invertebrates, algae and bees. However, the less hazardous pesticides represent a much higher volume of imports;
- The Environmental Toxic Load (ETL) (relative hazard corrected for surface of agricultural area) to aquatic organisms (fish, aquatic invertebrates and algae) increases from 2002 to 2010, but decreases for all three groups of species in 2011;
- Overall, the hazard of the imported pesticides is more than two times higher to aquatic invertebrates and algae than to fish;
- The ETL to bees also increases from 2002 to 2008, but is considerably lower from 2009 to 2011;
- Only few active ingredients with a very high or high leaching potential are imported in the country.

The pesticides that contributed most to the overall human health hazards and environmental hazards are given in the following table. Active ingredients of primary or secondary concern were identified using criteria that combine both potential hazard of the pesticides and imported quantities in Mozambique. The table may be used to focus hazard reducing measures in the country.

Pesticides imported in Mozambique from 2002 to 2011 that are of concern in terms of potential human health and environmental hazard and annually imported quantity.

Type of hazard	Pesticide active ingredient of primary concern	Pesticide active ingredient of secondary concern
<i>Human health</i>		
Acute (WHO classification)	Class I pesticide products containing: Abamectin Aldicarb Aluminium phoshide Fenamiphos Methomyl Mevinphos Monocrotophos Oxamyl Terbufos	Class II pesticide products containing: Ametryn DDT Lambda-cyhalothrin
Chronic	Diuron (carcinogenic) Mancozeb (carcinogenic)	Dichlorvos (carcinogenic)
<i>Environment</i>		
Fish	Lambda-cyhalothrin	Aluminium phoshide Chlorpyrifos Cyfluthrin Cypermethrin Endosulfan
Aquatic invertebrates	-	Chlorpyrifos Cypermethrin DDT Dichlorvos Ethion Fenvalerate Lambda-cyhalothrin Pirimiphos-methyl
Algae	Acetochlor	Ametryn Paraquat
Bees	Imidacloprid	Bendiocarb Chlorpyrifos Cyfluthrin Cypermethrin Deltamethrin Lambda-cyhalothrin Profenofos Thiamethoxam
Leaching to groundwater	Methyl bromide Tebuthiuron	Atrazine Clomazone Hexazone Imidacloprid Propoxur

1 Introduction

1.1 Scope of the project

Together with the government of Mozambique, The Food and Agriculture of the United Nations (FAO) has been implementing a project to identify the most Highly Hazardous Pesticides (HHPs) in Mozambique and to reduce risks of these pesticides by recommendations for mitigation measures.

In the framework of this project Alterra, Wageningen UR, has conducted a desk top study of the hazards associated with pesticides imported in Mozambique from 2002 to 2011.

1.2 Objectives

The objectives of the study were:

1. to conduct an evaluation of historical trends in the use of pesticides in Mozambique based on pesticide import data compiled by the Ministry of Agriculture over the period 2002 – 2011,
2. to assess trends in human health and environmental hazards and potential risks of the pesticides imported in Mozambique, and
3. to identify pesticides or pesticide use patterns (as far as feasible) contributing most to these hazards.

1.3 Approach

The potential risk related to the use of a specific pesticide is always determined by pesticide properties (hazard) and circumstances in which the pesticide is used (exposure). Therefore:

Risk = hazard × exposure

Hazard is determined by the toxicological properties of the pesticide. Environmental exposure is determined by pesticide use patterns, the physico-chemical properties of the active ingredient (a.i.) and the properties of the environment (e.g. soil, climate, surface water) of concern. Human occupational exposure is further determined by use of personal protective equipment, application equipment, skills and awareness of the operator, while dietary exposure is determined by many other factors like for instance composition of diet.

In order to analyse trends in potential hazards of pesticide use on human health and the environment, we used hazard based indicators for occupational health, aquatic organisms, bees and groundwater. When real exposure assessment data are not available, hazard based indicators can be used to rank pesticides relatively to each other from high to low hazard. These indicators, together with the quantitative information on pesticides use, can provide an indication of which pesticides are most likely to pose a potential problem. Such an approach has earlier been successful in identifying the trends in the hazards of pesticides used in cotton in different countries (De Blécourt et al., 2010). The actual risks posed by these pesticides, however, remain uncertain as realistic exposure profiles are not explicitly taken into consideration. This would need more location-specific data. But while perhaps less specific than risk indicators due to the lack of exposure data, hazard indicators are quite suitable for trend assessments and ranking exercises.

2 Methods

2.1 Datasets

FAO has supplied data to Alterra of pesticides imported into Mozambique from the years 2002 to 2011, as well as information on pesticides with a registration in Mozambique. Hereafter these spreadsheet files will be referred to as the Import data and the Registered pesticide data, respectively. Following an initial quality check conducted by Alterra, additional efforts by FAO and Alterra were needed in order to enhance the quality of these data, notably the Import data.

2.1.1 Import data

Text fields in the original Excel spreadsheet with Import data delivered by FAO contain Product names, Active ingredient names, Categories (i.e. the product group), Importer names, Units of Concentration, Units of Quantity, and the Monetary Units. These text fields were screened for typing errors, alternative spelling, abbreviations, etc.

Inconsistent entries were corrected when possible. Those which could not be corrected were removed from the dataset. For example, the active ingredient content is required for conversion of product volumes into active ingredient volumes. The import data included 11 bio pesticides and inorganic pesticides with an unknown formulation (i.e. a blank) or a value out of range in the content field. These import events had to be removed. In another five cases, a missing value for the content was replaced with the mean value of the content in the other imported products with exactly the same active ingredients. A numerical field was added to the text fields for identification. In some cases the number in the Concentration a.i. field was corrected in order to obtain a unique value for the content of the active ingredient of a formulated product

2.1.2 Pesticide properties

In order to make an analysis of the human and environmental hazards related to the agricultural use of pesticides in Mozambique, full consistency is required between the product formulation in the Import data and the active ingredients in the Registered pesticide data. On a few occasions, when the information in both datasets did not entirely match, we let the Import data prevail over the Registered pesticide data.

We gathered the toxicity and fate properties of the active ingredients and the products mentioned in the Import data from the following sources:

1. The Registered pesticide data, mainly for human toxicity data.
2. The internal compound database of the Alterra team Ecological Risk Assessment (ERA). This internal database is used for projects only and was last updated for the study on cotton (see De Blécourt *et al.*, 2010).
3. A compound database available from the evaluation of the Dutch policy plan for sustainable use of pesticides (mainly for fate properties).
4. The Pesticides Properties DataBase PPDB (Footprint; 2013, 2007) database, for the classification of physical properties and environmental toxicity.

Some 80% of the properties required for the analysis were found in these sources. We used a routine for the replacement of missing values for compound properties, which consists of the following steps:

- When a parameter value for an active ingredient is not available, the mean value of all active ingredients from the same chemical class will be used (e.g., carbamate, organophosphate).

-
- When the mean of the parameter values for the active ingredients from the same chemical class cannot be calculated, the mean of all active ingredients from the same product group is used (insecticides, fungicides, etc.).
 - When no mean values can be calculated, the parameter value is classified as unknown.

Accordingly, the status of each property will be either 1) original value, 2) estimated value based on chemical class, 3) estimated value based on product group, or 4) not available. This routine was developed in the framework of the European HAIR project on risk indicators for agricultural use of pesticides (Kruijne *et al.*, 2011). It was developed and approved by the scientists in the HAIR consortium, but it has so far not been validated.

Annex 1 contains the fate properties and toxicity values for all active ingredients, including the source.

2.2 Trends in pesticide import

Trends in pesticide import in Mozambique from 2002 to 2011 were explored in terms of numbers (type) of pesticides and volume (amount) of pesticides. Trends in imported pesticide products and their active ingredients were based on the annual volume imported and the formulation of these products. Metabolites are not considered in this study.

In reality, the annual volume of products used in agricultural crops in the country may be different from the volume imported due to changes in stocks, exports to other countries, and non-agricultural uses. Gathering information on these flows and stocks was beyond the scope of this study. Moreover, the Import data or Registered pesticide data did not contain information on their use in e.g. agriculture, public health or veterinary use, so no formal distinction can be made. The import data provided are regarded as a proxy for actual use in Mozambique in the different sectors combined.

2.3 Hazard indicators

Hazard based indicators were used to rank products and active ingredients relative to each other from **high to low hazard**. **Hazard is defined by the OECD (2003) as 'an inherent property of an agent or situation having the potential to cause adverse effects when an organism, system or (sub) population is exposed to that agent'.** Hazard is determined by the toxicological properties of the formulated pesticide or its active ingredients. The hazard assessments conducted in this study do not estimate the actual risks in the field since true risks depend on many more factors that are not explicitly taken into account here such as pesticide formulation, soil properties, weather conditions during application, use of protective personal equipment, method of application, buffer strips and other mitigation techniques, the species that do actually occur in the field, etc.

In this study hazard assessments were performed for: 1) acute hazard to human health (WHO hazard classification), 2) chronic hazard to human health (carcinogenicity, mutagenicity and effects on reproduction), 3) hazard to aquatic organisms (fish, *Daphnia*, and algae), 4) hazard to bees, and 5) groundwater leaching potential. The basis of the indicators is described more fully below.

2.3.1 Acute hazard to human health

The classification of active ingredients according to their acute toxicity to human health originated from **'The World Health Organization recommended classification of pesticides by Hazard'** (WHO, 2010). The hazard referred to is the acute hazard to health (that is, the potential effects of single or multiple exposures over a relatively short period of time) that might be encountered accidentally by any person handling the product in accordance with the directions for handling by the manufacturer or in accordance with the rules laid down for storage and transportation by competent international bodies. This definition does not include the regular handling of products in developing countries without personal protection equipment and consequent exposure.

The classification is primarily based on data on the acute oral and dermal toxicity to rats as standard testing species. Since 2009 it does not distinguish anymore between solid and liquid formulations. Provision is made for the classification of a particular compound to be adjusted if, for any reasons, the acute hazard to man differs from that indicated by the LD50 assessments alone. The WHO classification takes into consideration the toxicity of the technical compound and its common formulations. The criteria for classification are shown in Table 1.

Table 1: Categories of acute toxicity to human health according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) used for classification of formulations (WHO, 2010).

WHO Class		LD50 _p (mg/kg body weight)	
		Oral	Dermal
Ia	Extremely hazardous	< 5	< 50
Ib	Highly hazardous	5-50	50-200
II	Moderately hazardous	50-2000	200-2000
III	Slightly hazardous	2000-5000	2000-5000
U	Unlikely to present acute hazard	5000 or higher	

The classification of any product depends on the formulation concentration. If the concentration of the formulation is low, this may decrease the exposure and thus the acute risk (Equations 1, 2). Furthermore, for a solid formulation the exposure is usually lower compared to a liquid formulation since it is more difficult for a solid to pass through the skin.

Products containing a single active ingredient are classified based on the proportional toxicity and the categories shown in Table 1.

$$LD50_p = \frac{LD50_{ai}}{f_{ai}} \tag{Eq. 1}$$

LD50_p proportional LD50 for the product formulation (mg/kg body weight)
 LD50_{ai} oral acute LD50 or dermal acute LD50 of the active ingredient (mg/kg body weight)
 f_{ai} content of the active ingredient (fraction)

Mixtures, i.e. products containing multiple active ingredients, are classified according to

$$LD50_p = \frac{1}{\sum \frac{f_{ai}}{LD50_{ai}}} \tag{Eq. 2}$$

using the categories for oral toxicity shown in Table 1.

According to the WHO (2010), if both the oral acute LD50 and the dermal acute LD50 are available, the product should be classified based on the acute toxicity which results in the highest hazard class. The fields used for LD50 values in the Registered pesticide data were not entirely internally consistent. **Fields contained numbers with both decimal points and comma's, text characters instead of numbers,** combinations of both, lower limits, ranges, blanks and colours. This was too cumbersome to straighten out for 200 active ingredients in some 450 products. Numerical toxicity data were therefore partly gathered from the other sources used (see Annex 1). For practical reasons we decided only to use oral toxicity data. Oral LD50 data were more suitable to deal with the classification of mixtures. Often, there were no dermal data for all active ingredients in a mixture. Formulated mixtures of pesticides

cannot be classified on combined oral and dermal data (WHO, 2010). Moreover, the availability of dermal toxicity data is limited compared to oral toxicity, a fact that is recognised by the WHO (2010).

The consequence is that the oral toxicity criteria for classes Ia, Ib and II are slightly less strict than for purely dermal data. But oral toxicity is often higher than dermal toxicity, so in the majority of cases the use of oral toxicity data will lead to the most conservative classification. Another advantage is that all formulated pesticides are classified in a uniform way.

2.3.2 Chronic hazard to human health

According to the explanation provided with the HHP data, the classification of active ingredients of pesticides according to their chronic hazard to human health considering carcinogenicity, mutagenicity and reproductive toxicity according to the HHP data originated from at least four different sources including three different classification systems: the Globally Harmonized System (GHS) criteria, the classification system according to Directive 67/548/EEC and the US-EPA classification on carcinogenicity. The four different sources were needed in order to gather hazard classifications for as many active ingredients as possible:

- the active ingredient has been considered to be classified as a carcinogen of category 1A or 1B according to the GHS, a mutagen or reprotoxic ("yes"),
- the active ingredient is not classified as such ("no"), or
- **the active ingredient was not evaluated by these sources ("n.e.")**.

For this study we classified chronic hazard to human health according to the following decision rules:

- **"yes"** in case the active ingredient is toxic according to at least one of the sources mentioned,
- **"no"** in case the active ingredient is not qualified as toxic according to any of the sources and the active ingredient is qualified "not toxic" according to at least one of the sources.
- **"n.e."** in case the active ingredient is neither toxic nor "not toxic" according to all sources.

2.3.3 Acute environmental hazard

The parameter used to classify the acute toxicity of active ingredients of pesticides to algae is the concentration that causes a 50% reduction in growth rate or final yield (EC50) of the test organisms in a standard algae test (usually 72h). The acute toxicity of pesticides to fish and the water flea *Daphnia* (representing aquatic invertebrates) is also expressed as acute EC50 or LC50 values (an LC50 is the concentration that kills 50% of the test organisms). The classification criteria of active ingredients according to acute toxicity to aquatic organisms is listed in Table 2. The classification was established by the US-EPA: http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm (retrieved in July 2009).

Table 2: Categories of acute toxicity to aquatic organisms (according to EPA, 2009)

LC50 or EC50 (mg/L)	Acute hazard to aquatic organisms
< 0.1	Very highly toxic
0.1 - 1	Highly toxic
1 - 10	Moderately toxic
10 - 100	Slightly toxic
> 100	Practically nontoxic

The classification of active ingredients according to their acute toxicity to bees is based on the dose per bee that kills 50% of bees (orally or by contact). The criteria for this classification are provided in Table 3. The classification originates from the 'Manual for summarizing and evaluating the environmental aspects of plant protection products' published by the Dutch National Institute for Public Health and the Environment (Mensink et al., 1995).

Table 3: Categories of acute toxicity to bees (Mensink et al., 1995)

LD50 (µg/bee)	Hazard to bees
< 0.1	Highly toxic
0.1 - 1	Toxic
1 - 10	Moderately toxic
10 - 100	Slightly toxic
> 100	Very slightly toxic

2.3.4 Environmental Toxic Load

The Environmental Toxic Load (ETL) indicator represents the average amount of toxic pressure by active ingredients of pesticides applied on one hectare of agricultural land in one year. Toxicity is mediated by the fact that only a small proportion of the pesticide volume will reach the organism. Dissipation processes like degradation and sorption are not taken into account. A similar approach has been used by Benbrook et al. (2002) and De Blécourt et al., 2010.

The ETL indicator is calculated separately for fish, *Daphnia*, algae and bees. The ETL is based on the total imported volume of active ingredients per year, the toxicity (either L(E)C50 for algae, *Daphnia* or fish or the LD50 for bees), and the total agricultural area in Mozambique. It is calculated as:

$$ETL_{yr} = \frac{\sum_{ai} \frac{V_{ai, yr}}{T_{ai}}}{A_{yr}} \quad \text{Eq. 3}$$

ETL_{yr} Environmental Toxic Load indicator value for one year
V_{ai, yr} volume of an active ingredient imported in a particular year (kg)
T_{ai} toxicity of the active ingredient; i.e. L(E)C50 of either fish, *Daphnia* or algae (mg/L), or the **LD50 of bees (µg/bee)**
A_{yr} total agricultural area in Mozambique in a particular year (ha)

The ETL cannot be used to assess the actual risk (i.e., the probability of an adverse effect on organisms) as a consequence of pesticide treatments because there is no exposure assessment involved in its calculation. For instance there is no prediction of an environmental concentration (PEC) in water that can be compared with a 'no effect concentration' for water organisms (PEC/NEC analysis). There is no thresholds of the ETL that signifies an absolute risk.

The ETL can therefore only be used to evaluate the impact of changes in relative environmental hazards between pesticides and between years. Furthermore, since toxicity data for bees (LD50) are **expressed on the basis of µg/bee the ETL for bees cannot be compared to the ETL values for the aquatic organisms for which the toxicity (LC50 or EC50) is expressed in mg/L**. However, since the same units for toxicity are used for algae, *Daphnia* and fish, **it is justified to compare ETL's between these aquatic organisms**. For instance it is possible to indicate if the pesticide import in Mozambique in a given year poses a higher overall potential hazard to algae than to fish. If the ETL for algae equals 10 and the ETL for fish equals 1000 in a certain year, the overall hazard of the pesticide import in Mozambique is 100 times greater for fish than for algae.

2.3.5 Groundwater leaching potential

The Groundwater Ubiquity Score or GUS (Gustafson, 1989) is an indication of the potential of the active ingredient of a pesticide to reach the groundwater before it is degraded. The GUS is an empirically derived value that relates to the persistence and sorption to soil organic matter of the active ingredient. The GUS index is calculated as follows

$$GUS = \log (DegT50_{soil}) \cdot (4 - \log K_{oc}) \quad \text{Eq. 4}$$

GUS potential of an active ingredient to reach the groundwater (-)
DegT50_{soil} degradation half-life in soil (d)
K_{oc} organic carbon sorption coefficient (L/kg).

The pesticide leaching potential is derived from the GUS. The ratings of active ingredients of pesticides range from very low to very high. The criteria are set out in Table 4.

Table 4: categories of groundwater leaching potential based on the GUS index.

GUS	Class	Groundwater leaching potential
< 1.0	1	Very low
1.0 – 2.0	2	Low
2.0 – 3.0	3	Moderate
3.0 – 4.0	4	High
> 4.0	5	Very high

2.4 Pesticides of concern

After the indicators were calculated and the analyses were done, criteria were established to select pesticides of concern. These are the pesticides that represent both an high hazard to human health and/or to the environment and that are imported in relatively large quantities in Mozambique for several years. The aim of this classification is to identify those pesticides and pesticide products for which the biggest gain in terms of reducing overall hazard to human health and/or the environment can be achieved by measures such as reducing their use in the country.

We distinguish two categories: 1) pesticides of primary concern, i.e., pesticides that contribute to a very large extent to the indicator values and that really stand out, and 2) pesticides of secondary concern that also contribute significantly but in a less dominant way. Both categories of pesticides are suitable to realise reductions of overall hazards by specific measures.

The criteria are applied per indicator or per group of indicators. This means that the pesticides of concern only stand out against other pesticides for a particular hazard. The overall hazard of imported hazards may be much bigger for, say, aquatic organisms than for human health, but such comparisons cannot be made based on the type of indicators that were used.

The criteria that were applied are listed on the following page.

Acute human health hazard (WHO classification of formulated products)

Primary concern:	All active ingredients occurring in WHO Class I formulated products imported from 2002 to 2011.
Secondary concern:	Active ingredients occurring in WHO Class II formulated products of which the imported volume (of formulated products) constitutes >5% of the total annually imported volume in 2 years or more.

Chronic human health

Primary concern:	Carcinogenic, mutagenic or reprotoxic active ingredients of which the imported quantity of a.i. constitutes >5% of the total quantity of annually imported a.i. in 2 years or more.
Secondary concern:	Carcinogenic, mutagenic or reprotoxic active ingredients of which the imported quantity of a.i. constitutes >1% of the total quantity of annually imported a.i. in 1 year or more.

Environmental Toxic Loads (fish, aquatic invertebrates, algae, bees)

Primary concern:	Active ingredients of which the imported quantity of a.i. constitutes >50% of the total annual ETL value in 2 years or more.
Secondary concern:	Active ingredients of which the imported quantity of a.i. constitutes >10% of the total annual ETL value in 1 year or more.

Groundwater Ubiquity Score (GUS)

Primary concern:	GUS class 5 active ingredients of which the imported quantity of a.i. constitutes >1% of the annual GUS index value in 2 years or more. And/or GUS class 4 active ingredients of which the imported quantity of a.i. constitutes >2% of the annual GUS index value in 2 year or more.
Secondary concern:	GUS class 5 active ingredients of which the imported quantity of a.i. constitutes >0.5% of the annual GUS index value in 1 year or more. and/or GUS class 4 active ingredients of which the imported quantity of a.i. constitutes >1% of the annual GUS index value in 1 year or more.

3 Results

3.1 Agricultural statistics

The dynamics in the total agricultural area in Mozambique according to FAOSTAT data (<http://faostat3.fao.org/>; accessed on July 1, 2013) are shown in Figure 1. The total agricultural area increased with 1,4% during the study period (2002-2011), i.e., from 48,7 million ha in 2002 to 49,4 million ha in 2011.

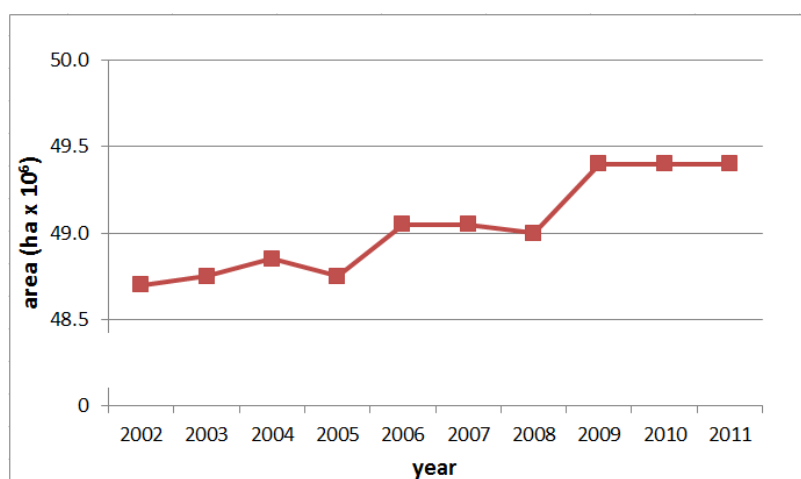


Figure 1: Total agricultural area in Mozambique in the years 2002 – 2011 (<http://faostat3.fao.org/>).

The total agricultural production according to FAOSTAT data (<http://faostat3.fao.org/>; July 1, 2013) is shown in Figure 2. These figures were calculated as the sum of eleven aggregated items¹. The total agricultural production increased with 40% from 9,9 million tonnes in 2002 to 13,9 million tonnes in 2011. Because the cultivated area in the country did hardly increase over this period, it can be concluded that agriculture in Mozambique must have considerably intensified during this period.

¹ Cereals, Total; Citrus Fruit, Total; Coarse Grain, Total; Fibre Crops Primary; Fruit excl Melons, Total; Jute & Jute-like Fibres; Oilcrops Primary; Pulses, Total; Roots and Tubers, Total; Treenuts, Total; and Vegetables Primary.

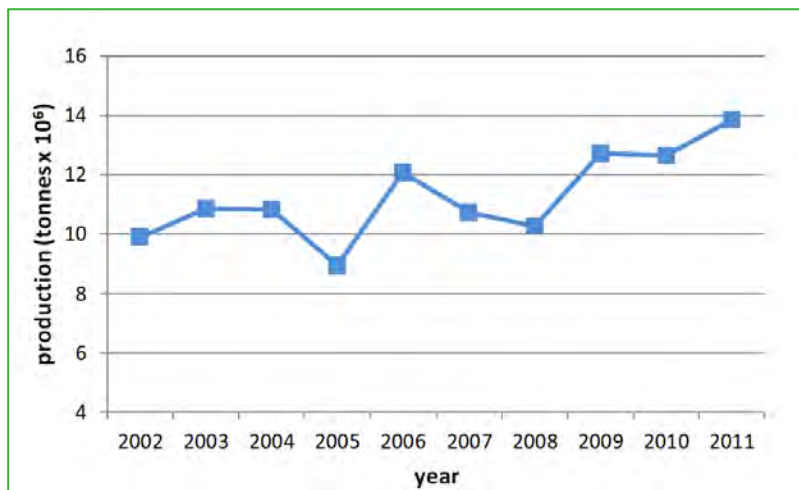


Figure 2: The total agricultural production in Mozambique in the years 2002 – 2011 (<http://faostat3.fao.org/>).

3.2 Pesticide imports

This section provides insights into trends in pesticide imports into Mozambique from 2002 to 2011. Trends are shown in the annual numbers and types (Section 3.2.1), the volume (Section 3.2.2) and the monetary value of imported pesticides (Section 3.2.3). In addition, the volume and the monetary value of imported pesticides are presented per unit of agricultural land and per unit weight of harvested product.

The Import data contain a relatively small number of import events for the first year, 2002. It seems logical that the dataset for this year is incomplete, but the authors have not received a confirmation of this. Since we cannot be entirely sure that the data of 2002 are representative for the entire year, we have decided to include the year 2002 in the graphs and tables but not to discuss the results for this particular year each time indicator values are lower compared to the other years.

3.2.1 Imported numbers of pesticides

Products

The annual number of formulated pesticide products imported is shown in Figure 3. The number fluctuates slightly and increases from 115 in the year 2003 to 157 in the year 2011.

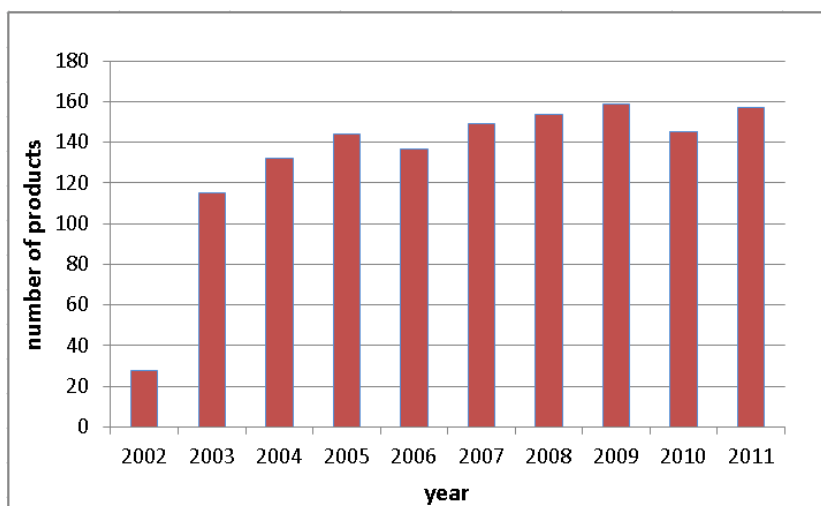


Figure 3: The annual number of formulated pesticide products imported in the years 2002 – 2011.

Product groups

The distribution of formulated pesticide products among the eight functional pesticide groups is shown in Figure 4. Insecticides constitute the major product group in all years, followed by herbicides and fungicides.

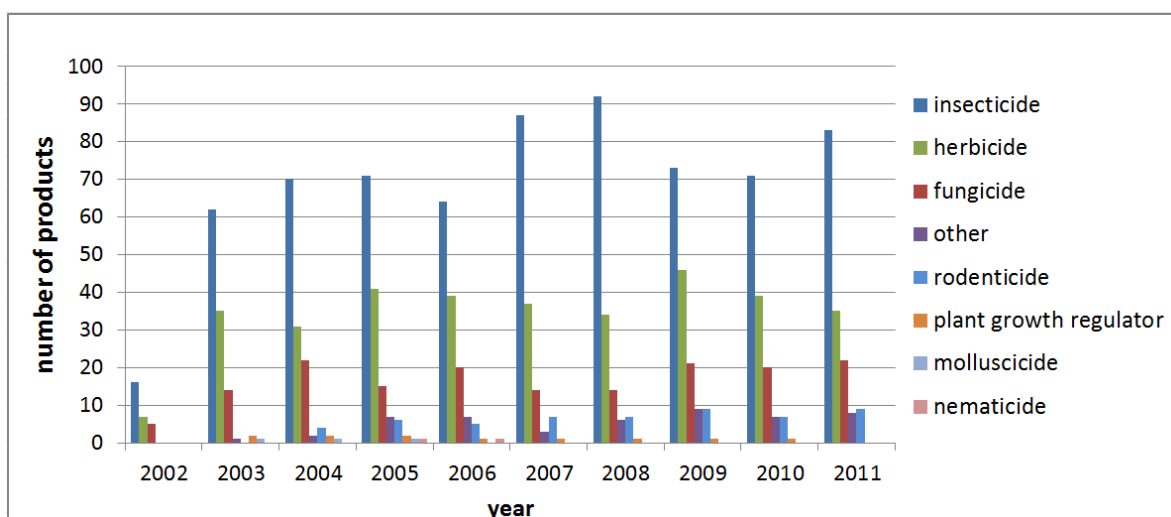


Figure 4: The number of formulated pesticide products per functional pesticide group imported yearly from 2002 to 2011.

Active ingredients

The formulated pesticide products imported in the period 2002-2011 contain 175 active ingredients assigned to 72 different chemical classes. The chemical classes with the largest number of active ingredients are the organophosphates (19 active ingredients), pyrethroids (16), carbamates (9), inorganic compounds (9), biopesticides (8), unclassified compounds (8), triazines (8) and triazoles (6). The annual number of chemical classes of active ingredients in the imported pesticides is shown in Figure 5. The numbers of the types of pesticides imported in the country increased up to 2005 and the fluctuated between c. 45 and 55.

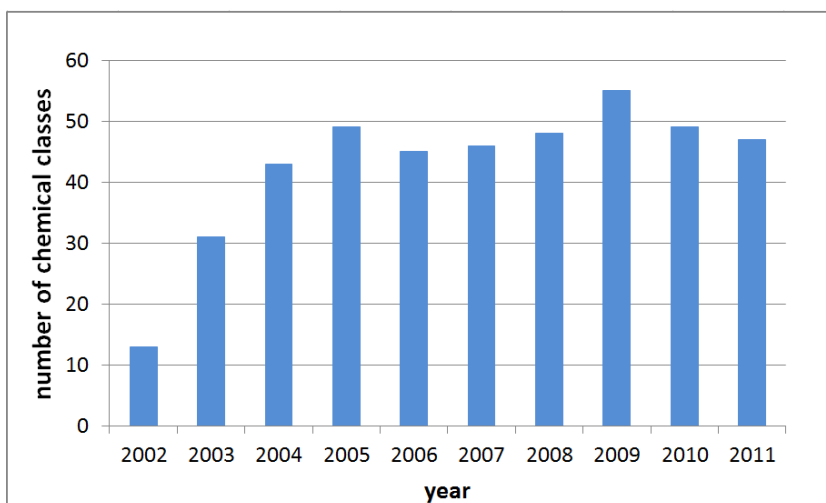


Figure 5: The number of chemical classes of the active ingredients imported annually in the years 2002 – 2011.

Importers

The annual number of active pesticide importers in Mozambique is shown in Figure 6. The numbers increase from 2002 to 2004, but decline in 2005 and 2006. From 2007 onwards the number increases again and the maximum number of importers is reached in the year 2010. Forty-four different importers were identified based on the Import data. The number of imported pesticide products per major importer is shown in Figure 7.

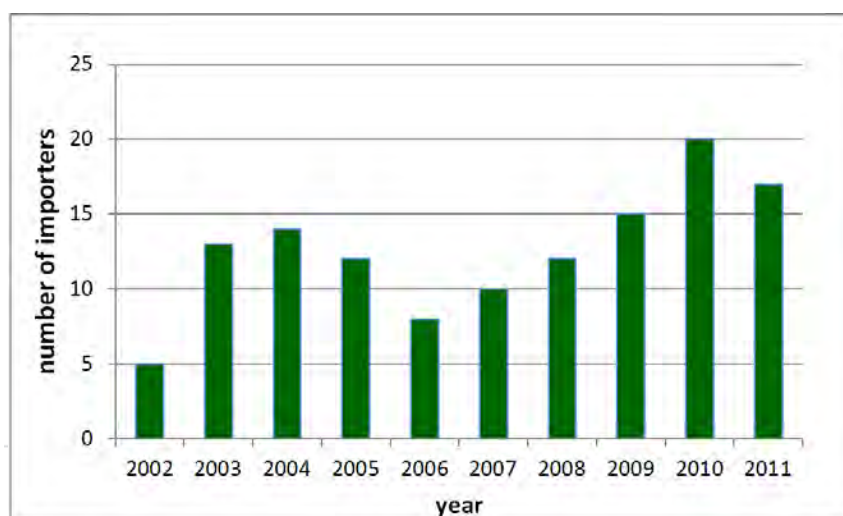


Figure 6: The number of pesticide importers responsible for the yearly imports from 2002 to 2011.

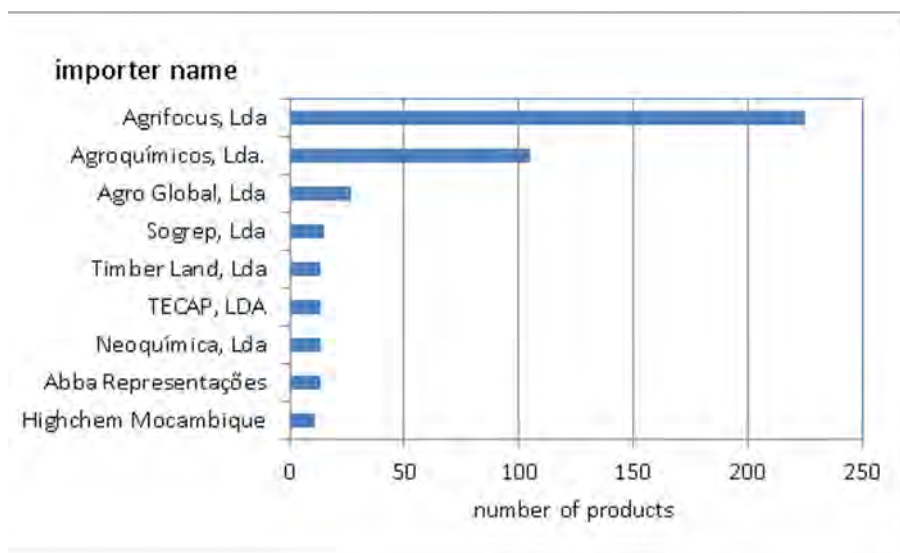


Figure 7: The total number of products imported by the major importers in the period 2002-2011.

3.2.2 Imported pesticide volume

Products

The annual volume of imported pesticides is shown in Figure 8. The imported volume increases until the year 2006. In the next year, 2007, the volume decreases by 37% to 1278 tonnes. As from 2008, the volume increases again to 2592 tonnes in the year 2011.

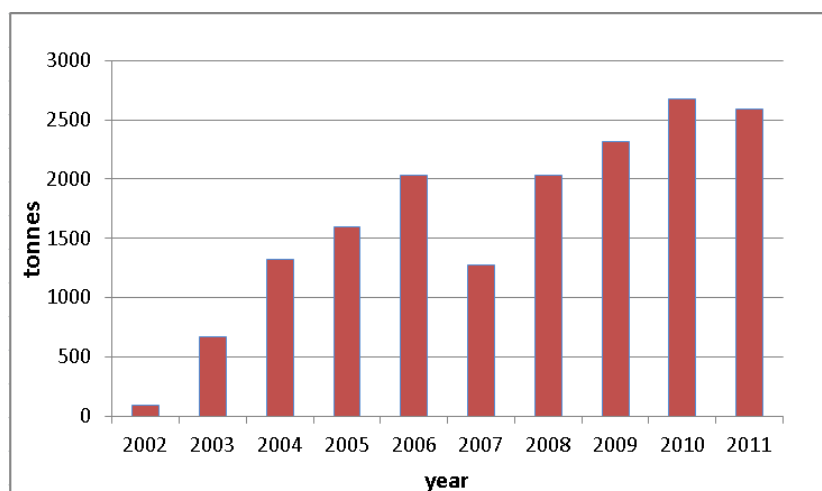


Figure 8: The annual volume of imported pesticide products in the years 2002 – 2011 (tonnes).

The volume of imported pesticides corrected for the total agricultural area (Figure 1) is shown in Figure 9, expressed in kg pesticides per hectare agricultural land. Because the total cultivated area changed only little during the study period, the pattern in Figure 9 is the same as in Figure 8.

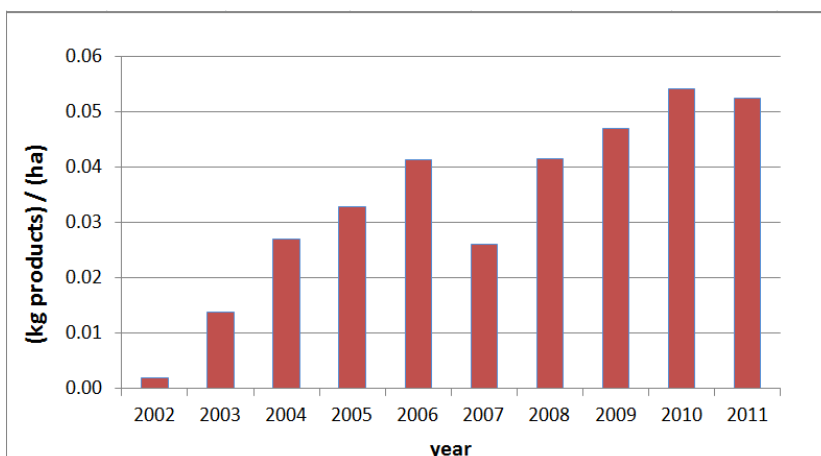


Figure 9: The annual volume of imported products corrected for the total agricultural area in the years 2002 – 2011 (kg/ha).

The volume of imported pesticides corrected for the total agricultural production (Figure 2) is shown in Figure 10. In the year 2007, the corrected volume of imported products decreases with 29% to 0.12 kg per ton harvested products. The figure clearly shows that although the total pesticide import per hectare in Mozambique is increasing (Figure 9), the pesticide import per tonne of harvested produce has been more or less constant from 2008 to 2011.

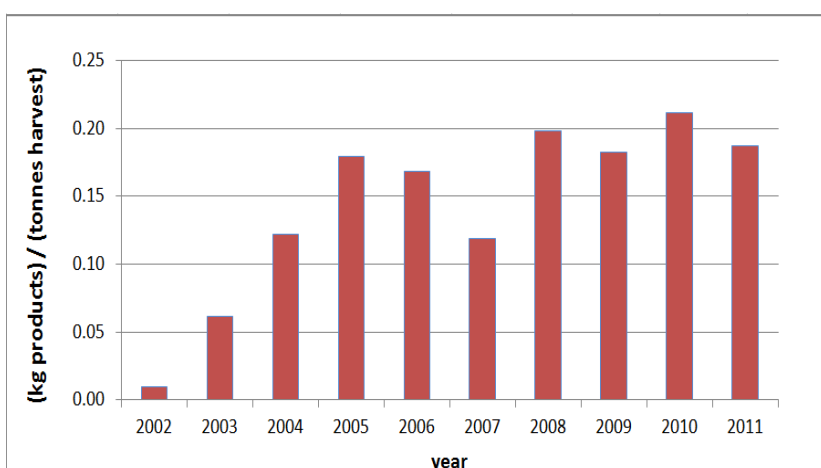


Figure 10: The annual volume of imported products corrected for the total agricultural production in the years 2002 – 2011 (kg products imported per ton of harvested products).

Product groups

The annual volume of imported products belonging to the eight functional groups is shown in Figure 11. Insecticides and herbicides constitute the major groups, followed by fungicides. The total amount of imported formulated pesticides increases in the first half of the decade and shows a dip in 2007. From 2008 to 2011 it is approximately the same. The annual volumes of insecticides and herbicides are more or less equal except in the years 2006 and 2008. In these two years, the volume of insecticides exceeds the volume of herbicides by some 50%.

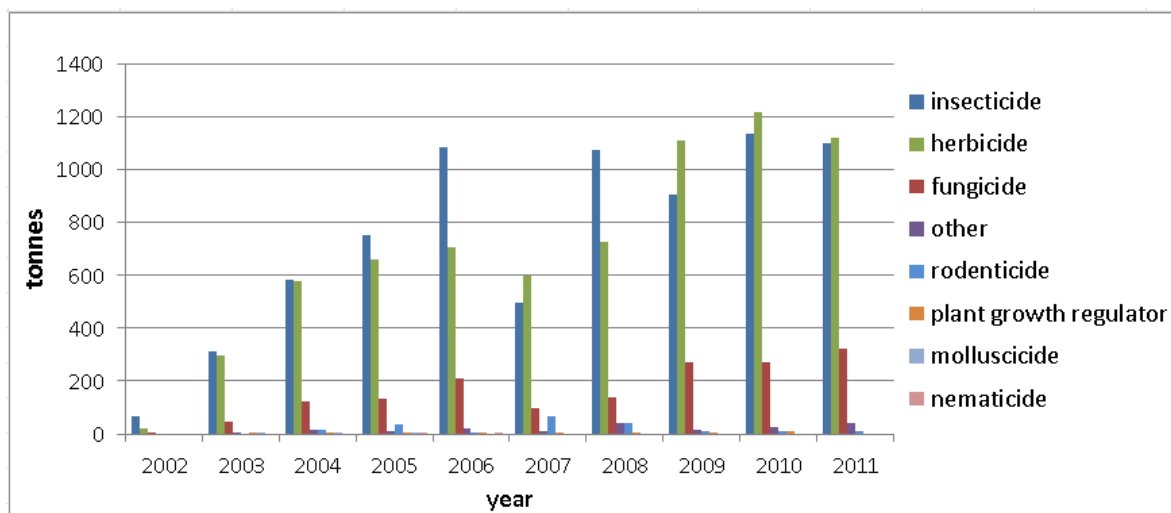


Figure 11: The annual volume per imported product group in the years 2002 – 2011 (tonnes)

The volume of imported pesticides belonging to the eight functional groups corrected for the total agricultural area (Figure 1) is shown in Figure 12. This parameter shows the same pattern as the uncorrected import data in Figure 11.

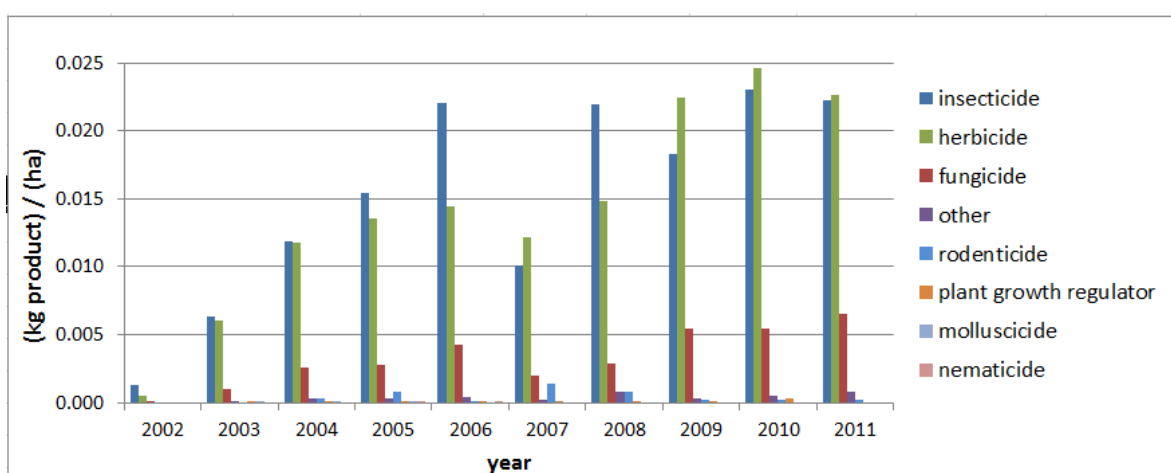


Figure 12: The annual volume per imported product group corrected for the total agricultural area in the years 2002 – 2011 (kg product/ ha)

The volume of imported pesticides corrected for the total agricultural production (Figure 2) is shown in Figure 13. The imports corrected for production still show the same pattern. A slight difference is that insecticide imports peak in 2008 instead of 2010.

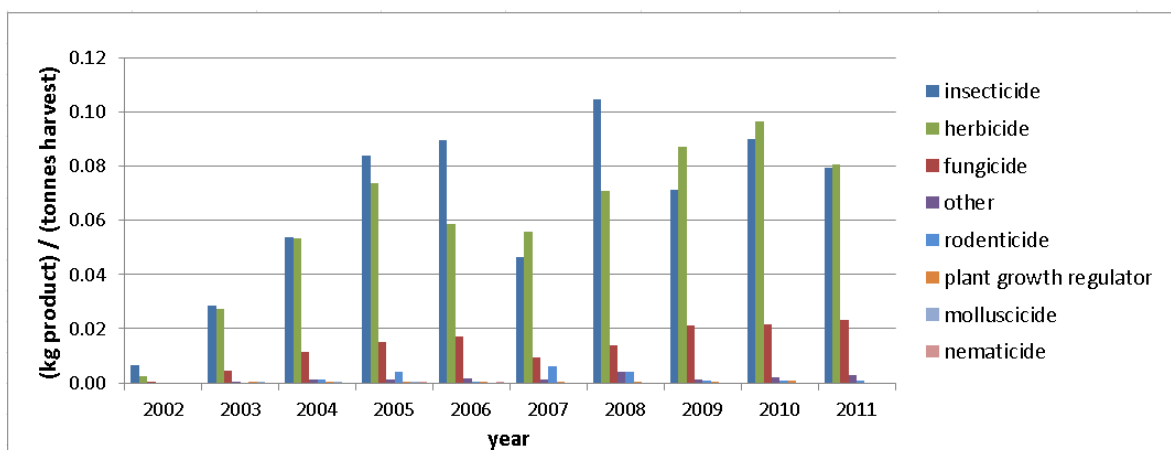


Figure 13: The annual volume per imported product group corrected for the total agricultural production in the years 2002 – 2011 (kg product / tonnes harvest)

Active ingredients

The annual volume of active ingredients per chemical class are shown in Figure 14. These are the major chemical classes based on the total volumes of products imported in the entire period 2002-2011. The volume of active ingredients in the chemical class of organochlorine compounds almost entirely consists of DDT (89% in the year 2005, 97% in 2006, and 100% in 2008). According to the Import data, DDT was only imported in these three years. There are conspicuous peaks in its import in 2006 and 2008, i.e., more DDT was imported than any other class of active ingredients. Endosulfan is the only other active organochlorine ingredient imported in the 10-year period. Another group of active ingredients that are reportedly imported in relative large quantities are the arsenates. Imports of these compounds keep on increasing from 2002 to 2011.

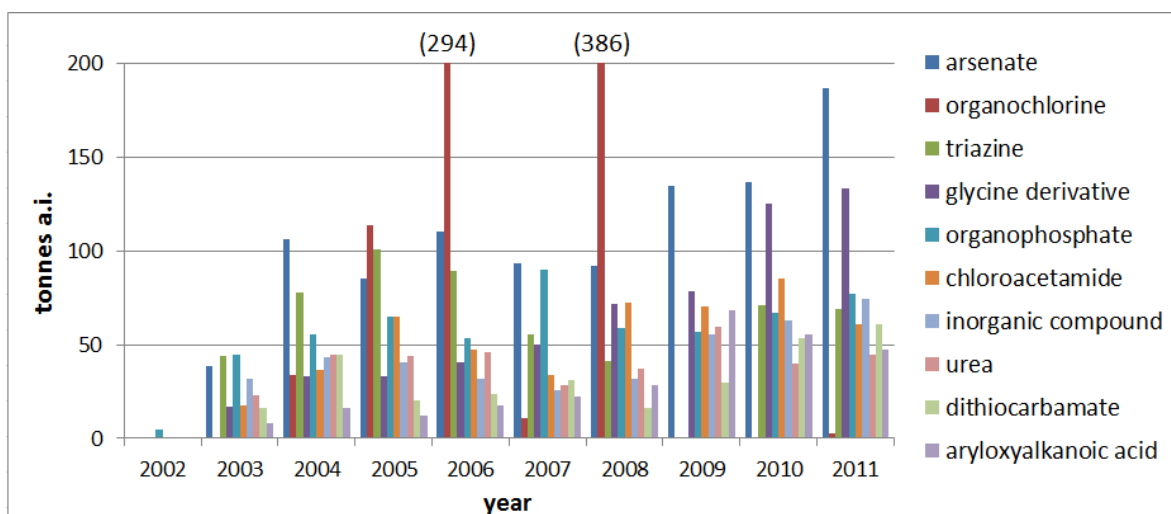


Figure 14: The annual volume per chemical class of active ingredients imported in the years 2002 – 2011 (in tonnes a.i.)

Importers

The five major importers in terms of their contribution to the total volume of imported products in the period 2002-2011 are shown in Figure 15. Agrifocus Lda is the major importer with almost 70% of the total volume of imported products in the entire period 2002-2011. The contributions of importers Agrifocus Lda and Sogrep Lda cover the entire period, whereas Abba Representações covers the years 2003-2011, Agroquímicos Lda covers the years 2002-2010, and Medimoc SA covers the years 2002-

2009. Contrary to these major importers, the majority of the other importers only contribute to the imported volume in one or two years over the 10-year period.

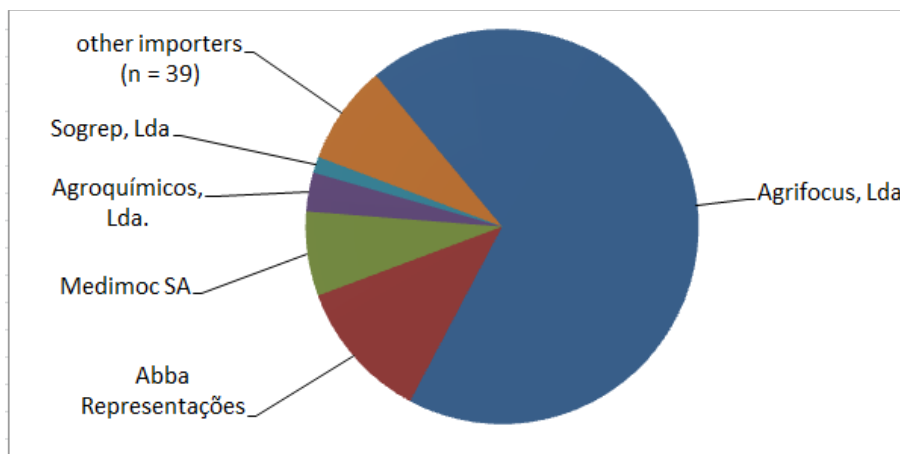


Figure 15: The five major pesticide importers according to the total volume of imported products in the period 2002-2011.

3.2.3 Monetary value

The monetary value of the imported quantity in the Import data is expressed in Metical or New Metical. In order to prepare the graphs and figures in this section, the monetary values in Metical (the years 2002 – 2005 and part of 2006) were converted into New Metical (1 Metical = 0.001 New Metical). The number of import events, the average price per L (or per kg) and the total monetary value of the imported product are shown in Table 5.

Table 5: The annual number of import events with the average price (in New Metical per L or per kg imported product)

Year	Number of import events	Average price per L or per kg in New Metical	Day rate US Dollar	Average price per L or per kg in US dollars	Total value of imports in New Metical (million)	Total value of imports in US dollar
2002	41	22	24.19	0.91	6.3	0.26
2003	263	100	24.02	4.17	115.2	4.80
2004	430	104	21.67	4.80	208.9	9.64
2005	493	112	26.68	4.20	309.5	11.60
2006	494	81	25.23	3.21	289.2	11.47
2007	431	123	25.79	4.77	202.7	7.30
2008	487	108	24.54	4.40	304.0	12.39
2009	563	191	27.40	6.96	459.6	16.78
2010	578	152	34.52	4.41	601.3	17.42
2011	590*	159	27.19	5.85	422.6	15.55

*For this year some import events were merged. Calculations were based on 461 import records.

Products

The annual monetary value of imported pesticides is shown in Figure 16 (in millions New Metical). The value of the imported pesticide products increases over the years with a dip in 2007 and a maximum in 2010. The annual value of imported pesticides corrected for the total agricultural area (Figure 1) is shown in Figure 17 (expressed in New Metical per hectare agricultural land) and the annual value of

imported pesticides corrected for the total agricultural production (Figure 2) is shown in Figure 18. The patterns for these corrected import data are comparable to the uncorrected imports.

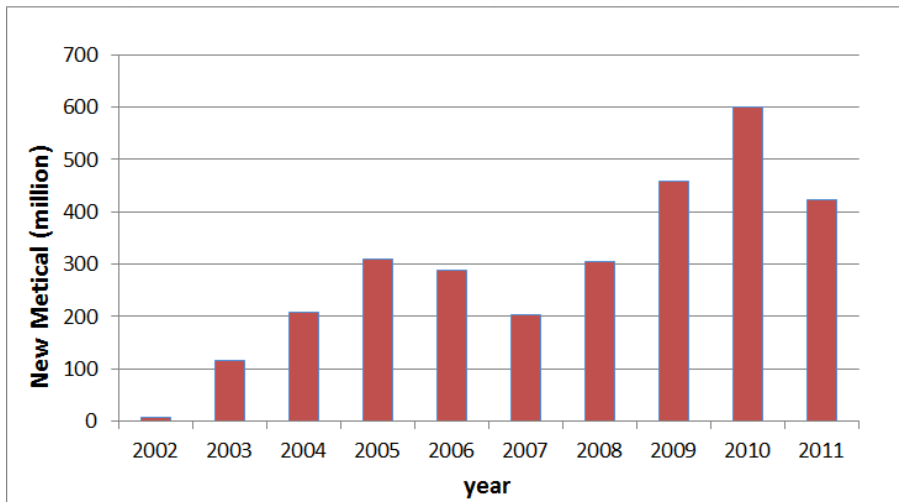


Figure 16: The annual value of imported products in the years 2002 – 2011 (million New Metical)

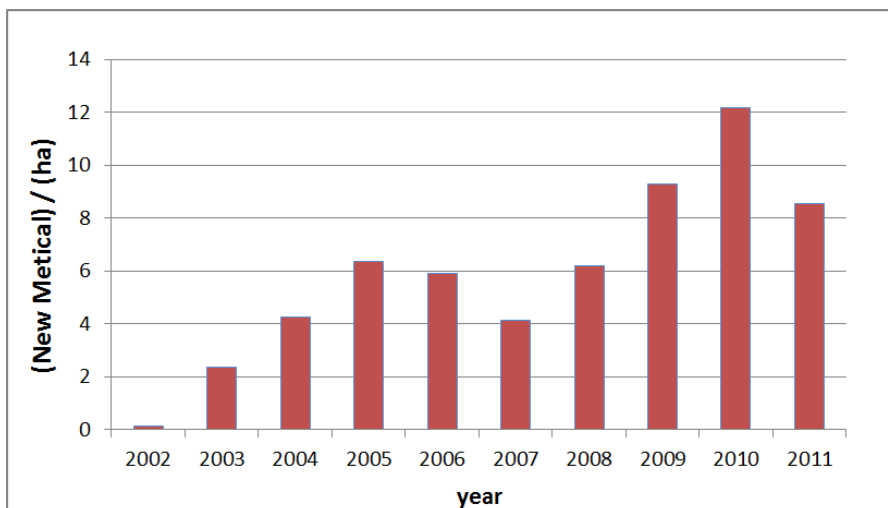


Figure 17: The annual value of imported products corrected for the total agricultural area in the years 2002 – 2011 (New Metical/ha)

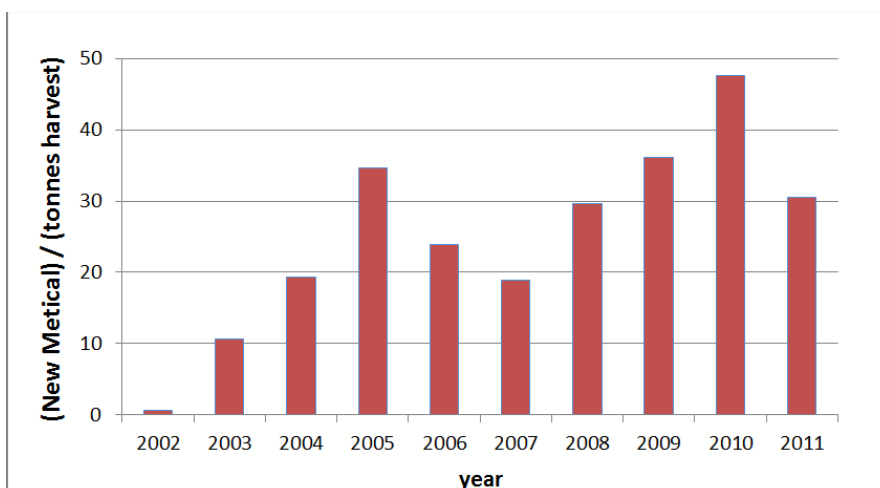


Figure 18: The annual value of imported products corrected for the total agricultural production in the years 2002 – 2011 (New Metical per ton harvested products)

Product groups

The annual value of imported products belonging to the major functional groups is shown in Figure 19. Imported insecticide products represent the highest imported value, followed by herbicides and fungicides. Since the imported volumes of insecticides and herbicides are comparable, imported insecticides must be more expensive than herbicides on average.

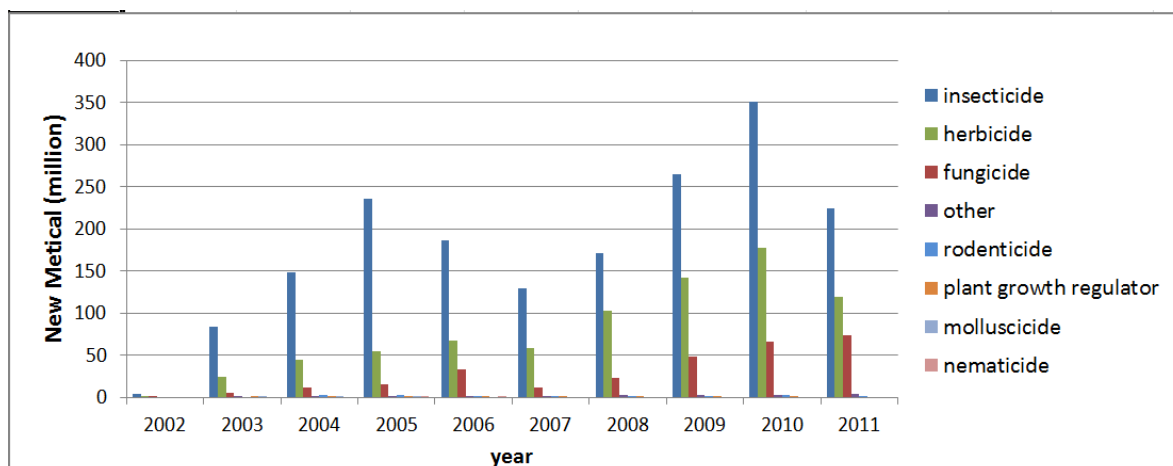


Figure 19: The annual monetary value per imported product group in the years 2002 – 2011 (million New Metical)

Importers

The five major importers according to the contribution to the total value of imported products in the period 2002-2011 are shown in Figure 20. These are also the importers with the major contribution in terms of volume (Figure 15).

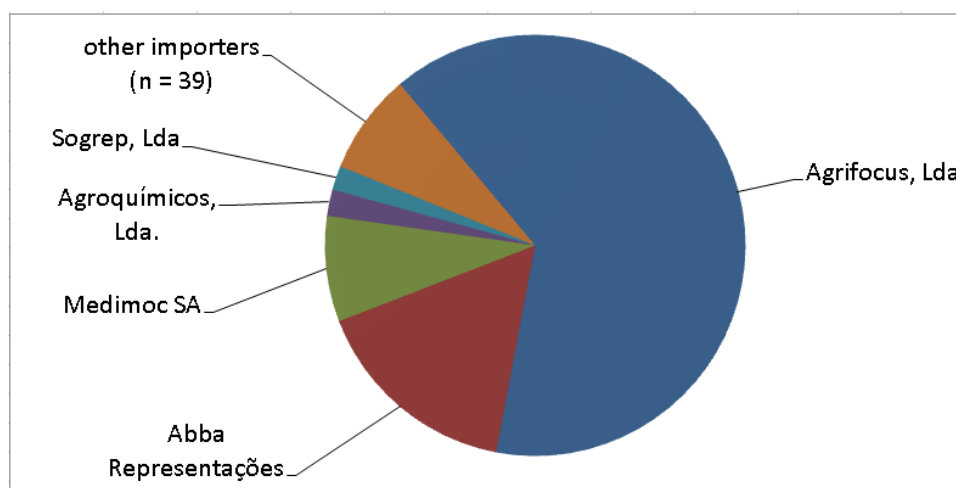


Figure 20: The five major pesticide importers according to the total value of imported products in the period 2002-2011 (in New Metical).

3.3 Acute hazard to human health

The classification of acute hazard to human health is made on a product basis according to Equations 1, 2 and the class boundaries shown in Table 1. The annual number of pesticide products per WHO

Class of acute hazard to human health is shown in Figure 21. Over the study period no products of the highest hazard class were imported (Ia, Extremely hazardous). The number of imported Highly hazardous pesticide products remains constant over the years at approximately 10 pesticides per year. The number and fraction of imported pesticide products unlikely to represent an acute hazard steadily increases over the ten years.

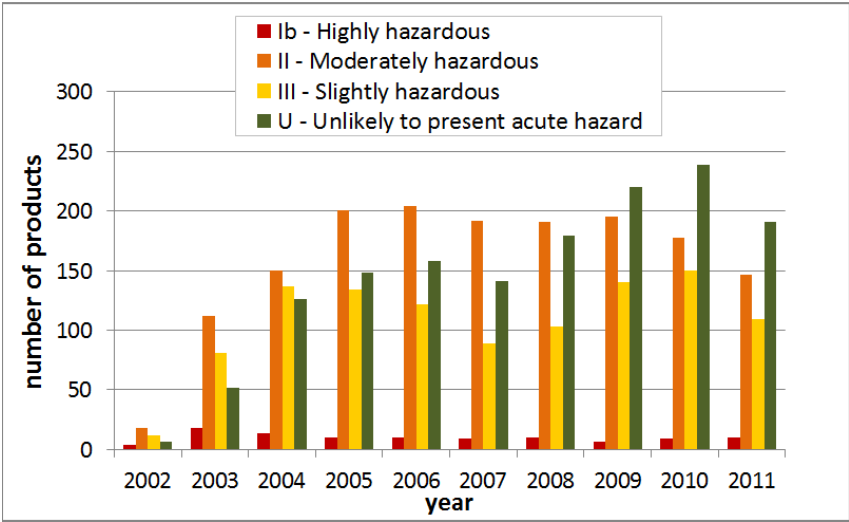


Figure 21: The annual imported number of pesticide products per WHO Class of acute hazard to human health in the period 2002-2011.

The annual volume of pesticide products per WHO Class of acute hazard to human health is shown in Figure 22. This graphs more clearly shows that fraction of imported volumes of moderately hazardous pesticides (Class II) of the total imported volume decreases whereas the fraction unlikely to present a hazard increases.

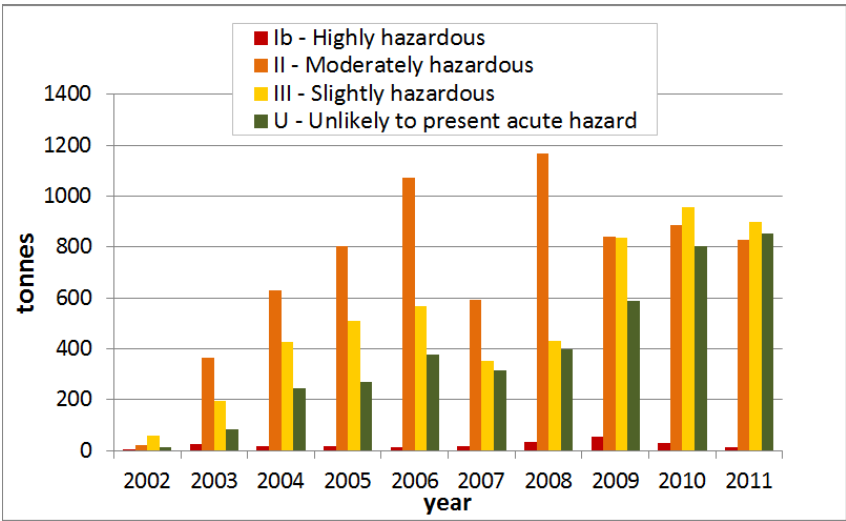


Figure 22: The annual volume of imported products per WHO Class of acute hazard to human health in the period 2002-2011 (tonnes).

In Table 2.1 in Annex 2 the imported pesticide products in WHO class Ib and II for each year are provided. The imported products in these classes change from year to year, but it can be seen that many of the Class Ib products contain only a few active ingredients under varying product names (also see Annex 5): abamectin (trade names: Agrometic, Moz Abamec Plus, Volcano), aldicarb (Temik, Volcano), aluminium phosphide (Moz Aluminium phoshide, Phosgard, Fumaphos, Falfume, Quickphos,

Volcano), fenamiphos (Nemacur, Volamiphos), Methomyl (Kuik), mevinphos (Universal), monocrotophos (Universal, Phoskill), oxamyl (Villa Platoon, Vydate) and terbufos (Rotam, Bongo). These pesticides of primary concern do only represent a small percentage of the yearly imports in Mozambique (<2% per product per year). Furthermore, the Class II products (moderately hazardous) representing >5% of total annual imports in two years or more (secondary concern) contained ametryn, DDT and lambda-cyhalothrin.

3.4 Chronic hazard to human health

The annual numbers and the volumes of imported pesticide per class of chronic hazard to human health are presented on active ingredient basis. The classification of chronic hazard to human health is taken from the Registered pesticide data (Section 2.3.2).

3.4.1 Carcinogenicity

The annual number of active ingredients per class of carcinogenicity is shown in Figure 23. The number of active ingredients in GHS Category 1A or 1B is less than ten per year and the majority of imported active ingredients are non-carcinogenic.

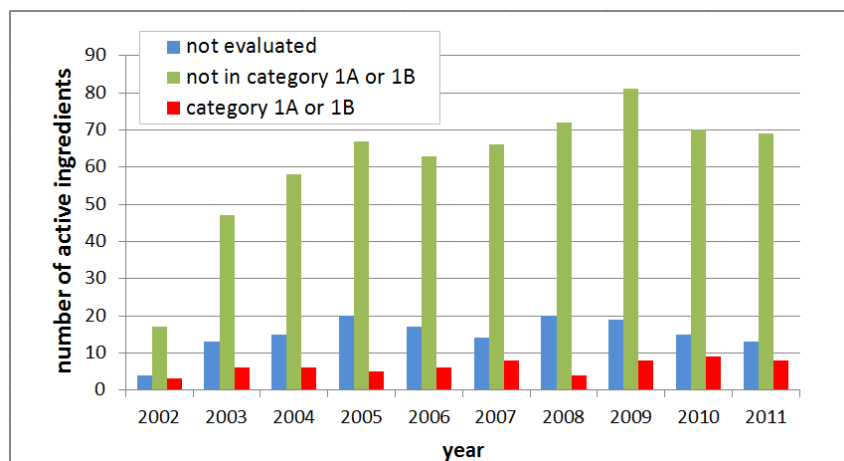


Figure 23: The annual number of imported active ingredients per class of carcinogenic hazard in the period 2002-2011.

The annual volume of active ingredients per class of carcinogenic hazard is shown in Figure 24. This graphs presents a slightly different picture than Figure 23. A relatively large volume of imported active ingredients is not evaluated in terms of carcinogenicity, especially those imported in 2006 and 2008. The imported amount of a.i. in GHS Category 1A or 1B is around 100 tonnes a year.

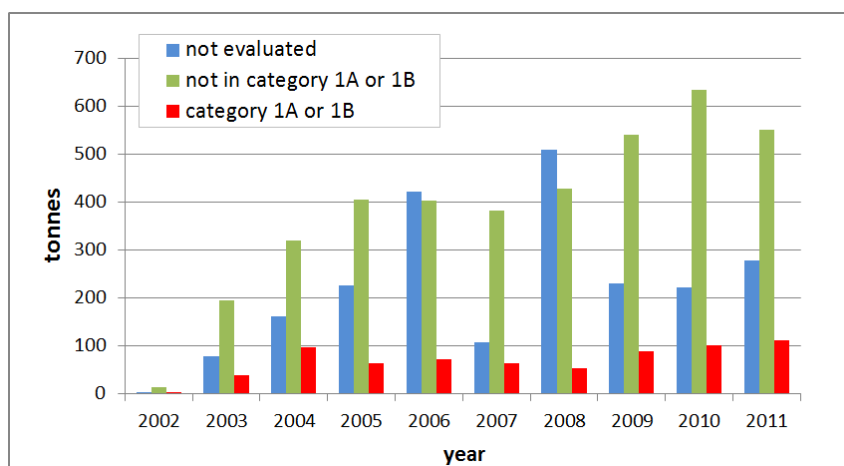


Figure 24: The annual volume of imported active ingredients per class of carcinogenic hazard in the period 2002-2011 (tonnes).

In Table 2.2 in Annex 2 the carcinogenic active ingredients that were imported in Mozambique are summarised. Carcinogenic active ingredients of primary concern (>5% in two years or more) are diuron (trade names: Diuron, Acticide, Rocima, Volcano) and mancozeb (>10 formulated products and trade names, see Annex 5 for the complete list). One carcinogenic active ingredient constituted >1% of the imports in one year, dichlorvos. This a.i. is of secondary concern.

3.4.2 Mutagenicity

The annual number of active ingredients per class of mutagenic hazard is shown in Figure 25. Only very few mutagenic active ingredients are imported in Mozambique. The majority of imported a.i. is non-mutagenic and for some substances there is no information.

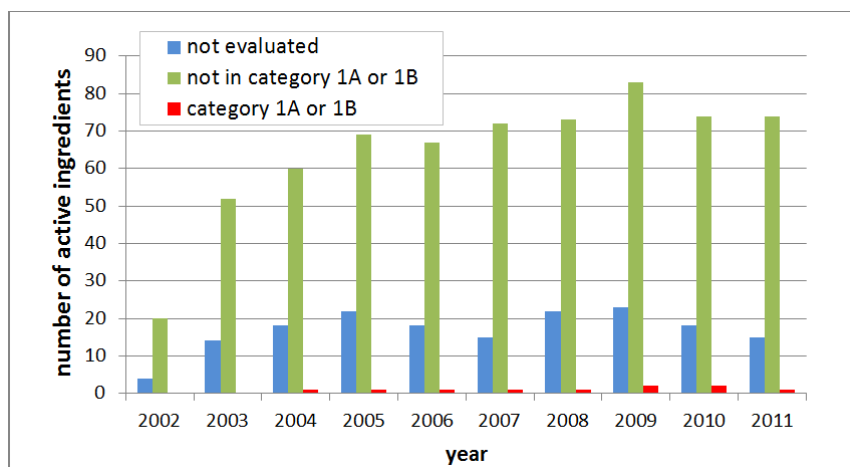


Figure 25: The annual number of imported active ingredients per class of mutagenic hazard in the period 2002-2011.

The annual imported volume of active ingredients per class of mutagenic hazard is shown in Figure 26. In terms of imported quantities, mutagenic active ingredients are almost negligible. As for the carcinogens, in 2006 and 2008 relative large volumes of active ingredients imported for which there is no information on their mutagenicity.

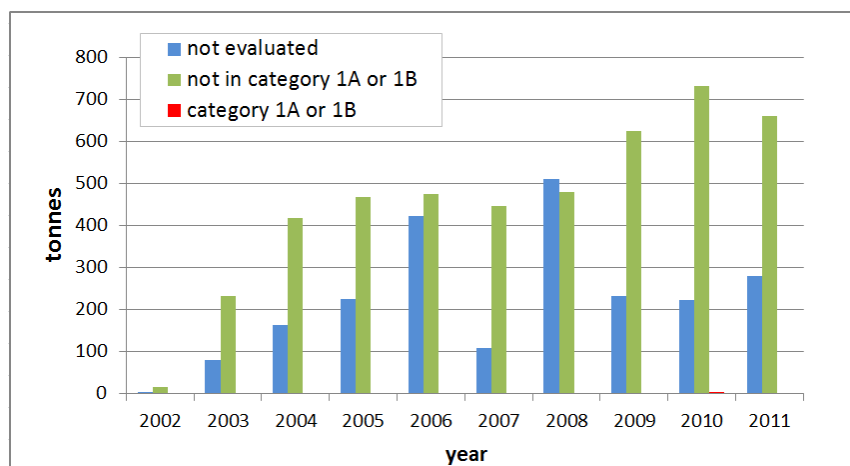


Figure 26: The annual volume of imported active ingredients per class of mutagenic hazard in the period 2002-2011 (tonnes).

In Table 2.3 in Annex 2 the mutagenic active ingredients that were imported in Mozambique are summarised. Only two active ingredients occur in this table, benomyl and carbendazim. They are not imported in Mozambique in large quantities (0.3% of total yearly imported volume or less) and are not compounds of primary or secondary concern according to the criteria used.

3.4.3 Toxicity to reproduction

The annual number of active ingredients per hazard class of reproductive toxicity is shown in Figure 27. Only very few a.i. that are toxic to reproduction are imported.

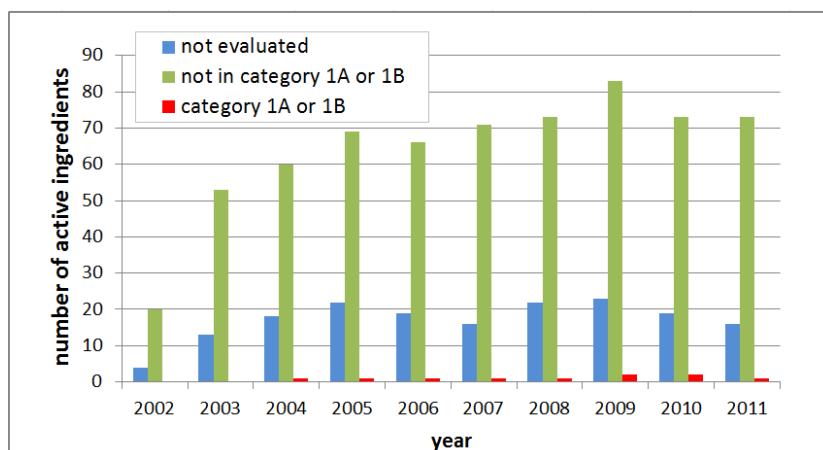


Figure 27: The annual number of imported active ingredients per hazard class of reproductive toxicity in the period 2002-2011.

The annual volume of active ingredients per hazard class of reproductive toxicity is shown in Figure 28. Again, almost no reproductively toxic a.i. are imported in Mozambique, but in 2006 and 2008 relative large volumes of active ingredients imported for which there is no information on reproductive toxicity.

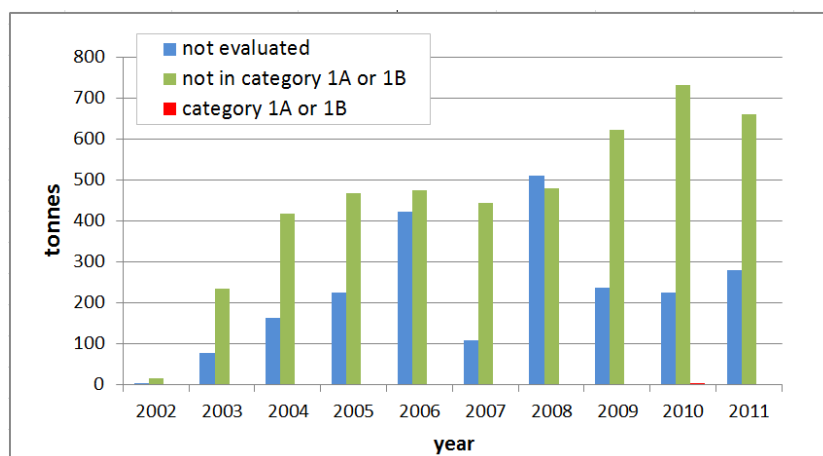


Figure 28: The annual volume of imported active ingredients per hazard class of reproductive toxicity in the period 2002-2011 (tonnes).

Table 2.4 in Annex 2 summarises the active ingredients that were imported in Mozambique and that are toxic to reproduction. The compounds in this table are the same as the mutagenic compounds (Table 2.3 in Annex 2): benomyl and carbendazim. These are not of primary or secondary concern (see §3.4.2).

3.5 Acute environmental hazard

The numbers and volumes per environmental hazard class are presented on active ingredient basis.

3.5.1 Fish

The annual number of imported active ingredients per fish toxicity class is shown in Figure 29. The graph shows that the active ingredients imported in Mozambique are relatively toxic to fish. More than half of the a.i. is moderately to highly toxic to fish and the relative numbers change little from 2002 to 2011.

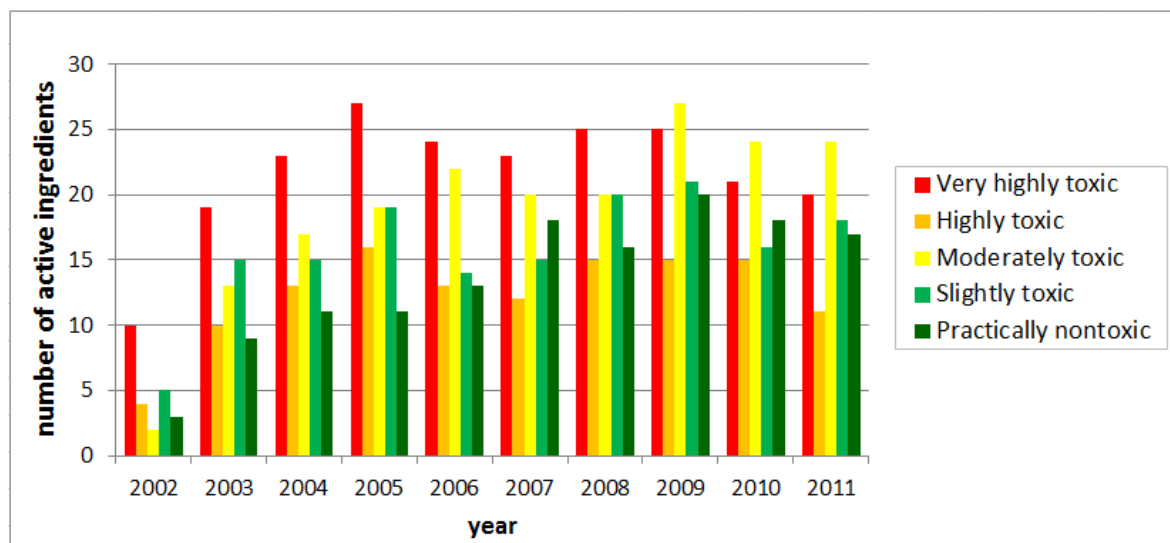


Figure 29: The annual number of imported active ingredients per fish toxicity class in the period 2002-2011.

The annual volume of active ingredients per fish toxicity class is shown in Figure 30. This image is different from Figure 29. Here, it can clearly be seen that imported volume of active ingredients that is only slightly or practically non-toxic to fish increases over the years. In 2011 more than half of the imported volume of a.i. belongs to these two classes. In 2005, 2006 and 2008 peaks can be observed for the imported volumes of a.i. that are moderately toxic to fish. These are caused by the relatively high amounts of DDT imported in Mozambique in those years.

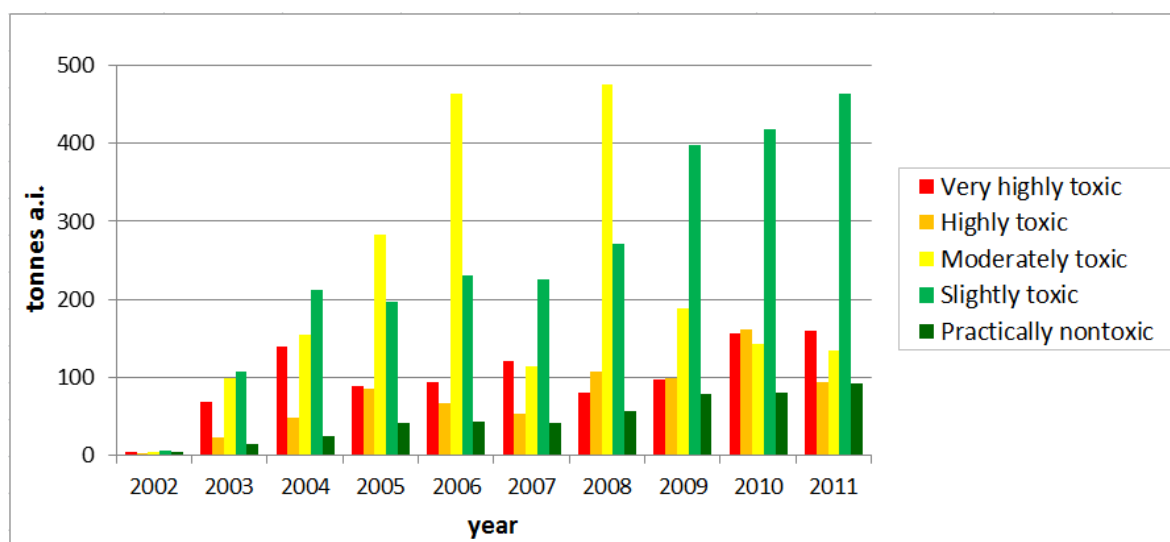


Figure 30: The annual volume of imported active ingredients per fish toxicity class in the period 2002-2011 (tonnes).

3.5.2 Aquatic invertebrates

The annual number of active ingredients per *Daphnia* toxicity class is shown in Figure 31. Many imported active ingredients are toxic to *Daphnia* and thus to aquatic invertebrates. The relative numbers of imported that are toxic change little over time.

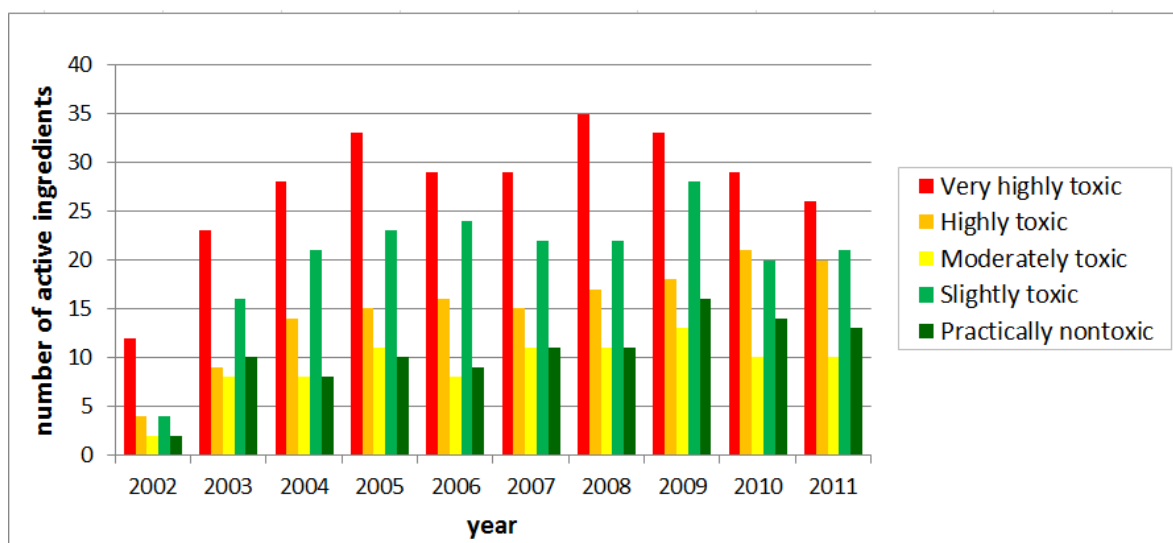


Figure 31: The annual number of imported active ingredients per *Daphnia* toxicity class in the period 2002-2011.

The annual volume of active ingredients per *Daphnia* toxicity class is shown in Figure 32. Expressed as imported volumes of a.i., the fractions highly and very highly toxic a.i. are lower, with the exception of the two familiar peaks in 2005, 2006 and 2008 (DDT). Over the years the relative imported volume of compounds that are slightly or practically non-toxic increases.

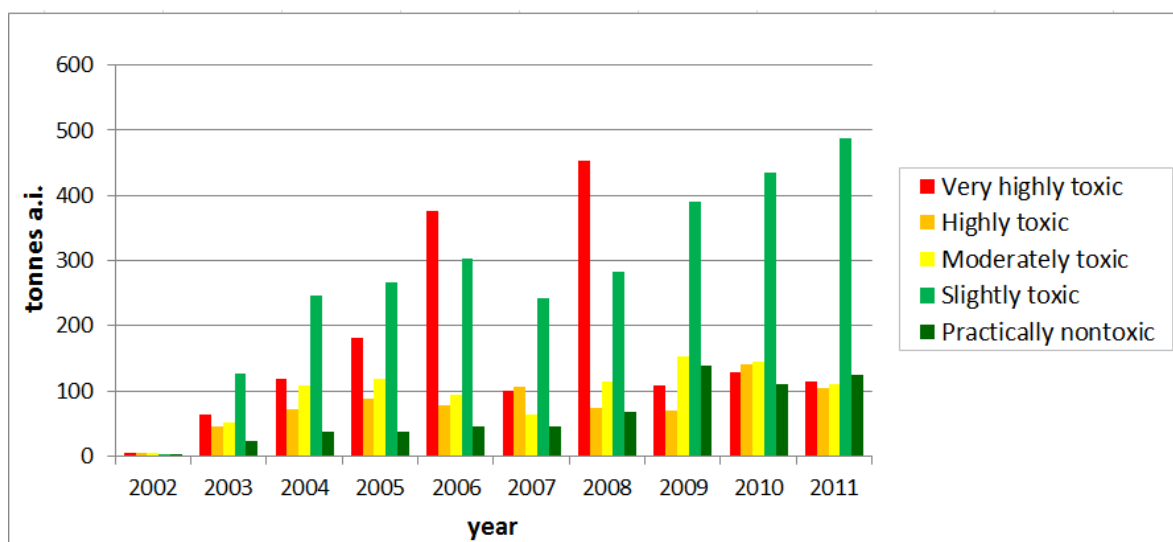


Figure 32: The annual volume of imported active ingredients per *Daphnia* toxicity class in the period 2002-2011 (tonnes).

3.5.3 Algae

The annual imported number of active ingredients per algae toxicity class is shown in Figure 33. More than half of the active ingredients imported in Mozambique are moderately, highly or very highly toxic to algae and relative numbers change little over time.

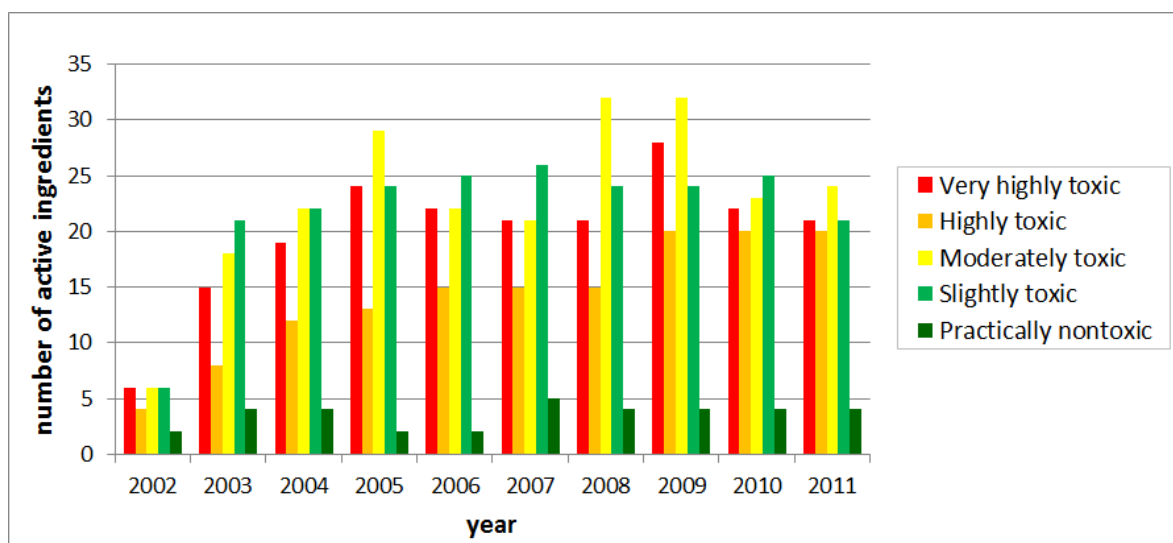


Figure 33: The annual number of imported active ingredients per algae toxicity class in the period 2002-2011.

The annual volume of active ingredients per algae toxicity class is shown in Figure 34. From 2004 to 2011 the imported volumes a.i. per class change little. The exceptions are the peaks for slightly toxic a.i. in 2005, 2008 and 2009, caused by the relatively high imports of DDT.

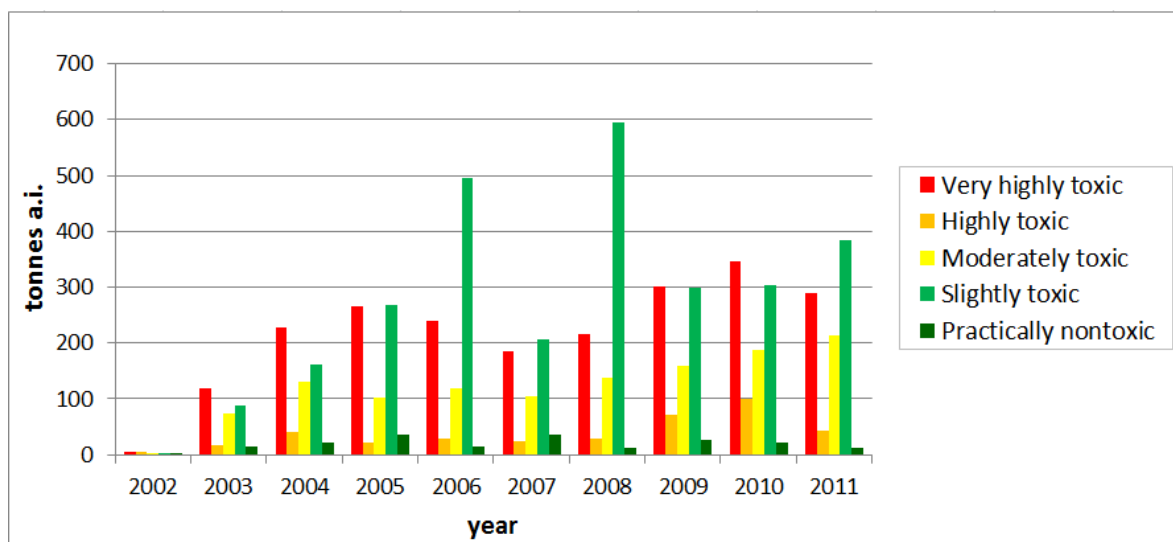


Figure 34: The annual volume of imported active ingredients per algae toxicity class in the period 2002-2011 (tonnes).

3.5.4 Bees

The annual number of active ingredients per bee toxicity class is shown in Figure 35. The relative imported numbers of a.i. that are slightly or very slightly toxic to bees is higher than for the aquatic organisms in the previous paragraphs, i.e., these two classes represent more than half of the imported a.i.

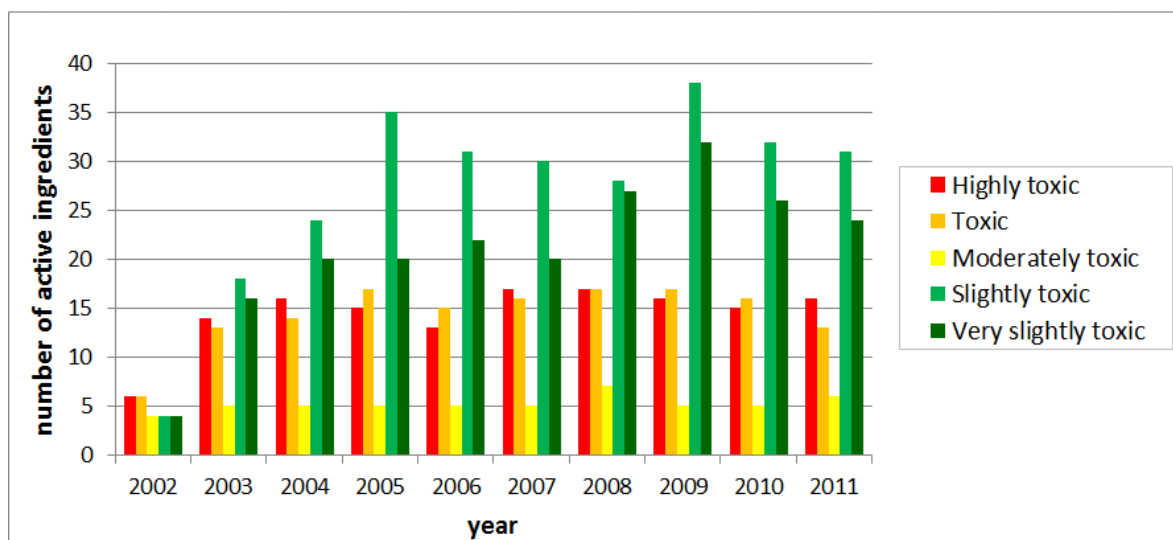


Figure 35: The annual number of imported active ingredients per bee toxicity class in the period 2002-2011.

The annual volume of active ingredients per bee toxicity class is shown in Figure 36. In terms of imported volume the a.i. that are slightly to very slightly toxic are even more represented, more than 75% in most years and increasing.

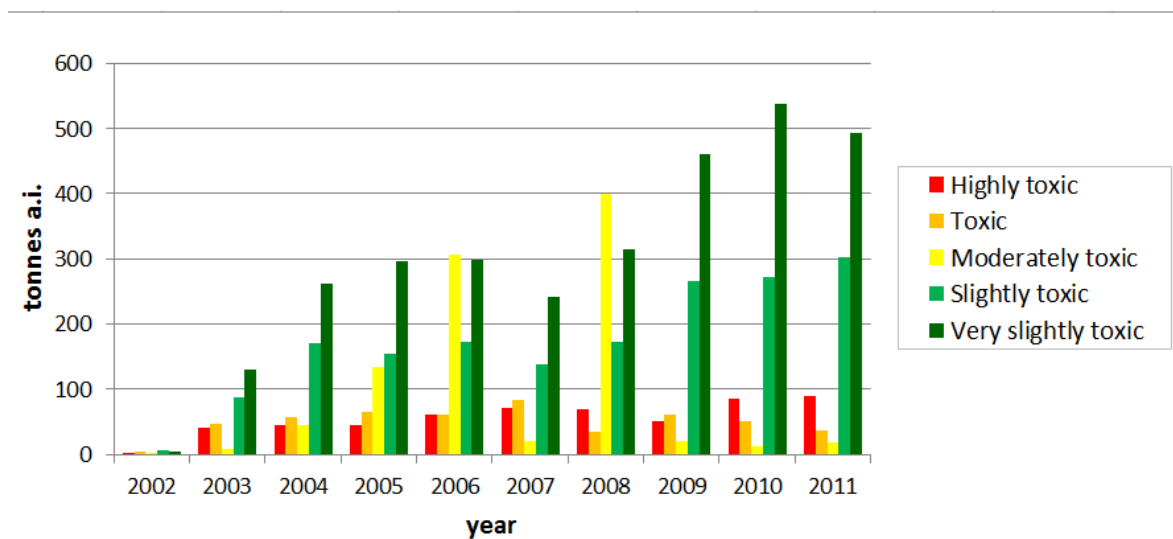


Figure 36: The annual volume of imported active ingredients per bee toxicity class in the period 2002-2011 (tonnes).

3.6 Environmental Toxic Load

The Environmental Toxic Load (ETL) indicators are calculated according to Equation 3 and presented in figures as the annual sum of all active ingredients imported. Compounds with the major contribution to the ETL are mentioned in the text. Annex 3 contains tables with the relative contributions of the 175 active ingredients to the total indicator values.

3.6.1 Fish

The annual Environmental Toxic Load for fish is shown in Figure 37. This indicator shows more changes over time than can be seen in the classification of imported numbers (Figure 29) and volumes (Figure 30) of active ingredients. The ETL for fish increases from 2002 to 2004 and peaks in 2010. In 2011 the ETL value is more than halved compared to 2010.

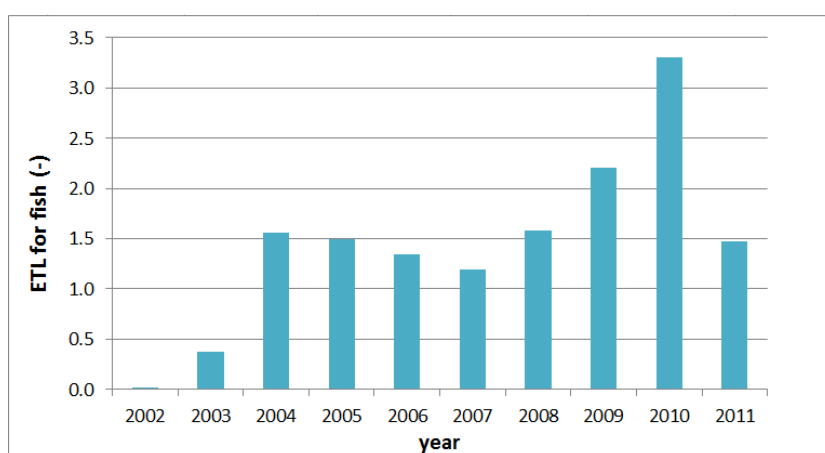


Figure 37: The annual Environmental Toxic Load for fish of active ingredients imported in Mozambique in the period 2002-2011.

Over the years one compound explains 50% or more of the total ETL for fish in more than two years (Table 3.1, Annex 3), lambda-cyhalothrin (trade names: Cyclon, Demand, Duduthrin Fortis, Icon, Iconet, Karate, Moz Lambda-cyhalothrin, Revival, Zakaka, Zakanaka, see Annex 5). It is therefore of primary concern. From 2005 to 2011 lambda-cyhalothrin was solely responsible for more than 80% of the ETL value (with the exception of 2007: 67%). The ETL peak value in 2010 is also explained by lambda-cyhalothrin. Active ingredients of secondary concern for fish are aluminium phosphide, chlorpyrifos, cyfluthrin, cypermethrin and endosulfan.

3.6.2 Aquatic invertebrates

The annual Environmental Toxic Load for the water flea *Daphnia* is shown in Figure 38. The ETL for *Daphnia* also increases initially, but from 2004 to 2011 it fluctuates between 3.0 and 7.0. It is considerably reduced in 2011 compared to 2010.

Over the years ETL values are determined by a limited number of active ingredients (Table 3.2 in Annex 3). They are mainly organophosphate compounds and synthetic pyrethroids: chlorpyrifos, cypermethrin, DDT (DDT, again, only in 2005, 2006 and 2008), dichlorvos, ethion, fenvalerate, lambda-cyhalothrin and pirimiphos-methyl. These active ingredients did not explain more than 50% of the ETL value in 2 years or more, but only >10% in one year or more. They are therefore categorised as of secondary concern for aquatic invertebrates according to the criteria set out in §2.4.

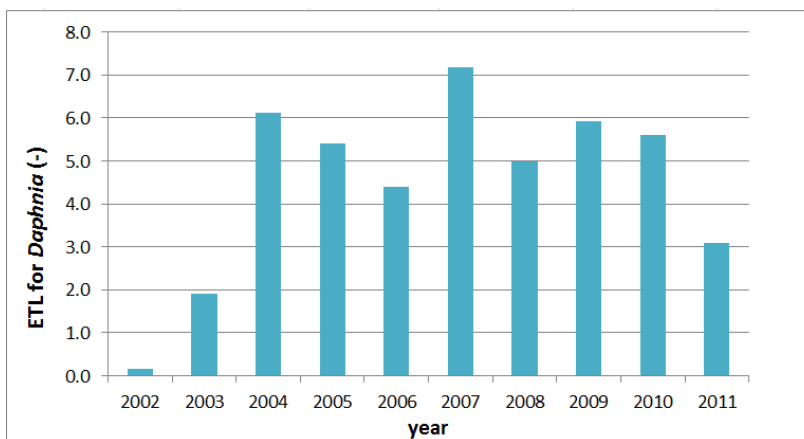


Figure 38: The annual Environmental Toxic Load for *Daphnia* of active ingredients imported in Mozambique in the period 2002-2011.

3.6.3 Algae

The annual Environmental Toxic Load for algae is shown in Figure 39. The toxic load of the imported active ingredients to algae increases from 2002 to 2005, decreases in 2006 and 2007 and increases again the following years. The pattern closely resembles the pattern observed for the total volume of pesticide products imported in Mozambique over the same period (Figure 7).

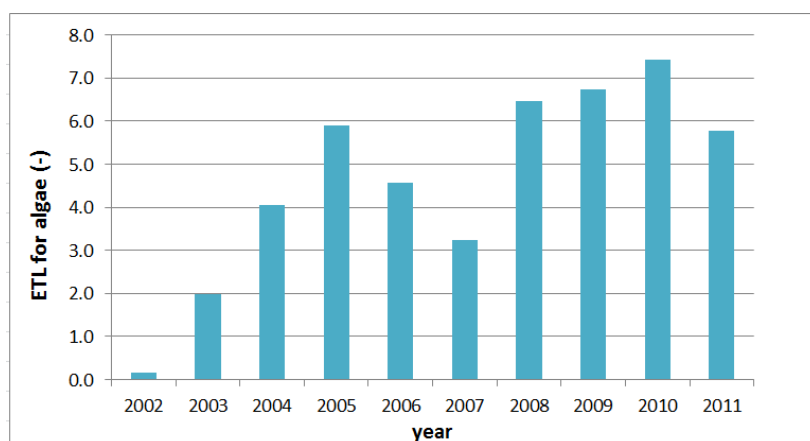


Figure 39: The annual Environmental Toxic Load for algae of active ingredients imported in Mozambique in the period 2002-2011.

In all years, except 2002, 69% to 85% of the ETL value for algae is caused by the import of the a.i. acetochlor (Table 3.3, Annex 3). This is the only active ingredient of primary concern to algae. Trade names are Acetochlor, Bullet, Villa and Volcano (Annex 5). Paraquat contributes 5%-21% from 2003 to 2011 and 99% in 2002. The third a.i. that causes a potential hazard for algae is ametryn, which explains 4%-12% of the ETL yearly from 2003 to 2011. Both compounds represent > 10% of the ETL in more than one year and are therefore classified as of secondary concern.

3.6.4 Bees

The annual Environmental Toxic Load for bee is shown in Figure 40. The ETL increases considerably from 2002 to 2008 and then drops again. From 2009 to 2011 it remains at almost the same level of 0.07-0.08.

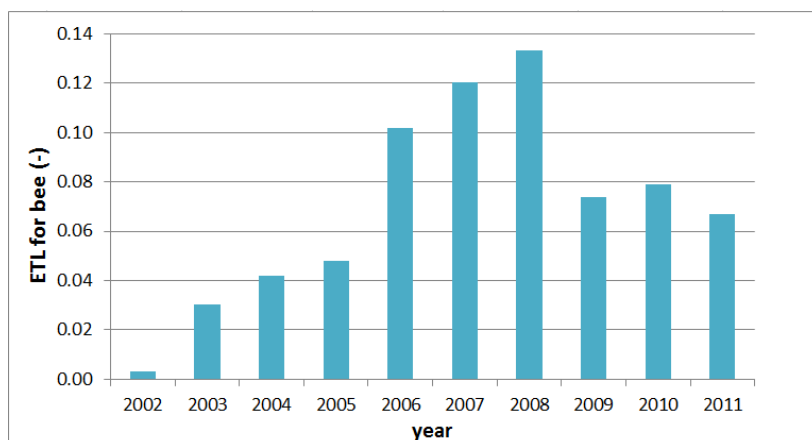


Figure 40: The annual Environmental Toxic Load for bees of active ingredients imported in Mozambique in the period 2002-2011.

The active ingredients that together determine most of the ETL values for bees vary considerably from year to year without any consistent trends in time (Table 3.4, Annex 3). One active ingredient constitutes >50% of the ETL value in more than 2 years and is of primary concern for bees, imidacloprid (trade names: Bandit, Condifor, Courag, Gaucho, Imidabiogel, Imidacel, Imidagold, Maxforce Quantum, Midaclordan, Monceren, Moz Imidacloprid, Premise, Protect, Quick Bait Spray Fly Bait, Seed Plus and Thunder, see Annex). The a.i. that are of secondary concern are bendiocarb, chlorpyrifos, cyfluthrin, cypermethrin, deltamethrin, lambda-cyhalothrin, profenofos and thiamethoxam.

3.7 Groundwater leaching potential

The calculated GUS indicator and the groundwater leaching potential class of the active ingredients in the imported products is listed Table 4.1 in Annex 4. The annual number of active ingredients per groundwater leaching potential class is shown in Figure 41. Over the whole period most imported a.i. have a low to very low leaching potential. Relative numbers in the different classes change little over time.

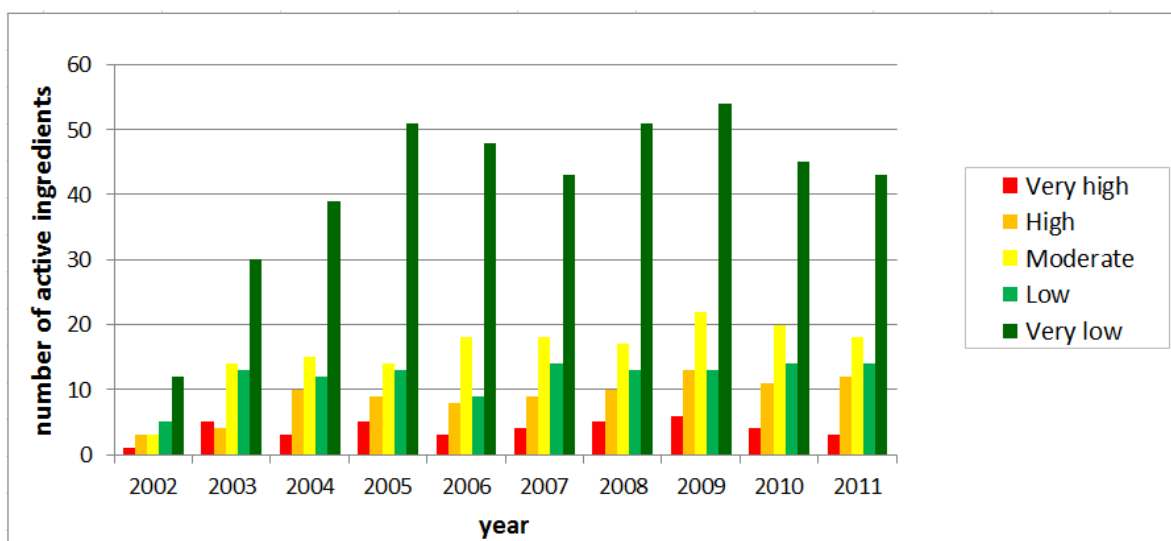


Figure 41: The annual number of imported active ingredients per groundwater leaching potential class in the period 2002-2011.

The annual volume of active ingredients per groundwater leaching potential class is shown in Figure 42. In terms of imported volume the a.i. with a moderate leaching potential are more important than in terms of imported numbers of a.i. (Figure 41), but the volumes of a.i. with a high or very high leaching potential are small. The two peaks of imported pesticides with a very low leaching potential in 2006 and 2008 are caused by DDT that strongly absorbs to particles and organic matter (GUS: -4.5).

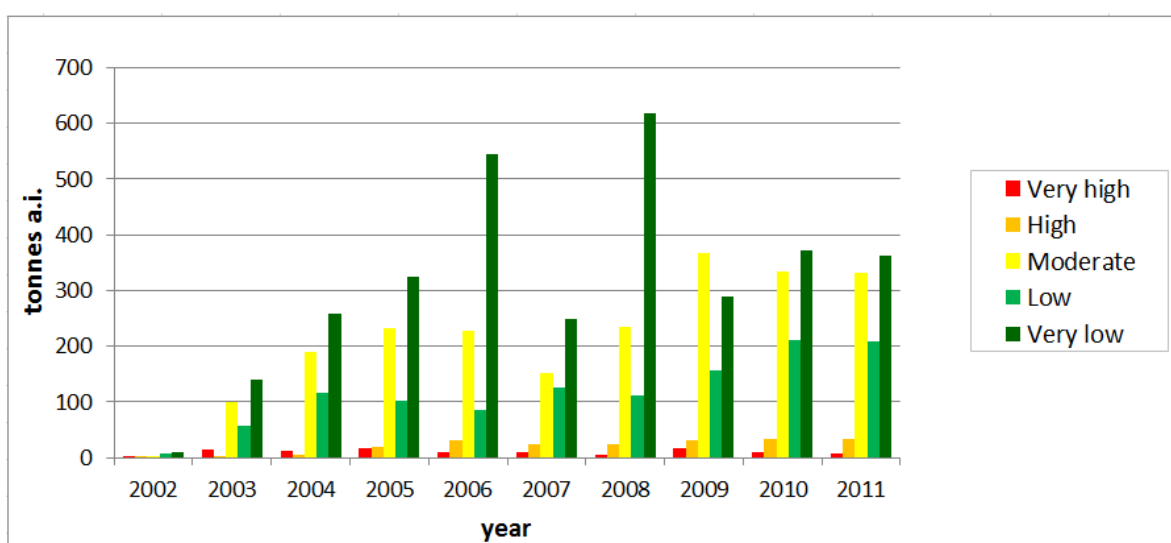


Figure 42: The annual volume of imported active ingredients per groundwater leaching potential class in the period 2002-2011 (tonnes).

The percentage of the total yearly imported volumes of active ingredients with a very high (Class 5) or high (Class 4) potential to leach to the groundwater are listed in Table 4.2 in Annex 4. Compounds of primary concern, i.e., Class 5 a.i. that constitute more than 1% of the total imported volume in two years or more, are methyl bromide (trade name: Volcano) and tebuthiuron (Volcano, Volcano Bundu). Of secondary concern are Atrazine (Class 4), Clomazone (Class 4), Hexazione (Class 5), Imidacloprid (Class 4) and Propoxur (Class 4).

4 Discussion

This chapter summarizes and discusses the main findings of the study. First the limitations of the methods are discussed. Secondly the trends in time of pesticide use, hazards and the Environmental Toxic Loads (ETLs) are analysed.²

4.1 Limitations and advantages of the methods

4.1.1 Use of import data

The analyses, trends and calculated indicators reported in this report are entirely based on import data. It is implicitly assumed that import data can be used as a surrogate for actual usage data when the potential hazards of formulated products and active ingredients are assessed. The assumption in that case would be that imported compounds are applied in the field in the same year that they are imported. It must be well understood that this is not the case in reality. Imported pesticide products may not be sold immediately, and if they are sold they may not be applied instantly. The actual hazards and risks of the use of the imported pesticides may well occur later and will depend on the actual use pattern, i.e., all applied within a short period or applied in portions over larger periods. We do, however, know that all imported pesticides are actually used in Mozambique and are not further exported.

There was no background information available to interpret several conspicuous observations such as the limited number of import events in the years 2002 and 2003, and for particular products, the large fluctuations of the volumes imported in subsequent years. An example is the imported volume of products based on DDT which alternately showed high import peaks in some years and absence of imported volumes in others.

Because import data were used in this report as a proxy for data on actual national use, care must be taken when interpreting and communicating the findings of the study.

4.1.2 Hazard assessments

The hazard assessments for aquatic organisms, groundwater and bees that were done during this study rank pesticides relative to each other from high to low hazard. The hazard assessments do not provide information on the actual risks in the field posed by these pesticides. Real risks to aquatic organisms, bees and groundwater depend on both the toxicity of the pesticide and the actual exposure of organisms to the pesticide. Exposure is, among other things, determined by pesticide formulation, soil properties, climate, application regimes, conditions during application, persistence of pesticides in the ecosystem, the presence and distance to surface water bodies, presence of fish and bees, buffer strips and other mitigation techniques employed, etc. These factors were not taken into account. Hazard assessments such as these, however, can be used to decide whether follow-up risk assessments are required.

The risk of judging pesticides on the basis of hazard assessment only is that farmers may be encouraged to base their choice of pesticide on only one parameter — low toxicity — without due consideration being taken into account of the overall risk, which requires the total exposure to also be considered. While, for pesticides with a low toxicity, repeated use may lead to increased exposure and therefore pose a higher risk than pesticides with a high toxicity but low rates of exposure. Therefore

² Parts of this discussion, especially about the methods, is the same as for the exercise that was done for pesticides used in cotton (De Blécourt et al., 2010). In these cases we have copied parts of this report and only slightly modified them (§4.1.2, §4.1.3).

drawing conclusions on hazard indicators only is not advised and it is recommended to use a simplified risk assessment method, for example PRIMET (Peeters et al., 2008).

The hazard assessments for aquatic organisms do not take into account the persistence of the compound. Highly toxic pesticides with a low persistence in the ecosystem can pose a lower risk to aquatic organisms than persistent compounds with lower toxicity. The approach could in the future be improved by including persistence and use patterns in the equation.

The hazard assessments for groundwater take into account mobility and degradation in soil, but not toxicity of the pesticides. Whether the use of a specific compound is a risk to groundwater depends on the toxicity of the compound, the distance to groundwater and the use of the groundwater. The hazard assessment for groundwater can be improved by including toxicity in the indicator.

4.1.3 Environmental Toxic Load

Environmental Toxic Load (ETL) indicators were used to evaluate the consequences of changes in pesticide use on average toxic loads to the environment. The ETL was calculated separately for fish, aquatic invertebrates (*Daphnia*), algae and bees. The ETL gives an indication of the average amount of toxic pressure applied on one (1) hectare of agricultural land in one (1) year. The ETL indicator combines the average amount of pesticides applied in the total agricultural area of the country with the toxicity of the active ingredients used. The actual exposure to the pesticide is not included in the ETL because this would require modelling. The ETL, therefore, is not an indicator of the risk associated with the use of a pesticide, or the actual impact on organisms in the field, but rather the ETL is a composed indicator for the relative hazard based on pesticide imports. For example, the active ingredient of an imported pesticide may be toxic to bees and increase the ETL value. But when it is a granular formulation and the pesticide is non-systemic, bees may never be exposed.

The ETL is used to compare average toxic loads to the environment (1) between pesticides, (2) between years and (3) in the case of the aquatic toxicity also between different groups of aquatic species (fish, water fleas and algae). As the ETL is averaged over the whole agricultural area, the ETL does not account for differences between regions where relatively high or low amounts of toxic substances are used. So even when the ETL is relatively low for a country in a given year, there could still be environmental risks in a particular area where a highly toxic active ingredient is used extensively.

4.1.4 GUS index

The GUS index has limited data needs and should be considered as a simple indicator of the groundwater leaching potential. It takes into account the persistence (degradation half-life) and mobility (sorption coefficient to soil organic carbon) of active ingredients. The leaching potential of metabolites is not considered, although some of these compounds pose greater hazards than their precursor. In addition, pH dependent sorption is not considered in the GUS. Using a combined sorption coefficient for calculating the GUS for soils with different pH, would result in a shift to a higher groundwater leaching potential class. For these reasons, the results of the analysis of the groundwater leaching potential of the imported active ingredients should be interpreted with some care.

4.1.5 Advantages of hazard analysis

In the previous paragraphs especially the limitations of the methods and indicators were discussed. However, the hazard-based method and the ETL also have certain advantages over more complex risk-based indicators. The amount of parameters needed for the analyses is limited. This is an advantage in developing countries where adequate data on pesticide use and exposure may often be very difficult to obtain. Furthermore, the methods are very suitable for trend analysis because data are analysed in a uniform way. Finally, these analyses are relatively cheap and fast. When time and budget are limiting factors their use will quickly provide some general insights which allows for a more focussed risk assessment as a follow-up.

4.2 Trends in pesticide imports

In this study trends in pesticide imports and hazards were assessed over a ten year period, from 2002 to 2011. During these years the total agricultural area of Mozambique, as reported by FAOSTAT, only very slightly increased (1.4%). Agricultural production, i.e., harvests that were reported for the various crops grown in the country, increased 40%, from 10 million tonnes in 2002 to 14 million tonnes in 2011. Because the total agricultural area only changed little during the same period, it must be concluded that on the whole agriculture in the country must have intensified.

This assumed intensification is reflected in the trend of the total volume of pesticides imported in the country. Imports were lowest in 2002, but it is not clear if the import data that were compiled for this year are complete. However, from 2003 to 2011 the imported total volume of formulated pesticides also increased considerably, from some 670 tonnes in 2003 to more than 2,500 tonnes in 2010 and 2011 (there was a temporary decrease in 2007). The number of active pesticide importers also increased over the study period, from a mere 5 in 2002 to more than 15 in 2011. The number of active importers temporarily declines around 2007, which could perhaps explain part of the reduced pesticide imports observed around the same time. Over the 10 year period one importer, Agrifocus Lda, is responsible for almost two thirds of the total imported volume of pesticide products.

The type of pesticides imported in Mozambique is very consistent over time. The majority of products consists of insecticides, followed by the herbicides and fungicides. The imported amounts of other type of pesticides such as rodenticides, nematocides, molluscicides and growth regulators is relatively small.

The trends in the imported volumes of active ingredients will be discussed in terms of their potential hazards in the following paragraphs. In general it could be observed that some older and very noxious active ingredients like methyl bromide may have been phased out already because they are not imported in later years. Other compounds keep on being used. The import data for 2005, 2006 and 2008 for example show some conspicuous peaks for DDT (Figure 13) which are repeatedly reflected by some of the human health and environmental indicators.

4.3 Human health hazard

The acute human health hazard of the pesticides imported in Mozambique was evaluated using the WHO classification for formulated pesticide products. Whereas the total volume of imported pesticides increased from 2002 to 2011, the fraction of highly hazardous products of the imported volume decreased and the fraction of products with a (very) low hazard increased. Over the period 9 active ingredients of primary concern (in Class 1b products) were imported, but mostly in rather limited quantities. Pesticide products containing aluminium phosphide were the most consistently imported Class 1b products over the 10-year period. However, some Class II products were imported in larger volumes and therefore of secondary concern. These contained active ingredients of secondary concern such as ametryn, DDT and more recently lambda-cyhalothrin.

Only few pesticide products with a known chronic hazard were imported in the country although imported volumes may still range from several tens to several hundred tonnes of the active ingredients. Compounds of primary concern are mancozeb and diuron (both carcinogenic), dichlorvos (also carcinogenic) is of secondary concern.

4.4 Environmental hazard

A considerable number of the pesticides imported into Mozambique are acutely toxic to fish, aquatic invertebrates, algae and to bees. However, the less hazardous pesticides represent a much higher volume of imports. For all four groups of species, the volume of slightly toxic or very slightly toxic active ingredients is highest. There are no clearly observable trends in time in environmental hazard of the imported products. Numbers and imported volumes for all toxicity classes increase as a

consequence of increasing imports, but there are no clear trends towards the import of more hazardous or less hazardous active ingredients in time.

The picture is somewhat different when the environmental toxic load is evaluated. This indicator corrects for the total agricultural area and cumulates the relative hazards of all imported active ingredients. All calculated ETL values increase during the first three or four years of the 10-yr. period. In other words, because more pesticides are imported per hectare of arable land, the potential environmental hazard increases (assuming that these pesticides are actually used). After this initial period the trends are slightly different.

The ETL for fish fluctuates around 1.5 from 2004 to 2008 and then suddenly increases in 2009 and 2010. In 2011 the ETL is back at c. 1.5 (Figure 37). During the first years many active ingredients that are well known to be very toxic to fish contribute to the ETL value (endosulfan, chlorpyrifos etc.). In the later years the ETL is for a very large part the result of the import of lambda-cyhalothrin (only compound classified as of primary concern). This pesticide is also responsible for the ETL peak values.

The relative hazard for aquatic invertebrates (*Daphnia*) also fluctuates but decreases in 2011 (Figure 38). The ETL usually depends on a combination of several organophosphate and synthetic pyrethroid compounds, but in changing combinations. Over the last four years, chlorpyrifos and lambda-cyhalothrin are major contributors to the hazard. DDT hazard to *Daphnia* peaks in 2006 and 2008.

The relative hazard to algae follows a trend that is similar as for *Daphnia*: an initial increase followed by a dip in 2007, an increase again and a slight decrease in 2011 (Figure 39). Acetochlor is responsible for a major part of the ETL value (of primary concern), followed by paraquat and ametryn (of secondary concern).

Because the indicators are based on a similar kind of data, The ETL values for fish, *Daphnia* and algae can be compared among each other. The ETL values for *Daphnia* and algae are of the same order of magnitude, i.e., 3-7 from 2004 to 2011. The value for fish is more than two times lower, c. 1-3 in the same years. These observations may be explained by the fact that more insecticides than herbicides are imported in Mozambique and that in general insecticides are more toxic to aquatic invertebrates than to fish, and that herbicides are more toxic to algae than to aquatic invertebrates or fish.

The ETL for bees, and thus the relative hazard of the imported pesticides, increases steadily from 2002 to 2006 before dropping to half the peak value in 2009. From 2009 to 2011 it stays at the same level (Figure 40). The ETL is the result of a suite of different insecticides, among which imidacloprid figures most prominently (of primary concern).

The groundwater leaching potential of the active ingredients imported in Mozambique is not very high. The hazard of the majority of the imported a.i. is classified as moderate to very low. The a.i. with the highest leaching potential are methyl bromide and tebuthiuron (of primary concern).

5 Conclusions

The most significant observations according to this study are:

- The volume of pesticides imported increased almost threefold, from 670 tonnes in 2003 to 2592 tons in 2011. Agricultural production increased by 40 % from 9.9 million tonnes in 2002 to 13,9 million tonnes in 2011, whereas the agricultural area increased only by 1.4%;
- The types of pesticides imported in the country are very consistent over time. The majority of products consists of insecticides, followed by the herbicides and fungicides;
- The volume of highly hazardous products imported over time decreased and the volume of products with a (very) low hazard increased;
- Only few pesticide products with a known chronic hazard to human health were imported in the country, although carcinogenic products were imported at the rate of 100 tons per year;
- A considerable number of the pesticides imported into the country are acutely toxic to fish, aquatic invertebrates, algae and bees. However, the less hazardous pesticides represent a much higher volume of imports;
- The Environmental Toxic Load (ETL) (relative hazard corrected for surface of agricultural area) to aquatic organisms (fish, aquatic invertebrates and algae) increases from 2002 to 2010, but decreases for all three groups of species in 2011;
- Overall, the hazard of the imported pesticides is more than two times higher to aquatic invertebrates and algae than to fish;
- The ETL to bees also increases from 2002 to 2008, but is considerably lower from 2009 to 2011;
- Only few active ingredients with a very high or high leaching potential are imported in the country.

The pesticides that contributed most to the overall human health hazards and environmental hazards are given in Table 6. Active ingredients of primary or secondary concern were identified the criteria set out in §2.4. These criteria combine both potential hazard of the pesticides and imported quantities in Mozambique. Annex 5 provides the volumes of the all formulated pesticides imported in Mozambique that contain active ingredients of primary concern for all years of the period 2002-2011. These tables may be used for specific hazard reducing measures. Such tables may also be generated for pesticides of secondary concern or for any other pesticide of interest using the pivot table that is provided with the revised spreadsheet containing the Pesticide Import data.

Three things must be noted in respect to this Table: 1) pesticides with a low toxicity and a high environmental persistence are not considered. Such pesticides may even represent a bigger threat to the environment than highly toxic pesticides with a low environmental persistence; 2) the Environmental Toxic Loads are based on import data and do not account for any regional variations in use, e.g. extensive use of highly toxic pesticides in a particular area; 3) none of the classifications of pesticide active ingredients as of primary or secondary concern was based on estimated properties (see §2.1.2).

One final and general recommendation is that records of pesticide import volumes and relevant properties, including the active ingredients, can be analysed much more efficiently when the data are organised in a database environment. A database structure is needed in order to define the relations between products and compounds, and to maintain the integrity of the data that will be entered. If similar exercises are planned for Mozambique or other countries in the future, designing and setting up such a database would proof a very fruitful investment.

Table 6: Pesticides imported in Mozambique from 2002 to 2011 that are of concern in terms of potential human health and environmental hazard and annually imported quantity (for criteria, see §2.4).

Type of hazard	Pesticide active ingredient of primary concern	Pesticide active ingredient of secondary concern
<i>Human health</i>		
Acute (WHO classification)	Class I pesticide products containing: Abamectin Aldicarb Aluminium phosphide Fenamiphos Methomyl Mevinphos Monocrotophos Oxamyl Terbufos	Class II pesticide products containing: Ametryn DDT Lambda-cyhalothrin
Chronic	Diuron (carcinogenic) Mancozeb (carcinogenic)	Dichlorvos (carcinogenic)
<i>Environment</i>		
Fish	Lambda-cyhalothrin	Aluminium phosphide Chlorpyrifos Cyfluthrin Cypermethrin Endosulfan
Aquatic invertebrates	-	Chlorpyrifos Cypermethrin DDT Dichlorvos Ethion Fenvalerate Lambda-cyhalothrin Pirimiphos-methyl
Algae	Acetochlor	Ametryn Paraquat
Bees	Imidacloprid	Bendiocarb Chlorpyrifos Cyfluthrin Cypermethrin Deltamethrin Lambda-cyhalothrin Profenofos Thiamethoxam
Leaching to groundwater	Methyl bromide Tebuthiuron	Atrazine Clomazone Hexazione Imidacloprid Propoxur

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Annexes

1. Compound properties
2. Hazard to human health
3. Environmental toxic load
4. Groundwater leaching

Annex 1: Compound properties

Compound properties

Tables with the properties of the active ingredients in the imported products, 2002-2011;

1. Sources
2. Fate
3. Toxicity

Table 1.1: Source of fate and toxicity properties of the 175 active ingredients in the imported products, 2002-2011.

Source	Code (Table 2, 3)	DegT50	Koc	EC50 algae	EC50 Daphnia	EC50 fish	LD50 bee	LD50 rat
FootPrint	FP	54	138	131	145	143	135	55
FAO HHP	HHP	33						95
NMI 3	NMI	57						
Alterra ERA	ERA		1	1		1		
Mean value chemical class	CC	13	11	21	19	13	16	15
Mean value product group	PG	18	25	22	11	18	24	10

Table 1.2: Fate properties of the 175 active ingredients in the imported products, 2002-2011.

Nr.	Cas-Nr.	CompoundName	Chemical class	Product group	DegT50 (d)	source	Koc (L/kg)	source
1	94-75-7	2,4-D	aryloxyalkanoic acid	herbicide	16	NMI	88.4	FP
2	2008-39-1	2,4-D dimethylamine	aryloxyalkanoic acid	herbicide	19	CC	81.2	CC
3	71751-41-2	Abamectin	avermectin	insecticide	29	NMI	14000	FP
4	30560-19-1	Acephate	organophosphate	insecticide	3	HHP	302	FP
5	135410-20-7	Acetamiprid	neonicotinoid	insecticide	3	FP	200	FP
6	-999	Acetic acid + ammonia	organic acid	herbicide	160	PG	24379	PG
7	34256-82-1	Acetochlor	chloroacetamide	herbicide	14	FP	156	FP
8	15972-60-8	Alachlor	chloroacetamide	herbicide	14	FP	335	FP
9	116-06-3	Aldicarb	carbamate	insecticide	5	NMI	36	FP
10	67375-30-8	Alpha-cypermethrin	pyrethroid	insecticide	35	FP	57889	FP
11	20859-73-9	Aluminium phosphide	inorganic compound	insecticide	0	FP	2701	CC
12	834-12-8	Ametryn	triazine	herbicide	37	HHP	316	FP
13	129909-90-6	Amicarbazone	triazolinone	herbicide	21	FP	51.7	FP
14	33089-61-1	Amitraz	amidine	insecticide	0	HHP	1000	FP
15	1912-24-9	Atrazine	triazine	herbicide	58	NMI	100	FP
16	131860-33-8	Azoxystrobin	strobilurin	fungicide	94	NMI	589	FP
18	68038-71-1	Bacillus thuringiensis	biopesticide	insecticide	19	CC	191989	PG
19	22781-23-3	Bendiocarb	carbamate	insecticide	4	FP	385	FP
20	17804-35-2	Benomyl	benzimidazole	fungicide	0	NMI	1900	FP
21	83055-99-6	Bensulfuron-methyl	sulfonylurea	herbicide	24	FP	370	FP
22	25057-89-0	Bentazone	benzothiazinone	herbicide	37	NMI	55.3	FP
23	68359-37-5	Beta-cyfluthrin	pyrethroid	insecticide	13	FP	64300	FP
24	56073-10-0	Brodifacoum	hydrocoumarin	other	157	HHP	86200	FP
25	314-40-9	Bromacil	uracil	herbicide	60	FP	32	FP
26	1689-99-2	Bromoxynil octanoate	hydroxybenzonitrile	herbicide	1	FP	639	FP
27	41483-43-6	Bupirimate	pyrimidinol	fungicide	151	NMI	767	FP

28	33629-47-9	Butralin	dinitroaniline	herbicide	22	FP	46391	FP
29	133-06-2	Captan	phthalimide	fungicide	1	NMI	200	FP
30	63-25-2	Carbaryl	carbamate	insecticide	16	FP	300	FP
31	10605-21-7	Carbendazim	benzimidazole	fungicide	71	NMI	400	FP
32	1563-66-2	Carbofuran	carbamate	insecticide	17	NMI	22	FP
33	55285-14-8	Carbosulfan	carbamate	insecticide	21	FP	9489	FP
34	5234-68-4	Carboxin	oxathiin	fungicide	0	FP	99.4	FP
35	470-90-6	Chlorfenvinphos	organophosphate	insecticide	62	NMI	680	FP
36	99283-00-8	Chlorimuron	sulfonylurea	herbicide	17	CC	205	CC
37	1897-45-6	Chlorothalonil	chloronitrile	fungicide	14	NMI	850	FP
38	2921-88-2	Chlorpyrifos	organophosphate	insecticide	50	FP	8151	FP
39	5598-13-0	Chlorpyrifos-methyl	organophosphate	insecticide	81	NMI	4645	FP
40	8000-29-1	Citronella oil	unclassified	other	136	PG	7721846	PG
41	81777-89-1	Clomazone	isoxazolidinone	herbicide	111	NMI	300	FP
42	13822-80-5	Copper ammonium acetate	inorganic compound	fungicide	4402	CC	4657	CC
43	20427-59-2	Copper hydroxide	inorganic compound	fungicide	10000	HHP	12000	FP
44	1317-39-1	Copper oxide	inorganic compound	fungicide	10000	HHP	2701	CC
45	1332-40-7	Copper oxychloride	inorganic compound	fungicide	10000	HHP	4657	CC
46	101205-02-1	Cycloxydim	cyclohexanedione oxime	herbicide	1	NMI	59	FP
47	68359-37-5	Cyfluthrin	pyrethroid	insecticide	0	NMI	123930	FP
48	57966-95-7	cymoxanil	cyanoacetamide oxime	fungicide	1	NMI	145	FP
49	52315-07-8	Cypermethrin	pyrethroid	insecticide	60	FP	156250	FP
50	66215-27-8	Cyromazine	triazine	insecticide	32	NMI	765	FP
51	584-79-2	D-allethrin	pyrethroid	insecticide	60	HHP	2414	FP
52	533-74-4	Dazomet	dithiocarbamate	other	0	NMI	10	FP
53	50-29-3	DDT	organochlorine	insecticide	6200	FP	260324	FP
54	11-30-1	Decanol	organic alcohol	other	136	PG	7721846	PG
55	52918-63-5	Deltamethrin	pyrethroid	insecticide	30	HHP	1.0E+07	FP
56	333-41-5	Diazinon	organophosphate	insecticide	49	NMI	609	FP
57	62-73-7	Dichlorvos	organophosphate	insecticide	2	NMI	50	FP

58	7173-51-5	Didecyldimethylammonium chloride	quaternary ammonium compound	fungicide	1495	PG	1469081	ERA
59	134-62-3	Diethyltoluamide	benzamide	other	136	PG	478	FP
60	119446-68-3	Difenoconazole	triazole	insecticide	109	NMI	3760	FP
61	104653-34-1	Difethialone	coumarin anticoagulant	other	635	FP	54000000	FP
62	35367-38-5	Diflubenzuron	benzoylurea	insecticide	12	NMI	10000	FP
63	60-51-5	Dimethoate	organophosphate	insecticide	8	NMI	30.1	FP
64	330-54-1	Diuron	urea	herbicide	81	NMI	813	FP
65	115-29-7	Endosulfan	organochlorine	insecticide	50	FP	11500	FP
66	106325-08-0/133855-98-8	Epoxiconazole	triazole	fungicide	314	NMI	1802	FP
67	16672-87-0	Ethephon	ethylene generator	other	16	FP	2540	FP
68	563-12-2	Ethion	organophosphate	insecticide	90	FP	17240	FP
69	52304-36-6	Ethylbutylacetylaminopropionate	organic ester	other	136	PG	7721846	PG
70	106-93-4	Ethylene dibromide	brominated alkene	other	136	PG	7721846	PG
71	75-21-8	Ethylene oxide	organic epoxide	other	136	PG	7721846	PG
72	22224-92-6	Fenamiphos	organophosphate	insecticide	1	FP	100	FP
73	13356-08-6	Fenbutatin oxide	organotin	insecticide	95	HHP	183550	FP
74	122-14-5	Fenitrothion	organophosphate	insecticide	21	NMI	2000	FP
75	39515-41-8/64257-84-7	Fenpropathrin	pyrethroid	insecticide	28	HHP	5000	FP
76	55-38-9	Fenthion	organophosphate	insecticide	34	HHP	1500	FP
77	51630-58-1	Fenvalerate	pyrethroid	insecticide	35	HHP	5273	FP
78	120068-37-3	Fipronil	phenylpyrazole	insecticide	142	FP	577	FP
80	79241-46-6	Fluazifop-P-butyl	aryloxyphenoxypropionate	herbicide	3	NMI	3394	FP
81	69770-45-2	Flumethrin	pyrethroid	insecticide	26	CC	853297	CC
82	2164-17-2	Fluometuron	unclassified	herbicide	160	PG	24379	PG
83	69377-81-7	fluroxypyr	pyridine compound	herbicide	111	NMI	24600	FP
84	50-00-0	Formaldehyde	organic aldehyde	other	6	FP	37	FP
85	98-01-1	Furfural	heterocyclic aldehyde	other	1	FP	94.82	FP
86	1071-83-6	Glyphosate	glycine derivative	herbicide	17	NMI	1435	FP
87	135397-30-7	Halosulfuron	pyrimidinylsulfonylurea	herbicide	247	HHP	14141	PG
88	100784-20-1	Halosulfuron-methyl	pyrimidinylsulfonylurea	herbicide	14	HHP	109	FP

89	79983-71-4	Hexaconazole	triazole	fungicide	225	HHP	1040	FP
90	51235-04-2	Hexazinone	triazinone	herbicide	105	FP	54	FP
91	67485-29-4	Hydramethylnon	trifluoromethyl aminohydrazone	insecticide	7	HHP	730000	FP
92	104098-48-8	Imazapic	imidazolinone	herbicide	120	FP	137	FP
93	81334-34-1	Imazapyr	imidazolinone	herbicide	11	FP	125	FP
94	138261-41-3	Imidacloprid	neonicotinoid	insecticide	169	NMI	189	FP
95	72963-72-5	Imiprothrin	pyrethroid	insecticide	5	FP	402	FP
96	173584-44-6	Indoxacarb	oxadiazine	insecticide	17	NMI	6450	FP
97	141112-29-0	Isoxaflutole	isoxazole	insecticide	2	NMI	145	FP
98	91465-08-6	Lambda-cyhalothrin	pyrethroid	insecticide	25	FP	157000	FP
99	330-55-2	Linuron	urea	herbicide	47	NMI	739	FP
100	103055-07-8	Lufenuron	benzoylurea	insecticide	16	FP	41182	FP
101	121-75-5	Malathion	organophosphate	insecticide	1	HHP	1800	FP
102	8018-01-7	Mancozeb	dithiocarbamate	fungicide	18	HHP	998	FP
103	94-74-6	MCPA	aryloxyalkanoic acid	herbicide	22	NMI	74	FP
104	104206-82-8	Mesotrione	triketone	herbicide	16	NMI	122	FP
105	57837-19-1	Metalaxyl	phenylamide	fungicide	70	HHP	165	FP
106	70630-17-0	Metalaxyl-M	phenylamide	fungicide	216	NMI	660	FP
107	108-62-3	Metaldehyde	cyclo-octane	insecticide	8	NMI	240	FP
109	10265-92-6	Methamidophos	organophosphate	insecticide	2	NMI	1	FP
110	2032-65-7	Methiocarb	carbamate	insecticide	35	HHP	660	FP
111	16752-77-5	Methomyl	carbamate	insecticide	30	HHP	72	FP
112	74-83-9	Methyl bromide	inorganic compound	insecticide	55	FP	22	FP
113	2682-20-4	Methyl isothiazolin one	isothiazolinones	other	136	PG	7721846	PG
114	26172-55-4	Methylchoroisothiazolinone	isothiazolinones	other	136	PG	7721846	PG
115	51218-45-2	Metolachlor	chloroacetamide	herbicide	32	NMI	120	FP
116	21087-64-9	Metribuzin	triazinone	herbicide	12	FP	37.9	FP
117	74223-64-6	Metsulfuron-methyl	sulfonylurea	herbicide	10	FP	39.5	FP
118	7786-34-7	Mevinphos	organophosphate	insecticide	0	NMI	44	FP
119	-999	Mineral oil	unclassified	insecticide	132	PG	191989	PG

120	2212-67-1	Molinate	thiocarbamate	herbicide	12	HHP	190	FP
121	6923-22-4	Monocrotophos	organophosphate	insecticide	7	FP	32.8	FP
122	2163-80-6	Monosodium methyl arsenate	arsenate	herbicide	200	HHP	24379	PG
123	25154-52-3	Nonylphenol	alkylphenol	other	136	PG	7721846	PG
124	1003-07-2	Octylisothiazolinone	isothiazolinones	other	136	PG	7721846	PG
125	19666-30-9	Oxadiazon	oxidiazole	herbicide	502	FP	3200	FP
126	23135-22-0	Oxamyl	carbamate	insecticide	12	NMI	16.6	FP
127	42874-03-3	Oxyfluorfen	diphenyl ether	herbicide	35	FP	17636	FP
128	4685-14-7	Paraquat	bipyridylum	herbicide	2800	HHP	1000000	FP
129	66063-05-6	pencycuron	phenylurea	insecticide	32	HHP	6207	FP
130	40487-42-1	Pendimethalin	dinitroaniline	herbicide	90	FP	17581	FP
131	52645-53-1	Permethrin	pyrethroid	insecticide	42	HHP	100000	FP
132	26002-80-2	phenothrin	pyrethroid	insecticide	1	FP	310320	FP
133	13598-36-2	Phosphoric acid	inorganic compound	other	4402	CC	4657	CC
134	1918-02-1	Picloram	pyridine compound	herbicide	83	FP	13	FP
135	8002-09-3	Pine oil	biopesticide	herbicide	19	CC	24379	PG
136	51-03-6	Piperonyl butoxide	unclassified	insecticide	13	HHP	89125	FP
137	29232-93-7	Pirimiphos methyl	organophosphate	insecticide	22	NMI	1100	FP
138	23031-36-9	Prallethrin	pyrethroid	insecticide	26	CC	853297.5	CC
139	41198-08-7	Profenofos	organophosphate	insecticide	7	HHP	3476	FP
140	7287-19-6	Prometryn	triazine	herbicide	60	HHP	400	FP
141	709-98-8	Propanil	anilide	herbicide	0	FP	152	FP
142	2312-35-8	Propargite	sulfite ester	insecticide	56	FP	56500	FP
143	12071-83-9/9016-72-2	Propineb	dithiocarbamate	fungicide	3	FP	18	FP
144	114-26-1	Propoxur	carbamate	insecticide	35	NMI	51.72	FP
145	8003-34-7	Pyrethrins	unclassified	insecticide	132	PG	191989	PG
146	84087-01-4	Quinclorac	quinolinecarboxylic acid	herbicide	450	FP	50	FP
147	119738-06-6	Quizalofop-P-tefuryl	aryloxyphenoxypropionate	herbicide	0	FP	477	FP
150	87392-12-9/178961-20-1	S-Metolachlor	chloroacetamide	herbicide	20	NMI	2261	FP
151	168316-95-8	Spinosad	biopesticide	insecticide	31	NMI	34600	FP

152	99105-77-8	Sulcotrione	triketone	herbicide	12	NMI	36	FP
153	122836-35-5	Sulfentrazone	aryl triazolinone	herbicide	541	FP	43	FP
154	7704-34-9	Sulphur	inorganic compound	fungicide	30	FP	1950	FP
155	107534-96-3	Tebuconazole	triazole	herbicide	95	NMI	1554	FP
156	34014-18-1	Tebuthiuron	urea	herbicide	1300	HHP	80	FP
157	13071-79-9	Terbufos	organophosphate	insecticide	12	HHP	500	FP
158	5915-41-3	terbuthylazine	triazine	herbicide	105	NMI	220	FP
159	886-50-0	Terbutryn	triazine	herbicide	43	NMI	2432	FP
160	116-29-0	Tetradifon	bridged diphenyl	insecticide	112	FP	100	FP
161	7696-12-0	Tetramethrin	pyrethroid	insecticide	3	HHP	1423	FP
162	153719-23-4	Thiamethoxam	neonicotinoid	insecticide	53	NMI	56.2	FP
163	137-26-8	Thiram	dimethyldithiocarbamate	insecticide	6	NMI	670	FP
164	118712-89-3	Transfluthrin	unclassified	insecticide	132	PG	111362	PG
165	43121-43-3	Triadimefon	triazole	fungicide	26	FP	300	FP
166	55219-65-3	Triadimenol	triazole	fungicide	159	NMI	750	FP
167	52-68-6	Trichlorfon	organophosphate	insecticide	1	NMI	10	FP
170	55335-06-3	Triclopyr	pyridine compound	herbicide	35	NMI	27	FP
171	-999	Tricozene	unclassified	other	136	PG	7721846	PG
172	141517-21-7	Trifloxystrobin	strobilurin	fungicide	1	NMI	2377	FP
173	1582-09-8	Trifluralin	dinitroaniline	herbicide	181	FP	15800	FP
174	-999	Trifluthrin	pyrethroid	insecticide	26	CC	853297	CC
175	-999	Violeta Genciana	unclassified	insecticide	132	PG	191989	PG

Table 1.3: Toxicity of the 175 active ingredients in the imported products, 2002-2011.

Nr.	Compound Name	LD50 rat (mg)	source	LC50 fish (mg/L)	source	EC50 daphnia (mg/L)	source	EC50 algae (mg/L)	source	LD50 bee (µg/bee)	source
1	2,4-D	469	FP	63.4	FP	100	FP	24.2	FP	94	FP
2	2,4-D dimethylamine	585	CC	56.7	CC	145	CC	52	CC	147	CC
3	Abamectin	8.7	HHP	0.0036	FP	0.0001	FP	1.59	FP	0.0022	FP
4	Acephate	945	HHP	110	FP	67.2	FP	980	FP	1.2	FP
5	Acetamiprid	213	HHP	100	FP	49.8	FP	98.3	FP	8.09	FP
6	Acetic acid + ammonia	2782	PG	51.8	PG	92.4	PG	14.0	PG	88.6	PG
7	Acetochlor	2950	HHP	0.36	FP	8.6	FP	0.00027	FP	100	FP
8	Alachlor	930	HHP	1.8	FP	10	FP	0.966	FP	16	FP
9	Aldicarb	0.93	HHP	0.56	FP	0.42	FP	50	FP	0.09	FP
10	Alpha-cypermethrin	79	HHP	0.0028	FP	0.0003	FP	0.1	FP	0.033	FP
11	Aluminium phosphide	8.7	HHP	0.0097	FP	0.37	FP	0.058	FP	0.24	FP
12	Ametryn	110	HHP	5	FP	28	FP	0.0036	FP	100	FP
13	Amicarbazone	1015	HHP	120	FP	119	FP	14.0	PG	24.8	FP
14	Amitraz	800	HHP	0.74	FP	0.035	FP	12	FP	50	FP
15	Atrazine	2000	HHP	4.5	FP	85	FP	0.059	FP	100	FP
16	Azoxystrobin	5000	FP	0.47	FP	0.23	FP	0.36	FP	25	FP
18	Bacillus thuringiensis	3579	CC	171	PG	57	CC	45.09	PG	50	CC
19	Bendiocarb	55	HHP	1.55	FP	0.03	FP	1.71	FP	0.1	FP
20	Benomyl	10000	FP	0.17	FP	0.28	FP	2	FP	10	FP
21	Bensulfuron-methyl	5000	FP	66	FP	130	FP	0.02	FP	51.4	FP
22	Bentazone	1100	HHP	100	FP	64	FP	10.1	FP	200	FP
23	Beta-cyfluthrin	11	HHP	0.000068	FP	0.00029	FP	10	FP	0.001	FP
24	Brodifacoum	0.3	HHP	0.051	FP	0.98	FP	5.53	PG	62	PG
25	Bromacil	5200	HHP	36	FP	119	FP	0.013	FP	100	FP
26	Bromoxynil octanoate	238	FP	0.041	FP	0.046	FP	0.043	FP	100	FP

27	Bupirimate	4000	FP	1	FP	3.41	FP	1.6	FP	50	FP
28	Butralin	1049	HHP	0.37	FP	0.12	FP	0.12	FP	95.7	FP
29	Captan	2000	FP	0.186	FP	7.1	FP	1.18	FP	100	FP
30	Carbaryl	300	HHP	2.6	FP	0.0064	FP	0.6	FP	0.14	FP
31	Carbendazim	10000	FP	0.19	FP	0.15	FP	7.7	FP	50	FP
32	Carbofuran	8	HHP	0.18	FP	0.0094	FP	6.5	FP	0.036	FP
33	Carbosulfan	250	HHP	0.015	FP	0.0015	FP	47	FP	0.18	FP
34	Carboxin	2588	FP	2.3	FP	57	FP	0.48	FP	100	FP
35	Chlorfenvinphos	31	HHP	1.1	FP	0.00025	FP	1.36	FP	0.55	FP
36	Chlorimuron	4102	HHP	108	CC	140	CC	0.033	CC	38.2	CC
37	Chlorothalonil	5000	FP	0.038	FP	0.084	FP	0.21	FP	40	FP
38	Chlorpyrifos	135	HHP	0.0013	FP	0.0001	FP	0.48	FP	0.059	FP
39	Chlorpyrifos-methyl	2814	FP	0.41	FP	0.0006	FP	0.57	FP	0.11	FP
40	Citronella oil	4323	CC	2.65	CC	0.256	CC	0.17	CC	62	PG
41	Clomazone	1369	HHP	15.5	FP	12.7	FP	0.136	FP	85.3	FP
42	Copper ammonium acetate	1298	CC	1667	CC	167	CC	73.9	CC	62.1	CC
43	Copper hydroxide	1000	HHP	0.017	FP	0.038	FP	0.009	FP	44.5	FP
44	Copper oxide	300	FP	0.207	FP	0.45	FP	0.147	FP	116	FP
45	Copper oxychloride	1298	CC	1667	CC	167	CC	73.9	CC	62.1	CC
46	Cycloxydim	3900	HHP	220	FP	70.8	FP	74.9	FP	100	FP
47	Cyfluthrin	15	HHP	0.00047	FP	0.00016	FP	10	FP	0.001	FP
48	cymoxanil	1196	HHP	29	FP	27	FP	0.254	FP	85.3	FP
49	Cypermethrin	250	HHP	0.0028	FP	0.0003	FP	0.1	FP	0.02	FP
50	Cyromazine	3300	HHP	100	FP	100	FP	124	FP	186	FP
51	D-allethrin	685	HHP	19	FP	0.021	FP	8.5	CC	3.4	FP
52	Dazomet	415	FP	0.3	FP	19	FP	0.16	FP	24	FP
53	DDT	113	FP	7	FP	0.005	FP	45.1	PG	5	FP
54	Decanol	631	PG	25.2	PG	21.1	PG	5.53	PG	62	PG
55	Deltamethrin	135	HHP	0.00026	FP	0.00056	FP	9.1	FP	0.0015	FP
56	Diazinon	300	HHP	3.1	FP	0.001	FP	6.4	FP	0.09	FP

57	Dichlorvos	56	HHP	0.55	FP	0.00019	FP	52.8	FP	0.29	FP
58	Didecyldimethylammonium chloride	150	HHP	1.16	FP	0.094	FP	0.66	ERA	88.3	PG
59	Diethyltoluamide	2000	HHP	71.3	FP	75	FP	5.53	PG	62	PG
60	Difenoconazole	1453	HHP	1.1	FP	0.77	FP	0.032	FP	100	FP
61	Difethialone	0.56	HHP	0.051	FP	0.0044	FP	0.18	FP	62	PG
62	Diflubenzuron	4640	FP	0.13	FP	0.0026	FP	20	FP	25	FP
63	Dimethoate	150	HHP	30.2	FP	2	FP	90.4	FP	0.12	FP
64	Diuron	3400	HHP	6.7	FP	5.7	FP	0.0027	FP	100	FP
65	Endosulfan	80	HHP	0.002	FP	0.44	FP	2.15	FP	7.81	FP
66	Epoxiconazole	3160	FP	3.14	FP	8.69	FP	1.19	FP	83	FP
67	Ethephon	1564	FP	100	FP	31.7	FP	20.9	FP	100	FP
68	Ethion	208	HHP	0.5	FP	0.000056	FP	88.3	CC	20.6	FP
69	Ethylbutylacetylaminopropionate	631	PG	25.2	PG	21.1	PG	5.53	PG	62	PG
70	Ethylene dibromide	631	PG	25.2	PG	21.1	PG	5.53	PG	62	PG
71	Ethylene oxide	631	PG	25.2	PG	21.1	PG	5.53	PG	62	PG
72	Fenamiphos	15	HHP	0.0093	FP	0.0019	FP	3.8	FP	0.28	FP
73	Fenbutatin oxide	2630	HHP	0.00114	FP	0.048	FP	0.0036	FP	200	FP
74	Fenitrothion	503	FP	1.3	FP	0.0086	FP	1.3	FP	0.16	FP
75	Fenpropathrin	66	HHP	0.0023	FP	0.00053	FP	2	FP	0.05	FP
76	Fenthion	586	HHP	0.8	FP	0.0057	FP	1.79	FP	0.308	FP
77	Fenvalerate	450	HHP	0.0036	FP	0.00003	FP	50	FP	0.23	FP
78	Fipronil	92	HHP	0.248	FP	0.19	FP	0.068	FP	0.0042	FP
80	Fluazifop-P-butyl	2451	HHP	1.41	FP	0.62	FP	0.67	FP	200	FP
81	Flumethrin	972	CC	1.36	CC	0.0093	CC	8.47	CC	0.33	CC
82	Fluometuron	4323	CC	2.65	CC	0.26	CC	0.17	CC	88.6	PG
83	fluroxypyr	2000	FP	14.3	FP	100	FP	49.8	FP	100	FP
84	Formaldehyde	550	HHP	1.84	FP	0.43	FP	0.88	FP	62	PG
85	Furfural	65	HHP	3.06	FP	20.4	FP	5.53	PG	62	PG
86	Glyphosate	4230	HHP	38	FP	40	FP	4.4	FP	100	FP
87	Halosulfuron	8866	HHP	51.8	PG	92.4	PG	98	FP	88.6	PG

88	Halosulfuron-methyl	7758	FP	131	FP	107	FP	0.0053	FP	100	FP
89	Hexaconazole	2180	HHP	3.4	FP	2.9	FP	1.7	FP	0.1	FP
90	Hexazinone	1690	HHP	320	FP	85	FP	0.0145	FP	60	FP
91	Hydramethylnon	1200	HHP	0.16	FP	1.14	FP	0.018	FP	30	FP
92	Imazapic	5000	FP	100	FP	100	FP	0.051	FP	100	FP
93	Imazapyr	2000	FP	100	FP	100	FP	71	FP	25	FP
94	Imidacloprid	450	HHP	211	FP	85	FP	10	FP	0.0037	FP
95	Imiprothrin	900	HHP	0.038	FP	0.051	FP	3.1	FP	0.33	CC
96	Indoxacarb	286	HHP	0.65	FP	0.6	FP	0.11	FP	0.094	FP
97	Isoxaflutole	5000	FP	1.7	FP	1.5	FP	0.12	FP	100	FP
98	Lambda-cyhalothrin	56	HHP	0.00021	FP	0.00036	FP	0.3	FP	0.038	FP
99	Linuron	1146	FP	3.15	FP	0.31	FP	0.016	FP	160	FP
100	Lufenuron	2000	FP	29	FP	0.0013	FP	8.8	FP	197	FP
101	Malathion	2100	HHP	0.018	FP	0.0007	FP	13	FP	0.16	FP
102	Mancozeb	5000	FP	0.074	FP	0.073	FP	0.044	FP	141	FP
103	MCPA	700	HHP	50	FP	190	FP	79.8	FP	200	FP
104	Mesotrione	5000	FP	120	FP	900	FP	3.5	FP	11	FP
105	Metalaxyl	670	HHP	100	FP	28	FP	33	FP	200	FP
106	Metalaxyl-M	375	HHP	100	FP	100	FP	36	FP	127	FP
107	Metaldehyde	227	HHP	75	FP	78.4	FP	75.9	FP	87.5	FP
109	Methamidophos	30	HHP	25	FP	0.27	FP	178	FP	0.22	FP
110	Methiocarb	20	HHP	0.65	FP	0.008	FP	2.2	FP	0.23	FP
111	Methomyl	17	HHP	0.63	FP	0.0076	FP	100	FP	0.16	FP
112	Methyl bromide	214	FP	3.9	FP	2.6	FP	3.2	FP	50	FP
113	Methyl isothiazolin one	631	PG	25.2	PG	21.1	PG	5.53	PG	62	PG
114	Methylchoroisothiazolinone	631	PG	25.2	PG	21.1	PG	5.53	PG	62	PG
115	Metolachlor	2780	HHP	3.9	FP	23.5	FP	57.1	FP	110	FP
116	Metribuzin	322	HHP	74.6	FP	49	FP	0.02	FP	53	FP
117	Metsulfuron-methyl	5000	FP	150	FP	150	FP	0.045	FP	25	FP
118	Mevinphos	3.5	FP	0.012	FP	0.00016	FP	71	FP	0.027	FP

119	Mineral oil	4323	CC	2.65	CC	0.256	CC	0.17	CC	26.3	PG
120	Molinate	720	HHP	16	FP	14.9	FP	0.5	FP	11	FP
121	Monocrotophos	14	HHP	7	FP	0.023	FP	88.3	CC	0.02	FP
122	Monosodium methyl arsenate	2782	PG	51.8	PG	92.4	PG	14.0	PG	88.6	PG
123	Nonylphenol	631	PG	25.2	PG	21.1	PG	5.53	PG	62	PG
124	Octylisothiazolinone	631	PG	25.2	PG	21.1	PG	5.53	PG	62	PG
125	Oxadiazon	5000	FP	1.2	FP	2.4	FP	0.004	FP	100	FP
126	Oxamyl	6	HHP	3.13	FP	0.319	FP	0.93	FP	0.38	FP
127	Oxyfluorfen	5000	FP	0.25	FP	0.72	FP	2	FP	100	FP
128	Paraquat	150	HHP	19	FP	4.4	FP	0.00023	FP	9.06	FP
129	pencycuron	5000	FP	0.3	FP	0.3	FP	0.3	FP	98.5	FP
130	Pendimethalin	1050	HHP	0.138	FP	0.28	FP	0.006	FP	100	FP
131	Permethrin	500	FP	0.0125	FP	0.0006	FP	0.0125	FP	0.029	FP
132	phenothrin	5000	FP	0.0027	FP	0.0043	FP	8.5	CC	0.33	CC
133	Phosphoric acid	454	FP	1667	CC	167	CC	73.9	CC	62.1	CC
134	Picloram	8200	HHP	8.8	FP	44.2	FP	60.2	FP	74	FP
135	Pine oil	3579	CC	51.8	PG	57	CC	14.0	PG	50.0	CC
136	Piperonyl butoxide	7220	FP	5.3	FP	0.51	FP	0.24	FP	294	FP
137	Pirimiphos methyl	1667	HHP	0.404	FP	0.00021	FP	1	FP	0.22	FP
138	Prallethrin	460	HHP	0.012	FP	0.0062	FP	8.47	CC	0.026	FP
139	Profenofos	358	HHP	0.08	FP	0.5	FP	88.3	CC	0.095	FP
140	Prometryn	3150	HHP	5.5	FP	12.66	FP	0.002	FP	99	FP
141	Propanil	1400	HHP	5.4	FP	2.39	FP	0.11	FP	94.3	FP
142	Propargite	2639	FP	0.043	FP	0.014	FP	1.08	FP	47.9	FP
143	Propineb	8500	HHP	0.4	FP	4.7	FP	2.68	FP	70	FP
144	Propoxur	50	FP	6.2	FP	0.15	FP	26.1	CC	1.35	FP
145	Pyrethrins	750	HHP	2.65	CC	0.26	CC	0.17	CC	26.3	PG
146	Quinclorac	2680	HHP	100	FP	29.8	FP	6.53	FP	181	FP
147	Quizalofop-P-tefuryl	1012	HHP	0.23	FP	1.51	FP	1.9	FP	100	FP
150	S-Metolachlor	2577	HHP	1.23	FP	26	FP	0.008	FP	85	FP

151	Spinosad	3738	HHP	30	FP	14	FP	0.09	FP	0.0029	FP
152	Sulcotrione	5000	FP	227	FP	848	FP	1.2	FP	50	FP
153	Sulfentrazone	2855	FP	93.8	FP	60.4	FP	32.8	FP	25.1	FP
154	Sulphur	2000	FP	0.063	FP	0.063	FP	0.063	FP	100	FP
155	Tebuconazole	1700	HHP	4.4	FP	2.79	FP	1.96	FP	83.05	FP
156	Tebuthiuron	644	HHP	87	FP	225	FP	0.05	FP	30	FP
157	Terbufos	2	HHP	0.004	FP	0.00031	FP	1.4	FP	4.1	FP
158	terbuthylazine	2160	HHP	2.2	FP	21.2	FP	0.012	FP	22.6	FP
159	Terbutryn	2500	FP	1.1	FP	2.66	FP	0.0024	FP	225	FP
160	Tetradifon	14700	FP	880	FP	2	FP	100	FP	11	FP
161	Tetramethrin	5000	FP	0.016	FP	0.045	FP	8.5	FP	0.16	FP
162	Thiamethoxam	1563	FP	125	FP	100	FP	100	FP	0.005	FP
163	Thiram	1800	FP	0.046	FP	0.011	FP	0.065	FP	100	FP
164	Transfluthrin	5000	FP	0.0007	FP	0.0017	FP	0.1	FP	26.3	PG
165	Triadimefon	300	FP	4.08	FP	7.16	FP	2.01	FP	25	FP
166	Triadimenol	900	HHP	21.3	FP	51	FP	9.6	FP	200	FP
167	Trichlorfon	212	FP	0.7	FP	0.00096	FP	10	FP	0.4	FP
170	Triclopyr	710	HHP	117	FP	131	FP	75.8	FP	100	FP
171	Tricozene	4323	CC	2.65	CC	0.256	CC	0.17	CC	62	PG
172	Trifloxystrobin	5000	FP	0.015	FP	0.011	FP	0.0053	FP	200	FP
173	Trifluralin	5000	FP	0.088	FP	0.245	FP	0.0122	FP	100	FP
174	Trifluthrin	972	CC	1.36	CC	0.0093	CC	8.5	CC	0.33	CC
175	Violeta Genciana	4323	CC	2.65	CC	0.256	CC	0.17	CC	26.3	PG

Annex 2 Human hazard

Tables:

1. Products with major contribution to the acute human hazard
2. Carcinogenic active ingredients
3. Mutagenic active ingredients
4. Active ingredients toxic to reproduction

Table 2.1: Products with major contribution to the acute human hazard: i.e. all Highly hazardous products (WHO class Ib) and the Moderately hazardous products (WHO class II) with a contribution > 1% of the annual volume of all products imported.

Year	Product ID	Product name	(kg)	(%)	WHO class
2002	1904	Phosgard 56% FT	1512	1.61	Ib
2002	1779	Nemacur 40% EC	500	0.53	Ib
2002	1406	Gramoxone 20% SL	8000	8.50	II
2002	2363	Tamaron 58% SL	2500	2.66	II
2002	2622	Villa Politrin 20% EC	2200	2.34	II
2002	818	Copper Oxychloride 85% WP	1500	1.59	II
2002	2535	Universal Metamidofos 58,5% SL	1500	1.59	II
2002	1827	Otrthene 75% SP	1200	1.28	II
2002	2501	Universal Cooper Oxychloride 85% WP	1000	1.06	II
2002	2563	Universal Skoffel 14.5% SL	1000	1.06	II
2002	2595	Villa MCPA 20% EC	1000	1.06	II
2003	1340	Fumaphos 56% FT	7015	1.05	Ib
2003	95	Aldicarb 15% GR	3800	0.57	Ib
2003	2376	Temik 15% GR	3200	0.48	Ib
2003	2866	Volcano Aldicarb 15% GR	2400	0.36	Ib
2003	97	Aluminium Phosphide 57% FT	2214	0.33	Ib
2003	1904	Phosgard 56% FT	2016	0.30	Ib
2003	2536	Universal Mevinfos 15% EC	1000	0.15	Ib
2003	1779	Nemacur 40% EC	750	0.11	Ib
2003	2634	Volamiphos 40% EC	750	0.11	Ib
2003	2537	Universal Monocrotofos 40% SL	500	0.07	Ib
2003	3011	Volcano Ametrin 50% EC	39920	5.96	II
2003	3172	Volcano cipermetrina 20% EC	35500	5.30	II
2003	1516	Karate 5% EC	27360	4.09	II
2003	1377	Gesapax 50% SC	25600	3.82	II
2003	883	Cipercal P 72% SL	25126	3.75	II
2003	1238	Ficam VC 80% WP	25038	3.74	II
2003	1406	Gramoxone 20% SL	21800	3.26	II
2003	98	Ametrin 50% SC	20600	3.08	II
2003	1322	Fortis Ultra 4.75% EC	14980	2.24	II
2003	3722	Volcano Methyl Bromide 100 %GA	10500	1.57	II
2003	1620	MCPA 400 SL	10100	1.51	II
2003	914	Cyperpro 72% EC	10000	1.49	II
2003	3668	Volcano MCPA 40% SL	9560	1.43	II
2003	3716	Volcano Methamidophos 58.5% SL	9000	1.34	II
2003	2746	Volcano 90 SL	7340	1.10	II
2003	2535	Universal Metamidofos 58,5% SL	7000	1.05	II
2004	1198	Falfume 57% FT	8000	0.61	Ib
2004	1957	Quickphos 56% FD	2880	0.22	Ib
2004	1904	Phosgard 56% FT	1512	0.11	Ib
2004	2878	Volcano Alluminium Phosphide 57% FT	1000	0.08	Ib
2004	2376	Temik 15% GR	600	0.05	Ib
2004	2866	Volcano Aldicarb 15% GR	560	0.04	Ib

2004	1906	Phoskill 40% SC	500	0.04	Ib
2004	1340	Fumaphos 56% FT	346	0.03	Ib
2004	2616	Villa Platoon 31% SL	250	0.02	Ib
2004	3011	Volcano Ametrin 50% EC	118820	9.00	II
2004	3286	Volcano Endosulfan 47.5% SC	71574	5.42	II
2004	1516	Karate 5% EC	41576	3.15	II
2004	3668	Volcano MCPA 40% SL	40180	3.04	II
2004	1406	Gramoxone 20% SL	36000	2.73	II
2004	1327	Fortis Xtra 8.8% EC	31250	2.37	II
2004	1321	Fortis K 5% EC	30750	2.33	II
2004	3716	Volcano Methamidophos 58.5% SL	30600	2.32	II
2004	4245	Zipper 20% EC	30240	2.29	II
2004	732	Ciclor 72% Ec	28050	2.12	II
2004	1455	Icon 10% WP	23345	1.77	II
2004	1377	Gesapax 50% SC	22400	1.70	II
2004	1238	Ficam VC 80% WP	17500	1.33	II
2004	3131	Volcano Cooper Oxychloride 85% WP	15500	1.17	II
2004	2746	Volcano 90 SL	15424	1.17	II
2005	2866	Volcano Aldicarb 15% GR	11400	0.71	Ib
2005	2878	Volcano Alluminium Phosphide 57% FT	3315	0.21	Ib
2005	2634	Volamiphos 40% EC	2000	0.12	Ib
2005	1340	Fumaphos 56% FT	378	0.02	Ib
2005	1904	Phosgard 56% FT	210	0.01	Ib
2005	4171	Vydate 31% SL	160	0.01	Ib
2005	139	Avi-DDT 75% WP	136000	8.49	II
2005	3011	Volcano Ametrin 50% EC	117000	7.31	II
2005	1455	Icon 10% WP	60698	3.79	II
2005	4080	Volmetra 50% SC	50800	3.17	II
2005	3716	Volcano Methamidophos 58.5% SL	50120	3.13	II
2005	1327	Fortis Xtra 8.8% EC	43100	2.69	II
2005	1321	Fortis K 5% EC	32820	2.05	II
2005	3287	Volcano Endosulfan 50% EC	24000	1.50	II
2005	1238	Ficam VC 80% WP	20000	1.25	II
2005	3131	Volcano Cooper Oxychloride 85% WP	19500	1.22	II
2005	3172	Volcano cipermetrina 20% EC	18764	1.17	II
2005	883	Cipercal P 72% SL	18000	1.12	II
2006	1198	Falfume 57% FT	6001	0.30	Ib
2006	2878	Volcano Alluminium Phosphide 57% FT	4311	0.21	Ib
2006	2634	Volamiphos 40% EC	1025	0.05	Ib
2006	1904	Phosgard 56% FT	210	0.01	Ib
2006	1340	Fumaphos 56% FT	126	0.01	Ib
2006	1954	Provoke 75% WG	369339	18.19	II
2006	3011	Volcano Ametrin 50% EC	132880	6.54	II
2006	1321	Fortis K 5% EC	68060	3.35	II
2006	4241	Zakanaka Top 10% EC	53910	2.66	II
2006	4198	Zakanaka K 6% EC	52440	2.58	II
2006	4080	Volmetra 50% SC	41080	2.02	II
2006	1238	Ficam VC 80% WP	36200	1.78	II
2006	3668	Volcano MCPA 40% SL	31810	1.57	II
2006	3172	Volcano cipermetrina 20% EC	24500	1.21	II
2006	4219	Zakaka Pro 64,8% EC	24290	1.20	II
2006	3716	Volcano Methamidophos 58.5% SL	23220	1.14	II
2006	3131	Volcano Cooper Oxychloride 85% WP	22750	1.12	II
2006	4134	Volquato 20% SL	20900	1.03	II
2007	1198	Falfume 57% FT	8800	0.69	Ib
2007	2878	Volcano Alluminium Phosphide 57% FT	6021	0.47	Ib
2007	2634	Volamiphos 40% EC	1500	0.12	Ib
2007	1906	Phoskill 40% SC	1200	0.09	Ib
2007	1957	Quickphos 56% FD	599	0.05	Ib
2007	1904	Phosgard 56% FT	210	0.02	Ib
2007	4171	Vydate 31% SL	120	0.01	Ib
2007	1340	Fumaphos 56% FT	42	0.00	Ib
2007	3011	Volcano Ametrin 50% EC	92140	7.21	II

2007	3668	Volcano MCPA 40% SL	54760	4.29	II
2007	3716	Volcano Methamidophos 58.5% SL	42800	3.35	II
2007	4198	Zakanaka K 6% EC	38000	2.97	II
2007	4219	Zakaka Pro 64,8% EC	35000	2.74	II
2007	1238	Ficam VC 80% WP	32719	2.56	II
2007	1575	Lambda cyhalothrin 5% EC	30090	2.35	II
2007	882	Cyper pro 72% EC	29200	2.29	II
2007	4241	Zakanaka Top 10% EC	27880	2.18	II
2007	4134	Volquato 20% SL	21360	1.67	II
2007	3287	Volcano Endosulfan 50% EC	21000	1.64	II
2007	1321	Fortis K 5% EC	17750	1.39	II
2007	830	Courage 70% WS	17000	1.33	II
2007	4080	Volmetra 50% SC	14840	1.16	II
2007	3131	Volcano Cooper Oxychloride 85% WP	13923	1.09	II
2008	2066	Rotam Terbufos 15% GR	31000	1.53	Ib
2008	1904	Phosgard 56% FT	2079	0.10	Ib
2008	4171	Vydate 31% SL	300	0.01	Ib
2008	1954	Provoke 75% WG	513300	25.28	II
2008	1321	Fortis K 5% EC	98970	4.87	II
2008	3668	Volcano MCPA 40% SL	71100	3.50	II
2008	3011	Volcano Ametrin 50% EC	62800	3.09	II
2008	4198	Zakanaka K 6% EC	60500	2.98	II
2008	4219	Zakaka Pro 64,8% EC	45000	2.22	II
2008	3131	Volcano Cooper Oxychloride 85% WP	33010	1.63	II
2008	2746	Volcano 90 SL	27900	1.37	II
2008	4241	Zakanaka Top 10% EC	26500	1.31	II
2008	1406	Gramoxone 20% SL	21000	1.03	II
2008	3172	Volcano cipermetrina 20% EC	20500	1.01	II
2009	662	Bongo	45000	1.94	Ib
2009	2878	Volcano Alluminium Phosphide 57% FT	6510	0.28	Ib
2009	1553	Kuik	1000	0.04	Ib
2009	4171	Vydate 31% SL	480	0.02	Ib
2009	1904	Phosgard 56% FT	462	0.02	Ib
2009	3011	Volcano Ametrin 50% EC	161140	6.96	II
2009	2020	Revival 10% WP	120333	5.20	II
2009	3668	Volcano MCPA 40% SL	60360	2.61	II
2009	3131	Volcano Cooper Oxychloride 85% WP	54660	2.36	II
2009	1321	Fortis K 5% EC	42750	1.85	II
2009	4134	Volquato 20% SL	42240	1.82	II
2009	4198	Zakanaka K 6% EC	32760	1.41	II
2009	3180	Volcano D 2,4 72% SL	32000	1.38	II
2009	3716	Volcano Methamidophos 58.5% SL	28830	1.24	II
2009	2677	Volcano 2,4 D 72% SL	28000	1.21	II
2009	4241	Zakanaka Top 10% EC	27230	1.18	II
2009	1238	Ficam VC 80% WP	26054	1.12	II
2010	2878	Volcano Alluminium Phosphide 57% FT	15519	0.58	Ib
2010	1198	Falfume 57% FT	13800	0.52	Ib
2010	1752	Moz Abamec Plus 18% EC	800	0.03	Ib
2010	1904	Phosgard 56% FT	525	0.02	Ib
2010	4171	Vydate 31% SL	500	0.02	Ib
2010	2020	Revival 10% WP	214300	8.00	II
2010	3011	Volcano Ametrin 50% EC	136060	5.08	II
2010	4241	Zakanaka Top 10% EC	63980	2.39	II
2010	3668	Volcano MCPA 40% SL	53440	2.00	II
2010	3131	Volcano Cooper Oxychloride 85% WP	52130	1.95	II
2010	2677	Volcano 2,4 D 72% SL	47000	1.76	II
2010	4219	Zakaka Pro 64,8% EC	42100	1.57	II
2010	4062	Volmet 58,5% SL	34760	1.30	II
2010	3172	Volcano cipermetrina 20% EC	32760	1.22	II
2010	1321	Fortis K 5% EC	30060	1.12	II
2011	2878	Volcano Alluminium Phosphide 57% FT	11970	0.46	Ib
2011	1904	Phosgard 56% FT	1470	0.06	Ib
2011	1756	Moz Aluminium Phosphide 56% FT	1250	0.05	Ib

2011	4171	Vydate 31% SL	300	0.01	Ib
2011	1752	Moz Abamec Plus 18% EC	240	0.01	Ib
2011	3011	Volcano Ametrin 50% EC	134900	5.20	II
2011	1203	Fendona 5% WP	75600	2.92	II
2011	3030	Volcano Copper Oxychloride 85% WP	70700	2.73	II
2011	4219	Zakaka Pro 64,8% EC	65500	2.53	II
2011	4241	Zakanaka Top 10% EC	60500	2.33	II
2011	3668	Volcano MCPA 40% SL	60200	2.32	II
2011	4198	Zakanaka K 6% EC	55300	2.13	II
2011	4134	Volquato 20% SL	35100	1.35	II
2011	1321	Fortis K 5% EC	35000	1.35	II
2011	2677	Volcano 2,4 D 72% SL	32600	1.26	II
2011	3172	Volcano cipermetrina 20% EC	30450	1.17	II

Table 2.2: Carcinogenic active ingredients with the contribution to the annual volume of active ingredients imported (in %).

Year	Compound ID	Compound name	(kg)	(%)
2002	102	Mancozeb	2000	10.7
2002	57	Dichlorvos	461	2.46
2002	131	Permethrin	24	0.13
2003	64	Diuron	20400	6.53
2003	102	Mancozeb	15248	4.88
2003	57	Dichlorvos	1641	0.53
2003	37	Chlorothalonil	400	0.13
2003	8	Alachlor	384	0.12
2003	131	Permethrin	18	0.01
2004	102	Mancozeb	44848	7.72
2004	64	Diuron	44672	7.69
2004	57	Dichlorvos	6162	1.06
2004	37	Chlorothalonil	1537	0.26
2004	8	Alachlor	384	0.07
2004	131	Permethrin	28	0.005
2005	64	Diuron	40976	5.90
2005	102	Mancozeb	20080	2.89
2005	57	Dichlorvos	1513	0.22
2005	37	Chlorothalonil	1382	0.20
2005	131	Permethrin	40	0.01
2006	64	Diuron	40312	4.49
2006	102	Mancozeb	23666	2.63
2006	57	Dichlorvos	5323	0.59
2006	8	Alachlor	1260	0.14
2006	37	Chlorothalonil	691	0.08
2006	131	Permethrin	28	0.003
2007	64	Diuron	33568	6.05
2007	102	Mancozeb	30936	5.57
2007	64	Diuron	23072	4.16
2007	102	Mancozeb	15782	2.84
2007	57	Dichlorvos	6376	1.15
2007	57	Dichlorvos	3551	0.64
2007	8	Alachlor	1800	0.32
2007	125	Oxadiazon	950	0.17
2007	37	Chlorothalonil	850	0.15
2007	131	Permethrin	246	0.04
2007	131	Permethrin	34	0.01
2007	30	Carbaryl	20	0.004
2009	64	Diuron	48899	5.69
2009	102	Mancozeb	30003	3.49
2009	125	Oxadiazon	5000	0.58
2009	57	Dichlorvos	2433	0.28
2009	37	Chlorothalonil	1000	0.12
2009	97	Isoxaflutole	750	0.09
2009	131	Permethrin	49	0.01
2009	84	Formaldehyde	13	0.00
2010	102	Mancozeb	53574	5.58
2010	64	Diuron	37889	3.95
2010	37	Chlorothalonil	5500	0.57
2010	57	Dichlorvos	2921	0.30
2010	97	Isoxaflutole	1920	0.20
2010	127	Oxyfluorfen	216	0.02
2010	131	Permethrin	114	0.01
2010	84	Formaldehyde	50	0.01
2010	30	Carbaryl	8	0.001
2011	102	Mancozeb	61075	6.48

2011	64	Diuron	43312	4.60
2011	57	Dichlorvos	5421	0.58
2011	84	Formaldehyde	1074	0.11
2011	37	Chlorothalonil	750	0.08
2011	131	Permethrin	84	0.01
2011	30	Carbaryl	84	0.01
2011	97	Isoxaflutole	15	0.002

Table 2.3: Mutagenic active ingredients with the contribution to the annual volume of active ingredients imported (in %).

Year	Compound ID	Compound name	(kg)	(%)
2004	20	Benomyl	735	0.13
2005	20	Benomyl	200	0.029
2006	20	Benomyl	200	0.022
2007	31	Carbendazim	1.3	0.0002
2008	31	Carbendazim	5	0.001
2009	20	Benomyl	500	0.058
2009	31	Carbendazim	54	0.006
2010	20	Benomyl	2800	0.29
2010	31	Carbendazim	0.4	0.00004
2011	31	Carbendazim	0.6	0.0001

Table 2.4: Active ingredients toxic to reproduction with the contribution to the annual volume of active ingredients imported (in %).

Year	Compound ID	Compound name	(kg)	(%)
2004	20	Benomyl	735	0.13
2005	20	Benomyl	200	0.029
2006	20	Benomyl	200	0.022
2007	31	Carbendazim	1.3	0.0002
2008	31	Carbendazim	5	0.001
2009	20	Benomyl	500	0.058
2009	31	Carbendazim	54	0.006
2010	20	Benomyl	2800	0.29
2010	31	Carbendazim	0.4	0.00004
2011	31	Carbendazim	0.6	0.0001

Annex 3 Environmental toxic Loads

Tables:

1. Active ingredients with the major contribution to the annual ETL for fish
2. Active ingredients with the major contribution to the annual ETL for Daphnia
3. Active ingredients with the major contribution to the annual ETL for algae
4. Active ingredients with the major contribution to the annual ETL for bees

Table 3.1: Active ingredients with the major contribution to the annual ETL for fish (i.e. > 0.5 %).

Year	RankNr	Compound Nr.	Compound name	(kg)	(%)
2002	1	38	Chlorpyrifos	240	30.1
2002	2	49	Cypermethrin	440	25.6
2002	3	11	Aluminium phosphide	847	14.2
2002	4	47	Cyfluthrin	37	12.7
2002	5	65	Endosulfan	70	5.7
2002	6	102	Mancozeb	2000	4.4
2002	7	72	Fenamiphos	200	3.5
2002	8	154	Sulphur	800	2.1
2002	9	142	Propargite	240	0.9
2003	1	98	Lambda-cyhalothrin	2158	56.8
2003	2	49	Cypermethrin	12317	24.3
2003	3	38	Chlorpyrifos	1699	7.2
2003	4	11	Aluminium phosphide	6319	3.6
2003	5	23	Beta-cyfluthrin	30	2.4
2003	6	139	Profenofos	22226	1.5
2003	7	102	Mancozeb	15248	1.1
2004	1	98	Lambda-cyhalothrin	7992	50.1
2004	2	65	Endosulfan	34103	22.4
2004	3	38	Chlorpyrifos	18078	18.3
2004	4	49	Cypermethrin	12034	5.7
2004	5	11	Aluminium phosphide	7783	1.1
2004	6	102	Mancozeb	44848	0.8
2004	7	23	Beta-cyfluthrin	40	0.8
2005	1	98	Lambda-cyhalothrin	12377	80.8
2005	2	65	Endosulfan	12140	8.3
2005	3	49	Cypermethrin	6813	3.3
2005	4	23	Beta-cyfluthrin	111	2.2
2005	5	38	Chlorpyrifos	1200	1.3
2005	6	77	Fenvalerate	3050	1.2
2005	7	73	Fenbutatin oxide	550	0.7
2006	1	98	Lambda-cyhalothrin	11698	84.4
2006	2	65	Endosulfan	7885	6.0
2006	3	49	Cypermethrin	7857	4.3
2006	4	38	Chlorpyrifos	1536	1.8
2006	5	11	Aluminium phosphide	6066	0.9
2006	6	139	Profenofos	27471	0.5
2006	7	23	Beta-cyfluthrin	23	0.5
2007	1	98	Lambda-cyhalothrin	8216	67.2
2007	2	65	Endosulfan	10588	9.1
2007	3	55	Deltamethrin	1204	7.9
2007	4	38	Chlorpyrifos	3056	4.0
2007	5	49	Cypermethrin	6174	3.8
2007	6	77	Fenvalerate	5439	2.6
2007	7	11	Aluminium phosphide	8925	1.6
2007	8	73	Fenbutatin oxide	605	0.9

2007	9	139	Profenofos	39720	0.9
2007	10	102	Mancozeb	30936	0.7
2007	11	23	Beta-cyfluthrin	23	0.6
2008	1	98	Lambda-cyhalothrin	13263	81.4
2008	2	55	Deltamethrin	1579	7.8
2008	3	38	Chlorpyrifos	3223	3.2
2008	4	49	Cypermethrin	5450	2.5
2008	5	157	Terbufos	4650	1.5
2008	6	65	Endosulfan	1050	0.7
2009	1	98	Lambda-cyhalothrin	20403	89.4
2009	2	38	Chlorpyrifos	4366	3.1
2009	3	157	Terbufos	6750	1.6
2009	4	49	Cypermethrin	4139	1.4
2009	5	77	Fenvalerate	4000	1.0
2009	6	73	Fenbutatin oxide	1164	0.9
2009	7	55	Deltamethrin	189	0.7
2010	1	98	Lambda-cyhalothrin	30610	89.4
2010	2	38	Chlorpyrifos	11772	5.6
2010	3	49	Cypermethrin	8335	1.8
2010	4	11	Aluminium phosphide	17006	1.1
2011	1	98	Lambda-cyhalothrin	12760	83.4
2011	2	38	Chlorpyrifos	4279	4.5
2011	3	49	Cypermethrin	6926	3.4
2011	4	10	Alpha-cypermethrin	3780	1.9
2011	5	65	Endosulfan	2548	1.7
2011	6	11	Aluminium phosphide	8346	1.2
2011	7	102	Mancozeb	61075	1.1
2011	8	139	Profenofos	55130	0.9
2011	9	55	Deltamethrin	145	0.8

Table 3.2: Active ingredients with the major contribution to the annual ETL for Daphnia (i.e. > 0.5 %).

Year	RankNr	Compound Nr.	Compound name	(kg)	(%)
2002	1	57	Dichlorvos	461	32.2
2002	2	38	Chlorpyrifos	240	31.8
2002	3	49	Cypermethrin	440	19.5
2002	4	137	Pirimiphos methyl	96	6.1
2002	5	39	Chlorpyrifos-methyl	200	4.4
2002	6	47	Cyfluthrin	37	3.0
2002	7	72	Fenamiphos	200	1.4
2002	8	131	Permethrin	24	0.5
2003	1	49	Cypermethrin	12317	43.9
2003	2	38	Chlorpyrifos	1699	18.2
2003	3	137	Pirimiphos methyl	3069	15.6
2003	4	57	Dichlorvos	1641	9.2
2003	5	98	Lambda-cyhalothrin	2158	6.4
2003	6	77	Fenvalerate	76	2.7
2003	7	118	Mevinphos	150	1.0
2003	8	19	Bendiocarb	20030	0.7
2003	9	33	Carbosulfan	835	0.6
2004	1	38	Chlorpyrifos	18078	60.4
2004	2	49	Cypermethrin	12034	13.4
2004	3	57	Dichlorvos	6162	10.8
2004	4	98	Lambda-cyhalothrin	7992	7.4
2004	5	137	Pirimiphos methyl	4094	6.5
2005	1	77	Fenvalerate	3050	38.6
2005	2	68	Ethion	2525	17.1
2005	3	98	Lambda-cyhalothrin	12377	13.1
2005	4	49	Cypermethrin	6813	8.6
2005	5	53	DDT	102000	7.7
2005	6	137	Pirimiphos methyl	2876	5.2
2005	7	38	Chlorpyrifos	1200	4.6
2005	8	57	Dichlorvos	1513	3.0
2005	9	35	Chlorfenvinphos	600	0.9
2006	1	53	DDT	285929	26.5
2006	2	68	Ethion	2525	20.9
2006	3	98	Lambda-cyhalothrin	11698	15.1
2006	4	57	Dichlorvos	5323	13.0
2006	5	49	Cypermethrin	7857	12.1
2006	6	38	Chlorpyrifos	1536	7.1
2006	7	77	Fenvalerate	100	1.5
2006	8	137	Pirimiphos methyl	538	1.2
2006	9	35	Chlorfenvinphos	636	1.2
2007	1	77	Fenvalerate	5439	51.5
2007	2	68	Ethion	3030	15.4
2007	3	57	Dichlorvos	6376	9.5
2007	4	38	Chlorpyrifos	3056	8.7
2007	5	98	Lambda-cyhalothrin	8216	6.5
2007	6	49	Cypermethrin	6174	5.8
2007	7	137	Pirimiphos methyl	857	1.2
2007	8	55	Deltamethrin	1204	0.6
2008	1	53	DDT	384975	31.4
2008	2	98	Lambda-cyhalothrin	13263	15.0
2008	3	38	Chlorpyrifos	3223	13.2
2008	4	77	Fenvalerate	800	10.9
2008	5	57	Dichlorvos	3551	7.6
2008	6	49	Cypermethrin	5450	7.4
2008	7	157	Terbufos	4650	6.1
2008	8	137	Pirimiphos methyl	2490	4.8
2008	9	55	Deltamethrin	1579	1.2

2008	10	35	Chlorfenvinphos	375	0.6
2009	1	77	Fenvalerate	4000	45.5
2009	2	98	Lambda-cyhalothrin	20403	19.4
2009	3	38	Chlorpyrifos	4366	14.9
2009	4	157	Terbufos	6750	7.4
2009	5	49	Cypermethrin	4139	4.7
2009	6	57	Dichlorvos	2433	4.4
2009	7	137	Pirimiphos methyl	1010	1.6
2010	1	38	Chlorpyrifos	11772	42.5
2010	2	98	Lambda-cyhalothrin	30610	30.7
2010	3	49	Cypermethrin	8335	10.0
2010	4	77	Fenvalerate	500	6.0
2010	5	57	Dichlorvos	2921	5.5
2010	6	137	Pirimiphos methyl	1966	3.4
2010	7	3	Abamectin	189	0.7
2011	1	38	Chlorpyrifos	4279	27.9
2011	2	98	Lambda-cyhalothrin	12760	23.1
2011	3	57	Dichlorvos	5421	18.6
2011	4	49	Cypermethrin	6926	15.1
2011	5	10	Alpha-cypermethrin	3780	8.2
2011	6	137	Pirimiphos methyl	1394	4.3
2011	7	3	Abamectin	115	0.8
2011	8	102	Mancozeb	61075	0.5

Table 3.3: Active ingredients with the major contribution to the annual ETL for algae (i.e. > 0.5 %).

Year	RankNr	Compound Nr.	Compound name	(kg)	(%)
2002	1	128	Paraquat	1745	98.5
2002	2	102	Mancozeb	2000	0.6
2003	1	7	Acetochlor	14652	56.5
2003	2	128	Paraquat	4721	21.4
2003	3	12	Ametryn	43060	12.5
2003	4	64	Diuron	20400	7.9
2004	1	7	Acetochlor	33768	63.0
2004	2	128	Paraquat	7418	16.3
2004	3	12	Ametryn	70610	9.9
2004	4	64	Diuron	44672	8.3
2004	5	159	Terbutryn	6203	1.3
2004	6	102	Mancozeb	44848	0.5
2005	1	7	Acetochlor	59061	76.0
2005	2	128	Paraquat	5377	8.1
2005	3	12	Ametryn	82480	8.0
2005	4	64	Diuron	40976	5.3
2005	5	140	Prometryn	5280	0.9
2005	6	130	Pendimethalin	15170	0.9
2006	1	7	Acetochlor	41454	68.7
2006	2	128	Paraquat	6604	12.8
2006	3	12	Ametryn	76710	9.5
2006	4	64	Diuron	40312	6.7
2006	5	130	Pendimethalin	14220	1.1
2007	1	7	Acetochlor	30591	71.3
2007	2	128	Paraquat	4272	11.7
2007	3	12	Ametryn	51060	8.9
2007	4	64	Diuron	23072	5.4
2007	5	130	Pendimethalin	11240	1.2
2008	1	7	Acetochlor	72239	84.3
2008	2	128	Paraquat	4600	6.3
2008	3	64	Diuron	33568	3.9
2008	4	12	Ametryn	41040	3.6
2008	5	130	Pendimethalin	26130	1.4
2009	1	7	Acetochlor	66996	74.5
2009	2	128	Paraquat	8448	11.0
2009	3	12	Ametryn	80570	6.7
2009	4	64	Diuron	48899	5.4
2009	5	130	Pendimethalin	20090	1.0
2010	1	7	Acetochlor	80856	81.8
2010	2	128	Paraquat	4540	5.4
2010	3	12	Ametryn	68030	5.2
2010	4	64	Diuron	37889	3.8
2010	5	130	Pendimethalin	61120	2.8
2011	1	7	Acetochlor	57456	74.6
2011	2	128	Paraquat	7020	10.7
2011	3	12	Ametryn	67450	6.6
2011	4	64	Diuron	43312	5.6
2011	5	130	Pendimethalin	27180	1.6

Table 3.4: Active ingredients with the major contribution to the annual ETL for bees (i.e. > 0.5 %)

Year	RankNr	Compound Nr.	Compound name	(kg)	(%)
2002	1	94	Imidacloprid	269	46.0
2002	2	47	Cyfluthrin	37	23.3
2002	3	49	Cypermethrin	440	13.9
2002	4	109	Methamidophos	2340	6.7
2002	5	38	Chlorpyrifos	240	2.6
2002	6	11	Aluminium phosphide	847	2.2
2002	7	39	Chlorpyrifos-methyl	200	1.2
2002	8	57	Dichlorvos	461	1.0
2002	9	32	Carbofuran	50	0.9
2002	10	131	Permethrin	24	0.5
2003	1	49	Cypermethrin	12317	41.6
2003	2	139	Profenofos	22226	15.8
2003	3	19	Bendiocarb	20030	13.5
2003	4	162	Thiamethoxam	521	7.0
2003	5	109	Methamidophos	12578	3.9
2003	6	98	Lambda-cyhalothrin	2158	3.8
2003	7	47	Cyfluthrin	41	2.8
2003	8	23	Beta-cyfluthrin	30	2.0
2003	9	38	Chlorpyrifos	1699	1.9
2003	10	11	Aluminium phosphide	6319	1.8
2003	11	9	Aldicarb	1410	1.1
2003	12	137	Pirimiphos methyl	3069	0.9
2003	13	3	Abamectin	23	0.7
2003	14	121	Monocrotophos	200	0.7
2004	1	49	Cypermethrin	12034	29.4
2004	2	38	Chlorpyrifos	18078	15.0
2004	3	162	Thiamethoxam	1488	14.5
2004	4	98	Lambda-cyhalothrin	7992	10.3
2004	5	19	Bendiocarb	14000	6.8
2004	6	94	Imidacloprid	332	4.4
2004	7	109	Methamidophos	19656	4.4
2004	8	139	Profenofos	5150	2.6
2004	9	47	Cyfluthrin	54	2.6
2004	10	23	Beta-cyfluthrin	40	2.0
2004	11	11	Aluminium phosphide	7783	1.6
2004	12	3	Abamectin	58	1.3
2004	13	57	Dichlorvos	6162	1.0
2004	14	137	Pirimiphos methyl	4094	0.9
2004	15	63	Dimethoate	1440	0.6
2004	16	89	Hexaconazole	1147	0.6
2005	1	94	Imidacloprid	2161	25.0
2005	2	49	Cypermethrin	6813	14.6
2005	3	98	Lambda-cyhalothrin	12377	13.9
2005	4	139	Profenofos	19977	9.0
2005	5	162	Thiamethoxam	910	7.8
2005	6	19	Bendiocarb	16000	6.8
2005	7	109	Methamidophos	35024	6.8
2005	8	23	Beta-cyfluthrin	111	4.8
2005	9	47	Cyfluthrin	90	3.9
2005	10	78	Fipronil	120	1.2
2005	11	53	DDT	102000	0.9
2005	12	38	Chlorpyrifos	1200	0.9
2005	13	9	Aldicarb	1710	0.8
2005	14	89	Hexaconazole	1733	0.7

2005	15	77	Fenvalerate	3050	0.6
2005	16	137	Pirimiphos methyl	2876	0.6
2006	1	94	Imidacloprid	12367	66.9
2006	2	49	Cypermethrin	7857	7.9
2006	3	98	Lambda-cyhalothrin	11698	6.2
2006	4	19	Bendiocarb	28960	5.8
2006	5	139	Profenofos	27471	5.8
2006	6	109	Methamidophos	14110	1.3
2006	7	53	DDT	285929	1.1
2006	8	47	Cyfluthrin	46	0.9
2006	9	89	Hexaconazole	3464	0.7
2006	10	78	Fipronil	120	0.6
2006	11	38	Chlorpyrifos	1536	0.5
2006	12	11	Aluminium phosphide	6066	0.5
2007	1	94	Imidacloprid	12924	59.1
2007	2	55	Deltamethrin	1204	13.6
2007	3	139	Profenofos	39720	7.1
2007	4	49	Cypermethrin	6174	5.2
2007	5	19	Bendiocarb	26175	4.4
2007	6	98	Lambda-cyhalothrin	8216	3.7
2007	7	109	Methamidophos	33521	2.6
2007	8	38	Chlorpyrifos	3056	0.9
2007	9	11	Aluminium phosphide	8925	0.6
2008	1	94	Imidacloprid	14802	61.3
2008	2	55	Deltamethrin	1579	16.1
2008	3	98	Lambda-cyhalothrin	13263	5.3
2008	4	139	Profenofos	29802	4.8
2008	5	49	Cypermethrin	5450	4.2
2008	6	19	Bendiocarb	10816	1.7
2008	7	53	DDT	384975	1.2
2008	8	109	Methamidophos	12969	0.9
2008	9	38	Chlorpyrifos	3223	0.8
2008	10	47	Cyfluthrin	47	0.7
2008	11	3	Abamectin	79	0.6
2009	1	94	Imidacloprid	5955	44.1
2009	2	98	Lambda-cyhalothrin	20403	14.7
2009	3	19	Bendiocarb	21243	5.8
2009	4	49	Cypermethrin	4139	5.7
2009	5	78	Fipronil	840	5.5
2009	6	47	Cyfluthrin	188	5.2
2009	7	139	Profenofos	14256	4.1
2009	8	55	Deltamethrin	189	3.4
2009	9	109	Methamidophos	23886	3.0
2009	10	162	Thiamethoxam	465	2.5
2009	11	38	Chlorpyrifos	4366	2.0
2009	12	3	Abamectin	82	1.0
2010	1	94	Imidacloprid	3781	26.2
2010	2	98	Lambda-cyhalothrin	30610	20.6
2010	3	49	Cypermethrin	8335	10.7
2010	4	78	Fipronil	1586	9.7
2010	5	139	Profenofos	27170	7.3
2010	6	38	Chlorpyrifos	11772	5.1
2010	7	162	Thiamethoxam	950	4.9
2010	8	47	Cyfluthrin	166	4.3
2010	9	109	Methamidophos	20335	2.4
2010	10	3	Abamectin	189	2.2
2010	11	55	Deltamethrin	120	2.1
2010	12	11	Aluminium phosphide	17006	1.8
2010	13	19	Bendiocarb	4648	1.2
2011	1	94	Imidacloprid	3553	29.1
2011	2	139	Profenofos	55130	17.6
2011	3	162	Thiamethoxam	1917	11.6
2011	4	49	Cypermethrin	6926	10.5

2011	5	98	Lambda-cyhalothrin	12760	10.2
2011	6	19	Bendiocarb	11648	3.5
2011	7	10	Alpha-cypermethrin	3780	3.5
2011	8	47	Cyfluthrin	101	3.1
2011	9	55	Deltamethrin	145	2.9
2011	10	38	Chlorpyrifos	4279	2.2
2011	11	3	Abamectin	115	1.6
2011	12	11	Aluminium phosphide	8346	1.1
2011	13	109	Methamidophos	7634	1.1
2011	14	57	Dichlorvos	5421	0.6
2011	15	151	Spinosad	52	0.5

Annex 4: Groundwater leaching

Tables:

1. GUS and groundwater leaching potential class of the active ingredients
2. Active ingredients with the Very high and High groundwater leaching potential class.

Table 4.1: The GUS and groundwater leaching potential class of the active ingredients in the imported products.

Nr.	Compound Name	GUS	Class
1	2,4-D	2.5	3
2	2,4-D dimethylamine	3.0	3
3	Abamectin	-0.2	1
4	Acephate	0.73	1
5	Acetamiprid	0.81	1
6	Acetic acid + ammonia	-0.3	1
7	Acetochlor	2.1	3
8	Alachlor	1.7	2
9	Aldicarb	1.7	2
10	Alpha-cypermethrin	-1.2	1
11	Aluminium phosphide	-2.8	1
12	Ametryn	2.4	3
13	Amicarbazone	3.3	4
14	Amitraz	-5	1
15	Atrazine	3.5	4
16	Azoxystrobin	2.4	3
18	Bacillus thuringiensis	-1.3	1
19	Bendiocarb	0.85	1
20	Benomyl	-3.6	1
21	Bensulfuron-methyl	2.0	2
22	Bentazone	3.5	4
23	Beta-cyfluthrin	-0.9	1
24	Brodifacoum	-1.5	1
25	Bromacil	4.4	5
26	Bromoxynil octanoate	0	1
27	Bupirimate	2.4	3
28	Butralin	-0.9	1
29	Captan	0	1
30	Carbaryl	1.8	2
31	Carbendazim	2.6	3
32	Carbofuran	3.3	4
33	Carbosulfan	0.030	1
34	Carboxin	-10.0	1
35	Chlorfenvinphos	2.1	3
36	Chlorimuron	2.4	3
37	Chlorothalonil	1.2	2
38	Chlorpyrifos	0.15	1
39	Chlorpyrifos-methyl	0.64	1

40	Citronella oil	-5.7	1
41	Clomazone	3.1	4
42	Copper ammonium acetate	2.1	3
43	Copper hydroxide	-0.3	1
44	Copper oxide	2.3	3
45	Copper oxychloride	2.3	3
46	Cycloxydim	0	1
47	Cyfluthrin	0.33	1
48	cymoxanil	0	1
49	Cypermethrin	-2.1	1
50	Cyromazine	1.7	2
51	D-allethrin	1.5	2
52	Dazomet	-15	1
53	DDT	-4.5	1
54	Decanol	-5.7	1
55	Deltamethrin	-4.4	1
56	Diazinon	2.1	3
57	Dichlorvos	0.69	1
58	Didecyldimethylammonium chloride	-6.9	1
59	Diethyltoluamide	3.3	4
60	Difenoconazole	0.87	1
61	Difethialone	-10.5	1
62	Diiflubenzuron	0	1
63	Dimethoate	2.3	3
64	Diuron	2.1	3
65	Endosulfan	-0.1	1
66	Epoxiconazole	1.9	2
67	Ethephon	0.72	1
68	Ethion	0	1
69	Ethylbutylacetylaminopropionate	-5.7	1
70	Ethylene dibromide	-5.7	1
71	Ethylene oxide	-5.7	1
72	Fenamiphos	0	1
73	Fenbutatin oxide	-2.5	1
74	Fenitrothion	0.92	1
75	Fenpropathrin	0.44	1
76	Fenthion	1.3	2
77	Fenvalerate	0.43	1
78	Fipronil	2.7	3
80	Fluazifop-P-butyl	0.22	1
81	Flumethrin	-2.4	1
82	Fluometuron	-0.3	1
83	fluroxypyr	-0.8	1
84	Formaldehyde	1.9	2
85	Furfural	0	1
86	Glyphosate	1.0	2
87	Halosulfuron	-0.4	1
88	Halosulfuron-methyl	2.2	3
89	Hexaconazole	2.3	3
90	Hexazinone	4.6	5
91	Hydramethylnon	-1.6	1

92	Imazapic	3.9	4
93	Imazapyr	2.0	2
94	Imidacloprid	3.8	4
95	Imiprothrin	0.98	1
96	Indoxacarb	0.23	1
97	Isoxaflutole	0.55	1
98	Lambda-cyhalothrin	-1.7	1
99	Linuron	1.9	2
100	Lufenuron	-0.7	1
101	Malathion	0	1
102	Mancozeb	1.3	2
103	MCPA	2.9	3
104	Mesotrione	2.3	3
105	Metalaxyl	3.3	4
106	Metalaxyl-M	2.8	3
107	Metalddehyde	1.5	2
109	Methamidophos	1.2	2
110	Methiocarb	1.8	2
111	Methomyl	3.2	4
112	Methyl bromide	4.6	5
113	Methyl isothiazolin one	-5.7	1
114	Methylchoroisothiazolinone	-5.7	1
115	Metolachlor	2.9	3
116	Metribuzin	2.6	3
117	Metsulfuron-methyl	2.4	3
118	Mevinphos	-11.8	1
119	Mineral oil	-2.2	1
120	Molinate	1.9	2
121	Monocrotophos	2.3	3
122	Monosodium methyl arsenate	-0.3	1
123	Nonylphenol	-5.7	1
124	Octylisothiazolinone	-5.7	1
125	Oxadiazon	1.3	2
126	Oxamyl	3.0	4
127	Oxyfluorfen	-0.4	1
128	Paraquat	-6.9	1
129	pencycuron	0.31	1
130	Pendimethalin	-0.5	1
131	Permethrin	-1.6	1
132	phenothrin	0	1
133	Phosphoric acid	2.1	3
134	Picloram	5.5	5
135	Pine oil	-0.2	1
136	Piperonyl butoxide	-1.1	1
137	Pirimiphos methyl	1.3	2
138	Prallethrin	-2.4	1
139	Profenofos	0.59	1
140	Prometryn	2.5	3
141	Propanil	-9.1	1
142	Propargite	-1.3	1
143	Propineb	1.3	2

144	Propoxur	3.9	4
145	Pyrethrins	-2.2	1
146	Quinclorac	6.1	5
147	Quizalofop-P-tefuryl	-6.6	1
150	S-Metolachlor	0.84	1
151	Spinosad	-0.8	1
152	Sulcotrione	2.6	3
153	Sulfentrazone	6.5	5
154	Sulphur	1.0	2
155	Tebuconazole	1.6	2
156	Tebuthiuron	6.5	5
157	Terbufos	1.4	2
158	terbuthylazine	3.4	4
159	Terbutryn	1.0	2
160	Tetradifon	4.1	5
161	Tetramethrin	0.40	1
162	Thiamethoxam	3.9	4
163	Thiram	0.91	1
164	Transfluthrin	-2.2	1
165	Triadimefon	2.2	3
166	Triadimenol	2.5	3
167	Trichlorfon	0	1
170	Triclopyr	4.0	4
171	Tricozene	-5.7	1
172	Trifloxystrobin	0	1
173	Trifluralin	-0.4	1
174	Trifluthrin	-2.4	1
175	Violeta Genciana	-2.2	1

Table 4.2: Active ingredients in the Very high (5) and High (4) groundwater leaching potential class with a contribution to the annual volume of Active ingredients imported > 0.01 %.

Year	Compound number	Compound name	Class number	Volume (kg ai)	(%)
2002	144	Propoxur	4	461	2.46
	94	Imidacloprid		269	1.44
	32	Carbofuran		50	0.27
2003	112	Methyl bromide	5	10290	3.29
	156	Tebuthiuron		2840	0.91
	25	Bromacil		1000	0.32
	90	Hexazinone		360	0.12
	144	Propoxur	4	641	0.21
	162	Thiamethoxam		521	0.17
	170	Triclopyr		96	0.03
2004	112	Methyl bromide	5	12740	2.19
	162	Thiamethoxam	4	1488	0.26
	144	Propoxur		1162	0.20
	15	Atrazine		713	0.12
	94	Imidacloprid		332	0.06
	126	Oxamyl		78	0.01
	158	terbuthylazine		75	0.01
2005	112	Methyl bromide	5	10290	1.48
	90	Hexazinone		3418	0.49
	156	Tebuthiuron		2950	0.42
	25	Bromacil		110	0.02
	15	Atrazine	4	13268	1.91
	94	Imidacloprid		2161	0.31
	170	Triclopyr		1795	0.26
	144	Propoxur		1513	0.22
	162	Thiamethoxam		910	0.13
	41	Clomazone		336	0.05
	158	terbuthylazine		175	0.03
2006	156	Tebuthiuron	5	5450	0.61
	90	Hexazinone		4046	0.45
	94	Imidacloprid	4	12367	1.38
	15	Atrazine		11020	1.23
	170	Triclopyr		2563	0.29
	144	Propoxur		1833	0.20
	105	Metalaxyl		332	0.04
	158	terbuthylazine		150	0.02
2007	156	Tebuthiuron	5	5590	1.01
	90	Hexazinone		3110	0.56
	94	Imidacloprid	4	12924	2.33
	15	Atrazine		3823	0.69
	170	Triclopyr		2678	0.48
	22	Bentazone		2208	0.40
	105	Metalaxyl		646	0.12
	144	Propoxur		364	0.07
2008	156	Tebuthiuron	5	3935	0.40
	90	Hexazinone		154	0.02
	94	Imidacloprid	4	14802	1.49
	41	Clomazone		4704	0.47
	170	Triclopyr		3754	0.38
	144	Propoxur		367	0.04
	15	Atrazine		113	0.01
2009	156	Tebuthiuron	5	10855	1.26
	90	Hexazinone		5674	0.66
	134	Picloram		480	0.06
	146	Quinclorac		315	0.04
	25	Bromacil		215	0.02
	41	Clomazone	4	13056	1.52
	94	Imidacloprid		5955	0.69

	170	Triclopyr		3955	0.46
	144	Propoxur		1869	0.22
	92	Imazapic		1050	0.12
	111	Methomyl		900	0.10
	13	Amicarbazone		875	0.10
	22	Bentazone		864	0.10
	105	Metalaxyl		696	0.08
	162	Thiamethoxam		465	0.05
	15	Atrazine		409	0.05
	126	Oxamyl		149	0.02
2010	90	Hexazinone	5	8227	0.86
	156	Tebuthiuron		2130	0.22
	41	Clomazone	4	19680	2.05
	94	Imidacloprid		3781	0.39
	170	Triclopyr		2640	0.28
	144	Propoxur		2394	0.25
	15	Atrazine		1450	0.15
	162	Thiamethoxam		950	0.10
	105	Metalaxyl		904	0.09
	92	Imazapic		378	0.04
	126	Oxamyl		155	0.02
	22	Bentazone		96	0.01
2011	90	Hexazinone	5	4560	0.48
	156	Tebuthiuron		1550	0.16
	41	Clomazone	4	11933	1.27
	170	Triclopyr		6163	0.65
	94	Imidacloprid		3553	0.38
	144	Propoxur		2376	0.25
	162	Thiamethoxam		1917	0.20
	15	Atrazine		1500	0.16
	92	Imazapic		1092	0.12
	13	Amicarbazone		700	0.07
	22	Bentazone		624	0.07
	105	Metalaxyl		550	0.06

Annex 5: Imported formulated products containing active ingredients of primary concern

Human health

CompoundName	Abamectin																	
Sum of Volume_ai_kg																		
	2003	2004	2005	2006	2007	2008	2009	2010	2011	Grand Total								
Agrometic 1.8% EC	23	40	16	41	45	79	82	45	72	444								
Moz Abamec Plus 18% EC								144	43	187								
Volcano Agromectin 1.8% EC		18								18								
Grand Total	23	58	16	41	45	79	82	189	115	649								

CompoundName	Aldicarb			
Sum of Volume_ai_kg				
	2003	2004	2005	Grand Total
Aldicarb 15% GR	570			570
Temik 15% GR	480	90		570
Volcano Aldicarb 15% GR	360	84	1710	2154
Grand Total	1410	174	1710	3294

CompoundName	Aluminium phosphide																			
Sum of Volume_ai_kg																				
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Grand Total									
Aluminium Phosphide 57% FT		1262									1262									
Falfume 57% FT			4560		3421	5016			7866		20863									
Fumaphos 56% FT		3929	194	212	71	24					4428									
Moz Aluminium Phosphide 56% FT										700	700									
Phosgard 56% FT	847	1129	847	118	118	118	1164	259	294	823	5715									
Quickphos 56% FD			1613			335					1948									
Volcano Alluminium Phosphide 57% FT			570	1890	2457	3432		3711	8846	6823	27728									
Grand Total	847	6319	7783	2219	6066	8925	1164	3969	17006	8346	62645									

CompoundName	Fenamiphos						
Sum of Volume_ai_kg							
	2002	2003	2005	2006	2007	Grand Total	
Nemacur 10% GR		50				50	
Nemacur 40% EC	200	300				500	
Volamiphos 40% EC		300	800	410	600	2110	
Grand Total	200	650	800	410	600	2660	

CompoundName	Methomyl	
Sum of Volume_ai_kg		
	2009	Grand Total
Kuik	900	900
Grand Total	900	900

CompoundName	Mevinphos	
Sum of Volume_ai_kg		
	2003	Grand Total
Universal Mevinfos 15% EC	150	150
Grand Total	150	150

CompoundName	Monocrotophos			
Sum of Volume_ai_kg				
	2003	2004	2007	Grand Total
Phoskill 40% SC		200	480	680
Universal Monocrotophos 40% SL	200			200
Grand Total	200	200	480	880


CompoundName	Oxamyl							
Sum of Volume_ai_kg								
	2004	2005	2007	2008	2009	2010	2011	Grand Total
Villa Platoon 31% SL	78							78
Vydate 31% SL		50	37	93	149	155	93	577
Grand Total	78	50	37	93	149	155	93	654

CompoundName	Terbufos		
Sum of Volume_ai_kg			
	2008	2009	Grand Total
Bongo	6750		6750
Rotam Terbufos 15% GR	4650		4650
Grand Total	4650	6750	11400


CompoundName	Diuron									
Sum of Volume_ai_kg										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	Grand Total
Acticide EPW							2			2
Diuron 80% SC	7200	1600			2592	4800				16192
Rocima 363 N							1	1		2
Volcano Diuron 800 SC	13200	43072	40976	40312	20480	28768	48896	37888	43312	316904
Grand Total	20400	44672	40976	40312	23072	33568	48899	37889	43312	333100

CompoundName	Mancozeb											
Sum of Volume_ai_kg												
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Grand Total	
Dithan M 45 800 WP		800	4000	1600							6400	
Dithane M 60 OS									390		390	
Dithane NT 80% WP										800	800	
Mancozeb 80% WP	1200	3440									4640	
Metamin Fae Pm 72% WP										627	627	
Milor								2624			2624	
Milthane Super 80% WP									16000		16000	
Policar MZ 80% WP										1408	1408	
Ridomil Gold MZ 68 WG		1088	2304		346	576	1382			64	5760	
Sunstar Super 72% WP									3200		3200	
Unilax 72% WP			144			40					184	
Unizeb 80% WP	800	3200	3600								7600	
Uthane 80% WP			6400		4000	1600					12000	
Volcano Crater MX 72% WP					2560	5120		2568	2432	3776	16456	
Volcano Mancozeb 80% WP		6720	28400	18480	16760	23600	14400	24811	31552	54400	219123	
Grand Total	2000	15248	44848	20080	23666	30936	15782	30003	53574	61075	297212	

Environment

CompoundName	Lambda-cyhalothrin 											
Sum of Volume_ai_kg												
	2003	2004	2005	2006	2007	2008	2009	2010	2011	Grand Total		
Cyclon 10 EC						2					2	
Demand 2.5 CS	15											15
Duduthrin 5% EC								250			250	
Fortis K 5% EC	1538	1641	3403	888	4949	2138	1503	1750	17808			
Fortis Ultra 4.75% EC	375										375	
Fortis Xtra 8.8% EC	2	1500	2069							3571		
Icon 10 CS						45					45	
Icon 10% WP	317	2334	6070	67	98	50			133	9069		
Icon 2,5% EC	63	12	38	24	60	72					268	
Iconet 2.5% CS	33	427	68	6						535		
Karate 5% CS			18	651	33						702	
Karate 5% EC	1368	2079	720				18				4185	
Karate Zeon 5% CS						17				29	45	
Lambda cyhalothrin 5% EC	88		53	1505							1645	
Moz Lambda-Cyhalothrin 5% EC									6	6		
Revival 10% WP							12033	21430			33463	
Revival 25% EC						750	1595			750	3095	
Zakaka Pro 64,8% EC			260	1166	1680	2160	1020	2021	3144	11451		
Zakanaka Top 10% EC			510	3235	1673	1590	1634	3839	3630	16110		
Zakanaka K 6% EC			300	3146	2280	3630	1966	1567	3318	16207		
Zakanaka Topro 68,8% EC			630								630	
Grand Total	2158	7992	12377	11698	8216	13263	20403	30610	12760	119476		

CompoundName	Acetochlor										
Sum of Volume_ai_kg											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	Grand Total	
Acetochlor 90% EC	2700					3105				5805	
Bullet 70% SC		126	75		126	126				453	
Villa Acetochlor 90% EC			13320	3204						16524	
Volcano Acetochlor 90% EC	11952	33642	45666	38250	30465	69008	66996	80856	57456	434291	
Grand Total	14652	33768	59061	41454	30591	72239	66996	80856	57456	457073	

CompoundName	Imidacloprid 										
Sum of Volume_ai_kg											
	2002	2004	2005	2006	2007	2008	2009	2010	2011	Grand Total	
Bandit 35% SC					316	4756	3290	1629	1925	11916	
Bandit 70% WG								2013		2013	
Confidor 20% SL	129		162		104	140				535	
Courage 60% FS			936							936	
Courage 70% WS				12187	11900	9660	2013			35760	
Gaucho 70% WS	140		1							141	
Imidabiogel 2,15% PC					2		161	62	86	312	
Imidacel 20% SL								77	300	377	
Imidagold 20% SL					160	40	10			210	
Maxforce Quantum RB									0	0	
Midaclordan									500	500	
Monceren GT 390 FS			140							140	
Moz Imidacloprid 35% SC									42	42	
Premise 35% SC							1			1	
Protect 20% SL		332	730	180	400	202	480		700	3024	
Quick Bait Spray Fly Bait									0	0	
Seed Plus 30% WS					1	5				6	
Thunder 145 O-TEQ			192		40					232	
Grand Total	269	332	2161	12367	12924	14802	5955	3781	3553	56144	

CompoundName	Methyl bromide			
Sum of Volume_ai_kg				
	2003	2004	2005	Grand Total
Volcano Methyl Bromide 100 %GA	10290	12740	10290	33320
Grand Total	10290	12740	10290	33320

CompoundName	Tebuthiuron									
Sum of Volume_ai_kg										
	2003	2005	2006	2007	2008	2009	2010	2011	Grand Total	
Tebuthiuron 50% SC	2200				1400				3600	
Volcano Bundu 50% SC		110			35	215			360	
Volcano Tebuthiuron 500 SC	640	2840	5450	5590	2500	10640	2130	1550	31340	
Grand Total	2840	2950	5450	5590	3935	10855	2130	1550	35300	

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Conclusion regarding the peer review of the pesticide risk assessment of the active substance

carbaryl

finalised: 12 May 2006

(revised version of 10 July with minor editorial changes marked yellow)

SUMMARY

Carbaryl is one of the 52 substances of the second stage of the review programme covered by Commission Regulation (EC) No 451/2000¹, as amended by Commission Regulation (EC) No 1490/2002². This Regulation requires the European Food Safety Authority (EFSA) to organise a peer review of the initial evaluation, i.e. the draft assessment report (DAR), provided by the designated rapporteur Member State and to provide within one year a conclusion on the risk assessment to the EU-Commission.

Spain being the designated rapporteur Member State submitted the DAR on carbaryl in accordance with the provisions of Article 8(1) of the amended Regulation (EC) No 451/2000, which was received by the EFSA on 29 April 2004. Following a quality check on the DAR, the peer review was initiated on 3 September 2004 by dispatching the DAR for consultation of the Member States and the sole applicant Bayer CropScience S.A. (notification and submission made by Aventis CropScience prior to merger to form Bayer CropScience). Subsequently, the comments received on the DAR were examined by the rapporteur Member State and the need for additional data was agreed in an evaluation meeting on 7 March 2005. Remaining issues as well as further data made available by the notifier upon request were evaluated in a series of scientific meetings with Member State experts in September 2005.

A final discussion of the outcome of the consultation of experts took place with representatives from the Member States on 7 April 2006 leading to the conclusions as laid down in this report.

The conclusion was reached on the basis of the evaluation of the representative use as a plant growth regulator as proposed by the applicant. The application method is by tractor mounted orchard sprayer with application to apple trees for the purpose of fruit thinning. The application rate is up to 0.9 kg of carbaryl per hectare. It should be noted that only the use as a plant growth regulator will be supported in the EU review programme. However, carbaryl is also an insecticide and acaricide.

¹ OJ No L 53, 29.02.2000, p. 25

² OJ No L 224, 21.08.2002, p. 25

The representative formulated product for the evaluation was Sevin XLR plus, a suspension concentrate (SC) containing 480 g/L carbaryl, formulations are also registered under different trade names in Europe.

In the main adequate methods are available to monitor all compounds given in the respective residue definition. Residues in food of plant origin can be determined by HPLC with fluorescence detection. Carbaryl can not be analysed by any currently available published monitoring methods due to the nature of the residues. For the other matrices only single methods are available for the same reasons as given above. For water and soil the method is HPLC with fluorescence detection and air is by HPLC-MS/MS. The method of analysis does not analyse for all components of the residue definition in surface water and therefore further data will be required to validate it for the compound 1-Naphthol.

Methods to determine residues of carbaryl in products of animal origin or for body fluids and tissues are not required because no MRLs will be set for products of animal origin and carbaryl is not classified as toxic or very toxic.

Sufficient methods of analysis for carbaryl and data relating to physical, chemical and technical properties are available to ensure that quality control measurements of the plant protection product are possible. However, methods of analysis are not available for the relevant impurities in the formulation and the current storage data are not acceptable as the relevant impurities were not analysed for before and after storage.

Carbaryl is harmful if swallowed (oral LD₅₀ 614 mg/kg bw) and by inhalation (LC₅₀ 2.43 mg/L); it has a low acute dermal toxicity (dermal LD₅₀ higher than 5000mg/kg bw). Carbaryl is not irritant to skin and eyes and it is not a skin sensitiser. The following classification was proposed: Harmful, R20 'Harmful by inhalation' and R22 'Harmful if swallowed'. The critical effect in short and long term studies was the inhibition of cholinesterase activity. The weight of evidence indicates that carbaryl is not an *in vivo* genotoxic agent. In mice and rats, carbaryl was found to be carcinogenic; classification with R40 'Limited evidence of a carcinogenic effect' or R45? 'May cause cancer' was discussed and agreed on to be forwarded to ECB. Carbaryl did not show any potential for reproductive and developmental toxicity. The ADI is 0.0075 mg/kg bw/day (safety factor of 2000 because of the carcinogenicity issue); the AOEL and ARfD are 0.01 mg/kg bw/day (safety factor 100). Operator exposure is below the AOEL when estimated with German model and considering the use of PPE like gloves during mixing/loading and hood, visor, coverall and sturdy footwear during application.

The metabolism of carbaryl has been investigated in four crop groups, allowing the elucidation of the degradation pathway of the compound, which includes methyl and ring hydroxylation, carbamate ester hydrolysis and N-demethylation. Most of the metabolites formed may be further conjugated to form water-soluble glycosides. The metabolic pattern of carbaryl is evolving with time. For long PHIs the available data suggest that relevant metabolites can be present at levels representing a possible significant contribution to the toxicological burden. For the use of carbaryl for apple thinning, with a PHI of 80 days, 2 metabolites, 4- and 5-hydroxy carbaryl, which are cholinesterase inhibitors, are

expected to be present in amounts of the same order of magnitude as the parent compound. Therefore these metabolites were included in the residue definition for risk assessment. Supervised residue trials were carried out with analysis of parent compound only. This allows proposing the MRL for apple to be set below the Limit of Quantification of 0.05 mg/kg, but a robust risk assessment is not possible to be conducted as information on the actual level at harvest of the 2 hydroxy metabolites is lacking. Considering that the exposure to the parent compound only is close to 50% of the ARfD for some specific population sub-groups, it cannot be excluded that the contribution of the metabolites leads to a global exceedence of the ARfD for those sub-groups.

Residues in succeeding crops, in processed commodities and in animal products are not expected.

In soil carbaryl exhibited low to medium persistence. The most significant sink for the 1-naphthyl-¹⁴C- radiolabel position used in the aerobic laboratory studies was residue not extracted by methanol/water and acidified acetone water (20-39% of applied radioactivity (AR) after 100 days). Mineralisation to CO₂ accounted for 15-58%AR at 100 days. In 4 of the 5 soils investigated no major (>10%AR) metabolites were identified in soil extracts. In the fifth soil 1-naphthol was a major breakdown product accounting for a maximum of 35%AR at 2 days. 1-Naphthol however exhibited very low persistence in this soil. Under anaerobic soil conditions 1-naphthol was also a major soil breakdown product. Carbaryl exhibited medium soil mobility based on the results of guideline batch laboratory adsorption experiments. 1-Naphthol was characterised as also exhibiting medium soil mobility on the basis of the estimation provided by a guideline HPLC method.

In aerobic laboratory natural sediment water system experiments, carbaryl exhibited low persistence (dissipation DT₅₀ in water 1.2-5 days) as a consequence of a combination of partitioning to sediment (accounting for up to 24%AR at 0-60 days) and biodegradation. In the water phase the metabolite 1-naphthol accounted for a maximum of 35%AR 2 days after application, levels subsequently declined. 1-naphthol was also present in sediment but at low levels (maximum 9.5%AR). Residues not extracted from sediment by acidified methanol:water and acidified acetone:water represented 36-64%AR at study end (30-101 days). Mineralisation to CO₂ of the 1-naphthol-¹⁴C-radiolabel used accounted for 10.6-18 % AR by 101 days. The available surface water exposure assessment just considered the spray drift route of entry to surface water. The potential exposure of surface water with parent carbaryl via the drainage and runoff routes of entry has not been assessed in the available EU level exposure assessment. Member states should therefore carry out a surface water exposure and consequent aquatic risk assessment for carbaryl from the runoff and drainage routes of exposure at the national level, should carbaryl be included in annex 1.

Appropriate FOCUS groundwater modelling indicated that for the applied for intended use on apples leaching to groundwater above the parametric drinking water limit (0.1µg/L) would not be expected for either carbaryl or 1-naphthol.

A high long-term risk to insectivorous birds and a high acute and long-term risk to herbivorous mammals were identified in a first tier risk assessment. The submitted information was not sufficient to address the potential high risk to insectivorous birds in orchards and a data gap was identified in the EPCO expert meeting. A refined risk assessment based on residue decline was not accepted to

refine the acute risk to herbivorous mammals. For the long-term risk assessment more information was requested on how the DT_{50} value for the residue decline was calculated. This information was included in addendum 2 of February 2006. The EFSA considers the information as sufficient and considers the long-term risk to herbivorous mammals as low. However, the potential high acute risk to herbivorous mammals still needs to be addressed.

Carbaryl is very toxic to aquatic arthropods. The submitted microcosm study was assessed by the RMS as not being of use in deriving an EAC value since the exposure regime was representative only for aquatic habitats with very basic pH conditions where carbaryl degrades very rapidly. The proposed probabilistic approach was discussed by the EPCO experts' meeting. Uncertainty remained on which endpoints were used to construct the SSD. The splitting of data as suggested by the applicant would only be accepted if data fall into discrete groups based on sensitivity. The meeting considered the proposed trigger of 1 based on acute LC_{50} values as not acceptable. The meeting proposed to take the awaited opinion of the PPR panel on the possibility of lowering the uncertainty factor into account. Based on the PPR opinion on the possibility of lowering the uncertainty factor (see main text) the EFSA calculated the TER values for insects and crustaceans. The TERs are still below the trigger of 100 even if a no-spray buffer zone of 50 m is taken into account for the PEC_{sw} calculation. Overall it is concluded that the representative use of carbaryl poses a high acute and long-term risk to crustaceans and aquatic insects.

The HQ values for bees indicated a high risk from oral and dermal exposure. A field study was submitted to address the potential high risk. Although the EPCO experts had some reservations regarding the submitted field study, the meeting was content that the particular use does not pose a high risk to bees because the product is applied only once per year after flowering.

The in-field and off-field HQ values indicated a high risk to *Aphidius rhopalosiphi*. Extended laboratory studies showed that residue decline within 14 days is sufficient to allow recolonisation of treated fields. However a high off-field risk remains. The HQ trigger of 2 is not met even at a distance of 250 m from the treated field. No field data were submitted to show recovery/recolonisation of non-target insects in the treated area. Therefore it is concluded that recolonisation of the treated in-field area from unaffected off-field populations is not sufficiently demonstrated and needs to be further addressed.

Since the DT_{90} of carbaryl was in the range of 100 to 365 days and the standard HQ for non-target arthropods was exceeded a study with other soil non-target macro organisms is triggered. A data gap was identified by the EFSA to submit a study with collembola to assess the effects on other soil-macro organisms.

The risk to earthworms, soil non-target micro-organisms, non-target plants and biological methods of sewage treatment was assessed as low.



Key words: carbaryl, peer review, risk assessment, pesticide, insecticide, acaricide and plant growth regulator.

TABLE OF CONTENTS

Summary	1
Table of Contents	6
Background	7
The Active Substance and the Formulated Product	8
Specific Conclusions of the Evaluation	9
1. Identity, physical/chemical/technical properties and methods of analysis.....	9
2. Mammalian toxicology	10
2.1. Absorption, Distribution, Excretion and Metabolism (Toxicokinetics).....	10
2.2. Acute toxicity	10
2.3. Short term toxicity	10
2.4. Genotoxicity	10
2.5. Long term toxicity	11
2.6. Reproductive toxicity.....	12
2.7. Neurotoxicity	12
2.8. Further studies	12
2.9. Medical data	13
2.10. Acceptable daily intake (ADI), acceptable operator exposure level (AOEL) and acute reference dose (ARfD)	13
2.11. Dermal absorption	14
2.12. Exposure to operators, workers and bystanders.....	14
3. Residues.....	15
3.1. Nature and magnitude of residues in plant.....	15
3.1.1. Primary crops.....	15
3.1.2. Succeeding and rotational crops	16
3.2. Nature and magnitude of residues in livestock	17
3.3. Consumer risk assessment	17
3.4. Proposed MRLs	18
4. Environmental fate and behaviour	18
4.1. Fate and behaviour in soil.....	18
4.1.1. Route of degradation in soil.....	18
4.1.2. Persistence of the active substance and their metabolites, degradation or reaction products.....	18
4.1.3. Mobility in soil of the active substance and their metabolites, degradation or reaction products.....	19
4.2. Fate and behaviour in water.....	20
4.2.1. Surface water and sediment	20
4.2.2. Potential for ground water contamination of the active substance their metabolites, degradation or reaction products.....	21
4.3. Fate and behaviour in air	21
5. Ecotoxicology	21
5.1. Risk to terrestrial vertebrate.....	22
5.2. Risk to aquatic organisms	23
5.3. Risk to bees.....	25
5.4. Risk to other arthropod species.....	25
5.5. Risk to earthworms	25
5.6. Risk to other soil non-target macro-organisms	25
5.7. Risk to soil non-target micro-organisms	26
5.8. Risk to other non-target-organisms (flora and fauna)	26
5.9. Risk to biological methods of sewage treatment	26
6. Residue definitions	26
List of studies to be generated, still ongoing or available but not peer reviewed.....	31
Conclusions and Recommendations.....	31
Critical areas of concern	34
Appendix 1 – List of endpoints for the active substance and the representative formulation	35
Appendix 2 – Abbreviations used in the list of endpoints.....	70

BACKGROUND

Commission Regulation (EC) No 451/2000 laying down the detailed rules for the implementation of the second and third stages of the work program referred to in Article 8(2) of Council Directive 91/414/EEC, as amended by Commission Regulation (EC) No 1490/2002, regulates for the European Food Safety Authority (EFSA) the procedure of evaluation of the draft assessment reports provided by the designated rapporteur Member State. Carbaryl is one of the 52 substances of the second stage covered by the amended Regulation (EC) No 451/2000 designating Spain as rapporteur Member State.

In accordance with the provisions of Article 8(1) of the amended Regulation (EC) No 451/2000, Spain submitted the report of its initial evaluation of the dossier on carbaryl, hereafter referred to as the draft assessment report, to the EFSA on 29 April 2004. Following an administrative evaluation, the EFSA communicated to the rapporteur Member State some comments regarding the format and/or recommendations for editorial revisions and the rapporteur Member State submitted a revised version of the draft assessment report. In accordance with Article 8(5) of the amended Regulation (EC) No 451/2000 the revised version of the draft assessment report was distributed for consultation on 3 September 2004 to the Member States and the main applicant Bayer CropScience S.A. (notification and submission made by Aventis CropScience prior to merger to form Bayer CropScience) as identified by the rapporteur Member State.

The comments received on the draft assessment report were evaluated and addressed by the rapporteur Member State. Based on this evaluation, representatives from Member States identified and agreed in an evaluation meeting on 7 March 2005 on data requirements to be addressed by the notifier as well as issues for further detailed discussion at expert level. A representative of the notifier attended this meeting.

Taking into account the information received from the notifier addressing the request for further data, a scientific discussion of the identified data requirements and/or issues took place in expert meetings organised on behalf of the EFSA by the EPCO-Team of the Pesticide Safety Directorate (PSD) in York, United Kingdom in September 2005. The reports of these meetings have been made available to the Member States electronically.

A final discussion of the outcome of the consultation of experts took place with representatives from Member States on 7 April 2006 leading to the conclusions as laid down in this report.

During the peer review of the draft assessment report and the consultation of technical experts no critical issues were identified for consultation of the Scientific Panel on Plant Health, Plant Protection Products and their Residues (PPR).

In accordance with Article 8(7) of the amended Regulation (EC) No 451/2000, this conclusion summarises the results of the peer review on the active substance and the representative formulation evaluated as finalised at the end of the examination period provided for by the same Article. A list of the relevant end points for the active substance as well as the formulation is provided in appendix 1.

The documentation developed during the peer review was compiled as a **peer review report** comprising of the documents summarising and addressing the comments received on the initial evaluation provided in the rapporteur Member State's draft assessment report:

- the comments received
- the resulting reporting table (rev. 1-1 of 16 March 2005)
- the consultation report

as well as the documents summarising the follow-up of the issues identified as finalised at the end of the commenting period:

- the reports of the scientific expert consultation
- the evaluation table (rev. 2-1 of 12 May 2006)

Given the importance of the draft assessment report including its addendum (compiled version of March 2006 containing all individually submitted addenda) and the peer review report with respect to the examination of the active substance, both documents are considered respectively as background documents A and B to this conclusion.

By the time of the presentation of this conclusion to the EU-Commission, the rapporteur Member State has made available amended parts of the draft assessment report which take into account mostly editorial changes. Since these revised documents still contain confidential information, the documents cannot be made publicly available. However, the information given can basically be found in the original draft assessment report together with the peer review report which both is publicly available.

THE ACTIVE SUBSTANCE AND THE FORMULATED PRODUCT

Carbaryl is the ISO common name for 1-naphthyl N-methylcarbamate (IUPAC).

Carbaryl, belonging to the class of carbamate insecticides and acaracides such as aldicarb, it is a weak cholinesterase inhibitor and it works by stomach and contact action it is also slightly systemic.

The representative formulated product for the evaluation was Sevin XLR plus, which is a suspension concentrate its registration status is unknown.

The evaluated representative use is as a plant growth regulator. The application method is by tractor mounted orchard sprayer with application to apple trees for the purpose of fruit thinning. The application rate is up to 0.9 kg of carbaryl per hectare.

SPECIFIC CONCLUSIONS OF THE EVALUATION

1. Identity, physical/chemical/technical properties and methods of analysis

The minimum purity of carbaryl as manufactured should not be less than 990 g/kg, which is higher than the minimum purity given in the FAO specification 26/TC/S (1989) of 960 g/kg. The higher value relates to the submitted results of current batch analysis and not to any toxicological concern to increase the minimum purity.

The technical material contains 2-naphthol and 2-naphthyl methylcarbamate which have to be regarded as relevant impurities. The maximum content in the technical material should not be higher than 0.5 g/kg for each compound (FAO specification 26/TC/S (1989)). However, it should be pointed out that no data were supplied by the applicant to either confirm or refute the relevance of these impurities.

As there is only one applicant with a single source a check for equivalence of technical material is not required.

The content of carbaryl in the representative formulation is 480 g/L (pure).

The assessment of the data package revealed no critical areas of concern with respect to the identity, physical, chemical and technical properties of carbaryl or the respective formulation.

The main data regarding the identity of carbaryl and its physical and chemical properties are given in appendix 1.

Sufficient test methods and data relating to physical, chemical and technical properties are available. Also adequate analytical methods are available for the determination of carbaryl in the technical material and in the representative formulation as well as for the determination of the respective impurities in the technical material. However, methods of analysis are not available for the relevant impurities in the formulation and the current storage data are not acceptable as the relevant impurities were not analysed for before and after storage.

Therefore, there are limited data available to ensure that quality control measurements of the plant protection product are possible.

In the main adequate methods are available to monitor all compounds given in the respective residue definition. Residues in food of plant origin can be determined by HPLC with fluorescence detection. Carbaryl can not be analysed by any currently available published monitoring methods due to the nature of the residues. For the other matrices only single methods are available for the same reasons as given above. For water and soil the method is HPLC with fluorescence detection and air is by HPLC/MS/MS. The method of analysis does not analyse for all components of the residue definition

in surface water and therefore further data will be required to validate it for the compound 1-naphthol.

Methods to determine residues of carbaryl in products of animal origin or for body foods and tissues are not required because no MRL's will be set for products of animal origin and carbaryl is not classified as toxic or very toxic.

The discussion in the experts' meeting (EPCO 35, 26 September 2005) on identity, physical and chemical properties and analytical methods was limited to the specification of the technical material and the possibly relevant impurities in the technical material.

2. Mammalian toxicology

Carbaryl mammalian toxicology was discussed during the EPCO experts' meeting (EPCO 33) in September 2005.

2.1. ABSORPTION, DISTRIBUTION, EXCRETION AND METABOLISM (TOXICOKINETICS)

Carbaryl is rapidly absorbed, about 91.5% within 24 hours based on urinary excretion. It is widely distributed, with the highest levels found in the kidney at 7 days. Carbaryl does not show any evidence of accumulation. It is extensively metabolised (only 2.9% of unchanged compound can be found in urine) through three main metabolic pathways:

Arene oxide formation with hydrolysis to dihydrodihydroxycarbaryl and glucuronide conjugation; hydrolysis to form 1-naphthol and conjugation; oxidation of N-methyl moiety (alkyl oxidation).

2.2. ACUTE TOXICITY

Carbaryl is harmful if swallowed (oral LD₅₀ 614 mg/kg bw) and by inhalation (LC₅₀ 2.43 mg/L); it has a low acute dermal toxicity (dermal LD₅₀ higher than 5000 mg/kg bw). Carbaryl is not irritant to skin and eyes and it is not a skin sensitiser. The following classification was proposed: Harmful, R20 'Harmful by inhalation' and R22 'Harmful if swallowed'.

2.3. SHORT TERM TOXICITY

Carbaryl short term toxicity was assessed in studies in rats, mice and dogs.

The critical effect was the inhibition of cholinesterase activity, while the target organ was the liver (increase of weight and histopathology changes). The relevant oral NOAEL was lower than 3.37 mg/kg/day in the 1-year dog study, due to RBC cholinesterase inhibition at all tested doses. The relevant dermal NOAEL was 20 mg/kg/day (4-week rat study).

2.4. GENOTOXICITY

The genotoxicity of carbaryl has been investigated in a number of *in vitro* and *in vivo* assays, including gene mutation, chromosomal aberration, DNA damage and DNA binding as endpoints, with purity levels ranging from 99.0% to 99.7%.

Carbaryl gave negative results in bacterial systems in the presence or absence of S9 from rat liver and in the culture mammalian cells in the absence of S9. Although there were equivocal results in the *in vitro* mammalian assay with S9, negative results were obtained in the *in vitro* UDS assay.

Positive results were obtained for *in vitro* chromosome aberrations with metabolic activation in mammalian (CHO) cells. The clastogenicity was not confirmed *in vivo*, for somatic cells in mouse bone marrow micronucleus and rat bone marrow chromosome aberrations assay. In relation to DNA damage, negative results were obtained for *in vivo* DNA binding.

In conclusion, the weight of evidence indicates that carbaryl is not an *in vivo* genotoxic agent.

2.5. LONG TERM TOXICITY

A rat combined chronic toxicity/carcinogenicity and a mouse carcinogenicity studies were conducted. Data from mechanistic studies, using induction of hepatic enzyme and cellular proliferation as endpoints, and from a test using heterozygous p53-deficient mice (proposed model for detection tumours caused by genotoxic carcinogens) were also supplied.

During the meeting, the RMS was asked to prepare a brief summary of a recent publication by Jacobson-Kram et al, Toxicologic Pathology, 32, (suppl.1):49-52, 2004 in an addendum, which was made available in February 2006.

When the test substance was administered to rats via the diet for 2 years, the main toxic effect observed was a decrease in erythrocyte and brain cholinesterase activity at 1500 ppm. Based on this effect, the chronic NOAEL was set at 250 ppm (10 mg/kg bw/day). Carbaryl was found to be carcinogenic at 349 mg/kg bw/day (a concentration exceeding the Maximum Tolerated Dose). In rats thyroid follicular adenomas and carcinomas (males), hepatocellular adenoma (females), carcinomas and adenomas in the urinary bladder (both sexes), a carcinoma in kidney (male) were recorded.

In mice the dietary administration of carbaryl for 2 years resulted in both neoplastic and non neoplastic findings. Based on the inhibition of erythrocyte and brain acetylcholinesterase activity and histopathological changes in the bladder, the relevant NOAEL for non-neoplastic lesion was 15 mg/kg/day. As for neoplastic findings, vascular tumors (located predominantly in the liver and spleen) at 15 mg/kg bw/day in males renal tubular cell adenoma and carcinoma, hepatocellular carcinoma and adenoma at 1248 mg/kg bw/day were recorded. Based on these observations, the NOAEL for carcinogenicity was not established.

Mechanistic studies suggested that the tumorigenic response was due to cell proliferation associated with a mitogenic effect of carbaryl or one of its metabolites. The results identified carbaryl as a weak barbiturate-type inducer of cytochrome P450 in the mouse liver.

Classification with R40 'Limited evidence of a carcinogenic effect' or R45? 'May cause cancer' was discussed and agreed on to be forwarded to ECB and indicated in the list of end points. Furthermore, during the meeting the experts discussed the toxicological significance of Non Hodgkin Lymphomas (NHL) and concluded that no particular concerns were identified in the available studies.

2.6. REPRODUCTIVE TOXICITY

One two-generation study in rats and one developmental studies in both rat and rabbit were performed.

The relevant parental, offspring and reproductive NOAEL was 4.67 mg/kg bw/day, based on the decreased body weight in the parents and on the significant reduction of the F2 n° pups/Litter and of the F2 pup survival at 21.04 mg/kg bw/day. Based on the studies available, the experts concluded that carbaryl did not have effects on sperm morphology.

The teratogenicity study performed in rats revealed that at the dose of 30 mg/kg bw/day, dams showed some clinic signs typical of anticholinesterase agents (increase of salivation), and affected the body weight of the dams and foetuses that decreased significantly; in addition, a delayed ossification in foetuses was observed, therefore the NOAEL for maternal and developmental toxicity was set at 4 mg/kg bw/day in rats.

2.7. NEUROTOXICITY

The main sensitive endpoints in acute and subacute studies were the observations in the functional observational battery (FOB) and the reduction in the cholinesterase activity and motor activity. The severity and frequency of clinical signs and reduction of cholinesterase activity were related to dose and decreased with time. The lowest oral NOAEL in neurotoxicity studies was 1 mg/kg bw per day based on a 13-week study. No signs of developmental neurotoxicity were recorded.

2.8. FURTHER STUDIES

Metabolites

Two metabolites were identified: 4-hydroxycarbaryl and 5-hydroxycarbaryl. They are both structurally similar to carbaryl, and therefore likely to be ChE inhibitors. They were of particular concern as it is not known whether the parent or metabolites are responsible for the carcinogenic effects. In the recently submitted addendum, 4-hydroxycarbaryl and 5-hydroxycarbaryl were discussed. They are found in plants and animals. According to the FAO monograph (1969) toxicological data show that the acute oral toxicity of 5-hydroxycarbaryl (LD₅₀ 297 mg/kg bw) is comparable to carbaryl (LD₅₀ 614 mg/kg bw) while LD₅₀ values for 4-hydroxycarbaryl and 1-naphthol are higher than the LD₅₀ value established for carbaryl (1190 mg/kg bw and 2590 mg/kg bw, respectively). The short-term toxicity of these metabolites was lower when compared to the parent compound carbaryl. *In vitro* cholinesterase inhibition studies showed that 1-naphthol, 4- and 5-hydroxycarbaryl are also inhibitors of cholinesterase activity, with similar or higher IC₅₀ values. The experts agreed they should be considered in the consumers' risk assessment. The RMS concludes that the toxicological information indicates that 4-hydroxycarbaryl and 5-hydroxycarbaryl should not be considered of toxicological relevance. This assessment was neither discussed nor agreed.

EFSA notes that, according to the data submitted, both metabolites are cholinesterase inhibitors, with inhibition activity comparable to carbaryl; further, 5-hydroxycarbaryl LD₅₀ is even lower than carbaryl's.

Metabolites - impurities

1-naphthol is a metabolite found in plants and animals, and it is also an impurity. According to European Chemical Information System 1-naphthol is classified as R21/22, harmful in contact with skin and if swallowed, R37/38 Irritating to respiratory system and skin and R41, risk of serious damage to eyes.

Impurities

1-naphthyl 2,4-dimethyl allophanate is an impurity. No experimental data are available but a position paper with a DEREK analysis has been submitted by the applicant and summarised in the addendum (Feb 06). The RMS states that according to the toxicological characteristics, this impurity does not pose any concerns. These assessments provided by the RMS were not peer reviewed.

A new data gap was identified during the meeting for the applicant to provide information on the levels of impurities (1-naphthol and 1-naphthyl 2,4-dimethyl allophanate) in batches used in toxicity studies as well as information on their toxicological properties.

For the two impurities 2-naphthol and 2-naphthyl methylcarbamate no toxicological data was provided.

2.9. MEDICAL DATA

Among the medical effects on manufacturing personnel, only one of the available studies showed that carbaryl increased the rate of sperm shape abnormalities. The clinical cases and poisoning incidents revealed only one fatal case of death due to ingestion of Sevin (carbaryl), whose results are nevertheless controversial.

One epidemiological study made on exposed farmers showed the evidence of occurrence of Non-Hodgkin Lymphoma (NHL) in men handling carbaryl for more than 20 years and epidemiological studies on mortality ratio revealed an association with NHL, liver cancer (not specified) and kidney cancer.

The experts noted that the manufacturer had provided no information relating to the routine, monitoring of workers other than that they monitored. A new data requirement was set for further information relating to this. So far, no new data was submitted by the notifier.

2.10. ACCEPTABLE DAILY INTAKE (ADI), ACCEPTABLE OPERATOR EXPOSURE LEVEL (AOEL) AND ACUTE REFERENCE DOSE (ARFD)

ADI

The meeting discussed the carcinogenic effects observed with carbaryl in relation to the derivation of the ADI. It was noted that tumours were observed in multiple organs in rats and mice, and that mechanistic studies indicated a non-genotoxic effect. It was additionally noted that a non-carcinogenic effect had not been demonstrated in humans. As a result it was concluded that while the LOAEL in the mouse carcinogenicity study was high compared to NOAELs from other studies, the use of the LOAEL from the mouse carcinogenicity study (with additional safety factors due to the use of LOAEL) highlighted the concern relating to this effect. Application of a safety factor of 2000 derived an ADI of 0.0075 mg/kg bw/day.

AOEL

From all the available data, it was considered appropriate to use the NOAEL of 1 mg/kg/day from the 13-week neurotoxicity study, where an inhibition of all types of ChE measured was observed. A safety factor of 100 was considered appropriate as LOAEL irreversible effect/AOEL > 1000. The AOEL was as follows:

$$\text{AOEL} = (1 \text{ mg/kg/day})/100 = 0.01 \text{ mg/kg/day}$$

ARfD

The studies available for the derivation of the ARfD were considered. Acute neurotoxicity studies were conducted at doses of ≥ 10 mg/kg bw, and a LOAEL of 10 mg/kg bw obtained, at which marked inhibition (40-50%) occurred. In the subchronic neurotoxicity a NOAEL of 1 mg/kg bw/day was obtained. Therefore it was considered appropriate to derive the ARfD from this study; applying a safety factor of 100, an ARfD of 0.01 mg/kg bw was derived.

2.11. DERMAL ABSORPTION

In vivo and *in vitro* studies lead to the conclusion that dermal absorption for Sevin XRL Plus was 9.54-15.3% within 10-24 h, respectively, for the dilution and 0.37-0.59% within 10-24 h, respectively, for the concentrate. During the EPCO dermal absorption values after 10h were considered and rounded up from 0.37% to 0.5% for concentrate and 9.54% to 10% for dilution.

2.12. EXPOSURE TO OPERATORS, WORKERS AND BYSTANDERS

DAR

Operators

Estimations of the potential operator exposure have been undertaken using the UK POEM and the German model. Estimated values ranged from 443.12-667.4% AOEL for UKPOEM at 10-24 hr and between 188.6-290.9 %AOEL at 10-24 hr for BBA Model.

Workers

Worker exposure was evaluated taking into account a new transfer coefficient extrapolated from a field study using iprodione. Estimated exposure levels ranged from 100-350.25 % of AOEL using 10hr to 24 hr dermal penetration data.

Bystanders

Bystanders exposure was estimated to be 7.43 or 10.27 % of AOEL using 10hr or 24 hr dermal absorption data.

Field studies reported in the DAR and conducted with in scenarios similar to the one under discussion but with different a.s., confirmed that exposure exceeded the AOEL.

Refinement after EPCO

According to the EPCO outcomes, the RMS was asked to recalculate operator and bystander exposure; worker exposure has to be recalculated also considering EUROPOEM transfer coefficients. In the feb 06 submitted addendum, not peer reviewed, recalculations are provided.

Operators

	UK POEM		BBA	
	Exposure	% of AOEL	Exposure	% of AOEL
	(mg/kg bw/day)		(mg/kg bw/day)	
Without PPE	0.18	1800	0.12	1200
PPE: Gloves ML & Applic.	0.13	1300		
PPE: Gloves ML & Applic. Hood and visor, Coverall and sturdy footwear in application			0.0075	75

Operator exposure is below the AOEL when estimated with German model and considering the use of PPE like gloves during mixing/loading and hood, visor, coverall and sturdy footwear during application.

Workers

The assessment has been performed considering data in the EUROPOEM database for hand harvesting suggest a transfer coefficient of 4500 cm²/person/hr for worker harvesting fruits from trees. The DFR is predicted from conservative assumptions which assume a DFR of 3 µg/cm² per kg a.s./ha applied. Estimated exposure corresponds to 81% of the AOEL.

Bystanders

Direct measurements of simulated bystander exposure for applications made to orchards in the UK by broadcast air assisted sprayers reported in a study by Lloyd and Cross (1987) were used as surrogate values. Estimated exposure corresponds to 60% of the AOEL.

3. Residues

Carbaryl was discussed during the EPCO experts' meeting for residues (EPCO 34) in September 2005.

3.1. NATURE AND MAGNITUDE OF RESIDUES IN PLANT

3.1.1. PRIMARY CROPS

The metabolism of carbaryl after foliar application in plants has been investigated in lettuce, soybean, radish and apple. The metabolic pattern observed was rather similar between these crops. Carbaryl is

stable when present on the surface of the plant and undergoes biotransformation when it enters into the plant tissues. The metabolic pathway includes methyl and ring hydroxylation, carbamate ester hydrolysis and N-demethylation. Most of the metabolites formed may be further conjugated to form water-soluble glycosides. These studies were conducted with rather short PHIs (8 days for lettuce, 45 days for soybean, 7 days for radish and 28 and 53 days for apples) in comparison with the PHI proposed for the use of carbaryl for apple thinning. Under these conditions, carbaryl was in all plant parts, except in soybean seeds, the dominant compound. Some metabolites present under conjugated form were found in the range of 10% of the TRR: hydroxymethyl carbaryl in soybean as well as 4- and 5-hydroxycarbaryl (both resulting of ring hydroxylation) in apples.

In apples, the ratio of the sum of these later two metabolites to parent compound appears to be dependant on the precocity of the application of carbaryl: this ratio is about 1/10 for application made 28 days before harvest and increases to 1/1 when the application occurs 53 days before harvest. Therefore, their expected contribution to the global toxicological burden for a PHI of 80 days can be considered as significant. The expert meeting (EPCO 34) discussed the residue definition applicable to apples. It was agreed that the parent compound is a valid indicator for monitoring. For risk assessment it was concluded that the necessity to include the 4- and 5-hydroxycarbaryl metabolites in the definition was depending on their toxicological relevance. As indicated under point 2.8, the available toxicological information suggests that they may have a similar level of toxicity as the parent compound and therefore they are included in the residue definition for risk assessment. The available data are not sufficient to fix a conversion factor between the residue definitions for monitoring and risk assessment. It must be noted that for other crops, beyond the scope of this peer-review, the residue definition for risk assessment may be different, depending of the specific metabolic pattern.

Nine valid supervised residue trials were submitted by the notifier according to the representative use supported by the applicant with 1 treatment at growth stage 71-73. Seven trials were carried out in Northern Europe and 2 were carried out in Southern Europe. In these trials only carbaryl was analysed. Results for PHIs varying from 76 to 83 days were 5 times < 0.05 mg/kg and 4 times < 0.01 mg/kg, depending on the method of analysis used and related Limit of Quantification (LOQ). These results are supported by storage stability studies demonstrating that residues of carbaryl are stable up to 24 months of storage at -20°C.

Additional data should be submitted concerning the residues of 4- and 5-hydroxy carbaryl in apples at harvest in order to have all the needed information to conduct a robust risk assessment for the safety of the consumer.

As carbaryl residues in raw apples are below the LOQ, the effect of processing on the nature and the level of residues were not investigated.

3.1.2. SUCCEEDING AND ROTATIONAL CROPS

Apple being a perennial crop, it is not relevant to investigate the potential of transfer of residues from the soil to succeeding and rotational crops.

3.2. NATURE AND MAGNITUDE OF RESIDUES IN LIVESTOCK

The use of carbaryl for apple thinning does not lead to significant animal exposure. Even if residue data are not available for 4- and 5-hydroxy carbaryl in apples it is expected given the early stage of application of the product that the amount of carbaryl and its metabolites present in apple pomace is low and at least not such that the animal exposure could be higher than 0.1 mg/kg total feed (fruit pomace is a processed feed item resulting from the mixing of products of different origins and enters for a maximum of 30% of the dry matter in animal diet). For this reason it is considered that livestock metabolism and feeding studies as well as residue definitions and MRLs for animal products are not necessary.

3.3. CONSUMER RISK ASSESSMENT

Assessments of the chronic and acute exposures of consumers could not be conducted on the basis of the residue definition proposed for risk assessment as data on the actual level of the metabolites 4- and 5-hydroxy carbaryl in plant commodities are lacking.

Only exposure assessments to carbaryl are at this stage possible and were performed by the RMS.

Chronic exposure.

The chronic dietary exposure assessment has been carried out according to the WHO guidelines for calculating Theoretical Maximum Daily Intakes (TMDI). Four consumption patterns were considered: the WHO European typical diet for adult consumers, the diets of UK for infants, toddlers, children and adults populations, which take into consideration high individual consumption levels (at the 97.5th percentile of the distribution of consumptions in the respective populations), the Spanish diet for adult consumers and the German diet for the 4-6 years old girl.

For TMDI calculations, residues in apples were assumed to be at the level of LOQ proposed as MRL on the basis of the supervised residue trials. No exposure resulting from the consumption of animal commodities was considered as the exposure of animals and the resulting transfer to edible animal commodities is considered not significant. These calculations indicated that the chronic exposure of all the here above mentioned populations was well below the ADI of carbaryl. The highest exposure was calculated for toddlers in UK (6% of the ADI).

Acute exposure.

The acute exposure to residues of carbaryl in apples has been assessed according to the WHO model for estimates of short term intakes. Large portion consumption data for various population groups (infants, toddlers, children, adults) in UK, France and Netherlands were used. Calculations were carried out considering residues in composite samples of treated apples at the level of the LOQ as well as high unit to unit variability (variability factor of 7). The highest predicted short term intakes were found for infants and toddlers in UK and were amounting to 36 and 49% respectively of the ARfD.

It must be kept in mind that the exposure assessments summarised here above represent an underestimation of the actual toxicological burden as the 4- and 5- hydroxyl metabolites of carbaryl

were not included in the calculations. Considering that the exposure to the parent compound only is close to 50% of the ARfD for some specific population sub-groups, it cannot be excluded that the contribution of the metabolites leads to a global exceedence of the ARfD for those sub-groups.

3.4. PROPOSED MRLS

The results of supervised residue trials suggest setting the MRL for carbaryl in apples below the LOQ of 0.05 mg/kg, supporting the representative use in Northern Europe.

4. Environmental fate and behaviour

The fate and behaviour in the environment of carbaryl was discussed in the experts' meeting (EPCO 31) of September 2005 on basis of the addendum to the DAR dated June 2005. After the meeting the RMS clarified the key open points identified by that meeting in the Corrigendum B-8, dated February 2006.

4.1. FATE AND BEHAVIOUR IN SOIL

4.1.1. ROUTE OF DEGRADATION IN SOIL

In soil experiments (5 different soils) carried out under aerobic conditions in the laboratory (20-25°C 75% field capacity (FC) or 40-52% maximum water holding capacity (MWHC) in the dark, the formation of residues not extracted by methanol:water followed by acidified acetone:water was a significant sink for the applied 1-naphthyl-¹⁴C-radiolabel (20-39% of the applied radiolabel (AR) after 100 days). Mineralisation to carbon dioxide of the radiolabel accounted for 15-58 % AR after 100 days). The most significant extractable breakdown product identified was 1-naphthol where maximum measured concentrations in 4 of the soils accounted for: not detected (2 soils) to 1.27%AR. In the fifth sandy loam soil, 1-naphthol accounted for 35%AR 1 day after treatment. In the sample taken on the second day after treatment, it accounted for only 2.8%AR. Other extracted unidentified resolved breakdown products accounted for a maximum of 1.6%AR.

Under anaerobic conditions in soil, the degradate pattern was essentially the same as described above for aerobic conditions, except the 1-naphthol formed would give a longer exposure duration, it accounted for a maximum of 21.7%AR at 94 days declining to 13.2%AR at the study end (126 days). In a laboratory soil photolysis study, the rate of degradation on light exposed 75% FC soil moisture soil was comparable to that observed in the dark control. No novel photodegradation products were identified, the degradation of parent carbaryl in the experiment was limited (6%AR over the 12 days experimental duration).

4.1.2. PERSISTENCE OF THE ACTIVE SUBSTANCE AND THEIR METABOLITES, DEGRADATION OR REACTION PRODUCTS

The rate of degradation of carbaryl was estimated from the results of the studies described in 4.1.1 above and was also investigated under aerobic conditions at a range of temperatures in an additional 2

soils. On the basis of the nine available study results where seven different soils were investigated, the single first order DT_{50} were: 80.9 days (10°C and 50% MWHC), 11.9 days (15°C, at 75% FC), 4-25.2 days (25°C at 75% FC) and 7.08-99 days (20°C and 40-52% MWHC). After normalisation to FOCUS reference conditions³ (20°C and -10kPa soil moisture content) this range becomes 2.3-98.7 days (arithmetic mean 25.8 days geometric mean that is appropriate for use in FOCUS modelling 15.8 days).

The major degradation product (> 10 %AR), formed in major amounts in just 1 soil 1-naphthol also degraded rapidly in soil with an estimated single first-order DT_{50} in this single soil of 0.9 days (normalised to FOCUS reference conditions 0.53 days).

The potential for the degradation of carbaryl to be pH dependant was considered by the RMS, but there was no correlation of first order DT_{50} with this soil property⁴.

No field soil dissipation studies were provided. As in 1 soil at 20°C and pF2 (-10kPa), the single first order DT_{50} was > 60 days (DT_{50} 98.7 days, extrapolated DT_{90} 328 days) field dissipation studies are triggered. On the basis of the remaining 8 single first order DT_{50} results field dissipation studies would not be triggered (the next longest 20°C and pF2 value was 31.9 days). In this case, for this active substance, with this laboratory soil study database, as it is not possible to attribute any single or combination of soil properties as being the cause of the longer DT_{50} , it is unlikely that any field trial database generated would add significant new information to improve our understanding of the fate and behaviour of carbaryl in soil. The EFSA considers having field data would not significantly increase the reliability of the environmental exposure assessment in this case. Therefore the EFSA considers the environmental exposure assessment at the EU level can be concluded without field soil dissipation studies on the basis of the available laboratory studies, as this is likely to result in a precautionary exposure and subsequent risk assessment.

The longest available laboratory single first order soil DT_{50} of 99 days was selected for use in PEC soil calculations with a crop interception of 70% agreed by the experts from member states as being appropriate for the growth stage after flowering in apples⁵.

4.1.3. MOBILITY IN SOIL OF THE ACTIVE SUBSTANCE AND THEIR METABOLITES, DEGRADATION OR REACTION PRODUCTS

The adsorption / desorption of carbaryl was investigated in four soils in guideline batch adsorptions studies. Calculated adsorption K_{oc} values varied from 177 to 249 mL/g, (mean 211 mL/g) indicating that carbaryl is moderately mobile in soil (1/n 0.78 – 0.84, mean 0.81). There was no evidence of a correlation of adsorption with pH.

³ Using section 2.4.2 of the generic guidance for FOCUS groundwater scenarios, version 1.1 dated April 2002.

⁴ Corrigendum B-8 dated February 2006.

⁵ in line interception tables in generic guidance for FOCUS groundwater scenarios, version 1.1 dated April 2002..

The adsorption of 1-naphthol was investigated in four soils using the batch adsorption screening experiments prescribed by OECD 106. The compound was unstable in the test soils and even under the non equilibrium conditions of 30 minutes shaking the mass balance of the test substance was low accounting for only 7-27% of that applied. As a result the definitive adsorption / desorption test could not be completed. Consequently the OECD screening test OECD 121 that estimates adsorption using an HPLC column (and not measurements with soil) was employed. This gave an estimated 1-naphthol K_{doc} value of 245mL/g. The experts from the member states agreed this estimate was an acceptable value to use in FOCUS modelling.

4.2. FATE AND BEHAVIOUR IN WATER

4.2.1. SURFACE WATER AND SEDIMENT

The aqueous hydrolysis of carbaryl under sterile conditions was faster under basic conditions than acidic ones. At pH 7, (the value tested closest to natural conditions), carbaryl was more stable than when microorganisms are present (the 25°C single first order DT_{50} was 12 days). The main hydrolysis product in these sterile conditions was 1-naphthol.

The aqueous photolysis of carbaryl investigated under sterile pH 5 conditions, where hydrolysis was slow, indicated the rate of degradation was slower than under dark microbially active conditions (single first order laboratory DT_{50} equated to summer sublight at 30-50°N was 11-14 days. No major (>10%AR) metabolites were formed in the study. Photolysis is not expected to be a significant route of dissipation of carbaryl in the environment as biodegradation is more rapid.

A ready biodegradability test (OECD 301D) indicated that carbaryl is 'readily biodegradable' using the criteria defined by the test.

In water-sediment studies (3 systems studied at 20-25°C in the laboratory, sediment pH 5 -7.6, water pH 6.5-9) carbaryl demonstrated low persistence in both the water phase (single first order DT_{50} 1.2-5 days) and in the total system (single first order DT_{50} 1.62-9.9 days). The metabolite 1-naphthol (max. 34.7 % AR at 2 days after treatment) was detected in the water phase but accounted for <1%AR in the water phase by 7-30 days. The terminal metabolite, CO_2 , accounted for 10.6-18 % AR by 101 days. Residues not extracted from sediment by acidified methanol:water and acidified acetone:water were a significant sink representing 36-64%AR at study end (30-101 days). The only major (>10%AR) residue in sediment extracts was parent carbaryl (max. 24%AR at 0-60 days) for which a single first order DT_{50} in sediment of 4.3 days was estimated. The experts from the member states discussed which water DT_{50} values should be used in the calculation of PEC surface water, which were presented based on late season spray drift values⁶ to a static 30cm deep water body. They confirmed the longest first order dissipation DT_{50} value for parent carbaryl of 5 days from the available dark water sediment studies should be used.

⁶ Appendix 1 Guidance document on aquatic ecotoxicology Sanco/3268/2001 date 1 October 2001.

The available surface water exposure assessment just considered the spray drift route of entry to surface water. The potential exposure of surface water with parent carbaryl via the drainage and runoff routes of entry has not been assessed in the available EU level exposure assessment. Member states should therefore carry out a surface water exposure and consequent aquatic risk assessment for carbaryl from the runoff and drainage routes of exposure at the national level, should carbaryl be included in annex 1. A drainage and runoff entry surface water exposure assessment is considered unnecessary for the major soil metabolite 1-naphthol in situations (such as the applied for intended use on apples) where prolonged anaerobic soil conditions can be excluded, due to its impersistence in soil under aerobic conditions.

4.2.2. POTENTIAL FOR GROUND WATER CONTAMINATION OF THE ACTIVE SUBSTANCE THEIR METABOLITES, DEGRADATION OR REACTION PRODUCTS

FOCUS PELMO 3.3.2 simulations were carried out for the good agricultural practice (GAP) of 1 application of 0.9 kg/ha (0.27 kg/ha accounting for 70% crop interception) being made to apples, with applications being made in March to May. Appropriate (though more conservative than guidance requires) substance properties of: carbaryl single first order DT_{50} 25.7 days K_{foc} 211.53 mL/g $1/n=0.81$ and 1-naphthol single first order DT_{50} 0.6 days K_{doc} 245mL/g or 0, $1/n=1.0$, formation fraction from carbaryl 100% were used as input. In these simulations annual average concentrations in leachate leaving the top 1m soil column were estimated to be <0.001 µg/L for both compounds at all 9 FOCUS groundwater scenarios.

Based on this modelling, leaching to groundwater from the applied for intended uses on Apples above the parametric drinking water limit (0.1µg/L) would not be expected for either carbaryl or 1-naphthol.

4.3. FATE AND BEHAVIOUR IN AIR

The vapour pressure of carbaryl (4.16×10^{-5} Pa at 25°C) means that carbaryl would be classified under the national scheme of The Netherlands as very slightly volatile, indicating limited losses due to volatilisation would be expected. Therefore the PEC_{air} is considered to be negligible. Calculations using the method of Atkinson for indirect photooxidation in the atmosphere through reaction with hydroxyl radicals resulted in an atmospheric half life estimated at 0.377 days (assuming an atmospheric hydroxyl radical concentration of 1.5×10^6 radicals cm⁻³ and a 12 hour photoperiod) indicating the small proportion of applied carbaryl that did volatilise would be unlikely to be subject to long range atmospheric transport.

5. Ecotoxicology

Carbaryl was discussed at the EPCO experts' meeting for ecotoxicology (EPCO 32) in September 2005.

5.1. RISK TO TERRESTRIAL VERTEBRATE

A risk assessment for birds and mammals was conducted according to SANCO/4145/2000 for insectivorous and earthworm-eating birds. A high long-term risk was indicated in a first tier risk assessment for insectivorous birds. Two published articles on effects of carbaryl on killdeer (*Charadrius vociferous*) and tree swallow (*Tachycineta bicolor*) were submitted by the applicant. The meeting was concerned about some lack of detail in the study reports (e.g. it was not certain if low effects were due to low exposure if the birds were foraging elsewhere rather than in the treated orchard). The relevance of tree swallow as a focal species was questioned due to its mode of feeding i.e. taking insects from the air rather than from the treated crop. The meeting agreed that the submitted information is not sufficient to address the potential high long-term risk to insectivorous birds and identified a data gap.

The RMS presented a TER calculation for herbivorous birds. The first tier TER values indicated a potential long-term risk. In addendum 1 (June 2005) a new TER calculation was presented taking into account 70% interception because the product is applied at a stage when the foliage of the trees is fully developed. It was noted that the RUD value for leafy crops was used for the TER calculation for medium herbivorous birds. Using the correct value of 76 for residues in short grass in orchards and 70% interception the resulting long-term TER would be 3.63. However, the meeting agreed that the risk assessment for herbivorous birds in orchards is not standard and that the risk to herbivorous birds is sufficiently addressed.

From the observed endpoints from studies with the formulation Sevin XLR and mammals the RMS suggested that the formulated carbaryl is about a factor 2 more toxic than technical carbaryl. The meeting considered that the observed difference is not very pronounced and that the difference might also be explained by natural variation. It was concluded that it is not necessary to request a formulation study with birds taking into account that exposure via residues on food items will be primarily from the active substance.

The first tier risk assessment for herbivorous and earthworm-eating mammals indicated a potential high acute and long-term risk. A new risk assessment based on refinement of PD and $f(twa)$ and taking into account 70% interception was presented in addendum 1 (June 2005). This resulted in an acute TER of 7.9 and long-term TER of 6.1 indicating a high acute risk. The suggested PD refinement was accepted for the long-term risk but rejected for the acute risk assessment. The meeting considered that it cannot be excluded that the animals feed solely on one food type in a short period of time relevant for the acute risk assessment. The information provided in the addendum was insufficient to assess the derivation of the $f(twa)$ value of 0.28. It was agreed that clarification is required regarding the relevance of the crop, situation (i.e. northern Member States vs. southern Member States) and how the DT_{50} was calculated. It was agreed by the meeting that the endpoint from the F1 generation should be used for the long-term risk assessment instead of the lower endpoint observed in F2 because the duration of exposure in the test is much longer than expected in the field. The use of the acute endpoint from the formulation or technical carbaryl was discussed. The meeting agreed that the lowest observed endpoint should be used. It was noted that the LD50 was the mean of the LD50s for male and female rats. The meeting concluded that the lower endpoint of the two sexes should be used and confirmed the data requirement for a refined acute risk assessment. The acute TER was

recalculated as 4.6 based on the lowest observed endpoint for female rats from a test with the formulation.

Further details were provided in addendum 2 from February 2006 on how the DT_{50} for the residue decline was calculated. The EFSA is of the opinion that the information is sufficient to conclude that the DT_{50} of 4.21 is acceptable and can be used to adjust the $f(twa)$. Hence, the long-term risk to herbivorous mammals is considered to be low.

The risk from uptake of contaminated drinking water was assessed as low based on PEC_{sw} water values. A new calculation according to SANCO/4145/2000 for a medium sized bird was presented in addendum 2. A mistake in the exposure concentration was noticed (it should read 180 mg a.s./L instead of 0.018 mg/L). Therefore the EFSA recalculated the TER values in an addendum. The acute and short-term TER values exceeded the Annex VI trigger in a first tier risk assessment except the acute TER for mammals (9.5) at the higher recommended concentration of the spray solution. The long-term TERs are below the trigger. However since the product is applied only once per growing season it is considered unlikely that contaminated drinking water would be available for a period of time long enough to cause long-term effects. Overall it is concluded that the risk from uptake of contaminated drinking water is assumed to be low for the representative use if sprayed at the lowest recommended concentration. A refined risk assessment is required to address the potential high acute risk to mammals for the highest recommended concentration of the spray solution.

Overall it is concluded that a high long-term risk to insectivorous birds and a high acute risk to herbivorous mammals cannot be excluded for the representative use.

5.2. RISK TO AQUATIC ORGANISMS

The lowest endpoints for carbaryl were observed in studies with aquatic invertebrates. The TER values in the DAR calculated with PEC_{sw} from spray drift indicated a high acute and chronic risk to aquatic invertebrates from exposure to carbaryl and a high chronic risk to fish from exposure to the metabolite 1-naphtol. One microcosm study and published articles on the effects of carbaryl on aquatic habitats were submitted. The published articles were assessed to be of use as additional information but cannot be used directly to derive an EAC value since the tests did not comply to accepted guidelines (e.g. test substance was not measured during the test). The exposure regime in the microcosm study was assessed by the RMS as being representative only for habitats with basic water conditions (pH >9) where carbaryl degrades significantly more rapidly than under neutral or acidic conditions. The meeting wished to have a more detailed summary of the study e.g. a graphical presentation of the results (e.g. PRCs). A probabilistic risk assessment was suggested by the RMS to refine the risk to aquatic organisms.

A new aquatic risk assessment was presented in addendum 1 of June 2005 to address the comments received by Member States. The probabilistic approach suggested by the RMS and the new probabilistic assessment submitted by the applicant were discussed in the experts' meeting. The meeting did not reach a final judgement on the proposed use of the SSD. Uncertainty remained regarding the quality of data which were used to construct the SSD. The meeting requested a short

summary indicating the studies used and the endpoints selected in order to aid transparency and understanding. It was agreed that HC5 values should be read-off the experimental data and from the fitted curve. The applicant suggested splitting the data set. The proposed splitting was not agreed by the meeting but it was noted that it might be acceptable to split data into groups provided that data fall into discrete groups based on sensitivity. Once these issues had been addressed the HC5 could be used in the risk assessment. The proposed trigger value of 1 based on acute LC50s was not accepted by the meeting.

With regard to the long-term risk assessment the meeting agreed that time weighted PECs can be used only if the time to onset of effects is known. Hence the long-term risk assessment should be based on initial PECs. The RMS presented a new long-term TER calculation based on initial PECsw for Daphnids in addendum 2 (February 2006). The results suggest a high long-term risk to aquatic invertebrates even if a no-spray buffer zone of 50 m is applied.

The metabolite 1-naphtol is of similar toxicity to fish but is significantly less toxic to crustaceans compared to carbaryl. The long-term TERs for fish are 8.54 and 123 for a PECsw of 11.7 µg 1-naphtol/L (initial at 3 m) and 0.81 µg 1-naphtol/L (initial at 20 m). The risk from 1-naphtol to fish is significantly lower than the risk from carbaryl to aquatic arthropods. Hence the risk from 1-naphtol to fish is covered by risk mitigation measures for aquatic arthropods, e.g. large buffer zones. The meeting accepted the argumentation that 1-naphtol was formed in the test with *Lemna gibba* and that the endpoint from the Lemna study covers also potential effects of 1-naphtol.

The use of a long-term endpoint for fish from a published article was discussed and considered acceptable because fish toxicity is not driving the risk assessment. Hence a new study is dispensable.

The meeting proposed to take the awaited opinion of the PPR panel on the possibility of lowering the uncertainty factor into account. Based on the opinion⁷ the EFSA calculated geometric mean values⁸ for crustaceans and insects as 28.2 µg carbaryl/L and 40.76 µg carbaryl/L. The resulting TERs for a PECsw of 0.66 µg carbaryl/L (entry via spray drift, 50 m no spray buffer zone) for crustaceans and insects are 42.77 and 53.97. The TERs are below the Annex VI trigger value of 100 indicating a high acute risk to crustaceans and aquatic insects from the representative use of carbaryl.

Overall it is concluded that the representative use of carbaryl poses a high acute and long-term risk to crustaceans and aquatic insects.

⁷ Opinion of the Scientific Panel on Plant health, Plant protection products and their Residues on a request from EFSA related to the assessment of the acute and chronic risk to aquatic organisms with regard to the possibility of lowering the uncertainty factor if additional species were tested. (Question N° EFSA-Q-2005-042). *The EFSA Journal*(2005) 301, 1-45

http://www.efsa.eu.int/science/ppr/ppr_opinions/1332/ppr_op_ej301_aquatic_ecotox_en1.pdf

⁸ All endpoints from studies which were assessed as acceptable by the RMS and listed in Table 9.2.10.2-1b in addendum 2 of February 2006 were included. Only the lowest endpoint observed in three studies with *Mysidopsis bahia* was included in the geometric mean for crustaceans to avoid giving more weight to the endpoints observed for *Mysidopsis bahia* compared to the other tested species.

5.3. RISK TO BEES

The HQ values for bees were calculated as 4285 and 6429 for the risk from oral and contact exposure to carbaryl indicating a potential high risk to bees. The experts' meeting was concerned that the submitted field study was too short to address potential effects on the bee brood and the study design was such that it was not certain that bees had actually foraged in the treated crop. The meeting was content that the particular use poses no high risk to bees because the product is applied only once per year after flowering. For other uses reservations remained about the adequacy of the field study.

5.4. RISK TO OTHER ARTHROPOD SPECIES

The risk assessment according to ESCORT 2 resulted in HQ values of 36437 and 5730 indicating a high in and off-field risk for *Aphidius rhopalosiphi*. The risk for *Typhlodromus pyri* was assessed as low. The tested insects were more sensitive than the tested mites and spiders. No mortality or sublethal effects were observed in extended laboratory studies with *T. pyri*, *Chrysoperla carnea* and *A. rhopalosiphi* after exposure to residues on foliage after 14 days of ageing showing the potential of recolonisation. However the off-crop HQ for *A. rhopalosiphi* indicated a high off-field risk. No spray buffer zones of more than 250 m would be required to protect non-target arthropods in the off-field area. No field studies were submitted. It is questionable if recolonisation of in-field areas from unaffected off-field areas is possible within one year taking the high off-field risk into account.

Overall it is concluded that a high risk to non-target arthropods cannot be excluded for the representative use. Further data (e.g. field studies) are required to address the potential high risk to non-target arthropods.

5.5. RISK TO EARTHWORMS

Several acute toxicity studies were conducted with *Eisenia foetida*. The TER values for this species were markedly above the trigger of 10. However, the first tier risk assessment indicated a high acute risk to *Allobophora caliginosa*. Two field studies were submitted to address the potential high risk to earthworms. Transient effects on earthworm populations were observed in two field studies. The meeting agreed to the assessment of the RMS presented in addendum 1 of June 2005 that no long-term effects on earthworms are expected from the representative use. The risk from 1-naphtol to earthworms was assessed as low.

The risk from the representative use posed to earthworms is considered to be low.

5.6. RISK TO OTHER SOIL NON-TARGET MACRO-ORGANISMS

The field DT₉₀ for carbaryl was not determined. The DT₉₀ derived from laboratory studies was 328 days. The effects to soil micro-organisms were < 25% and the long-term risk to earthworms were assessed as low. However, the standard HQ for non-target arthropods of 2 was exceeded. Therefore a study with collembola or mites is triggered. The test should be conducted with collembola since mites were less sensitive compared to insects (see 5.4.). The EFSA proposes a data gap for a study with collembola to address the potential high risk to other soil non-target organism.

5.7. RISK TO SOIL NON-TARGET MICRO-ORGANISMS

No effects of $> \pm 25\%$ on soil respiration and nitrification were observed in tests with technical and formulated carbaryl at dose rates equivalent to 5 times and 3.9 times the suggested application rate. Therefore the risk to soil non-target micro-organisms is considered to be low for the representative use of carbaryl.

5.8. RISK TO OTHER NON-TARGET-ORGANISMS (FLORA AND FAUNA)

Only very slight effects for some plant species were observed in screening tests with the formulated product on seedling emergence and vegetative vigour of 12 monocotyl and 12 dicotyl plant species at a dose of about 4 times the suggested field rate. Effects of up to 14% reduction in dry weight of cucumber, soybean and tomato were observed in a second study with six different crops at the proposed application rate of 900 g carbaryl/ha. However, the observed effects were less than 50 % and considering non-target plants in the off-field area which are exposed via spray drift and thus exposed to lower amounts of carbaryl the risk to non-target plants is considered to be low for the representative use.

5.9. RISK TO BIOLOGICAL METHODS OF SEWAGE TREATMENT

No consistent inhibitory effects on respiration of activated sewage sludge were observed at concentrations of 10 and 32 mg carbaryl/L. Inhibitory effects increased from 29 % to 45 % with the amount of applied carbaryl of 100 to 1000 mg carbaryl/L. The EC_{50} for inhibition of respiration of activated sewage sludge was extrapolated to 1232 mg carbaryl/L. Therefore no risk to biological methods of sewage treatment is anticipated from the representative use.

6. Residue definitions

Soil

Definitions for risk assessment: carbaryl and 1-naphthol

Definitions for monitoring: carbaryl

Water

Ground water

Definitions for exposure assessment: carbaryl and 1-naphthol

Definitions for monitoring: carbaryl

Surface water

Definitions for risk assessment: surface water carbaryl and 1-naphthol
sediment carbaryl

Definitions for monitoring: water carbaryl and 1-naphthol
sediment carbaryl

Air

Definitions for risk assessment: carbaryl

Definitions for monitoring: carbaryl

Food of plant origin

Definitions for risk assessment: sum of carbaryl, 4-hydroxycarbaryl and 5-hydroxycarbaryl expressed as carbaryl

Definitions for monitoring: carbaryl

Food of animal origin

Definitions for risk assessment: no residue definition needed due to low exposure of livestock

Definitions for monitoring: no residue definition needed due to low exposure of livestock



Overview of the risk assessment of compounds listed in residue definitions for the environmental compartments

Soil

Compound (name and/or code)	Persistence	Ecotoxicology
carbaryl	Low to medium persistence Single first order DT ₅₀ 2.3-98.7 days (20°C -10kPa soil moisture)	A potential acute risk was observed for one of the tested earthworm species. No long-term effects were detected in two field studies with earthworms. A potential high risk to other non-target macro-organisms (in particular with regard to soil dwelling insects) cannot be excluded. A data gap for a study with collembola was identified.
1-naphthol	Very low persistence Single first order DT ₅₀ 0.53 days (20°C -10kPa soil moisture)	The risk of 1-naphthol to earthworms was assessed as low.

Ground water

Compound (name and/or code)	Mobility in soil	> 0.1 µg / L 1m depth for the representative uses (at least one FOCUS scenario or relevant lysimeter)	Pesticidal activity	Toxicological relevance	Ecotoxicological relevance
carbaryl	Medium mobility K_{foc} 177-249 mL/g	No	Yes	Yes	Carbaryl is very toxic to aquatic arthropods. The risk to aquatic arthropods dwelling in surface water was assessed as high
1-naphthol	Medium mobility K_{doc} 245 mL/g	No	1-naphthol acts as a growth regulator for plants	R21/22: harmful in contact with skin and if swallowed R37/38 Irritating to respiratory system and skin R41, risk of serious damage to eyes.	The first tier risk assessment indicated a potential long-term risk to fish

Surface water and sediment

Compound (name and/or code)	Ecotoxicology
carbaryl	Carbaryl is very toxic to aquatic arthropods. The acute and long-term risk to aquatic arthropods is high.
1-naphthol	The first tier risk assessment indicated a potential long-term risk to fish.



Air

Compound (name and/or code)	Toxicology
carbaryl	Harmful by inhalation (LC ₅₀ 2.43 mg/L)

LIST OF STUDIES TO BE GENERATED, STILL ONGOING OR AVAILABLE BUT NOT PEER REVIEWED

- Validated method of analysis for the relevant impurities in the formulation (data gap identified by RMS in DAR and confirmed by EPCO 35, September 2005; date of submission unknown; refer to chapter 1).
- Storage stability study where the relevant impurities are analysed before and after storage (date of submission unknown, data gap identified by EPCO 35 September 2005 see evaluation table; refer to chapter 1).
- Validated method of analysis for 1-naphthol in surface water with an appropriate limit of quantification (data gap identified by EFSA; date of submission unknown; refer to chapter 1).
- Supervised residue trials with analysis of 4- and 5-hydroxy carbaryl (data gap identified as a result of the inclusion of 4- and 5- hydroxyl carbaryl in the residue definition for risk assessment by the EPCO expert meeting; no submission date proposed by the notifier; refer to point 3.1.1).
- The long-term risk to insectivorous birds needs to be addressed (data gap identified at the EPCO experts' meeting in September 2005; date of submission unknown; refer to point 5.1).
- A refined risk assessment is required to address the acute risk to mammals from uptake of contaminated drinking water if the product is sprayed at the highest recommended concentration (data gap identified by EFSA; date of submission unknown; refer to point 5.1).
- The risk to aquatic invertebrates needs to be further addressed (data gap identified in the EPCO expert meeting; date of submission unknown; refer to point 5.2).
- Further data (e.g. field studies) are required to address the potential high in-field and off-field risk to non-target arthropods (data gap identified by EFSA; date of submission unknown; refer to point 5.4).
- A study with collembola is required to address the potential high risk to other soil non-target organism (data gap identified by EFSA; date of submission unknown; refer to point 5.6).

CONCLUSIONS AND RECOMMENDATIONS

Overall conclusions

The conclusion was reached on the basis of the evaluation of the representative use as a plant growth regulator as proposed by the applicant. The application method is by tractor mounted orchard sprayer with application to apple trees for the purpose of fruit thinning. The application rate is up to 0.9 kg of carbaryl per hectare. It should be noted that only the use as a plant growth regulator will be supported in the EU review programme. However, carbaryl is also an insecticide and acaricide.

The representative formulated product for the evaluation was Sevin XLR plus, a suspension concentrate (SC) containing 480 g/L carbaryl, formulations are also registered under different trade names in Europe.

In the main adequate methods are available to monitor all compounds given in the respective residue definition. Residues in food of plant origin can be determined by HPLC with fluorescence detection.

Carbaryl can not be analysed by any currently available published monitoring methods due to the nature of the residues. For the other matrices only single methods are available for the same reasons as given above. For water and soil the method is HPLC with fluorescence detection and air is by HPLC-MS/MS. The method of analysis does not analyse for all components of the residue definition in surface water and therefore further data will be required to validate it for the compound 1-naphthol. Methods to determine residues of carbaryl in products of animal origin or for body foods and tissues are not required because no MRLs will be set for products of animal origin and carbaryl is not classified as toxic or very toxic.

Sufficient methods of analysis for carbaryl and data relating to physical, chemical and technical properties are available to ensure that quality control measurements of the plant protection product are possible. However, methods of analysis are not available for the relevant impurities in the formulation and the current storage data are not acceptable as the relevant impurities were not analysed for before and after storage.

Carbaryl is harmful if swallowed (oral LD₅₀ 614 mg/kg bw) and by inhalation (LC₅₀ 2.43 mg/L); it has a low acute dermal toxicity (dermal LD₅₀ higher than 5000mg/kg bw). Carbaryl is not irritant to skin and eyes and it is not a skin sensitiser. The following classification was proposed: Harmful, R20 'Harmful by inhalation' and R22 'Harmful if swallowed'. The critical effect in short and long term studies was the inhibition of cholinesterase activity. The weight of evidence indicates that carbaryl is not an *in vivo* genotoxic agent. In mice and rats, carbaryl was found to be carcinogenic; classification with R40 'Limited evidence of a carcinogenic effect' or R45? 'May cause cancer' was discussed and agreed on to be forwarded to ECB. Carbaryl did not show any potential for reproductive and developmental toxicity. The ADI is 0.0075 mg/kg bw/day (safety factor of 2000 because of the carcinogenicity issue); the AOEL and ARfD are 0.01 mg/kg bw/day (safety factor 100). Operator exposure is below the AOEL when estimated with German model and considering the use of PPE like gloves during mixing/loading and hood, visor, coverall and sturdy footwear during application.

The metabolism of carbaryl has been investigated in four crop groups, allowing the elucidation of the degradation pathway of the compound, which includes methyl and ring hydroxylation, carbamate ester hydrolysis and N-demethylation. Most of the metabolites formed may be further conjugated to form water-soluble glycosides. The metabolic pattern of carbaryl is evolving with time. For long PHIs the available data suggest that relevant metabolites can be present at levels representing a possible significant contribution to the toxicological burden. For the use of carbaryl for apple thinning, with a PHI of 80 days, 2 metabolites, 4- and 5-hydroxy carbaryl, which are cholinesterase inhibitors, are expected to be present in amounts of the same order of magnitude as the parent compound. Therefore these metabolites were included in the residue definition for risk assessment. Supervised residue trials were carried out with analysis of parent compound only. This allows proposing the MRL for apple to be set below the Limit of Quantification of 0.05 mg/kg, but a robust risk assessment is not possible to be conducted as information on the actual level at harvest of the 2 hydroxy metabolites is lacking. Considering that the exposure to the parent compound only is close to 50% of the ARfD for some

specific population sub-groups, it cannot be excluded that the contribution of the metabolites leads to a global exceedence of the ARfD for those sub-groups.

Residues in succeeding crops, in processed commodities and in animal products are not expected.

The available information on the fate and behaviour of carbaryl in the environment is considered sufficient to complete an appropriate EU level environmental exposure assessment. Whilst based on annex II data requirements, one of the laboratory degradation results would trigger field soil dissipation studies and these are not available, it is considered that having field data would not significantly increase the reliability of the environmental exposure assessment in this particular case. The available surface water exposure assessment just considered the spray drift route of entry to surface water. The potential exposure of surface water with parent carbaryl via the drainage and runoff routes of entry has not been assessed in the available EU level exposure assessment. Member states should therefore carry out a surface water exposure and consequent aquatic risk assessment for carbaryl from the runoff and drainage routes of exposure to surface water at the national level, should carbaryl be included in annex 1.

Appropriate FOCUS groundwater modelling indicated that for the applied for intended use on apples leaching to groundwater above the parametric drinking water limit (0.1µg/L) would not be expected for either carbaryl or its potential major soil metabolite 1-naphthol.

A high long-term risk to insectivorous birds and a high acute and long-term risk to herbivorous mammals were identified in a first tier risk assessment. The submitted information was not sufficient to address the potential high risk to insectivorous birds in orchards. A refined risk assessment based on residue decline was not accepted to refine the acute risk to herbivorous mammals. For the long-term risk assessment more information was requested on how the DT₅₀ value for the residue decline was calculated. This information was included in addendum 2 of February 2006. The EFSA considers the information as sufficient and considers the long-term risk to herbivorous mammals as low. However, the potential high acute risk to herbivorous mammals needs to be addressed.

Carbaryl is very toxic to aquatic arthropods. The submitted microcosm study was assessed by the RMS as not being of use in deriving an EAC value since the exposure regime was representative only for aquatic habitats with very basic pH conditions where carbaryl degrades very rapidly. The proposed probabilistic approach was discussed by the EPCO experts' meeting. Uncertainty remained on which endpoints were used to construct the SSD. The splitting of data as suggested by the applicant would only be accepted if data fall into discrete groups based on sensitivity. The meeting considered the proposed trigger of 1 based on acute LC₅₀ values as not acceptable. Based on the PPR opinion the EFSA calculated the TER values for insects and crustaceans. The TERs are still below the trigger of 100 even if a no-spray buffer zone of 50 m is taken into account for the PEC_{sw} calculation indicating a high acute risk. Overall it is concluded that the representative use of carbaryl poses a high acute and long-term risk to crustaceans and aquatic insects.

Although carbaryl is very toxic to bees, the meeting was content that the representative use does not pose a high risk to bees because it is applied only once a year after flowering. A high in-field and off-

field risk to non-target arthropods (particularly with regard to insects) was indicated. Further data e.g. field studies are needed to show recovery of non-target insects in fields. Since the DT₉₀ of carbaryl was in the range of 100 to 365 days and the standard HQ for non-target arthropods was exceeded a study with other soil non-target macro organisms is needed.

Particular conditions proposed to be taken into account to manage the risk(s) identified

- Estimated operator exposure is below the AOEL considering the use of PPE like gloves during mixing/loading and hood, visor, coverall and sturdy footwear during application.

Critical areas of concern

- A threshold for vascular tumours in the liver and spleen in mouse was not identified. Classification of R40 or R45 was discussed in the expert meeting.
- A robust risk assessment for the safety of the consumer is not possible due to the lack of information on the actual levels of 4- and 5-hydroxy carbaryl in apples. Considering that the exposure to the parent compound only is close to 50% of the ARfD for some specific population sub-groups, it cannot be excluded that the contribution of the metabolites leads to a global exceedence of the ARfD for those sub-groups.
- A high long-term risk to insectivorous birds and a high acute risk to herbivorous mammals.
- A high acute and chronic risk to aquatic invertebrates which require considerable risk mitigation measures (with 50 m no-spray bufferzone, the TER is still below the trigger).
- A high risk to non-target arthropods (particularly with regard to insects) which require considerable risk mitigation measures, e.g. no-spray buffer zones of more than 250 m would be required to protect non-target arthropods in the off-field area.

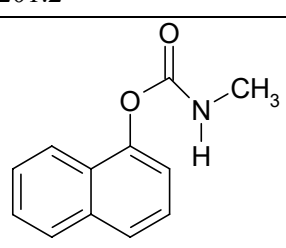
APPENDIX 1 – LIST OF ENDPOINTS FOR THE ACTIVE SUBSTANCE AND THE REPRESENTATIVE FORMULATION

(Abbreviations used in this list are explained in appendix 2)

Appendix 1.1: Identity, Physical and Chemical Properties, Details of Uses, Further Information

Active substance (ISO Common Name) ‡	Carbaryl
Function (e.g. fungicide)	Insecticide, acaricide and plant growth regulator.
Rapporteur Member State	Spain
Co-rapporteur Member State	--

Identity (Annex IIA, point 1)

Chemical name (IUPAC) ‡	1-Naphthyl <i>N</i> - methylcarbamate
Chemical name (CA) ‡	1-Naphthalenyl- methylcarbamate
CIPAC No ‡	26
CAS No ‡	63-25-2
EEC No (EINECS or ELINCS) ‡	200-555-0
FAO Specification ‡ (including year of publication)	Specifications comply with FAO specification 26/TC/S (year 1989): Carbaryl: 980 g/kg ± 20 g/kg 2-naphthol: 0.5 g/kg 2-naphthyl methylcarbamate: 0.5 g/kg Lose on vacuum drying: 10 g/kg
Minimum purity of the active substance as manufactured ‡ (g/kg)	990 g/kg
Identity of relevant impurities (of toxicological, environmental and/or other significance) in the active substance as manufactured (g/kg)	2-Naphthol, maximum content 0.5 g/kg, 2-naphthyl methylcarbamate, maximum content 0.5 g/kg
Molecular formula ‡	C ₁₂ H ₁₁ NO ₂
Molecular mass ‡	201.2
Structural formula ‡	

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

Physical-chemical properties (Annex IIA, point 2)

Melting point (state purity) ‡	138.0 ± 0.2°C (purity: 99.1%)
Boiling point (state purity) ‡	210°C (mean boiling point by Differential Scanning Calorimetry), 212.0 ± 0.2°C (boiling point by photocell detection method) (purity: 99.1%)
Temperature of decomposition	254°C: start of the exothermal decomposition (purity: 99.1%)
Appearance (state purity) ‡	White powder (purity: 99.1%)
Relative density (state purity) ‡	1.21 ± 0.01 at 20°C (purity: 99.1%)
Surface tension	65.5 mN/m (90% water saturated solution at 20°C) (purity: 99.1%)
Vapour pressure (in Pa, state temperature) ‡	4.16 x 10 ⁻⁵ ± 4.51 x 10 ⁻⁶ Pa at 23.5°C (purity: 99.1%)
Henry's law constant (Pa m ³ mol ⁻¹) ‡	9.2 x 10 ⁻⁵ Pa m ³ mol ⁻¹ @ 20°C
Solubility in water ‡ (g/L or mg/L, state temperature)	pH 4: 9.4 ± 0.2 mg/L
	pH 7: 9.1 ± 0.3 mg/L
	pH 9: 7.2 ± 0.3 mg/L at 20±0.5°C (purity: 99.1%)
Solubility in organic solvents ‡ (in g/L or mg/L, state temperature)	n-Heptane: 0.25g/L
	Xylene: 9.86 g/L
	1,2-Dichloroethane 100-120 g/L
	Methanol: 75-100 g/L
	Acetone: 150-200 g/L
	Ethylacetate: 75-100 g/L
	Acetonitrile: 100-120 g/L
	Dimethylsulfoxide: > 600 g/L at 20 ± 0.5 °C (purity: 99.1%)
Partition co-efficient (log POW) ‡ (state pH and temperature)	Carbaryl: 2.36 ± 0.012 (RSD = 0.51%) at 23 °C ± 2°C in Milli-Q purified water (neutral pH) (purity: 99.8%)
	1-naphtol: 2.995 ± 0.02 (RSD = 0.7%) at 23 °C. (purity: 99.8%)
Hydrolytic stability (DT ₅₀) ‡ (state pH and temperature)	pH 5: Stable
	pH 7: Degraded with half-life values of 12.5 and 11.6 days in both pH7 buffers.

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

	pH 9: Degraded with half-life of 3.2 hours. (radiochemical purity >98%)																				
Dissociation constant ‡	pK _a = 10.4 ± 0.4 (s), n=7. In solution in water, there is no dissociated species but carbaryl itself. Temperature: 24.3 ± 0.1°C. (purity: 99.7%)																				
UV/VIS absorption (max.) ‡ (if absorption > 290 nm state ε at wavelength)	All findings are consistent with the compound structure. <table> <tr> <th>λ_{max}[nm]</th><th>ε[L*mol⁻¹*cm⁻¹]</th></tr> <tr> <td colspan="2"><u>neutral water</u></td></tr> <tr> <td>220</td><td>82696</td></tr> <tr> <td>270</td><td>5743</td></tr> <tr> <td>279</td><td>6434</td></tr> <tr> <td>291</td><td>4211</td></tr> <tr> <td colspan="2"><u>acidic MeOH:</u></td></tr> <tr> <td>221.5</td><td>18362</td></tr> <tr> <td>280.0</td><td>6703</td></tr> <tr> <td>295</td><td><2743.</td></tr> </table> <p><u>Modifications of the spectrum were observed in basic medium, due to the hydrolysis of carbaryl in 1-naphthol.</u></p>	λ _{max} [nm]	ε[L*mol ⁻¹ *cm ⁻¹]	<u>neutral water</u>		220	82696	270	5743	279	6434	291	4211	<u>acidic MeOH:</u>		221.5	18362	280.0	6703	295	<2743.
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<u>neutral water</u>																					
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Photostability (DT ₅₀) ‡ (aqueous, sunlight, state pH)	pH = 5: 25 °C DT ₅₀ : 9.9 days (r ² = 0.98), assuming first order kinetic and based on experimental conditions of 12 hour light/dark cycles. 1-Naphthol is a minor degradation product ¹⁴ CO ₂ representing an average of 30.2% AR (radiochemical purity >98%)																				
Quantum yield of direct phototransformation in water at λ > 290 nm ‡	2.67 x 10 ⁻³ .																				
Flammability ‡	Not a readily combustible solid (purity: 99.1%)																				
Explosive properties ‡	No explosive (purity: 99.1%)																				

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Appendix 1 – list of endpoints

List of representative uses evaluated*

Crop and/or situation	Member State or Country	Product name	F G or	Pests or Group of pests controlled	Formulation		Application				Application rate per treatment			PHI (days)	Remarks:
					Type	Conc. of a.s.	method kind	growth stage & season	number min max	interval between applications (min)	kg a.s./hl	water l/ha	kg a.s./ha	(l)	(m)
(a)			(b)	(c)	(d-f)	(i)	(f-h)	(j)	(k)		min max	min max	min max		
Apple	North and South Europe	Sevin XLR plus	F	Apple thinning after flowering	SC	480 g/L	High volume spray	End of flowering BBCH 71-72	1	-	0.06-0.09	1000-1500	0.9	80	[1] [2]

[1] The risk assessment has revealed a risk (exceedance of relevant threshold) in section 5.

[2] A robust risk assessment for the safety of the consumer is not possible due to the lack of information on the actual levels of 4- and 5-hydroxy carbaryl in apples. Considering that the exposure to the parent compound only is close to 50% of the ARfD for some specific population sub-groups, it cannot be excluded that the contribution of the metabolites leads to a global exceedance of the ARfD for those sub-groups

Remarks:	*	Uses for which risk assessment could not been concluded due to lack of essential data are marked grey	(h)	Kind, e.g. overall, broadcast, aerial spraying, row, individual plant, between the plants - type of equipment used must be indicated
	(a)	For crops, the EU and Codex classifications (both) should be used; where relevant, the use situation should be described (e.g. fumigation of a structure)	(i)	g/kg or g/L
	(b)	Outdoor or field use (F), glasshouse application (G) or indoor application (I)	(j)	Growth stage at last treatment (BBCH Monograph, Growth Stages of Plants, 1997, Blackwell, ISBN 3-8263-3152-4), including where relevant, information on season at time of application
	(c)	e.g. biting and suckling insects, soil born insects, foliar fungi, weeds		
	(d)	e.g. wettable powder (WP), emulsifiable concentrate (EC), granule (GR)	(k)	The minimum and maximum number of application possible under practical conditions of use must be provided
	(e)	GCPF Codes - GIFAP Technical Monograph No 2, 1989		
	(f)	Method, e.g. high volume spraying, low volume spraying, spreading, dusting, drench	(l)	PHI - minimum pre-harvest interval
	(g)	All abbreviations used must be explained	(m)	Remarks may include: Extent of use/economic importance/restrictions

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

Appendix 1.2: Methods of Analysis

Analytical methods for the active substance (Annex IIA, point 4.1)

Technical as (principle of method)	<p>CIPAC Method: Liquid Chromatography method using an UV detector (CIPAC Method)</p> <p>AL042/01-1. Reversed phase isocratic HPLC with UV detection. Quantification external standard of certified reference substance of AE F054158</p>
Impurities in technical as (principle of method)	<p>Gradient profile HPLC method</p> <p>AL040/01-1 employing a reversed stationary phase and UV detection. Quantification external standard of certified substances.</p> <p>Confirmatory method by HPLC/DAD</p>
Plant protection product (principle of method)	<p>C-989-02-99. Standard and sample solutions (5 µL) are injected twice in the HPLC-UV system (Column: Nucleosil C18, 12.5 cm, Eluent: Acetonitrile/Water (55:45), Tcolumn = 40 °C, UV λ = 280 nm). Amount of active ingredient is calculated by comparison of peak areas of Carbaryl peak in standard and samples.</p> <p><i>Data gap: method for the determination of impurities in the formulated product.</i></p>

Analytical methods for residues (Annex IIA, point 4.2)

Food/feed of plant origin (principle of method and LOQ for methods for monitoring purposes)	<p>Method: AR 269-01: apples, apple juice and olives. extraction of carbaryl residues with dichloromethane. HPLC equipped with post-column hydrolysis/derivatisation system and fluorescence detection on an octadecyl column. Quantification is done by external standardisation. The qualitative confirmatory test was performed for apples and apple juice by HPLC equipped with post-column hydrolysis / derivatisation system and fluorescence detection on a phenyl column (column of different polarity). LOQ is 0.01 mg/kg</p> <p>An independent laboratory validation of Method No AR-269-01 was performed.</p>
Food/feed of animal origin (principle of method and LOQ for methods for monitoring purposes)	Not required

Soil (principle of method and LOQ)	Method AR 287-01 : extraction of the soil sample with a 50:50 acetone:water solution and determination of carbaryl residues by HPLC (Isocratic: water 50 % - methanol 50 %; Column: Puresil C18, Waters; 40 °C) with a post-column hydrolysis and fluorescence detection system. LOQ = 0.005 mg/kg.
Water (principle of method and LOQ)	Method AR 281-01 : hydrolysis and determination of carbaryl residues by liquid chromatography on an octadecyl column using fluorescence detection system. Quantification is made through external standardisation. LOQ = 0.10 µg/L for surface and drinking water. <i>Data gap: method required for 1-naphthol in surface water.</i>
Air (principle of method and LOQ)	Method AR 270-01 : Air was sucked through XAD [®] adsorption tubes at about 1.4 L/min for 6 hours for a total air sampling volume of 0.5 m ³ . The adsorption Tmaterial was extracted with acetonitrile and the extract analysed by liquid chromatography with mass spectrometric detection (LC/MS/MS). A limit of quantification (LOQ) of 0.3 µg/m ³ was achieved for carbaryl residues in air.
Body fluids and tissues (principle of method and LOQ)	Not required

Classification and proposed labelling (Annex IIA, point 10)

with regard to physical/chemical data	None
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Appendix 1.3: Impact on Human and Animal Health

Absorption, distribution, excretion and metabolism in mammals (Annex IIA, point 5.1)

Rate and extent of absorption ‡	Rapidly absorbed, about 91.5% within 24 hours based on urine (rat, 1 or 50 mg/kg bw)
Distribution ‡	Widely distributed, highest levels in the kidney at 7 days
Potential for accumulation ‡	No evidence of accumulation
Rate and extent of excretion ‡	Mainly via urine: about 91.5% within 24 hours.
Metabolism in animals ‡	Extensively metabolised. 2.9% of unchanged Carbaryl in urine. Three main metabolic pathways: Arene oxide formation with hydrolysis to dihydrodihydroxycarbaryl and glucuronide conjugation; Hydrolysis to form 1-naphthol and conjugation; Oxidation of N-methyl moiety (alkyl oxidation)
Toxicologically significant compounds ‡ (animals, plants and environment)	Carbaryl

Acute toxicity (Annex IIA, point 5.2)

Rat LD ₅₀ oral ‡	614 mg/kg bw, R22
Rat LD ₅₀ dermal ‡	>5000mg/kg bw
Rat LC ₅₀ inhalation ‡	2.4 mg/L for females, R20
Skin irritation ‡	Non-irritant
Eye irritation ‡	Non-irritant
Skin sensitization ‡ (test method used and result)	Non-sensitising (Maximisation test)

Short term toxicity (Annex IIA, point 5.3)

Target / critical effect ‡	Inhibition of brain and red blood cell cholinesterase activity
Lowest relevant oral NOAEL / NOEL ‡	<3.73 mg/kg bw/day, female dogs (1year, diet)
Lowest relevant dermal NOAEL / NOEL ‡	20 mg/kg bw/day, rats (5 days/week, 4 weeks)
Lowest relevant inhalation NOAEL / NOEL ‡	No data

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Genotoxicity ‡ (Annex IIA, point 5.4)

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No genotoxic potential

Long term toxicity and carcinogenicity (Annex IIA, point 5.5)

Target/critical effect ‡

Erythrocyte and brain cholinesterase inhibitions in rats and mice
Mice: Urinary bladder (intracytoplasmic droplets).

Lowest relevant NOAEL / NOEL ‡

10 mg/kg bw/day (2-year dietary study in rats)
LOAEL: 15 mg/kg bw/day (2-year dietary study in mice)

Carcinogenicity ‡

Rats: thyroid follicular adenomas and carcinomas (males), hepatocellular adenoma (females), carcinomas and adenomas in the urinary bladder (both sexes), a carcinoma in kidney (male) at 349 mg/kg bw/day.
Mice: vascular tumors at 15 mg/kg bw/day (males) (lowest dose tested). Renal tubular cell adenoma and carcinoma (males) and hepatocellular carcinoma and adenoma (female) and vascular tumors (females) at 1248 mg/kg bw/day.

R40, R45?

Reproductive toxicity (Annex IIA, point 5.6)

Reproduction target / critical effect ‡

Parental: reduced bodyweight and food consumption
Reproductive: reduction in pup numbers
Offspring: reduced pup survival

Lowest relevant reproductive NOAEL / NOEL ‡

Reproductive, parental and offspring NOAEL of 4.7 mg/kg bw/day
Two-generation study in rats

Developmental target / critical effect ‡

Reduction in maternal and foetal body weight, delayed ossification

Lowest relevant developmental NOAEL / NOEL ‡

NOAEL for maternal/development of 4 mg/kg bw/day (developmental study in rat)

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

Neurotoxicity / Delayed neurotoxicity ‡ (Annex IIA, point 5.7)

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Tremors, autonomic signs, inhibition of all types of cholinesterase activity.

Oral neurotoxicity NOAEL = 1 mg/kg bw/day (13-weeks; by gavage; rat)

No adverse effects on development neurotoxicity identified following exposure by the oral route

LOAEL = 10 mg/kg bw in acute neurotoxicity study

NOAEL = 10 mg/kg bw/day in developmental neurotoxicity study

Other toxicological studies ‡ (Annex IIA, point 5.8)

Mechanistic studies

Rats: a significant increase in the number of PCNA positive urothelial cells was seen in the urinary bladder of males, a slight increase in the number of cycling cells was observed in the thyroid glands of males and in the liver of females. Carbaryl did not modify the total liver cytochrome P-450 content, a small increase in CYP1A activity was observed at 40 mg/kg/day in males only. Carbaryl increased significantly T4 and T3-UGT in males (40 mg/kg/day) and females (10 and 40 mg/kg/day) (Phenobarbital like inducer profile). An increase in cells in G1 and S was observed at 10 (females) and 40 mg/kg/day (males and females). In conclusion, tumors in rats were compatible with a non-genotoxic potential of carbaryl, associated with prolonged cellular proliferation leading tumor formation after long-term exposure at high dose levels.

Mice: when carbaryl was administered to p53 knockout mice for 6 months at concentration ranged 0 to 4000 ppm) no neoplastic or preneoplastic changes were observed in the vascular tissue in any organ. Studies conducted with PCNA staining in liver and kidney showed an increased PCNA-positive cortical tubular cells in males and females at 8000 ppm, no increase in PCNA positive cells were observed in the liver. Carbaryl administration to mice for 2 weeks induced an increase in hepatic microsomal protein content, an elevated microsomal cytochrome P450 content, an increased EROD activity, and PORD activity as well as a slight increase in microsomal testosterone hydroxylation. These results identify carbaryl as a weak barbiturate type inducer in

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

mouse liver.

Metabolites 4-hydroxycarbaryl and 5-hydroxycarbaryl are likely to be ChE inhibitors; acute oral toxicity of 5-hydroxycarbaryl (LD50 297 mg/kg bw); LD50 values for 4-hydroxycarbaryl and 1-naphthol are 1190 mg/kg bw and 2590 mg/kg bw, respectively. The short-term toxicity of these metabolites was lower when compared to the parent compound carbaryl.

In vitro cholinesterase inhibition studies showed that 1-naphthol, 4- and 5-hydroxycarbaryl are also inhibitors of cholinesterase activity, with similar or higher IC50 values.

1-naphthol is a metabolite found in plants and animals, and it is also an impurity. According to European Chemical Information System 1-naphthol is classified as R21/22, harmful in contact with skin and if swallowed, R37/38 Irritating to respiratory system and skin and R41, risk of serious damage to eyes.

1-naphthyl 2,4-dimethyl allophanate is an impurity. A DEREK analysis indicates that it does not pose any concerns.

Medical data ‡ (Annex IIA, point 5.9)

.....

Epidemiological studies of exposed populations were inconclusive. Scarce fatal cases of poisoning. Treatment with oximes is contraindicated when carbaryl poisoning

Summary (Annex IIA, point 5.10)

	Value	Study	Safety factor
ADI ‡	0.0075mg/kg bw/day	2 year study mouse study (based on LOAEL for tumours)	2000*
AOEL ‡	0.01mg/kg bw/day	13-week rat neurotoxicity study	100
ARfD ‡ (acute reference dose)	0.01mg/kg bw/day	13-week rat neurotoxicity study	100

* an additional safety factor was considered due to the use of LOAEL to derive the reference value

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Dermal absorption (Annex IIIA, point 7.3)

Sevin XLR Plus

0.5% for concentrate and 10% for dilution, based on in vivo rat and in vitro rat/human

Acceptable exposure scenarios (including method of calculation)

Operator

Tractor-mounted/trailed broadcast air-assisted sprayer

Citrus, pome fruit, olive tree

Workers

75% AOEL (PPE) BBA Model
1300% AOEL (PPE) UK-POEM
PPE: Gloves ML & applic. hood and visor,
Coverall and sturdy footwear in application

81% AOEL
pre-harvest interval recommended:
-Apple: 80 days
-Citrus, Olive: 7-14 days

Bystanders

60% AOEL

Classification and proposed labelling (Annex IIA, point 10)

with regard to toxicological data

Xn;	Harmful
R20/R22	Harmful if swallowed and by inhalation
R40	Limited evidence of a carcinogenic effect
R45?	May cause cancer

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Appendix 1.4: Residues

Metabolism in plants (Annex IIA, point 6.1 and 6.7, Annex IIIA, point 8.1 and 8.6)

Plant groups covered	Lettuce (leafy crops), radish (root and tuber), soybean (oilseeds) and apples (fruits)
Rotational crops	Not required (supported use apple thinning)
Plant residue definition for monitoring	Carbaryl
Plant residue definition for risk assessment	Sum of carbaryl, 4-hydroxy carbaryl and 5-hydroxy carbaryl, expressed as carbaryl (valid for apples only)
Conversion factor (monitoring to risk assessment)	Cannot be determined on the basis of the available information

Metabolism in livestock (Annex IIA, point 6.2 and 6.7, Annex IIIA, point 8.1 and 8.6)

Animals covered	Not required (supported use apple thinning)
Animal residue definition for monitoring	
Animal residue definition for risk assessment	
Conversion factor (monitoring to risk assessment)	
Metabolism in rat and ruminant similar (yes/no)	
Fat soluble residue: (yes/no)	

Residues in succeeding crops (Annex IIA, point 6.6, Annex IIIA, point 8.5)

.....	Not required (supported use apple thinning)
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Stability of residues (Annex IIA, point 6 introduction, Annex IIIA, point 8 introduction)

.....	Stable on apples, olives, olive oil for 2 years at -20 °C.
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Residues from livestock feeding studies (Annex IIA, point 6.4, Annex IIIA, point 8.3)

Intakes by livestock ≥ 0.1 mg/kg diet/day:	Ruminant: no	Poultry: no	Pig: no
Muscle	Not required (supported use apple thinning)		
Liver			
Kidney			

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Fat

Milk

Eggs



Note: Based on current information, only a realistic expectation can be made that the intake by animal of all toxicologically relevant residual compounds is < 0.1 mg/kg diet. A final and fully reliable exposure assessment of livestock will only be possible when quantitative data on the amount of 4- and 5-OH carbaryl in apple pomace will be available.



Appendix 1 – list of endpoints

Summary of critical residues data (Annex IIA, point 6.3, Annex IIIA, point 8.2)

Crop	Northern or Mediterranean Region	Trials results relevant to the critical GAP (a) mg carbaryl/kg	Recommendation/comments	MRL	STMR (b)
Apple	N	5 X < 0.01; 2 X < 0.05	This table reports residue levels of carbaryl only as only the parent compound was analysed in the reported residue trials. A full package of supervised residue trials with analysis of carbaryl and its 2 hydroxy metabolites should be submitted.	0.05* mg/kg	0.01
	S	2 X < 0.05		0.05* mg/kg	0.05

(a) Numbers of trials in which particular residue levels were reported *e.g.* 3 x <0.01, 1 x 0.01, 6 x 0.02, 1 x 0.04, 1 x 0.08, 2 x 0.1, 2 x 0.15, 1 x 0.17

(b) Supervised Trials Median Residue *i.e.* the median residue level estimated on the basis of supervised trials relating to the critical GAP

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Consumer risk assessment (Annex IIA, point 6.9, Annex IIIA, point 8.8)

ADI	0.0075 mg/kg bw/d
TMDI (% ADI) according to WHO European diet	0.4% (European adult)
TMDI (% ADI) according to national (to be specified) diets	6% (UK diet for toddlers), 2% (German diet for the 4-6 years old girl), 0.8% (Spanish diet for adults)
ARfD	0.01 mg/kg bw/d
NESTI (% ARfD) according to national (to be specified) large portion consumption data	United Kingdom: Infants: 36% Toddlers: 49%

Note: all these exposure assessments (acute and chronic) were made considering the contribution of the parent compound only). They may therefore underestimate the actual toxicological burden.

Processing factors (Annex IIA, point 6.5, Annex IIIA, point 8.4)

Crop/processed crop	Number of studies	Transfer factor	% Transference *
Not required. Supervised residue trials showed no residue situation			

Proposed MRLs (Annex IIA, point 6.7, Annex IIIA, point 8.6)

Apple	0.05* mg/kg
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*: LOQ

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Appendix 1.5: Fate and Behaviour in the Environment

Route of degradation (aerobic) in soil (Annex IIA, point 7.1.1.1.1)

Mineralization after 100 days ‡	15-58.4% after 100 d, [1-naphthyl-methylcarbamate]-label (n= 4) 59.7 % after 14 d, [1-naphthyl- methylcarbamate]-label (n= 1) Sterile conditions: no data
Non-extractable residues after 100 days ‡	20-39% after 100 d, [1-naphthyl-methylcarbamate]-label (n= 4) max .64% at 21 days (n=1) 17.7 % after 14 d, [1-naphthyl- methylcarbamate]-label (n= 1) Sterile conditions: No data
Relevant metabolites - name and/or code, % of applied ‡ (range and maximum)	1-Naphthol- 34.6 % at 2d (n= 1) <2% in the other 4 soils tested

Route of degradation in soil - Supplemental studies (Annex IIA, point 7.1.1.1.2)

Anaerobic degradation ‡	Mineralisation – 12.4 % after 126d Non-extractable residues 23.6 % after 126 d [1-naphthyl- methylcarbamate]-label (n= 1) carbaryl 21.7% at 126 d Metabolites 1-naphthol –max 26.3% at 94 d [1-naphthyl- methylcarbamate]-label (n= 1)
Soil photolysis ‡	Soil: well structured at 20°C and 75% of 1/3 bar water holding capacity No significant photodegradation was observed at the end of the study: CO ₂ : 0.6 % AR at the end of the study Unextracted residues: 6.9% at the end of the study Carbaryl: 93.6% at the end of the study 1-naphthol: 1.1% at the end of the study

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

Rate of degradation in soil (Annex IIA, point 7.1.1.2, Annex IIIA, point 9.1.1)

Laboratory studies

DT₅₀ values

Carbaryl

Study	Soil code	Soil type	pH	GWC @ pF2	Incub T ^a (°C)	Incub Moist % v/v	Model	Exp DT ₅₀ (d)	R ²	Norm. DT ₅₀ @ pF2 and 20°C (d)
7.1.1.1.1/01	N Carolina	Sandy loam	6.7	19 ¹	25	5.08	SFO ²	4.0	0.7	2.3
7.1.1.2.1.1/01	Texas	Sandy loam	7.8	19 ¹	25	18.53	SFO	9.1	0.97	13.0
7.1.1.2.1.1/01	Texas	Sandy loam	7.8	19 ¹	15	18.53	SFO	11.9	0.95	8.0
7.1.1.2.1.1/01	California	Silty clay loam	8.1	3	25	24.75	SFO	25.2	0.98	31.9
7.1.1.1.1/02	02/02	Sandy loam	5.8 ³	14.5	20	16.2	SFO	22.4	0.934	22.4
7.1.1.1.1/02	02/03	Sandy loam	4.1 ³	22.7	20	22.6	SFO	99	0.93	98.7
7.1.1.1.1/02	02/05	Loam	6.9 ³	36.4	10	24.2	SFO	80.9	0.961	27.8
7.1.1.1.1/02	02/05	Loam	6.9 ³	36.4	20	24.2	SFO	30.4	0.937	22.8
7.1.1.1.1/02	02/06	Clay loam	7.6 ³	41.6	20	29.7	SFO	7.08	0.83	5.6
Arithmetic mean									25.8	
Geometric mean									15.8	

1 Wosten et al 1998; PETE as presented in FOCUS (2000)

2 The DT₅₀ calculated by the applicant using TopFit was 1.8 d (r² 0.802) that normalized at 20°C and FC gave a value of 1.7 d However this small difference in 1 value is not considered to have an impact on the arithmetic mean result that was used in FOCUS GW modelling.

3 pH measured in CaCl² solution

1-Naphthol

Study	Soil code	Soil type	pH	GWC @ pF2	Incub T ^a (°C)	Incub Moist % v/v	Model	Exp DT ₅₀ (d)	R ²	Norm. DT ₅₀ @ pF2 and 20°C (d)
7.1.1.1.1/01	N Carolina	Sandy loam	6.7	19 ¹	25	5.08	SFO ²	0.9	0.76	0.53
<p>1 Wosten et al 1998; PETE as presented in FOCUS (2000)</p> <p>2 The applicant calculated a DT₅₀ using TopFit of 0.6 d (r²=0.802) that normalized at 20°C and FC gave a value of 0.35 d However these small differences were not considered to have an impact on the result of FOCUS GW modelling where 0.6 days was used.</p>										

DT₉₀ values

Carbaryl

Study	Soil code	Soil type	pH	Incub T ^a (°C)	Incub Moist % v/v	Model	Exp DT ₉₀ (d)	R ²
7.1.1.1.1/01	N Carolina	Sandy loam	6.7	25	5.08	SFO	13.29	0.7
7.1.1.2.1.1/01	Texas	Sandy loam	7.8	25	18.53	SFO	30.23	0.97
7.1.1.2.1.1/01	Texas	Sandy loam	7.8	15	18.53	SFO	39.53	0.95
7.1.1.2.1.1/01	California	Silty clay loam	8.1	25	24.75	SFO	83.71	0.98
7.1.1.1.1/02	02/02	Sandy loam	5.8 ³	20	16.2	SFO	74.41	0.934
7.1.1.1.1/02	02/03	Sandy loam	4.1 ³	20	22.6	SFO	328.57	0.93
7.1.1.1.1/02	02/05	Loam	6.9 ³	10	24.2	SFO	268.74	0.961
7.1.1.1.1/02	02/05	Loam	6.9 ³	20	24.2	SFO	100.99	0.937
7.1.1.1.1/02	02/06	Clay loam	7.6 ³	20	29.7	SFO	23.52	0.83
<p>1 Wosten et al 1998; PETE as presented in FOCUS (2000)</p> <p>3 pH measured in CaCl² solution</p>								

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



1-Naphthol

Study	Soil code	Soil type	pH	Incub T ^a (°C)	Incub Moist % v/v	Model	Exp DT ₉₀ (d)	R ²
7.1.1.1.1/01	N Carolina	Sandy loam	6.7	25	5.08	SFO	2.99	0.76

Anaerobic conditions

DT_{50lab} (25°C, anaerobic): 72.2 d (n= 1, r²= 0.93). Linear. 1st order kinetics.

degradation in the saturated zone ‡: No data submitted, no data required

Field studies ‡ (state location, range or median with n value)

Data not available, formally data triggered. However considered not required to complete the EU level environmental exposure assessment.

Soil accumulation and plateau concentration ‡

No data

Soil adsorption/desorption (Annex IIA, point 7.1.2)

Carbaryl

K_f/K_{oc} (mL/g)

	Soil proprieties		Adsorption				Desorption			
	pH	%OC	K _f	K _{oc}	1/n	r ²	K	K _{oc}	1/n	r ²
Sandy Loam	5.3	0.84	1.74	207	0.84	0.997	6.72	800	1.016	0.999
Silty Clay Loam	6.7	1.99	3.52	177	0.797	0.999	7.66	385	0.858	0.997
Silt Loam	6.7	1.42	3.00	211	0.784	1.000	6.89	485	0.861	0.998
Sediment	7.5	0.82	2.04	249	0.835	0.999	6.78	827	0.949	1.000
Mean			2.58	211	0.813	1.000	7.01	624	0.920	1.000

K_d ‡

pH dependence ‡ (yes / no) (if yes type of dependence)

Not required

No

K_f was positively correlated with the percent of organic matter (r²=0.97).

1-naphthol

K_{oc}:

245 mL/g (HPLC method)

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Mobility in soil (Annex IIA, point 7.1.3, Annex IIIA, point 9.1.2)

Column leaching ‡	No data
Aged residues leaching ‡	<p>Guideline: Pesticide Assessment Guidelines, Subdiv. N, Section 163-1</p> <p>Aged for (d): Time period (d): 7-13 d Precipitation (mm): 50.8 mm Leachate: 2-4 % total residues/radioactivity in leachate</p> <p>>74.8-89.0% total residues/radioactivity retained in top 6 cm</p>
Lysimeter/ field leaching studies ‡	No data

PEC (soil) (Annex IIIA, point 9.1.3)

Parent

Method of calculation	<p>DT₅₀ (d): 99 days Kinetics: 1st order Field or Lab: representative worst case from laboratory studies.</p>
Application rate	<p>Crop: apples % plant interception: 70 Number of applications: 1 Interval (d): <i>n.a</i> Application rate(s): 900 g a.s./ha</p>

PEC _(s) (mg/kg)	70% crop interception	
	Single application Actual	Single application Time weighted average
Initial	0.360	0.360
Short term 24 h	0.357	0.359
2 d	0.355	0.357
4 d	0.350	0.355

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



PEC _(s) (mg/kg)	70% crop interception	
	Single application Actual	Single application Time weighted average
Long term 7 d	0.343	0.351
14 d	0.326	0.343
21 d	0.311	0.335
28 d	0.296	0.327
50 d	0.254	0.304
100 d	0.179	0.259

1-naphthol

Method of calculation	Kinetics: first order kinetics.	
Application rate	Crop: apples % plant interception: 70% Number of applications: 1 Interval (d): <i>n.a</i> Application rate(s): 900 g a.s./ha (assumed 1-naphthol is formed at a maximum of 34.6% the applied dose)	
PEC _(s) (mg/kg)	70% crop interception	
	Single application Actual	Single application Time weighted average
Initial	0.089	

Route and rate of degradation in water (Annex IIA, point 7.2.1)

Hydrolysis of active substance and relevant metabolites (DT ₅₀) ‡ (state pH and temperature)	pH5: 25 °C DT ₅₀ negligible at 30 d pH7: 25 °C DT ₅₀ 12 d (1 st order, r ² =0.99) 1-naphthol: 76.02%AR (30 d) pH9: 25 °C DT ₅₀ 3 h (1 st order, r ² =0.99) 1-naphthol: 94.66% AR (2 d)
Photolytic degradation of active substance and relevant metabolites ‡	Study 1 Experimental conditions: buffer solution at pH 5 at 25 °C Irradiation apparatus: Heraeus Suntest CPS+ with

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

a xenon arc lamp. With UV glass filter.

Sunlight intensity: 455 W/m² (for the 300-800nm region)

Exposure time and intensity in the sunset unit: The average solar energy at 40 °N lastitude is 4560 W/m².

Thus 10 h of artificial light irradiation is equivalent to one day of sunlight exposure.

Experimental DT₅₀: 9.9 d (r²= 0.98) for 12 h light/dark cycles.

Quantum yield: 2.67 x 10⁻³

Environmental half lives:

Theoretical Lifetime (days) at the Water Surface	Spring	Summer	Autumn	Winter
Latitude 30° N	13.2	11.0	19.8	32.1
Latitude 40° N	16.4	12.0	30.2	66.2
Latitude 50° N	22.2	13.9	113.8	193.7

Study 2

Identification of metabolites

Experimental conditions: buffer solution at pH 5

Irradiation apparatus: Suntest XLS+ unit containing a Heraeus xenon-arc lamp. Eliminated wavelengths < 290 nm.

Sunset Light intensity: 680 W/m² (290-800 nm)

Exposure time and intensity in the Sunset unit: Approximate natural solar radiation found in Phoenix, Arizona. Meteorological data obtained from the weather station (DSET Laboratories) in New River, AZ (June 23, 1988; Tilt angle: 5% South; Total radiant exposure:9.5MJ/m2)

7.0 h represents 1 environmental day, 216 h of continuous irradiation at 680 W/m2 is equivalent to 30.8 environmental days

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



	<p>Experimental DT₅₀: 16.2 d</p> <p>Environmental DT₅₀:</p> <p>55 of solar summer days at Phoenix (New River Arizona, USA)</p> <p>81.8 of solar summer days in Athens, Greece).</p> <p>Incubation conditions: 25° C</p> <p>No metabolites > 10% were identified at the end of the study:</p> <p>Phthalic acid: 6.4 % AR</p> <p>Phthalic acid hydrated: 6.3% AR</p> <p>Metabolite A: 6.2 % AR</p> <p>Metabolite G 3.9% AR</p> <p>Metabolite H: 4.6% AR</p>
Readily biodegradable (yes/no)	Yes
Degradation in water/sediment	
- DT ₅₀ water ‡	1.21- 5.0 days dissipation from the water column
- DT ₉₀ water ‡	4 –18.23 days (1st order, r2= 0.99-0.97, n= 2)
- DT ₅₀ whole system ‡	1.62-9.9 days
- DT ₉₀ whole system ‡	5.4-32.8 days (1st order, r2= 0.98-0.9, n= 2)
Mineralization	0.88% (at 30 d, study end, n= 1) 18.53-10.58 %AR (at 101 d, study end, n= 2)
Non-extractable residues	63.8% (at 30 d, study end, n= 1) 42.37-36.13% AR (at 101 d, study end, n= 2)
Distribution in water / sediment systems (active substance) ‡	Maximum of 23.66-23.57 %AR in sediment after 0-60 days. DT ₅₀ in sediment 4.3 days (DT90 13.8 days, 1st order, r2= 0.95, n= 1)
Distribution in water / sediment systems (metabolites) ‡	1-Naphthol: water: 34.73% (at -2 days, n= 2) sediment: 9.46 % (at 2 days, n=1)

PEC (surface water) (Annex IIIA, point 9.2.3)

Parent

Method of calculation	<p>DT₅₀ (d) in water phase: 5.0 days</p> <p>Kinetics: 1st order</p> <p>Lab: representative worst case from sediment water studies</p>
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‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Application rate

Crop: apples
 Number of applications: 1
 Interval (d): *n.a*
 Application rate(s): 900 g a.s./ha
 Depth of water body: 30 cm

Main routes of entry

Late season drift in line with GAP
 15.73% at 3 m
 1.09% at 20 m
 0.22% at 50 m

PEC(sw) (µg / L DAT)	3 m		20 m		50 m	
	Single application Actual	Single application TWA	Single application Actual	Single application TWA	Single application Actual	Single application TWA
0	47.19		3.27	3.27	0.660	0.660
24h	41.08	44.07	2.85	3.05	0.616	0.575
2	35.76	41.21	2.48	2.86	0.577	0.501
3	31.13	38.61	2.16	2.68		
4	27.1	36.22	1.88	2.51	0.507	0.380
7	17.88	30.2	1.24	2.09	0.423	0.251
10	11.8	25.53	0.82	1.77	0.358	0.166
14					0.292	0.096
15	5.9	19.86	0.41	1.38	x	x

PEC(sw) (µg / L DAT)	3 m		20 m		50 m	
	Single application Actual	Single application TWA	Single application Actual	Single application TWA	Single application Actual	Single application TWA
21	2.602	15.39	0.18	1.066	0.215	0.036
28					0.167	0.014
29	0.85	11.53	0.06	0.8		
30	0.74	11.17	0.00	0.77		
50						
60	0.01	5.67	0.00	0.39	0.096	0.000
90	0.00	3.78	0.00	0.26		
100	0.00	3.4	0.00	0.24	0.048	0.000

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



1-naphthol

Method of calculation	DT ₅₀ (d): not required to calculate an initial PEC when there is only 1 application per year. Kinetics: Lab: representative worst case from sediment water studies)
Application rate	Crop: apples Number of applications: 1 Interval (d): n.a Application rate(s): 900 g a.s./ha (assumed 1-naphthol is formed at a maximum of 34.73% of the applied dose in water) Depth of water body: 30 cm
Main routes of entry	15.73% drift from 3 metres 1.09 % from 20 m 0.22 % from 50 m
PEC _(sw) (µg / l)	Single application Actual
Initial at 3 m	11.7
Initial at 20 m	0.81
Initial at 50 m	0.16

PEC (sediment)

Parent

Method of calculation	(see below)	
Application rate	Crop: apples Number of applications: <i>1</i> Interval (d): <i>n.a</i> Application rate(s): <i>900</i> g a.s./ha	
PEC_(sed) (µg / L)	Single application Actual	Method of calculation
Initial at 3 m	11.13 µg/L	Taking into account an initial PEC _{sw} 47.19 ug/L with a buffer zone of 3 m and a maximum observed in the sediment 23.6% AR:

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

PEC _(sed) (µg / L)	Single application Actual	Method of calculation
Initial at 20 m	0.77 µg/L	Taking into account an initial PEC _{sw} 3.27 ug/L with a buffer zone of 20 m and a maximum observed in the sediment 23.6% AR:
Initial at 50 m	0.16 µg/L	taking into account an initial PEC _{sw} 0.66ug/L with a buffer zone of 50 m and a maximum observed in the sediment 23.6% AR:

PEC _(sed) (µg / kg)	Single application Actual	Method of calculation
Initial at 3 m	51.4 µg/kg	Considering a depth layer of 5 cm; bulk density =1.3 g/cc and an rate of entry in the water layer = 900x 15.73/100= 141.6 g/ha (buffer zone of 3 m) and considering a max amount of 23.6% AR:in the sediment
Initial at 20 m	2.31 µg/kg	Considering a depth layer of 5 cm; bulk density =1.3 g/cc and an rate of entry in the water layer = 900x 0.54/100= 4.9 g/ha (buffer zone of 20 m) and considering a max amount of 23.6% AR:in the sediment
Initial at 50 m	0.72 µg/kg	Considering a depth layer of 5 cm; bulk density =1.3 g/cc and an rate of entry in the water layer = 900x 0.22/100= 1.98 g/ha (buffer zone of 50 m) and considering a max amount of 23.6% AR:in the sediment

PEC (ground water) (Annex IIIA, point 9.2.1)

Method of calculation and type of study (e.g. modelling, monitoring, lysimeter)

Inputs

For FOCUS gw modelling, values used –
PELMO 3.0 (Apples scenarios; BBCH growth stage 71-79; interception 70%)

Application rate: 900 g/ha (effective application rate 270 g/Ha)
No. of applications:1
Time of application (month or season):10 days after emergence
parent K_{foc}: 211 ml/g; 1/n exponenet: 0.81
parent DT₅₀: 25.7 days (mean of normalized data at FC and 20 °C)
1-naphthol K_{oc}: 245 ml/g (by HPLC method). 1/n=

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



	1.0 1-naphthol DT ₅₀ : 0.6 d (TopFit 2.0, 5 compartments, normalized at FC and 20°C).
PEC _(gw)	
Maximum concentration	< 0.001 µg/L
Average annual concentration (Results quoted for modelling with FOCUS gw scenarios, according to FOCUS guidance)	< 0.001 µg/L

PEC(gw) - FOCUS modelling results

PELMO 3.0/Apples	Scenario	Parent (µg/L)	Metabolite (µg/L)		
			1-naphthol	2	3
	Châteaudun ⁽¹⁾	< 0.001	< 0.001		
	Hamburg	< 0.001	< 0.001		
	Jokioinen	< 0.001	< 0.001		
	Kremsmünster	< 0.001	< 0.001		
	Okehampton	< 0.001	< 0.001		
	Piacenza ⁽¹⁾	< 0.001	< 0.001		
	Porto	< 0.001	< 0.001		
	Sevilla ⁽¹⁾	< 0.001	< 0.001		
	Thiva ⁽¹⁾	< 0.001	< 0.001		

(1) irrigation option

Fate and behaviour in air (Annex IIA, point 7.2.2, Annex III, point 9.3)

Direct photolysis in air ‡	Not studied
Quantum yield of direct phototransformation	Active substance: f 2.67 10 ⁻³ based on a concurrently irradiated (PNAP/PYR) actinometer
Photochemical oxidative degradation in air ‡	Half life 0.277 days assuming an atmospheric OH concentration of 1.5 x 10 ⁶ radicals cm ⁻³
Volatilization ‡	No data

PEC (air)

Method of calculation	No data
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‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



PEC_(a)

Maximum concentration

No data

Provisional Definition of the Residue (Annex IIA, point 7.3)

Residue definition for risk assessment

Soil and groundwater: carbaryl and 1-naphtol
Surface water carbaryl and, 1-naphtol

Sediment: carbaryl

Air: carbaryl

Monitoring data, if available (Annex IIA, point 7.4)

Soil (indicate location and type of study)

No data

Surface water
(indicate
location and
type of study)

Location	µg/L	Number of samples	loq µg/L	Sampling period
Spain (León)	< LOQ-0.2	2/40	0.03	Autumn
Italy	0.05	1	0.01	A year. Sampling were taken at 15 days intervals from March 1995
Spain (Valencia)	1231-6484	6/40	1.49- 0.482	once a month between April 1997 and September 1998
Spain (Huelva)	River: 0.7-0.4 (naphthol) wells: 1.2-0.2 (carbaryl) 4.8-0.6 (naphthol)		0.1-1	
Ioannina	0.001-0.038	23/97	-	1984 to Oct. 1985.

Ground water (indicate location and type of
study)

No data

Air (indicate location and type of study)

No data

Classification and proposed labelling (Annex IIA, point 10)

with regard to fate and behaviour data

N; Dangerous for the environment

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

Appendix 1.6: Effects on non-target Species

Effects on terrestrial vertebrates (Annex IIA, point 8.1, Annex IIIA, points 10.1 and 10.3)

Acute toxicity to mammals	<p><u>Oral</u> technical: LD₅₀: 614 mg/kg_{bw}/d (rat, male/female rats combined).</p> <p>Formulation*: LD₅₀: 300 mg a.s./kg_{bw}/d, rat, sex combined)</p> <p><u>Inhalation</u> LD₅₀ 2.43 mg/L (rat, female)</p>
Long term toxicity to mammals	<p>Oral NOAEL: 10.8 mg a.s./kg_{bw}/d (dog)</p> <p>Reproduction NOEL: 4.67 mg a.s./kg_{bw}/d (rat, 2nd generat.)</p> <p>NOEL: 31.34 mg a.s./kg_{bw}/d (rat, 1st generat.)</p>
Acute toxicity to birds	<p>Technical: LD₅₀ > 2000 mg a.s./kg_{bw} (Mallard duck)</p> <p>Formulation: Not required since it is considered that birds will be exposed primarily from the active residue substance not the spray formulation.</p> <p>Metabolites: No data</p>
Dietary toxicity to birds (short term)	<p>Technical: Bobwhite quail</p> <p>LC₅₀ > 1000 mg a.s./kg_{bw}/d (5000 mg a.s./kg_{food})</p> <p>Metabolites: No data</p>
Long term toxicity to birds	<p>Technical: Mallard duck</p> <p>NOEC 30 mg a.s./kg_{bw}/d (300 mg/kg diet)</p> <p>Metabolites: No data</p>
Reproductive toxicity to birds	<p>Technical: Mallard duck</p> <p>NOEC 30 mg a.s./kg_{bw}/d (300 mg/kg diet)</p>

* The acute risk assessment to mammals will be done with LD₅₀ 246 mg a.s./kg_{bw} for female (from LD₅₀ 575 mg formul/kg_{bw} female)

Toxicity/exposure ratios for terrestrial vertebrates (Annex IIIA, points 10.1 and 10.3)

Application rate (kg a.s./ha)	Crop	Category (e.g. insectivorous bird)	Time-scale	TER	Annex VI Trigger
Ground-feeding birds					
0.9	apple orchard	Large herbivorous	acute	118	10
0.9	apple orchard	Small insectivorous birds	acute	41	10
0.9	apple orchard	Earthworms feeding	acute	4360	10
0.9	apple orchard	Large herbivorous	Short term	110	10
0.9	apple orchard	Small insectivorous birds	short-term	36	10

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



EFSA Scientific Report (2006) 80, 1-71, Conclusion on the peer review of carbaryl
Appendix 1 – list of endpoints

Application rate (kg a.s./ha)	Crop	Category (e.g. insectivorous bird)	Time-scale	TER	Annex VI Trigger
0.9	apple orchard	Earthworm-feeding	short-term	2183	10
0.9	apple orchard	Large herbivorous	long-term and (reproduction)	6.2	5
0.9	apple orchard	Small insectivorous birds	long-term and (reproduction)	1.1	5
0.9	apple orchard	Earthworms feeding	long-term (reproduction)	65	5
Ground-feeding mammals					
0.9	apple orchard	Herbivorous mammals	acute	4.6	10
0.9	apple orchard	Earthworms-feeding mammals	acute	514	10
0.9	apple orchard	Herbivorous mammals	long-term	6.1	5
0.9	apple orchard	Earthworms-feeding mammals	long-term	8	5

**Toxicity data for aquatic species (most sensitive species of each group) (Annex IIA, point 8.2,
Annex IIIA, point 10.2)**

Group	Test substance	Time-scale	Endpoint	Toxicity (mg/L)
Laboratory tests ‡				
Fish				
Sheepshead minnow <i>Cyprinodon variegates</i>	Technical	Acute dynamic	96h LD ₅₀	2.60
Rainbow trout <i>Oncorhynchus mykiss</i>	Sevin (81.5 % a.s.)	Acute dynamic	96h LD ₅₀	0.61
Fathead minnow <i>Pimephales promelas</i>	Sevin (80% a.s.)	Chronic dynamic	34d NOEC	0.21
Bluegill sunfish	1-naphtol	Acute semistatic	96h LD ₅₀	0.75
Fathead minnow <i>Pimephales promelas</i>	1-naphtol	Chronic dynamic (early life stage)	34d NOEC	0.10
Invertebrates				
<i>Daphnia pulex</i>	Technical	Acute	48h EC ₅₀	0.0064
<i>Mysidopsis bahia</i> (marine)	Technical	Acute	LC ₅₀	0.0057

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

Appendix 1 – list of endpoints

Group	Test substance	Time-scale	Endpoint	Toxicity (mg/L)
<i>Daphnia longispina</i> (with sediment)	Technical	Acute	48h EC ₅₀	0.0078
<i>Daphnia magna</i>	Technical	Chronic flow through	48h NOEC	0.0033
<i>Mysidopsis bahia</i> (marine)	1-naphtol	Acute	48h EC ₅₀	0.2
<i>Daphnia magna</i>	1-naphtol	Chronic	21d NOEC	0.25
Algae				
<i>Skeletonema sp.</i> (marine)	Technical	Acute	120 h EC ₅₀	0.70
<i>Skeletonema sp.</i>	Technical	Chronic	NOEC	0.36
Plant <i>Lemna gibba</i>	Technical	Acute static	7 d IrC50	13.70
<i>Lemna gibba</i>	Technical	Acute static	7 d-NOErC	5.0

Microcosm or mesocosm tests

An outdoor microcosm study provided evidence that exposure levels up to and including 20 µg/L carbaryl did not result in effects upon phytoplankton, macrophytes, fish and benthic macroinvertebrates. Unfortunately, it can't be employed to assess the risk due to the pH of water is very high (pH 9.2) and the DT₅₀ at this pH is too short comparing with the DT₅₀ at neutral pH.

Toxicity/exposure ratios for the most sensitive aquatic organisms (Annex IIIA, point 10.2)

Application rate (kg a.s./ha)	Crop	Organism	Time-scale	Distance (m)	TER	Annex VI Trigger
0.9	apple orchard	Rainbow trout	96 hours	15	129	100
0.9	apple orchard	<i>Fathead minnow</i>	34 days	3	19	10
0.9	apple orchard	<i>Mysidopsis bahia</i>	48 h	20	1.7	100
0.9	apple orchard	<i>Daphnia magna</i>	21 days	20	1	10
				50	5	
0.9	apple orchard	Algae	72 hours	3	17	10
0.9	apple orchard	Higher aquatic plants	7 days	3	290	10

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Bioconcentration

Bioconcentration factor (BCF) ‡

BCF (whole fish)= 44
 Not required log Pow = 2.36 and DT₉₀<100 days

Annex VI Trigger:for the bioconcentration factor

Not applicable

Clearance time (CT₅₀)
 (CT₉₀)

Not required

Effects on honeybees (Annex IIA, point 8.3.1, Annex IIIA, point 10.4)

Acute oral toxicity ‡

Technical 72 h-LD₅₀ ≥ 0.21 µg a.s./bee
 Formulation 72h-LD₅₀ > 1.08µg form./bee
 (>0.69µg a.s./bee)

Acute contact toxicity ‡

Technical 72 h-LD₅₀ 0.14 µg a.s./bee
 Formulation 72h-LD₅₀ > 3.84µg form./bee
 (>1.69µg a.s./bee)

Hazard quotients for honey bees (Annex IIIA, point 10.4)

Application rate (kg a.s./ha)	Crop	Route	Hazard quotient	Annex VI Trigger
Laboratory tests				
0.9	apple orchard	oral	4285	50
0.9	apple orchard	contact	6429	50

Field or semi-field tests

The EPCO experts' meeting considered the risk to bees as low because the product is applied only once a year after flowering. For other uses reservations remain on the adequacy of the submitted field study.

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

Effects on other arthropod species (Annex IIA, point 8.3.2, Annex IIIA, point 10.5)

Species	Stage	Test Substance	Dose (kg a.s./ha)	Endpoint	LR50* (g a.s./ha)	HQ	Annex VI Trigger
Laboratory tests							
<i>Aphidius rhopalosiphi</i>	adults	Sevin® XLR Plus	0.00213 - 0.05	Mortality	0.0247	3637 in field 5730 off field	2
<i>Typhlodromus pyri</i>	proto-nymphs	Sevin® XLR Plus	8.5 - 850	Mortality	457	0.31	2
<i>Pardosa sp.</i>	adults	Sevin® XLR Plus	850 and 28.9	Mortality	> 28.9	Not applicable	Not applicable
<i>Chrysoperla carnea</i>	larvae	Sevin® XLR Plus	1.1 - 22.83	Mortality	< 1.1	Not applicable	Not applicable
Extended laboratory tests							
<i>Chrysoperla carnea</i>	larvae	Sevin® XLR Plus	1.875 L product/ha	Mortality	0 DAA: lethal 14 DAA: NOEC	98% 16%	50%
<i>Typhlodromus pyri</i>	proto-nymphs	Sevin® XLR Plus	1.875 L product/ha	Mortality	0 DAA: lethal 14 DAA: NOEC	38% 6%	50%
<i>Aphidius rhopalosiphi</i>	adult	Sevin® XLR Plus	1.875 L product/ha	Mortality	0 DAA: lethal 14 DAA: NOEC	100% 0%	50%
				Reproduction	14 DAA: NOEC	3.5%	50%

*DAA: days after application.

Tier 2 off-crop HQ values for *Aphidius rhopalosiphi*

Specie	Substance	Distance from crop	Drift factor (%)	Drift rate (g a.s/ha)	LR50 (g a.s/ha)	HQ	Annex VI Trigger
<i>Aphidius rhopalosiphi</i>	adults	3 m	15.73	141.5	0.0247	5730	2
		50 m	0.22	1.98		80	
		150 m	0.03	0.27		10	
		250 m	0.006	0.171		2.1	

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Field or semi-field tests

No data available

Effects on earthworms (Annex IIA, point 8.4, Annex IIIA, point 10.6)

Acute toxicity ‡

Technical:

A. caliginosa 14 days-LC₅₀ < 4 mg a.s./kg soil
(corrected <2 mg a.s./kg)

1-Naphtol:

E. fetida 14 days-LC₅₀ = 472mg /kg soil
(corrected <236 mg a.s./kg)

Reproductive toxicity ‡

NOEC: no submitted study but field study provided.

Toxicity/exposure ratios for earthworms (Annex IIIA, point 10.6)

Application rate (kg a.s./ha)	Crop	Time-scale	TER	Annex VI Trigger
0.9	apple orchard	14 days	< 3.3	10

Field study

The canopy application of the plant protection product in apples for fruit thinning at a dose of 1.875L/ha resulted in a slight transient effect on the earthworms community due to the partial impact on *A. caliginosa* population. However, this effect was completely recovered after 4 months.

Effects on soil micro-organisms (Annex IIA, point 8.5, Annex IIIA, point 10.7)

Nitrogen mineralization ‡

< ±25% at a concentration of 6.5 mg a.s./kg soil

Carbon mineralization ‡

< ±25% at a concentration of 6.5 mg a.s./kg soil

Effects on non-target plants

.....

Under green house conditions Sevin (formulation) did not cause any significant impact on seedling Emergence and Vegetative Vigour of a great amount of different plants from different taxonomic groups at spray concentrations up to 13.89 g a.s./L (equivalent to 4.4 time the recommended application rate) when it is applied pre and post emergence.

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles



Effects on biological methods for sewage treatment

.....

The EC50 was 1232 mg/L. Carbaryl has low toxicity to the respiration of activated sludge.

Classification and proposed labelling (Annex IIA, point 10)

with regard to ecotoxicological data

N	Dangerous for the environment
R50	Very toxic to aquatic organisms

‡ Endpoints identified by EU-Commission as relevant for Member States when applying the Uniform Principles

APPENDIX 2 – ABBREVIATIONS USED IN THE LIST OF ENDPOINTS

ADI	acceptable daily intake
AOEL	acceptable operator exposure level
ARfD	acute reference dose
a.s.	active substance
bw	body weight
CA	Chemical Abstract
CAS	Chemical Abstract Service
CIPAC	Collaborative International Pesticide Analytical Council Limited
d	day
DAR	draft assessment report
DM	dry matter
DT ₅₀	period required for 50 percent dissipation (define method of estimation)
DT ₉₀	period required for 90 percent dissipation (define method of estimation)
ε	decadic molar extinction coefficient
EC ₅₀	effective concentration
EEC	European Economic Community
EINECS	European Inventory of Existing Commercial Chemical Substances
ELINKS	European List of New Chemical Substances
EMDI	estimated maximum daily intake
ER50	emergence rate, median
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FOCUS	Forum for the Co-ordination of Pesticide Fate Models and their Use
GAP	good agricultural practice
GCPF	Global Crop Protection Federation (formerly known as GIFAP)
GS	growth stage
h	hour(s)
ha	hectare
hL	hectolitre
HPLC	high pressure liquid chromatography or high performance liquid chromatography
ISO	International Organisation for Standardisation
IUPAC	International Union of Pure and Applied Chemistry
K _{oc}	organic carbon adsorption coefficient
L	litre
LC	liquid chromatography
LC-MS	liquid chromatography-mass spectrometry
LC-MS-MS	liquid chromatography with tandem mass spectrometry
LC ₅₀	lethal concentration, median

LD ₅₀	lethal dose, median; dosis letalis media
LOAEL	lowest observable adverse effect level
LOD	limit of detection
LOQ	limit of quantification (determination)
µg	microgram
mN	milli-Newton
MRL	maximum residue limit or level
MS	mass spectrometry
NESTI	national estimated short term intake
NIR	near-infrared-(spectroscopy)
nm	nanometer
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NOEL	no observed effect level
PEC	predicted environmental concentration
PEC _A	predicted environmental concentration in air
PEC _S	predicted environmental concentration in soil
PEC _{SW}	predicted environmental concentration in surface water
PEC _{GW}	predicted environmental concentration in ground water
PHI	pre-harvest interval
pK _a	negative logarithm (to the base 10) of the dissociation constant
PPE	personal protective equipment
ppm	parts per million (10 ⁻⁶)
ppp	plant protection product
r ²	coefficient of determination
RPE	respiratory protective equipment
STMR	supervised trials median residue
TER	toxicity exposure ratio
TMDI	theoretical maximum daily intake
UV	ultraviolet
WHO	World Health Organisation
WG	water dispersible granule
yr	year

DATE: April 26, 2006

SUBJECT: Chemicals Evaluated for Carcinogenic Potential by the Office of Pesticide Programs

FROM: Jess Rowland, Chief
Science Information Management Branch
Health Effect Division (7509C)
Office of Pesticide Programs

TO: Division Directors AD, BPPD, EFED, FEAD, HED, RD and SRRD

The attached list provides an overview of chemicals evaluated for carcinogenic potential by the Health Effects Division (HED) of the Office of Pesticide Programs (OPP) through December 2005. Applying the Agency's Guidelines for Carcinogen Risk Assessment, the classification of the chemical is made by HED's Cancer Assessment Review Committee (CARC). In addition to the OPP classification, this list includes those chemicals evaluated by peer review committees in two other Agency workgroups (indicated in the table by their acronyms): the Carcinogen Assessment Group (CAG); and the Carcinogen Risk Assessment Verification Endeavor (CRAVE).

This list includes the chemical name, CAS Number, PC code, the cancer classification, reviewing organization, date reviewed, species, tumor types, and, if required, the human equivalency potency factor (Q1*). The potency factor (Q1*), unless otherwise indicated, is based on the oral route. The Q1* is expressed as $(\text{mg/kg/day})^{-1}$ for the oral route and as $(\text{mg/m}^3)^{-1}$ for the inhalation route.

It should be noted that the evaluation of many of these chemicals is an ongoing process, therefore, the information in this list (i.e., classification and/or the quantification) may be subject to change as new and/or additional data are submitted to OPP. This list should not be used as the single source for either the classification or quantification of the carcinogenic potential. This list will be updated annually.

If further information is required please contact Brenda S. May (Phone: 703-308-6175; E-mail: may.brenda@epa.gov) or me (Phone: 703-308-2719; E-mail: rowland.jess@epa.gov).

Chemicals Evaluated for Carcinogenic Potential
Science Information Management Branch
Health Effects Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

BACKGROUND

What is this list?

The Chemicals Evaluated for Carcinogenic Potential provides an overview of the compounds evaluated for carcinogenicity by the Health Effects Division of the Office of Pesticide Programs. It also includes evaluations by other groups that HED may use until HED completes its evaluation.

NOTE: As new information becomes available, the list may become out-of-date. Therefore, it should not be used as the sole reference regarding the carcinogenic potential for a pesticide. EPA intends to update the list each year to include new evaluations or re-evaluations.

How does EPA review pesticides for potential carcinogenicity?

The Health Effects Division of the Office of Pesticide Programs performs an independent review of studies conducted in mice and rats to evaluate the carcinogenic potential of pesticides. The results of the independent review are peer-reviewed by the Cancer Assessment Review Committee. This committee recommends a cancer classification. The classification will determine how the Agency regulates the pesticide and will include methods for quantification of human risk. In some cases, EPA also requests review by the FIFRA Scientific Advisory Panel. For some chemicals, other groups of EPA scientists have provided the assessment, and OPP uses these assessments.

What factors does EPA consider in its review of cancer risk?

When assessing possible cancer risk posed by a pesticide, EPA considers how strongly carcinogenic the chemical is (its potency) and the potential for human exposure. The pesticides are evaluated not only to determine if they cause cancer in laboratory animals, but also as to their potential to cause human cancer. For any pesticide classified as a potential carcinogen, the risk would depend on the extent to which a person might be exposed (how much time and to what quantity of the pesticide). The factors considered include short-term studies, long-term cancer studies, mutagenicity studies, and structure activity concerns. (The term Aweight-of-the-evidence@ is used in referring to such a review. This means that the recommendation is not based on the results of one study, but on the results of all studies that are available.)

When does EPA review pesticides for potential carcinogenicity?

EPA reviews studies submitted when a pesticide is proposed for registration. Studies are required in two species (mice and rats) and two sexes (males and females). These studies are required for all pesticides used on food and some non-food pesticides that could lead to long-term exposures in humans. These studies may be reviewed again when a pesticide undergoes reregistration and the cancer classification may be re-evaluated, particularly if new studies have been submitted.

Why are there several different cancer classifications in the list?

EPA's guidelines for evaluating the potential carcinogenicity of chemicals have been updated over the years to reflect increased understanding of ways chemicals may cause cancer. The current guidelines call for greater emphasis on characterization discussions for hazard, dose-response assessment, exposure assessment, and risk characterization, as well as the use of mode of action in the assessment of potential carcinogenesis. EPA does not have the resources to re-evaluate every chemical to determine how it would be described under new guidelines, and there is no reason to re-evaluate chemicals unless there is some new information that could change the basic understanding of that chemical.

How have the guidelines changed?

EPA issued its first set of principles to guide evaluation of human cancer potential in 1976. In 1986, EPA issued updated guidance, which included a letter system (A-E) for designating degree of carcinogenic potential. In the 1986 guidelines, hazard identification and the weight-of-evidence process focused on tumor findings. The human carcinogenic potential of agents was characterized by a six-category alphanumeric classification system (A, B1, B2, C, and D).

In 1996, EPA released *A Proposed Guidelines for Carcinogen Risk Assessment*,@ which used descriptive phrases rather than the alphanumeric classification to classify carcinogenic potential. In the 1996 classification structure, increased emphasis was placed on discussing characterization of hazard, dose-response, and exposure assessments. The hazard and weight of evidence process embraced an analysis of all relevant biological information and emphasized understanding the agent's mode of action in producing tumors to reduce the uncertainty in describing the likelihood of harm.

By 1999, the science related to carcinogens had advanced significantly. EPA issued draft guidelines that continued the greater emphasis on characterization discussions for hazard, dose-response assessment, exposure assessment, risk characterization and the use of mode of action in the assessment of potential carcinogenesis. In addition, the guidelines included consideration of risk to children, as well as addressing other issues such as nuances related to the amount and adequacy of data on a chemical.

In March, 2005, EPA released its final *Guidelines for Carcinogen Risk Assessment* (EPA/630/P-03/001B). These guidelines represent the culmination of a long development process, replacing EPA's original cancer risk assessment guidelines (1986) and its interim final guidelines (1999). <http://www.epa.gov/IRIS/cancer032505.pdf>

How do the different designations compare?

The short answer is that they cannot be directly compared. Each system's designations refer to the reviews and criteria it contains. A substance that is, for example, a AC@ in the 1986 system may not be directly translatable to any particular category in the later systems. The designation for any substance must be considered in the context of the system under which it was reviewed.

A list of the descriptors from the various classification systems and their definitions follows.

Carcinogenicity Classification of Pesticides: Derivation and Definition of Terms

CLASSIFICATION – 2005

The following descriptors from the 2005 Guidelines for Carcinogen Risk Assessment can be used as an introduction to the weight of evidence narrative in the cancer risk assessment. The examples presented in the discussion of the descriptors are illustrative. The examples are neither a checklist nor a limitation for the descriptor. The complete weight of evidence narrative, rather than the descriptor alone, provides the conclusions and the basis for them.

CARCINOGENIC TO HUMANS. This descriptor indicates strong evidence of human carcinogenicity. It covers different combinations of evidence.

- This descriptor is appropriate when there is convincing epidemiologic evidence of a causal association between human exposure and cancer.
- Exceptionally, this descriptor may be equally appropriate with a lesser weight of epidemiologic evidence that is strengthened by other lines of evidence. It can be used when all of the following conditions are met: (a) there is strong evidence of an association between human exposure and either cancer or the key precursor events of the agent's mode of action but not enough for a causal association, and (b) there is extensive evidence of carcinogenicity in animals, and (c) the mode(s) of carcinogenic action and associated key precursor events have been identified in animals, and (d) there is strong evidence that the key precursor events that precede the cancer response in animals are anticipated to occur in humans and progress to tumors, based on available biological information. In this case, the narrative includes a summary of both the experimental and epidemiologic information on mode of action and also an indication of the relative weight that each source of information carries, e.g., based on human information, based on limited human and extensive animal experiments.

LIKELY TO BE CARCINOGENIC TO HUMANS. This descriptor is appropriate when the weight of the evidence is adequate to demonstrate carcinogenic potential to humans but does not reach the weight of evidence for the descriptor “Carcinogenic to Humans.” Adequate evidence consistent with this descriptor covers a broad spectrum. As stated previously, the use of the term “likely” as a weight of evidence descriptor does not correspond to a quantifiable probability. The examples below are meant to represent the broad range of data combinations that are covered by this descriptor; they are illustrative and provide neither a checklist nor a limitation for the data that might support use of this descriptor. Moreover, additional information, e.g., on mode of action, might change the choice of descriptor for the illustrated examples. Supporting data for this descriptor may include:

- an agent demonstrating a plausible (but not definitively causal) association between human exposure and cancer, in most cases with some supporting biological, experimental evidence, though not necessarily carcinogenicity data from animal experiments;
- an agent that has tested positive in animal experiments in more than one species, sex, strain, site, or exposure route, with or without evidence of carcinogenicity in humans;
- a positive tumor study that raises additional biological concerns beyond that of a statistically significant result, for example, a high degree of malignancy, or an early age at onset;
- a rare animal tumor response in a single experiment that is assumed to be relevant to humans; or
- a positive tumor study that is strengthened by other lines of evidence, for example, either plausible (but not definitively causal) association between human exposure and cancer or evidence that the agent or an important metabolite causes events generally known to be associated with tumor formation (such as DNA reactivity or effects on cell growth control) likely to be related to the tumor response in this case.

SUGGESTIVE EVIDENCE OF CARCINOGENIC POTENTIAL. This descriptor of the database is appropriate when the weight of evidence is suggestive of carcinogenicity; a concern for potential carcinogenic effects in humans is raised, but the data are judged not sufficient for a stronger conclusion. This descriptor covers a spectrum of evidence associated with varying levels of concern for carcinogenicity, ranging from a positive cancer result in the only study on an agent to a single positive cancer result in an extensive database that includes negative studies in other species. Depending on the extent of the database, additional studies may or may not provide further insights. Some examples include:

- a small, and possibly not statistically significant, increase in tumor incidence observed in a single animal or human study that does not reach the weight of evidence for the descriptor "Likely to Be Carcinogenic to Humans." The study generally would not be contradicted by other studies of equal quality in the same population group or experimental system (see discussions of *conflicting evidence* and *differing results*, below);
- a small increase in a tumor with a high background rate in that sex and strain, when there is some but insufficient evidence that the observed tumors may be due to intrinsic factors that cause background tumors and not due to the agent being assessed. (When there is a high background rate of a specific tumor in animals of a particular sex and strain, then there may be biological factors operating independently of the agent being assessed that could be responsible for the development of the observed tumors.) In this case, the reasons for determining that the tumors are not due to the agent are explained;
- evidence of a positive response in a study whose power, design, or conduct limits the ability to draw a confident conclusion (but does not make the study fatally flawed), but where the carcinogenic potential is strengthened by other lines of evidence (such as structure-activity relationships); or
- a statistically significant increase at one dose only, but no significant response at the other doses and no overall trend.

INADEQUATE INFORMATION TO ASSESS CARCINOGENIC POTENTIAL. This descriptor of the database is appropriate when

available data are judged inadequate for applying one of the other descriptors. Additional studies generally would be expected to provide further insights. Some examples include:

- little or no pertinent information;
- conflicting evidence, that is, some studies provide evidence of carcinogenicity but other studies of equal quality in the same sex and strain are negative. Differing results, that is, positive results in some studies and negative results in one or more different experimental systems, do not constitute *conflicting evidence*, as the term is used here. Depending on the overall weight of evidence, differing results can be considered either suggestive evidence or likely evidence; or
- negative results that are not sufficiently robust for the descriptor, “Not Likely to Be Carcinogenic to Humans.”

NOT LIKELY TO BE CARCINOGENIC TO HUMANS. This descriptor is appropriate when the available data are considered robust for deciding that there is no basis for human hazard concern. In some instances, there can be positive results in experimental animals when there is strong, consistent evidence that each mode of action in experimental animals does not operate in humans. In other cases, there can be convincing evidence in both humans and animals that the agent is not carcinogenic. The judgment may be based on data such as:

- animal evidence that demonstrates lack of carcinogenic effect in both sexes in well-designed and well-conducted studies in at least two appropriate animal species (in the absence of other animal or human data suggesting a potential for cancer effects),
- convincing and extensive experimental evidence showing that the only carcinogenic effects observed in animals are not relevant to humans,
- convincing evidence that carcinogenic effects are not likely by a particular exposure route (see Section 2.3), or
- convincing evidence that carcinogenic effects are not likely below a defined dose range.

A descriptor of “not likely” applies only to the circumstances supported by the data. For example, an agent may be “Not Likely to Be Carcinogenic” by one route but not necessarily by another. In those cases that have positive animal experiment(s) but the results are judged to be not relevant to humans, the narrative discusses why the results are not relevant.

MULTIPLE DESCRIPTORS. More than one descriptor can be used when an agent's effects differ by dose or exposure route. For example, an agent may be “Carcinogenic to Humans” by one exposure route but “Not Likely to Be Carcinogenic” by a route by which it is not absorbed. Also, an agent could be “Likely to Be Carcinogenic” above a specified dose but “Not Likely to Be Carcinogenic” below that dose because a key event in tumor formation does not occur below that dose.

CLASSIFICATION – 1999 Draft

The terms used to describe carcinogenic potential in the July 1999 AReview Draft of the Guidelines for Carcinogen Risk Assessment.@ are listed

and defined as follows:

CARCINOGENIC TO HUMANS. This descriptor is appropriate when there is convincing epidemiologic evidence demonstrating causality between human exposure and cancer. This descriptor is also appropriate when there is an absence of conclusive epidemiologic evidence to clearly establish a cause and effect relationship between human exposure and cancer, but there is compelling evidence of carcinogenicity in animals and mechanistic information in animals and humans demonstrating similar mode(s) of carcinogenic action. It is used when all of the following conditions are met:

- There is evidence in a human population(s) of association of exposure to the agent with cancer, but not enough to show a causal association, and
- There is extensive evidence of carcinogenicity, and
- The mode(s) of carcinogenic action and associated key events have been identified in animals, and
- The key events that precede the cancer response in animals have been observed in the human population(s) that also shows evidence of an association of exposure to the agent with cancer.

LIKELY TO BE CARCINOGENIC TO HUMANS. This descriptor is appropriate when the available tumor effects and other key data are adequate to demonstrate carcinogenic potential to humans. Adequate data are within a spectrum. At one end is evidence for an association between human exposure to the agent and cancer and strong experimental evidence of carcinogenicity in animals; at the other, with no human data, the weight of experimental evidence shows animal carcinogenicity by a mode or modes of action that are relevant or assumed to be relevant to humans.

SUGGESTIVE EVIDENCE OF CARCINOGENICITY, BUT NOT SUFFICIENT TO ASSESS HUMAN CARCINOGENIC POTENTIAL. This descriptor is appropriate when the evidence from human or animal data is suggestive of carcinogenicity, which raises a concern for carcinogenic effects but is judged not sufficient for a conclusion as to human carcinogenic potential. Examples of such evidence may include: a marginal increase in tumors that may be exposure-related, or evidence is observed only in a single study, or the only evidence is limited to certain high background tumors in one sex of one species. Dose-response assessment is not indicated for these agents. Further studies would be needed to determine human carcinogenic potential.

DATA ARE INADEQUATE FOR AN ASSESSMENT OF HUMAN CARCINOGENIC POTENTIAL. This descriptor is used when available data are judged inadequate to perform an assessment. This includes a case when there is a lack of pertinent or useful data or when existing evidence is conflicting, e.g., some evidence is suggestive of carcinogenic effects, but other equally pertinent evidence does not confirm a concern.

NOT LIKELY TO BE CARCINOGENIC TO HUMANS. This descriptor is used when the available data are considered robust for deciding that there is no basis for human hazard concern. The judgment may be based on:

- Extensive human experience that demonstrates lack of carcinogenic effect (e.g., phenobarbital).
- Animal evidence that demonstrates lack of carcinogenic effect in at least two well- designed and well-conducted studies in two appropriate animal species (in the absence of human data suggesting a potential for cancer effects).
- Extensive experimental evidence showing that the only carcinogenic effects observed in animals are not considered relevant to humans (e.g., showing only effects in the male rat kidney due to accumulation of "2u-globulin).
- Evidence that carcinogenic effects are not likely by a particular route of exposure
- Evidence that carcinogenic effects are not anticipated below a defined dose range.

CLASSIFICATION – 1996

In April 1996, EPA released the AProposed Guidelines for Carcinogen Risk Assessment.@ This scheme varied from the earlier 1986 scheme in that it used descriptors rather than letters to classify carcinogenic potential. The descriptors are:

KNOWN/LIKELY. This category of descriptors is appropriate when the available tumor effects and other key data are adequate to convincingly demonstrate carcinogenic potential for humans.

CANNOT BE DETERMINED. This category of descriptors is appropriate when available tumor effects or other key data are suggestive or conflicting or limited in quantity and, thus, are not adequate to convincingly demonstrate carcinogenic potential for humans. In general, further agent specific and generic research and testing are needed to be able to describe human carcinogenic potential.

NOT LIKELY. This is the appropriate descriptor when experimental evidence is satisfactory for deciding that there is no basis for human hazard concern, as follows (in the absence of human data suggesting a potential for cancer effects).

1986 CLASSIFICATION

The following cancer classification scheme was first introduced in 1986. It was used until 1996.

GROUP A – HUMAN CARCINOGEN. This group is used only when there is sufficient evidence from epidemiologic studies to support a causal association between exposure to the agents and cancer.

GROUP B – PROBABLE HUMAN CARCINOGEN. This group includes agents for which the weight of evidence of human carcinogenicity based on epidemiologic studies is "limited" and also includes agents for which the weight of evidence of carcinogenicity based on animal studies is "sufficient." The group is divided into two subgroups. **Group B1** is reserved for agents for which there is limited evidence of carcinogenicity

from epidemiologic studies. **Group B2** is used for Agents for which there is "sufficient: evidence from animal studies and for which there is "inadequate evidence" or "no data" from epidemiologic studies.

GROUP C – POSSIBLE HUMAN CARCINOGEN. This group is used for agents with limited evidence of carcinogenicity in animals in the absence of human data.

GROUP D – NOT CLASSIFIABLE AS TO HUMAN CARCINOGENICITY. This group is generally used for agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.

GROUP E – EVIDENCE OF NON-CARCINOGENICITY FOR HUMANS. This group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.

OTHER DEFINITIONS

Quantification of Cancer Risk - Carcinogenic Potency Factor (Q_1^*)

Q_1 STAR (Q_1^*) - In the classification of human or probable-human carcinogens, mathematical models are used to estimate an upper-bound excess cancer risk associated with lifetime ingestion in the diet. The data used in these estimates usually come from lifetime exposure studies in animals. The USEPA generally uses the linearized multistage model for its cancer risk assessment. This model fits linear dose-response curves to low doses and is consistent with a no-threshold model of carcinogenesis, i.e., exposure to even a very small amount of the substance produces a finite increased risk of cancer.

The linearized multistage model uses dose-response data from the most appropriate carcinogenic study to calculate a carcinogenic potency factor (q_1^*) for humans. The q_1^* is then used to determine the concentrations of the chemical in the diet that are associated with theoretical upper-bound excess lifetime cancer risks of 1 in 10,000, 1 in 100,000, and 1 in 1,000,000 (10^{-4} , 10^{-5} , 10^{-6} respectively) individuals over a lifetime of exposure.

Mode of Action (MOA) - The key cellular and biochemical events that have to happen for a biological effect to develop. Mode of action is contrasted with mechanism of action which is a more complete understanding of the step by step pathway leading to a biological effect. Some established MOAs include:

Androgen Dependent - The chemical disrupts the normal levels of reproductive hormones (e.g., testosterone, luteinizing hormone) which in turn stimulates the target tissue (e.g., leydig cells, testicular tissue) to divide which may lead to hyperplasia and neoplasia. For agents to pose a hazard to humans by this MOA, sufficient exposure levels need to be encountered which produce the same level of biological effect as seen in rodents. This is consistent with the MOA for Leydig cell tumorigenesis.

Cytotoxicity and Regenerative Proliferation - Continuous exposure to a chemical or its metabolite causes persistent cell killing which in turn may result in a persistent regenerative proliferative response in the damaged tissue. For irreversible tissue alterations to occur in humans, including cancer by this mode of action, a sufficient exposure must be encountered over a prolonged period.

Mitogenesis - Mitogenic chemicals act by promoting the clonal expansion of preneoplastic cells by stimulating cell proliferation. This mode of action is frequently found in the rodent liver where it is generally associated with an increase in metabolizing enzymes. A mitogenic chemical stimulates cell proliferation in the target organ without obvious cytotoxicity or cell death. Another important feature of this MOA is that the mitogenic effect is not persistent over time; instead it is resolved and then is manifested within proliferative foci which are considered preneoplastic lesions. Through continuous exposure, it is these preneoplastic lesions that develop into tumors. At this time, the adverse health effects caused by this MOA are presumed to be relevant to humans.

Mutagenesis - The chemical or a metabolite has the ability to react with or bind DNA in a manner that causes mutations. It is usually positive in multiple test systems for different genetic endpoints (particularly gene mutations and structural chromosome aberrations) and in tests performed *in vivo* and *in vitro*. Adverse health effects in rodents from these chemicals are considered relevant for human health risk.

Neuroendocrine Disruption - Chemicals that disrupt hypothalamic control of pituitary function leading to a decrease in hormone release (e.g., luteinizing hormone) and the disruption of the ovarian cycle. This may result in an increase in cell proliferation in the mammary gland due to a hyperstimulation by estrogen. In the case of chloro-s-triazines, this neuroendocrine MOA is not considered relevant to humans because it depends on a rodent specific reproductive process.

PPAR-alpha Agonism - Chemicals that bind to and activate the Peroxisome Proliferator-Activated Receptor (PPAR) stimulate biological responses in the liver (e.g., peroxisome proliferation, induction of lipid metabolizing enzymes, oxidative stress, and hepatocyte mitogenesis). Activation of PPAR-alpha results in an increase in cell proliferation and clonal expansion of preneoplastic foci in the liver. While the human relevance of this MOA has not been definitively determined, most of the evidence indicates that this mode of action is not operative in the human liver.

Thyroid Hormone Disruption - Disruption of normal levels of thyroid hormones may lead to an increase of thyroid stimulating hormone (TSH) which results in an increase in cell proliferation of the thyroid gland. If exposure is continuous in the animal, thyroid follicular cell tumors can potentially develop. However, the development of thyroid cancer by this mode of action in humans is considered unlikely since prolonged stimulation of the thyroid gland by TSH has not been associated with tumorigenesis in humans. However, this MOA is relevant as an indicator for potential noncancer health effects (e.g., goiter, neurodevelopmental, etc) due thyroid disruption in humans.

Chemicals Evaluated for Carcinogenic Potential
Science Information Management Branch
Health Effects Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

April 26, 2006

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
1,3-Dibromo-5,5-dimethylhydantoin	77-48-5	006317	Not Likely to Be Carcinogenic to Humans	OPP (8/28/00)	Not Required (N/R)	Not Applicable
1,3-dichloro-5-methylhydantoin	89415-87-2	128826	Not Likely to Be Carcinogenic to Humans	OPP (8/28/00)	NR	Not Applicable
1,4-Naphthalenedione, 2-(acetyloxy)-3-dodecyl-	57960-19-7	006329	Not Likely to Be Carcinogenic to Humans	OPP (11/13/03)	NR	Not Applicable
2-Benzyl-4-chlorophenol	120-32-1	062201	Group C--Possible Human Carcinogen	OPP (9/5/95)	RfD Approach	Renal tubule combined adenomas/carcinomas; B6C3F1 mice (M). Renal transitional cell carcinomas; F344/N rats (F)
2,4-Dichlorophenoxy acetic acid (2,4-D)	94-75-7	030001	Group D--Not Classifiable as to Human Carcinogenicity	OPP (1/29/97)	NR	Not Applicable
2,4-DB 2,4-DB-DMA	94-82-6	030801	Not Likely to Be Carcinogenic to Humans	OPP (6/13/03)	NR	Not Applicable
2,4-Imidazolidinedione, 1-bromo-3-chloro-5,5-dimethyl-	16079-88-2	006315	Not Likely to Be Carcinogenic to Humans	OPP (8/28/00)	NR	Not Applicable
Acephate	30560-19-1	103301	Group C--Possible Human Carcinogen	OPP (5/8/85)		Hepatocellular carcinomas; CD-1 mice (F)
Acetaldehyde	75-07-0	202300	Group B2--Probable Human Carcinogen	CRAVE ³ (1/13/88)	Q1* = 2.2 E-6 (Inhalation)	Nasal tumors; SPF Wistar rats (M & F). Laryngeal tumors; Syrian Golden hamsters (M & F).
Acetamide	60-35-5	111101	Group C--Possible Human Carcinogen	OPP (5/29/90)	NR	Liver tumors; Wistar rats (M); F344 rats (M & F).
Acetamiprid	135410-20-7	099050	Not Likely to Be Carcinogenic to Humans	OPP (12/11/01)	NR	Not Applicable
Acetochlor	34256-82-1	121601	Likely to be Carcinogenic to Humans	OPP (8/31/04)	Q1* = 3.27 E-2	Pulmonary adenomas in CD-1 mice (M & F); ovarian histiocytic sarcomas (F) mice; rare nasal adenomas and carcinomas in Sprague-Dawley rats (M & F)

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
Acetone	67-64-1	044101	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (12/6/89)	NR	Not Applicable
Acetophenone	98-86-2	129033	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (11/7/90)	NR	Not Applicable
Acibenzolar-S-methyl	135158-54-2	061402	Not Likely to be Carcinogenic to Humans	OPP (12/9/99)	NR	Not Applicable
Acifluorfen, sodium	62476-59-9	114402	Likely to be Carcinogenic to Humans at High Doses Not Likely to be Carcinogenic to Humans at Low Doses	OPP (5/21/03)	MOE Approach	Liver; B6C3F1 & CD-1 mice (M & F).
Acrinathrin	101007-06-1	129141	Group D--Not Classifiable as to Human Carcinogenicity	OPP (7/15/96)	NR	Not Applicable
Acrolein	107-02-8	000701	Group CBPossible Human Carcinogen	CRAVE (12/2/87)	NR	Adrenal cortical adenomas; Fischer 344 rats (F).
Acrylamide	79-06-1	600008	Group B2BProbable Human Carcinogen	CRAVE (5/25/88)	Q1* = 4.5 E+0 (Oral); Q1* = 1.3 E-3 (Inhalation)	Benign &/or malignant tumors at multiple sites in M & F rats (F344), & carcinogenic effects in a series of 1-year limited bioassays in mice (SENCAR, Swiss-ICR & A/J strains) by several routes of exposures
Acrylonitrile	107-13-1	000601	Group B1BProbable Human Carcinogen	CRAVE (2/11/87)	Q1* = 5.4 E-1 (Oral); Q1* = 6.8 E-5 (Inhalation)	Significant increase in incidence of lung cancer in exposed workers & observation of tumors, generally astrocytomas in the brain, in 2 rat strains exposed by various routes (water, gavage, inhalation).
Alachlor	15972-60-8	090501	Likely to be Carcinogenic to Humans (High Doses); Not Likely to be Carcinogenic to Humans (Low Doses)	OPP (6/27/97)	MOE Approach	Increased incidences of malignant & combined benign/malignant multiple tumor types in both sexes; Long Evans rat
Aldicarb	116-06-3	098301	Group E--Evidence of Non-carcinogenicity for Humans	OPP (9/15/98)	NR	Not Applicable
Aldrin	309-00-2	045101	Group B2--Probable Human Carcinogen	CRAVE (3/22/87)	1.7 E+1 (Oral); 4.9 E-3 (Inhalation)	Liver carcinomas; C3HeB/Fe mice (M & F); Hepatic hyperplasia & benign hepatomas; C3H mice (M & F); Hepatocellular carcinomas; B6C3F1 mice (M).
Alkyl dimethyl benzyl ammonium chloride (ADBAC)	68424-85-1	069105	Not Likely to be Carcinogenic to Humans	OPP (11/18/99)	NR	Not Applicable
Ametryn	834-12-8	080801	Data are Inadequate for an Assessment of Human Carcinogenic Potential	OPP (9/17/04)	NR	Not Applicable

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
Aminopyridine, 4-	504-24-5	069201	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (5/30/89)	NR	Not Applicable
Amitraz	33089-61-1	106201	Group C--Possible Human Carcinogen	OPP (10/31/90)	2.83 E-2 (3/4)	Lymphoreticular tumors; CFLP mice (F). Hepatocellular adenomas, carcinomas & adenomas/carcinomas combined; B6C3F1 mice (F); Lung adenomas; B6C3F1 mice (M).
Amitrole	61-82-5	004401	Group B2--Probable Human Carcinogen	OPP (8/20/90)	1.13 E+0	Thyroid, liver & pituitary tumors in Charworth Farms, Fischer 344 & Wistar rats (M & F). Liver & thyroid tumors in B6C3F1 & NMRI mice (M & F).
Aniline	62-53-3	251400	Group B2--Probable Human Carcinogen	CRAVE (6/3/87)	5.7 E-3 (Inhalation)	Induction of tumors of the spleen and the body cavity in 2 strains of rat (CD-F & Fischer 344).
Aramite	140-57-8	062501	Group B2--Probable Human Carcinogen	CRAVE (1/10/91)	2.5 E-2 (Oral); 7.1 E-6 (Inhalation)	Liver tumors &/or neoplastic nodules in three strains of M & F rats (FDRL, CFN & Osborne-Mendel) & M of one strain of mice (C57BL/6XC3H/Anf)F1. Extrahepatic biliary system tumors in dogs (mongrel).
Arsenic acid Arsenic pentoxide Arsenate, sodium	7778-39-4 1303-28-2 13464-38-5	006801 006802 013505	Group ABHuman Carcinogen	IRIS (4/10/1998)	NR	Evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic.
Assert	69969-22-8	128841 128842 128843	Group D--Not Classifiable as to Human Carcinogenicity	OPP (6/11/87)	NR	Not Applicable
Asulam	3337-71-1	106901	Group C--Possible Human Carcinogen	OPP (2/17/88)	NR	Malignant thyroid C-cell tumors; Benign adrenal pheochromocytomas; Sprague-Dawley rats (M).
Atrazine, hydroxyatrazine	1912-24-9	080803	Not Likely to be Carcinogenic to Humans	OPP (12/13/00)	NR	Neuroendocrine Disruption MOA.
Avermectin B1	65195-55-3	122804	Group E--Evidence of Non-carcinogenicity for humans)	OPP (6/27/96)	NR	Not Applicable
Azafenidin	68049-83-2	119016	Data are Inadequate for an Assessment of Human Carcinogenic Potential	OPP (10/18/99)	NR	Not Applicable
Azinphos-methyl	86-50-0	058001	Not Likely to be Carcinogenic to Humans	OPP (12/7/93)	NR	Not Applicable

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
Azobenzene	103-33-3	007401	Group B2--Probable Human Carcinogen	CRAVE (2/3/88)	1.1 E-1 (Oral); 3.1 E-5 (Inhalation)	Invasive sarcomas in the spleen & other abdominal organs; F344 rats (M & F).
Azoxystrobin	131860-33-8	128810	Not Likely to be Carcinogenic to Humans	OPP (1/14/97)	NR	Not Applicable
Bardac 22 (also 2250, 2280)	7173-51-5	069149	Not Likely to be Carcinogenic to Humans	OPP (4/11/00)	NR	Not Applicable
BAS 510 F	188425-85-6	128008	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (9/25/02)	NR	Thyroid follicular cell adenomas, male and female Wistar rats.
BAS 670 H	210631-68-8	123009	Not Likely to be Carcinogenic to Humans at Doses that Do Not Alter Rat Thyroid Hormone Homeostasis	OPP (5/19/05)	NR	Thyroid follicular cell in Wistar rats (both sexes, adenoma driven); Antithyroid MOA.
Bendiocarb	22781-23-3	105201	Group E--Evidence of Non-carcinogenicity for Humans)	OPP (12/16/97)	NR	Not Applicable
Benfluralin	1861-40-1	084301	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (12/27/01)	NR	Liver tumors in female B6C3F1 mice
Benomyl	17804-35-2	099101	Group C--Possible Human Carcinogen	OPP (09/21/00)	2.39 E-3 (3/4)	Liver tumors (hepatocellular adenomas & carcinomas) in 2 genetically related strains of mice (CD-1 & Swiss SPF) (M & F)
Bensulide	741-58-2	009801	Not Likely to be Carcinogenic to Humans	OPP (6/10/97)	NR	Not Applicable
Bentazon	25057-89-0	275200	Group E--Evidence of Non-carcinogenicity for Humans	OPP (11/10/93)	NR	Not Applicable
Benthiavalicarb-isopropyl	177406-68-7	098379	Likely to be Carcinogenic to Humans	OPP (10/18/05)	6.2795 E-2 (3/4)	Malignant uterine tumors in female Fisher 344 rats; Liver tumors in both sexes of B6C3F1 mice with some supporting evidence of liver tumors in male rats; Tthyroid follicular cell tumors in male B6C3F1 mice.
Benzene	71-43-2	008801	Carcinogenic to Humans	IRIS (1/19/00)	1.5 E-2 to 5.5 E-2 (Oral); 2.2 E-6 to 7.8 E-6 (Inhalation)	Acute Nonlymphocytic leukemia (ANLL), suggestive evidence for chron- ic Nonlymphocytic leukemia (CNLL) & chroni lymphocytic leukemia (CLL) Other neoplastic conditions associated with an incr risk in humans are hematologic neoplasms, blood disorders (preleukemia & aplastic anemia), Hodgkin's

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
						lymphoma & myelodysplastic syndrome (MDS).
Benzoic acid	65-85-0	009101	Group D--Not Classifiable as to Human Carcinogenicity)	CRAVE (3/1/89)	NR	Not Applicable
Bifenazate	149877-41-8	000586	Not Likely to be Carcinogenic to Humans	OPP (8/28/01)	NR	Not Applicable
Bifenthrin	82657-04-3	128825	Group C--Possible Human Carcinogen	OPP (4/29/92)	RfD Approach	Hemangiopericytomas in the urinary bladder; Hepatocellular carcinomas & combined hepatocellular adenomas & carcinomas; Swiss Webster mice (M)
Biphenyl, 1,1-	92-52-4	017002	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (12/6/90)	NR	Not Applicable
Bis(chloroethyl)ether (BCEE)	111-44-4	029501	Group B2--Probable Human Carcinogen	CRAVE (7/23/86)	1.1 E+0 (Oral); 3.3 E-4 (Inhalation)	Increased evidence of hepatomas; (C57B1/6 x C3H/Anf)F1 mice (M & F) and (C57B1/6 x AKR)F1 mice (M).
Bispyribac-Sodium	125401-92-5	078906	Not Likely to be Carcinogenic to Humans	OPP (8/2/01)	NR	Not Applicable
Borax	1303-96-4	011102	Group E--Evidence of Non-carcinogenicity for humans	OPP (11/24/93)	NR	Not Applicable
Boric acid	10043-35-3	011001	Group E--Evidence of Non-carcinogenicity for humans	OPP (11/24/93)	NR	Not Applicable
Boron	7440-42-8	128945	Group E--Evidence of Non-carcinogenicity for humans	OPP (11/24/93)	NR	Not Applicable
Bromacil	314-40-9	012301	Group C--Possible Human Carcinogen	OPP (1/13/93)	RfD Approach	Liver tumors (carcinomas & combined adenomas/carcinomas); CD-1 mice (M). Thyroid tumors (C-cell adenomas & follicular cell combined adenomas/carcinomas); Crl:CD (BR) rats (M).
Bromotrichloromethane	75-62-7	008708	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (1/10/91)	NR	Not Applicable
Bromoxynil	1689-84-5	035301	Group C--Possible Human Carcinogen	OPP (3/12/97)	1.03 E-1 (3/4)	Statistically significant increases in hepatocellular adenomas and/ or carcinomas and combined adenomas/carcinomas; CD-1 mice (M & F).
Bromuconazole	116255-48-2	120503	Group E--Evidence of Non-carcinogenicity for humans	OPP (4/24/95)	NR	Not Applicable
Bronopol	52-51-7	216400	Group E--Evidence of Non-carcinogenicity for humans	OPP (6/16/95)	NR	Not Applicable

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
Buprofezin	69327-76-0	275100	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (3/15/00)	NR	Significant increase by pair-wise comparison w/the controls for combined hepatocellular adenomas/carcinomas in females; CD-1 mice
Butafenacil	134605-64-4	122004	Not Likely to be Carcinogenic to Humans	OPP (7/11/03)	NR	Not Applicable
Butylate (Sutan)	2008-41-5	041405	Group E--Evidence of Non-carcinogenicity for humans	OPP (11/25/92)	NR	Not Applicable
Cacodylic acid	75-60-5	012501	Group B2--Probable Human Carcinogen	OPP (12/14/99)	6.23 E-2 (3/4)	Urinary bladder tumor; Fischer 344 rats (M & F). Fibrosarcomas (multiple organs); B6C3F1 mice (F).
Cadmium	7440-43-9	NR	Group B1--Probable Human Carcinogen	CRAVE (11/12/86)	1.8 E-3 (Inhalation)	Limited evidence from occupational epidemiologic studies. Evidence of carcinogenicity in rats mice by inhalation and intramuscular & subcutaneous injection.
Cadusafos	95465-99-9	128864	Group E--Evidence of Non-carcinogenicity for humans	OPP (5/28/92)	NR	Not Applicable
Captafol	2939-80-2	081701	Group B2--Probable Human Carcinogen	OPP (5/15/89)	5.1 E-2 (2/3)	Lymphosarcomas & hemangiosarcomas (M & F), harderian gland adenomas (M) CD-1 mice. Mammary fibroadenoma (M & F), renal adenomas/carcin- omas (combined) (M); Sprague-Dawley rats (M).
Captan	133-06-2	081301	Likely to be carcinogenic to humans following prolonged, high-level exposures causing cytotoxicity and regenerative cell hyperplasia in the proximal region of the small intestine (oral exposure) or the respiratory tract (inhalation exposure), but not likely to be a human carcinogen at dose levels that do not cause cytotoxicity and regenerative cell hyperplasia.	OPP (9/22/04)	NR	Intestinal adenomas and adenocarcinomas in CD-1 mice (M & F). Cytotoxicity and Regenerative Proliferation MOA established.
Carbaryl	63-25-2	056801	Likely to be Carcinogenic to Humans	OPP (2/12/02)	8.75 E-4 (3/4)	Hemangiosarcomas (malignant vascular tumors) & combined hemangiomas/ hemangiosarcomas; CRL:CD-1 (ICR)BR mice (M).
Carbofuran	1563-66-2	090601	Not Likely to be Carcinogenic to Humans	OPP (6/17/97)	NR	Not Applicable
Carbon tetrachloride	56-23-5	016501	Group B2--Probable Human	CRAVE (12/4/86)	1.3 E-1 (Oral);	Hepatocellur carcinomas; Osborne-Mendel,

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
			Carcinogen		1.5 E-5 (Inhalation)	Japanese & Wistar rats; B6C3F1, C3H, A, Y, C and L mice; Syrian golden hamsters.
Carboxin	5234-68-4	090201	Not Likely to be Carcinogenic to Humans	OPP (6/5/03)	NR	Not Applicable
Carfentrazone-ethyl	128639-02-1	128712	Not Likely to be Carcinogenic to Humans	OPP (3/24/98)	NR	Not Applicable
Chlordane	57-74-9	058201	Group B2--Probable Human Carcinogen	CRAVE (4/1/87)	1.3 E+0 (Oral); 3.7E-4 (Inhalation)	Benign & malignant liver tumors; C57B1/6N, CD-1, B6C3F1 & ICR mice (M & F); F344 rats (M).
Chlordimeform	6164-98-3	059701	Group B2--Probable Human Carcinogen	OPP (12/20/85)	1.3 E+0 (Diet); 9.4 E-1 (occup.)	Malignant hemangioendothelomas; Tif:MAG:SPF mice (M & F).
Chlorethoxyfos	54593-83-8	129006	Group D--Not Classifiable as to Human Carcinogenicity	OPP (3/9/95)	NR	Not Applicable
Chlorfenapyr	122453-73-0	129093	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (3/18/03)	NR	The overall evidence in animals was Not persuasive, but could Not be dismissed. Increased in tumors in rats occurred with significant positive trends only, and mainly at the highest dose.
Chloroaniline, p-	106-47-8	017203	Group B2--Probable Human Carcinogen	OPP (4/27/95)	1.12 E-1 (3/4)	Spleen (fibrosarcomas, hemangiosarcomas & osteosarcomas) (M); Adrenal (pheochromocytomas) (M & F); F344/N rats. Hepatocellular adenomas/carcinomas (M); Hemangiosarcomas in spleen and/or liver (M) in B6C3F1 mice.
Chlorobenzene	108-90-7	056504	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (4/4/90)	NR	Not Applicable
Chloroform	67-66-3	020701	Group B2--Probable Human Carcinogen	CRAVE (8/26/87)	6.1 E-3 (Oral); 2.3E-5 (Inhalation)	Kidney tumors; Osborne-Mendel rats (M). Hepatocellular carcinomas; B6C3F1 mice (M & F); Hepatomas; A and NLC strain mice (F).
Chloroneb	2675-77-6	027301	Data Are Inadequate for an Assessment of Carcinogenic Potential	OPP (12/18/03)	NR	Not Applicable
Chlorothalonil	1897-45-6	081901	Group B2--Probable Human Carcinogen	OPP (10/27/97)	7.66 E-3 (3/4)	Renal adenomas & carcinomas, both sexes of rats & mice; rarity of the tumor response in the kidney; papillomas and/or carcinomas of the forestomach in rats & mice; CD-1 mice; Fischer 344 & Osborne-Mendel rats.
Chlorpropham (CIPC)	101-21-3	018301	Group E--Evidence of Non-carcinogenicity for humans	OPP (10/11/94)	NR	Not Applicable
Chlorpyrifos	2921-88-2	059101	Group E--Evidence of	OPP (11/23/93)	NR	Not Applicable

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
			Non-carcinogenicity for humans			
Chlorpyrifos-methyl	1351032	059102	Not Likely to be Carcinogenic to Humans	OPP (5/17/99)	NR	Not Applicable
Chlorsulfuron	64902-72-3	118601	Group E--Evidence of Non-carcinogenicity for humans	OPP (7/17/02)	NR	Not Applicable
Chromium (VI)	18540-29-9	021101	Group ABHuman Carcinogen by Inhalation	IRIS (9/3/98)	NR	Dose-response relationships have been established for chromium exposure and lung cancer in humans. Hexavalent chromium compounds are carcinogenic in animal bioassays, producing the following tumor types: intramuscular injection site tumors in rats and mice, intrapleural implant site tumors for various Cr(VI) compounds in rats, intrabronchial implantation site tumors for various Cr(VI) compounds in rats, and subcutaneous injection site sarcomas in rats. The oral carcinogenicity of Cr(VI) cannot be determined. No data were located in the available literature that suggested that Cr(VI) is carcinogenic by the oral route of exposure.
Sodium dichromate	10588-01-9	068304	Group D--Not Classifiable as to Human Carcinogenicity by Oral Route	OPP (8/28/01)		
Clodinafop-propargyl	105512-06-9	125203	Suggestive Evidence of Carcinogenic Potential	OPP (2/8/06)	NR	Prostate gland adenomas in male Tif:RAIf(SPF) rats at the high dose only cannot be discounted; Peroxisome Proliferator-Activated Receptor Agonism MOA for liver tumors in mice.
Clofencet (MON 21200)	82697-71-0	128726	Group C--Possible Human Carcinogen	OPP (7/23/96)	RfD Approach	Statistically significant increase in histiocytic sarcomas (F); CD-1 mice.
Clofentezine	74115-24-5	125501	Group C--Possible Human Carcinogen	OPP (4/3/90)	3.76 E-2 (3/4)	Increased incidence of benign & malignant thyroid follicular cell adenoma/carcinoma in male Sprague-Dawley rat
Clomazone	81777-89-1	125401	Not Likely to be Carcinogenic to Humans	OPP (1/31/01)	NR	Not Applicable
Clopyralid	1702-17-6	117403	Not Likely to be Carcinogenic to Humans	OPP (12/20/99)	NR	Not Applicable
Cloquintoced-Methylhexyl	99607-70-2	700099	Not Likely to be Carcinogenic to Humans	OPP (11/24/98)	NR	Not Applicable
Cloransulam-methyl	147150-35-4	129116	Group E--Evidence of Non-carcinogenicity for humans	OPP (9/30/97)	NR	Not Applicable
Cocamide Diethanolamine	68603-42-9	224600	Likely to be Carcinogenic to Humans	OPP (7/25/01)	4.01 E-1 (3/4)	Liver adenomas, carcinomas hepatoblastomas; B6C3F1 mice (M & F) and kidney tumors (F)
Copper (metallic)	7440-50-8	022501	Group D--Not Classifiable as to	CRAVE (9/15/87)	NR	Not Applicable

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			Human Carcinogenicity			
Coumaphos	56-72-4	036501	Not Likely to be Carcinogenic to Humans	OPP (6/25/99)	NR	Not Applicable
Creosote	8001-58-9	025004	Group B1--Probable Human Carcinogen	CRAVE (5/13/87)	NR	Limited evidence of the association between occupational creosote contact & subsequent tumor formation, sufficient Evidence of local & distant tumor formation after dermal application to mice.
Cresol, p-Chloro-m-	59-50-7	064206	Group D--Not Classifiable as to Human Carcinogenicity	OPP (11/28/95)	NR	Not Applicable
Cryolite	15096-52-3	075101	Group D--Not Classifiable as to Human Carcinogenicity	OPP (1/26/93)	NR	Not Applicable
Cyanazine	21725-46-2	100101	Group C--Possible Human Carcinogen	OPP (7/30/91)	1.66 E-1 (2/3)	Mammary gland tumors (adenocarcinoma, carcinosarcoma); Sprague- Dawely rat (F).
Cyclanilide	113136-77-9	026201	Not Likely to be Carcinogenic to Humans	OPP (4/9/97)	NR	Not Applicable
Cycloate	1134-23-2	041301	Not Likely to be Carcinogenic to Humans	OPP (9/25/03)	NR	Not Applicable
Cyfluthrin	68359-37-5	128831	Not Likely to be Carcinogenic to Humans	OPP (2/11/01)	NR	Not Applicable
Cyhalothrin	68085-85-8	128867	Group D--Not Classifiable as to Human Carcinogenicity	OPP (9/15/94)	NR	Not Applicable
Cyhalothrin, gamma	76703-62-3	128807	Not Likely to be Carcinogenic to Humans	OPP (3/01/04)	NR	Not Applicable
Cyhexatin (TCTH)	13121-70-5	101601	Data are Inadequate for an Assessment of Human Carcinogenic Potential	OPP (4/7/05)	NR	Not Applicable
Cymoxanil	57966-95-7	129106	Not Likely to be Carcinogenic to Humans	OPP (1/21/98)	NR	Not Applicable
Cypermethrin & z-Cypermethrin	NR 52315-07-8	109702 129064	Group C--Possible Human Carcinogen	OPP (9/27/88)	NR	Benign lung adenomas (increase in both adenomas and adenomas/ carcinomas combined); Alderly Park SPF Swiss strain mice (F).
Cyproconazole	94361-06-5	128993	Group B2--Probable Human Carcinogen	OPP (12/04/92)	3.0 E-1 (2/3)	Hepatocellular adenomas & carcinomas; CD-1 mice (M & F).
Cyprodinil	121552-61-2	288202	Not Likely to be Carcinogenic to Humans	OPP (1/14/98)	NR	Not Applicable
Cyromazine	66215-27-8	121301	Group E--Evidence of	OPP (1/6/95)	NR	Not Applicable

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			Non-carcinogenicity for humans			
Dacthal (DCPA)	1861-32-1	078701	Group C--Possible Human Carcinogen	OPP (2/10/95)	1.49 E-3 (3/4)	Thyroid tumors (M & F); Hepatocellular adenoma/carcinoma/hepatobiliary cholangiocarcinoma (F); Sprague-Dawley rats. Hepatocellular adenomas & combined adenoma/carcinoma; CD-1 mice (F).
Daminozide	1596-84-5	035101	Group B2--Probable Human Carcinogen	OPP (9/27/91)	8.7 E-3 (2/3)	Multiple sites (eg. lungs, vessels, liver & kidney); Multiple species, strains & studies.
Dazomet	533-74-4	035602	Group D B Not Classifiable as a Human Carcinogen	OPP (12/7/93)	NR	Not Applicable
DDD	72-54-8	029101	Group B2--Probable Human Carcinogen	CRAVE (6/24/87)	2.4 E-1 (Inhalation)	Lung tumors (M & F), liver tumors (M); CF-1 mice. Thyroid tumors (follicular cell adenomas & carcinomas); Osborne-Mendel rats (M).
DDE	72-55-9	NR	Group B2--Probable Human Carcinogen	CRAVE (6/24/87)	3.4 E-1 (Inhalation)	Liver tumors; B6C3F1 mice (hepatocellular carcinomas) (M & F); CF-1 mice (hepatomas) (M & F). Liver (neoplastic nodules); Syrian Golden Hamsters (M & F). Thyroid tumors; Osborne-Mendel rats (F).
DDT	50-29-3	029201	Group B2--Probable Human Carcinogen	CRAVE (6/24/87)	3.4 E-1 (Oral); 9.7 E-5 (Inhalation)	Tumors (generally of the liver) were observed in 7 studies in various mouse strains [BALB/C, CF-1, A strain, Swiss/Bomaby & (C57B1)x(C3HxAkR)] and in 3 rat studies (Wistar, MRC Porton & Osborne-Mendel).
DEET	134-62-3	080301	Group D--Not Classifiable as to Human Carcinogenicity	OPP (1/4/96)	NR	Not Applicable
Deltamethrin	52918-63-5	097805	Not Likely to be Carcinogenic to Humans	OPP (9/9/03)	NR	Not Applicable
Desmedipham	13684-56-5	104801	Group E--Evidence of Non-carcinogenicity for humans	OPP (7/26/94)	NR	Not Applicable
Di(2-ethylhexyl)phthalate	117-81-7	295200	Group B2--Probable Human Carcinogen	CRAVE (10/7/87)	1.4 E-2 (I)	Hepatocellular carcinomas & combined incidence of carcinomas & adenoma; Fischer 344 rats (F) and B6C3F1 mice (M & F). Neoplastic nodules & hepatocellular carcinomas; Fischer 344 rats (M).
Diazinon	333-41-5	057801	Not Likely to be Carcinogenic to Humans	OPP (6/17/97)	NR	Not Applicable
Dibromochloropropane (DBCP)	96-12-8	011301	Group B2--Probable Human Carcinogen	(CAG)I	1.2 E-5 (2/3)	Liver, kidney, stomach, nasal; Osborne-Mendel & Fischer 344 rats.

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Dibromoethane, 1,2-	106-93-4	042002	Group B2--Probable Human Carcinogen	CRAVE (5/13/87)	8.5 E+1 (Oral); 2.2 E-4 (Inhalation)	Increased incidence of a variety of tumors in rats & mice by 3 routes of administration at both the site of application and at distant sites. EDB is mutagenic in various in vitro and in vivo assays.
Dibutyl phthalate	84-74-2	028001	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (8/26/87)	NR	Not Applicable
Dicamba	1918-00-9	029801	Group D--Not Classifiable as to Human Carcinogenicity	OPP (7/29/96)	NR	Not Applicable
Dichlobenil	1194-65-6	027401	Group C--Possible Human Carcinogen	OPP (7/18/95)	RfD Approach	Adenomas alone & in combined adenoma/carcinoma at the HDT only (F); Hepatocellular adenomas and carcinomas, alone and combined (M & F); Fischer 344 rats.
Dichlorobenzamide, 2,6-	2008-88-4	027402	Group D--Not classifiable as to human carcinogenicity	OPP (11/28/95)	NR	Not Applicable
Dichlorobenzene, 1,2-	95-50-1	059401	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (12/6/89)	NR	Not Applicable
Dichloroethane, 1,2-	107-06-2	042003	Group B2--Probable Human Carcinogen	CRAVE (12/4/86)	9.1 E-2 (Oral); 2.6E-5 (Inhalation)	Induction of several tumor types in Osborne-Mendel rats & B6C3F1 mice treated by gavage and lung papillomas in ICR/HA Swiss mice after topical application.
Dichloroethylene, 1,1-	75-35-4	600033	Group C--Possible Human Carcinogen	CRAVE (1/7/87)	NR	Kidney adenomacarcinoma; Swiss mice (M)
Dichloromethane	75-09-2	042004	Group B2--Probable Human Carcinogen	CRAVE (4/6/89)	7.5 E-3 (Oral); 4.7 E-7 (Inhalation)	Hepatocellular neoplasms & alveolar/bronchiolar neoplasms; B6C3F1 mice (M & F). Benign mammary tumors (M & F), salivary gland sarcomas (M), leukemia (F); F344 rats.
Dichloropropene, 1,3- Telone II	542-75-6	029001	Group B2--Probable Human Carcinogen	OPP (4/15/99)	1.3 E-5 (3/4) (Inhalation)	Forestomach, liver, mammary, thyroid, adrenal, urinary & lung tumors; Fischer 344 rats & B6C3F1 mice (M & F). Bronchioloalveolar adenomas; B6C3F1 mice (M).
Dichlorvos (DDVP)	62-73-7	084001	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (3/1/00)	NR	Mononuclear cell leukemia in male rats and forestomach tumors (squamous cell papilloma and/or carcinoma) in female mice.

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Diclofop-methyl	51338-27-3	110902	Likely to be Carcinogenic to Humans	OPP (5/24/00)	7.36 E-2 (3/4)	Liver tumors were seen in both sexes of two species including both benign & malignant liver tumors in Wistar rats & B6C3F1 mice. Increases in the incidence of thyroid follicular cell tumors in F rats & Leydig cell tumors in M rats were possibly treatment-related.
Diclosulam	145701-21-9	129122	Not Likely to be Carcinogenic to Humans	OPP (11/9/99)	NR	Not Applicable
Dicofol	115-32-2	010501	Group C--Possible Human Carcinogen	OPP (4/15/92)	NR	Liver tumors (adenomas/carcinomas); B6C3F1 mice (M)
Dicrotophos	141-66-2	035201	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (10/18/99)	NR	Increasing trend for thyroid follicular cell adenomas; C57BL/10 J CD-1 Alpk mice (M & F)
Dieldrin	60-57-1	045001	Group B2--Probable Human Carcinogen	CRAVE (3/5/87)	1.6 E+1 (O); 4.6 E-3 (I)	Effects range from benign liver tumors to hepatocarcinomas with transplantation confirmation, to pulmonary metastases; M & F mice (C3HeB/Fe, C3H, CF1, B6C3F1, C3H/HE & C57B1/6J)
Diethyl phthalate	84-66-2	128947	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (8/26/87)	NR	Not Applicable
Difenoconazole	119446-68-3	128847	Group C--Possible Human Carcinogen	OPP (7/27/94)	NR	Statistically significant increases in liver adenomas, carcinomas & combined adenomas/carcinomas; CD-1 mice (M & F).
Difenzoquat methyl sulfate	43222-48-6	106401	Group E--Evidence of Non-carcinogenicity for humans	OPP (5/24/94)	NR	Not Applicable
Diflubenzuron	35367-38-5	108201	Group E--Evidence of Non-carcinogenicity for humans	OPP (4/27/95)	NR	Not Applicable
Diflufenzopyr-sodium	109293-98-3	005107	Not Likely to be Carcinogenic to Humans	OPP (10/6/98)	NR	Not Applicable
Dimethenamid	87674-68-8	129051	Group C--Possible Human Carcinogen	OPP (9/15/95)	RfD Approach	Statistically significant increasing trend for benign combined and/ or malignant liver tumors; Sprague-Dawley rat (M). Unresolved issues regarding nasal tumors, strong mutagenicity data & SAR.
Dimethipin	55290-64-7	118901	Group C-- Possible Human Carcinogen	OPP (1/5/90)	NR	Lung adenomas & carcinomas; CD-1 mice (M)

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Dimethoate	60-51-5	035001	Group C--Possible Human Carcinogen	OPP (8/29/91)	RfD Approach	Hemolymphoreticular tumors; B6C3F1 mice (M). Spleen (hemangioma & hemangiosarcoma) skin (hemangiosarcoma), lymph (angioma and angiosarcoma) tumors; Wistar rats (M).
Dimethomorph	110488-70-5	268800	Not Likely to be Carcinogenic to Humans	OPP (5/11/98)	NR	Not Applicable
Dimethoxane	828-00-2	001001	Suggestive Evidence for Carcinogenicity in Humans	OPP (12/21/00)	NR	Not Applicable
Dimethyl ether	115-10-6	900382	Group D--Not Classifiable as to Human Carcinogenicity	OPP (1/12/94)	NR	Not Applicable
Dimethyl phthalate	131-11-3	028002	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (8/26/87)	NR	Not Applicable
Dimethylhydantoin, 5,5 -	118-52-5	028501	Not Likely to be Carcinogenic to Humans	OPP (8/14/2000)	NR	Not Applicable
Dinocap (Karathane)	39300-45-3	036001	Group E--Evidence of Non-carcinogenicity for Humans	OPP (6/22/94)	NR	Not Applicable
Dinoseb	88-85-7	037505	Group C--Possible Human Carcinogen	OPP (6/19/86)	NR	Liver adenomas; CD-1 mice (F).
Dinotefuran	165252-70-0	044312	Not Likely to be Carcinogenic to Humans	OPP (3/5/04)	NR	Not Applicable
Diphenylamine	122-39-4	038501	Not Likely to be Carcinogenic to Humans	OPP (4/1/97)	NR	Not Applicable
Diquat dibromide	85-00-7	032201	Group E--Evidence of Non-carcinogenicity for Humans	OPP (5/12/94)	NR	Not Applicable
Disulfoton (Disyston)	298-04-4	032501	Group E--Evidence of Non-carcinogenicity for Humans	OPP (4/21/97)	NR	Not Applicable
Dithiopyr (MON 7200)	97886-45-8	128994	Group E--Evidence of Non-carcinogenicity for Humans	OPP (10/13/93)	NR	Not Applicable
Diuron	330-54-1	035505	Known/Likely	OPP (5/8/97)	1.91 E-2 (3/4)	Urinary bladder carcinomas (M&F); Kidney carcinomas (M); Wistar rat (M & F). Mammary gland carcinomas; NMRI mice (F). .
DSMA	144-21-8	013802	Not Likely to be Carcinogenic to Humans	OPP (7/26/00)	NR	Not Applicable
Emamectin	137512-74-4	122806	Not Likely to be Carcinogenic to Humans	OPP (3/19/98)	NR	Not Applicable

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Endosulfan	115-29-7	079401	Not Likely to be Carcinogenic to Humans	OPP (1/31/00)	NR	Not Applicable
Endrin	72-20-8	041601	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (10/19/88)	NR	Not Applicable
Epichlorohydrin	106-89-8	097201	Group B2--Probable Human Carcinogen	CRAVE (10/29/86)	9.9 E-3 (Oral); 1.2 E-6 (Inhalation)	Multiple studies in rats & mice administered epichlorohydrin by various routes were positive. As Epichlorohydrin is a strong alkylating agent, tumors are produced at the site of application.
Epoxiconazole	106325-08-0 133855-98-8	123909	Likely to be Carcinogenic to Humans	OPP (1/24/01)	3.04E-2 (3/4)	Combined hepatocellular tumors in male or female mice
EPTC	759-94-4	041401	Not Likely to be Carcinogenic to Humans	OPP (8/31/99)	NR	Not Applicable
Bioallethrin Esbiothrin	584-79-2 28434-00-6	004003 004004	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (10/29/03)	NR	Renal tubular adenomas in male Sprague-Dawley Crl-CD-SD(BR) rats
Esfenvalerate	66230-04-4	109303	Group E--Evidence of Non-carcinogenicity for Humans	OPP (7/1/96)	NR	Not Applicable
Ethalfuralin	55283-68-6	113101	Group C--Possible Human Carcinogen	OPP (9/14/94)	8.9 E-2 (3/4)	Mammary tumors (F); Suggestion of bladder tumors (F) and kidney tumors (M & F); Fischer 344 rats
Ethephon	16672-87-0	099801	Group D--Not Classifiable as to Human Carcinogenicity	OPP (5/5/94)	NR	Not Applicable
Ethion	563-12-2	058401	Group E--Evidence of Non-carcinogenicity for humans	OPP (1/26/94)	NR	Not Applicable
Etofenprox	80844-07-1	128965	Not Likely to be Carcinogenic to Humans at Doses that Do Not Alter Rat Thyroid Hormone Homeostasis	OPP (2/8/06)	NR	Combined thyroid follicular cell adenomas/carcinomas; Sprague-Dawley rats (M & F). Antithyroid MOA.
Ethofumesate	26225-79-6	110601	Group D--Not Classifiable as to Human Carcinogenicity	OPP (2/24/94)	NR	Not Applicable
Ethoprop (Ethoprophos)	13194-48-4	041101	Likely to be Carcinogenic to Humans	OPP (10/7/98)	2.81 E-2 (3/4)	Pheochromocytoma - adrenal glands (malignant); Sprague-Dawley rat (M); Cell carcinomas - thyroid gland; Sprague-Dawley & Fischer 344 rat (M);
Ethylene diamine	107-15-3	004205	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (7/25/91)	NR	Not Applicable

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Ethylene thiourea (ETU)	96-45-7	600016	Group B2--Probable Human Carcinogen	OPP (3/19/90)	6.1 E-2 (3/4)	Thyroid adenoma, carcinoma, & combined adenoma/carcinoma; F344 & CRCD rats (M & F). Thyroid adenomas & carcinoma, pituitary & liver tumors; B6C3F1 & C57BL/6 x AKR mice (M & F).
Etoazole	153233-91-1	107091	Not Likely to be Carcinogenic to Humans	OPP (8/7/03)	NR	Not Applicable
Famoxadone	131807-57-3	113202	Not Likely to be Carcinogenic to Humans	OPP (4/16/03)	NR	Not Applicable
Ferdam	128-04-1	034804	Likely to be Carcinogenic to Humans	OPP (4/6/00)	NR	C-cell thyroic tumors and hemangiomas; F344 & CD rats (M) Alveolar/bronchiolar adenomas & combined adenomas/carcinomas; B6C3F1 mice (F)
Fenamidone	161326-34-7	046679	Not Likely to be Carcinogenic to Humans	OPP (7/12/02)	NR	Not Applicable
Fenamiphos (Nemacur)	22224-92-6	100601	Group E--Evidence of Non-carcinogenicity for Humans	OPP (11/23/93)	NR	Not Applicable
Fenarimol	60168-88-9	206600	Not Likely to be Carcinogenic to Humans	OPP (9/5/01)	NR	Not Applicable
Fenbuconazole (Fenethanil)	114369-43-6	129011	Group C--Possible Human Carcinogen	OPP (4/15/96)	3.59 E-3 (3/4)	Thyroid follicular cell adenomas &/or combined adenomas/carcinomas; Sprague-Dawley rats (M). Hepatocellular carcinomas (M); Hepatocell- ular adenomas & combined adenomas and/or carcinomas (F); CD-1 mice.
Fenbutatin oxide (Vendex)	13356-08-6	104601	Group E--Evidence of Non-carcinogenicity for Humans	OPP (10/8/92)	NR	Not Applicable
Fenhexamid	126833-17-8	090209	Not Likely to be Carcinogenic to Humans	OPP (3/4/99)	NR	Not Applicable
Fenitrothion (Sumithion)	122-14-5	105901	Group E--Evidence of Non-carcinogenicity for Humans	OPP (7/13/93)	NR	Not Applicable
Fenoxycarb	72490-01-8	125301	Likely to be Carcinogenic to Humans	OPP (12/22/97)	7.00 E-2 (3/4)	Lung adenomas, carcinomas & combined adenoma/carcinoma; Harderian gland adenomas; CD-1 mice (M).

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Fenpropathrin (Danitol)	39515-41-8	127901	Not Likely to be Carcinogenic to Humans	OPP (12/22/03)	NR	Not Applicable
Fenpyroximate	134098-61-6	129131	Not Likely to be Carcinogenic to Humans	OPP (2/19/97)	NR	Not Applicable
Fenthion	55-38-9	053301	Group E--Evidence of Non-carcinogenicity for Humans	OPP (3/11/96)	NR	Not Applicable
Fenvalerate (Pydrin)	51630-58-1	109301	Group E--Evidence of Non-carcinogenicity for Humans	OPP (7/1/96)	NR	Not Applicable
Fipronil	120068-37-3	129121	Group C--Possible Human Carcinogen	OPP (7/18/95)	RfD Approach	Thyroid follicular cell adenomas, carcinomas & combined adenomas/ carcinomas (M); thyroid follicular cell adenomas and combined adenomas/carcinomas (F); Charles River CD rats.
Flonicamid	158062-67-0	128016	Suggestive Evidence of Carcinogenicity, but not sufficient to assess human carcinogenic potential	OPP (2/24/05)	NR	Nasal lacrimal duct squamous cell carcinomas possibly treatment-related in female Wistar rats; Mitogenesis MOA accepted for lung tumors in CD-1 mice (both sexes).
Fluazinam	79622-59-6	129098	Suggestive Evidence of Carcinogenicity to Humans	OPP (3/29/01)	NR	An increase in thyroid gland follicular cell tumors in male rats, and an increased incidence of hepatocellular tumors observed in the male mice was treatment-related
Flucarbazon sodium	181274-17-9	114009	Not Likely to be Carcinogenic to Humans	OPP (7/19/00)	NR	Not Applicable
Fludioxonil (Maxim)	131341-86-1	071503	Group D--Not Classifiable as to Human Carcinogenicity	OPP (9/19/96)	NR	Not Applicable
Flufenpyr-ethyl	188489-07-8	108853	Not Likely to be Carcinogenic to Humans	OPP (6/8/03)	NR	Not Applicable
Flumetsulam (XRD-498)	98967-40-9	129016	Group E--Evidence of Non-carcinogenicity for Humans	OPP (6/23/93)	NR	Not Applicable
Flumiclorac pentyl	87546-18-7	128724	Group E--Evidence of Non-carcinogenicity for Humans	OPP (9/7/94)	NR	Not Applicable
Flumioxazin	103361-09-7 141490-50-8	129034	Not Likely to be Carcinogenic to Humans	OPP (2/22/01)	NR	Not Applicable

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Fluometuron	2164-17-2	035503	Group C--Possible Human Carcinogen	OPP (8/28/96)	1.80 E-2 (3/4)	Statistically significant increases in combined adenomas/carcinomas of the lung (M); Malignant lymphocytic lymphomas (F); CD-1 mice.
Fluridone	59756-60-4	112900	Group E--Evidence of Non-carcinogenicity for Humans	OPP (7/1/85)	NR	Not Applicable
Fluroxypyr	69377-81-7	128959 128968	Not Likely to be Carcinogenic to Humans	OPP (1/28/98)	NR	Not Applicable
Fluthiacet-methyl	117337-19-6	108803	Likely to be Carcinogenic to Humans	OPP (12/8/98)	2.07 E-1 (3/4)	Pancreatic cell tumors (exocrine adenomas, islet cell adenomas, and combined islet cell tumors); Sprague-Dawley rats (M). Hepatocellular tumors (adenomas and combined adenoma/carcinoma); CD-1 mice (M & F). CD-1 mice (M & F).
Flutolanil	66332-96-5	128975	Group E--Evidence of Non-carcinogenicity for Humans	OPP (6/9/94)	NR	Not Applicable
Folpet	133-07-3	081601	Group B2--Probable Human Carcinogen	OPP (9/4/86)	1.86 E-3 (3/4)	Duodenum (carcinoma & adenoma); CD-1 & B6C3F1 mice (M & F); Hyperkeratosis/acanthosis; B6C3F1 mice (M).
Fomesafen	108731-70-0	123802	Not Likely to be Carcinogenic to Humans	OPP (11/3/05)	NR	Peroxisome Proliferator-Activated Receptor Agonism MOA for liver tumors in mice.
Fonofos	944-22-9	041701	Group E--Evidence of Non-carcinogenicity for Humans	OPP (11/10/93)	NR	Not Applicable
Foramsulfuron	173159-57-4	122020	Not Likely to be Carcinogenic to Humans	OPP (9/19/01)	NR	Not Applicable
Formaldehyde	50-00-0	043001	Group B1--Probable Human Carcinogen	CRAVE (2/3/88)	1.3 E-5 (Inhalation)	Statistically significant associations between site-specific respiratory neoplasms & exposure to formaldehyde; Humans. Nasal squamous cell carcinomas; Sprague-Dawley & Fischer 344 rats, B6C3F1 mice.
Formetanate hydrochloride	23422-53-9	097301	Group EBEvidence of Non-carcinogenicity for Humans	OPP (5/20/96)	NR	Not Applicable
Fosetyl-Al	39148-24-8	123301	Not Likely	OPP (4/22/99)	NR	Not Applicable
Fosthiazate	98886-44-3	129022	Not Likely to be Carcinogenic to Humans	OPP (9/15/03)	NR	Not Applicable

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Furmecyclox	60568-05-0	122601	Group B2BProbable Human Carcinogen	OPP (7/3/85)	2.98 E-2 (2/3)	Liver tumors (M & F); Urothelial tumors (M); Sprague-Dawley rats.
Furilazole (MON 13900)	121776-33-8	911596	Likely to be Carcinogenic to Humans	OPP (9/21/99)	2.74 E-2 (3/4)	Multiple tumors were seen at multiple sites in two species including both benign & malignant liver tumors in Sprague- Dawley rats (M&F) and CD-1 mice, rare tumors such as stomach & testicular tumors in rats (M) & lung tumors in mice (M & F).
Glufosinate ammonium	77182-82-2	128850	Not Likely to be Carcinogenic to Humans	OPP (5/17/99)	NR	Not Applicable
Glyphosate trimesium	81591-81-3	128501	Group EBEvidence of Non-carcinogenicity for Humans	OPP (7/26/94)	NR	Not Applicable
Glyphosate	1071-83-6	417300	Group EBEvidence of Non-carcinogenicity for Humans	OPP (12/16/91)	NR	Not Applicable
Clothianidin	210880-92-5	044309	Not Likely to be Carcinogenic to Humans	OPP (1/6/03))	NR	Not Applicable
Halosulfuron-methyl	100784-20-1	128721	Not Likely to be Carcinogenic to Humans	OPP (2/26/98)	NR	Not Applicable
Haloxypop-methyl (Verdict)	690806-40-2	125201	Group B2BProbable Human Carcinogen	OPP (9/18/89)	7.39 E+0 (2/3)	Liver tumors [adenomas (M), carcinomas (F) & adenomas/carcinomas (M & F)]; B6C3F1 mice.
Heptachlor	76-44-8	044801	Group B2BProbable Human Carcinogen	CRAVE (4/1/87)	4.5 E+0 (Oral); 1.3 E-3 (Inhalation)	Benign and malignant liver tumors (M & F) in mice (C3H & B6C3F1),
Heptachlor epoxide	1024-57-3	044801	Group B2BProbable Human Carcinogen	CRAVE (4/1/87)	9.1 E+0 (2/3) (Oral); 2.6 E-2 (2/3) (Inhalation)	Liver carcinomas; C3H & CD-1 mice (M & F); CFN rats (F).
Hexachlorobenzene (HCB)	118-74-1	061001	Group B2BProbable Human Carcinogen	CRAVE (3/1/89)	1.02 E+0 (3/4) (Oral)	Tumors in the liver, thyroid & kidney in rats (Sprague-Dawley, Agus & Wistar), mice (Swiss & ICR) and hamsters (Syrian Golden).
Hexachlorocyclohexane	608-73-1	008901	Group B2BProbable Human Carcinogen	CRAVE (12/17/86)	1.8 E+0 (Oral); 5.1 E-4 (Inhalation)	Benign hepatic nodules & hepatocellular carcinomas; Swiss mice (M). Liver nodules hepatomas; dd mice (M & F). Hepatomas; ICR-JCL mice (M & F).
Hexachlorocyclopentadiene	77-47-4	027502	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (10/5/89)	NR	Not Applicable
Hexachloroethane	67-72-1	045201	Group C--Possible Human Carcinogen	CRAVE (7/23/86)	NR	Hepatocellular carcinoma; B6C3F1 mice (M & F).

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Hexaconazole (Anvil)	79983-71-4	128925	Group C--Possible Human Carcinogen	OPP (1/21/99)	1.6 E-2 (3/4)	Benign Leydig cell tumors; Wistar (Alpk:APfSD) rat (M)
HexaziNone	51235-04-2	107201	Group D--Not Classifiable as to Human Carcinogenicity	OPP (7/27/94)	NR	Not Applicable
Hexythiazox (Savey)	78587-05-0	128849	Group C--Possible Human Carcinogen	OPP (3/16/88)	2.22 E-2 (3/4)	Liver (hepatocellular carcinomas & carcinomas/adenomas combined); B6C3F1 mice (F).
HOE 107892	135590-91-9	811800	Not Likely to be Carcinogenic to Humans	OPP (10/13/98)	NR	Not Applicable
HydramethylNon (Amdro)	67485-29-4	118401	Group C--Possible Human Carcinogen	OPP (3/28/91)	RfD Approach	Lung adenomas & combined adenomas/carcinomas; CD-1 mice (F).
Hydrogen cyanamide	420-04-2	014002	Group C--Possible Human Carcinogen	OPP (9/15/93)	6.64 E-2 (3/4)	Ovarian granulosa-theca tumors; CRL:CD-1 (ICR)BR mice (F) [Hydrogen cyanamide]. Positive trend in hemangiosarcomas; B6C3F1 mice (M) [Calcium cyanamide].
Hydroprene (Altozar)	41096-46-2	486300	Group D--Not Classifiable as to Human Carcinogenicity	OPP (6/8/95)	NR	Not Applicable
Imazalil	35554-44-0	111901	Likely to be Carcinogenic to Humans	OPP (12/7/99)	6.11 E-2 (3/4)	An increase (both trend and pair-wise) in combined liver adenomas/ carcinomas in male Swiss albino mice & male Wistar rats and an increase in combined thyroid follicular adenomas/carcinomas in male Wistar rats.
Imazapic	81334-60-3	129041	Group E--Evidence of Non-carcinogenicity for Humans	OPP (9/27/95)	NR	Not Applicable
Imazamox	114311-32-9	129171	Not Likely to be Carcinogenic to Humans	OPP (2/27/97)	NR	Not Applicable
Imazapyr	81334-34-1	128821	Group E--Evidence of Non-carcinogenicity for Humans	OPP (10/5/95)	NR	Not Applicable
Imazethapyr	81335-77-5	128922	Not Likely to be Carcinogenic to Humans	OPP (1/31/02)	NR	Not Applicable
Imidacloprid	105827-78-9	129099	Group E--Evidence of Non-carcinogenicity for Humans	OPP (11/10/93)	NR	Not Applicable
Indoxacarb (DPX-MP062)	173584-44-6	067710	Not Likely to be Carcinogenic to Humans	OPP (7/17/00)	NR	Not Applicable

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Iodomethane	74-88-4	000011	Not Likely to be Carcinogenic to Humans at Doses that Do Not Alter Rat Thyroid Hormone Homeostasis	OPP (11/10/05)	NR	Thyroid follicular cell tumors in male rats and mice; Antithyroid MOA.
Iodosulfuron	144550-36-7	122021	Not Likely to be Carcinogenic to Humans	OPP (1/5/04)	NR	Not Applicable
Iprodione (Glycophene)	36734-19-7	109801	Likely to be Carcinogenic to Humans	OPP (11/19/97)	4.39 E-2 (3/4)	Hepatocellular tumors (M&F); Ovarian luteomas (F); CD-1 mice. Testicular interstitial cell tumors (Leydig cell); Crl:CD(SD)BR rats (M).
Iprovalicarb	140923-17-7	098359	Likely to be Carcinogenic to Humans	OPP (2/6/02)	4.47E-4	Osteosarcomas, (M) transitional cell papillomas of the urinary bladder (F), mixed Mullerian tumors of the uterus,(F) and follicular cell adenomas/carcinomas of the thyroid gland (F) in Wistar (Hsd/WIN:WU) rats
Isofenphos	25311-71-1	109401	Group E--Evidence of Non-carcinogenicity for Humans	OPP (1/13/98)	NR	Not Applicable
Isophorone	78-59-1	047401	Group C--Possible Human Carcinogen	OPP (9/2/99)	6.08 E-4 (3/4)	Preputial gland carcinomas; F344/N rats (M)
Isoxaben	82558-50-7	125851	Group C--Possible Human Carcinogen	OPP (1/4/89)	NR	Hepatocellular adenomas; B6C3F1 mice (M & F).
Isoxadifen-ethyl	NR	823000	Not Likely to be Carcinogenic to Humans	OPP (1/29/01)	NR	Not Applicable
Isoxaflutole	141112-29-0	123000	Likely to be Carcinogenic to Humans	OPP (8/6/97)	1.02 E-2 (3/4)	Statistically significant increases in liver tumors in both sexes of CD-1 mice & Spague-Dawley rats; statistically significant increases in thyroid tumors in male rats.
Kathon 886	55965-84-9	107106	Group D--Not Classifiable as to Human Carcinogenicity	OPP (6/30/95)	NR	Not Applicable
KBR 3023 (propidine)	119515-38-7	070705	Not Likely to be Carcinogenic to Humans	OPP (6/9/99)	NR	Not Applicable
Kresoxim-methyl	143390-89-0	129111	Likely to be Carcinogenic to Humans	OPP (8/19/99)	2.90 E-3 (3/4)	Liver tumors (hepatocellular adenomas, hepatocellular carcinomas & combined adenomas/carcinomas); Wistar rats (M & F).

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Lactofen (Cobra)	77501-63-4	128888	Likely to be Carcinogenic in Humans at High Doses Not Likely to be Carcinogenic to Humans at Low Doses	OPP (4/8/02)	1.19 E-1 (3/4)	Hepatocellular carcinomas (M); Hepatocellular adenomas & carcinomas (M & F); CD-1 mice. Liver neoplastic nodules; Sprague-Dawley rats (M & F). MOE approach should be used for estimating human cancer risk, using a NOAEL of 2 ppm (0.3 mg/kg/day)
lambda-cyhalothrin	91465-08-6	128897	Group D--Not classifiable as to Human Carcinogenicity	OPP (9/12/02)	NR	Not Applicable
Lindane	58-89-9	009001	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (11/29/01)	NR	lung tumors (benign) in female mice only
Linuron	330-55-2	035506	Group C--Possible Human Carcinogen	OPP (11/20/01)	NR	Testicular tumors; CD rats (M); Hepatocellular adenomas; CD-1 mice (M & F).
Malathion	121-75-5	057701	Suggestive Evidence of Carcinogenicity but Not Sufficient to Assess Human Carcinogenic Potential	OPP (4/28/00)	NR	Occurrence of liver tumors in male & female B6C3F1 mice & in female Fischer 344 rats only at excessive doses. Presence of a few rare tumors, oral palate mucosa in F & nasal respiratory epithelium in M&F Fischer 344 rats. Malaoxon is Not carcinogenic in M&F Fischer 344 rats.
Maleic hydrazide	123-33-1	051501	Group E--Evidence of Non-carcinogenicity for Humans	OPP (11/10/93)	NR	Not Applicable
Mancozeb	8018-01-7	014504	Group B2--Probable Human Carcinogen	OPP (7/7/99)	6.01 E-2 (3/4). Based on ETU	Thyroid follicular cell adenomas & carcinomas, combined thyroid follicular cell adenomas and/or carcinomas; Crl:CD(BR) rats (M & F).
Maneb	12427-38-2	014505	Group B2--Probable Human Carcinogen	OPP (7/7/99)	6.01 E-2 (3/4) Based on ETU	Thyroid follicular cell adenomas & carcinomas, combined thyroid follicular cell adenomas and/or carcinomas; Crl:CD(BR) rats (M & F).
MB46513 (photodegrate of Fipronil)	120067-83-6	600050	Not Likely to be Carcinogenic to Humans	OPP (12/6/00)	NR	Not Applicable
MBC (Carbendazim)	10605-21-7	128872	Group C--Possible Human Carcinogen	OPP (4/7/89)	2.39 E-3 (3/4)	Liver tumors (hepatocellular adenomas & carcinomas) in 2 genetically related strains of mice (CD-1 & Swiss SPF) (M & F).
MCPA (and salts and esters)	94-74-6	030501	Not Likely to be Carcinogenic to Humans	OPP (10/29/03)	NR	Not Applicable

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Mecroprop-p	16484-77-8	129046	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (1/15/03)	NR	Hepatocellular adenomas and carcinomas in female B6C3F1/CrIbR mice.
Mefenoxam	70630-17-0	113502	Not Likely to be Carcinogenic to Humans	OPP (5/17/00)	NR	Not Applicable
Melamine	108-78-1	777201	Group D--Not Classifiable as to Human Carcinogenicity	OPP (7/29/92)	NR	Not Applicable
Mepanipyrin	110235-47-7	288203	Likely to be Carcinogenic to Humans	OPP (4/20/04)	1.35 E-2 (3/4)	Benign and malignant liver tumors in Fischer 344 rats (F) and B ₆ C ₃ F ₁ mice (M & F) at multiple doses.
Mepiquat chloride	24307-26-4	109101	Not likely to be carcinogenic to Non-humans	OPP (2/19/03)	NR	Not Applicable
Mercaptobenzothiazole, 2-	149-30-4	051701	Group C--Possible Human Carcinogen	OPP (11/19/92)	RfD Approach	Adrenal gland tumors (M & F), some evidence of preputial gland tumors (M) & equivocal evidence for pituitary gland tumors (M); F344/N rats.
Mercury (Inorganic)	7439-97-6	052301	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (1/13/88)	NR	Not Applicable
Mesosulfuron Methyl	208465-21-8	122009	Not Likely to be Carcinogenic to Humans	OPP (3/4/04)	NR	Not Applicable
Mesotrione	104206-82-8	122990	Not Likely to be Carcinogenic to Humans	OPP (4/12/01)	NR	Not Applicable
Metalaxyl	57837-19-1	113501	Group E--Evidence of Non-carcinogenicity for Humans	OPP (12/31/85)	NR	Not Applicable
Metaldehyde	108-62-3	053001	Suggestive Evidence of Carcinogenic Potential	OPP (6/23/05)	NR	Benign liver tumors in female SD CD rats and in both sexes of CD-1 mice
Metam sodium Metam potassium	137-42-8	039002 039003	Group B2--Probable Human Carcinogen	OPP (5/1/95)	1.98 E-1 (3/4)	Malignant angiosarcomas (by both pair-wise & trend analysis); C57BL/10JfCD-1/Alpk mice (M & F). Malignant hemangiosarcomas; Hsd/Ola: Wistar rats (M).
Metconazole	125116-23-6	125619	Not Likely to be Carcinogenic to Humans	4/19/06	NR	Mitogenesis MOA for liver tumors in CD-1 mice
Methamidophos (Monitor)	10265-92-6	101201	Not Likely to be Carcinogenic to Humans	OPP (2/12/98)	NR	Not Applicable
Methanearsonic Acid	5902-95-4	013806	Not Likely to be Carcinogenic to Humans	OPP (12/14/00)	NR	Not Applicable

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Methidathion	950-37-8	100301	Group C--Possible Human Carcinogen	OPP (2/19/88)	NR	Liver tumors (benign and malignant); CD-1 mice (M).
Methiocarb (Mesurol)	2032-65-7	100501	Group D--Not Classifiable as to Human Carcinogenicity	OPP (3/2/93)	NR	Not Applicable
Methomyl	16752-77-5	090301	Group E--Evidence of Non-carcinogenicity for Humans	OPP (10/26/96)	NR	Not Applicable
Methoxychlor	72-43-5	034001	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (10/7/87)	NR	Not Applicable
Methoxyfenozide	161050-58-4	121027	Not Likely to be Carcinogenic to Humans	OPP (7/1/99)	NR	Not Applicable
Methyl ethyl ketone (MEK)	78-93-3	044103	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (5/30/89)	NR	Not Applicable
Methyl isothiocyanate	6317-18-6	068103	Group B2--Probable Human Carcinogen -- Based on Metam Sodium Data	OPP (2/2200)	3.5 E-1 Molar equivalent of MITC	Based on Metam Sodium data: Malignant angiosarcomas (by both pair-wise & trend analysis); C57BL/10JfCD-1/Alpk mice (M & F). Malignant hemangiosarcomas; Hsd/Ola: Wistar rats (M).
Methyl bromide	74-83-9	053201	Not Likely	OPP (8/4/92)	NR	Not Applicable
Methyl parathion	298-00-0	053501	Not Likely to be Carcinogenic to Humans	OPP (12/1/97)	NR	Not Applicable
Methylene bis(thiocyanate)	6317-18-6	068102	Group B2--Probable Human Carcinogen -- Based on Metam Sodium Data	OPP (2/22/00)	NR	Not Applicable
Methylphenol, 3-	108-39-4	022102	Group C--Possible Human Carcinogen	CRAVE (10/5/89)	NR	Increased incidence of skin papillomas in mice in an initiation- promotion study.
Metiram	9006-42-2	014601	Group B2--Probable Human Carcinogen	OPP (7/7/99)	6.01 E-2 (3/4). Based on ETU	Thyroid follicular cell adenomas & carcinomas, combined thyroid follicular cell adenomas and/or carcinomas; Crl:CD(BR) rats (M & F).
Metolachlor and S-Metolachlor	51218-45-2 87392-12-9	108800 108801	Group C Possible Human Carcinogen	(OPP (11/16/94)	MOE Approach	Liver adenomas and combined adenomas/carcinomas; Charles River CD (SD)BR rats (F).
Metribuzin (Sencor)	21087-64-9	101101	Group D--Not Classifiable as to Human Carcinogenicity	OPP (5/16/95)	NR	Not Applicable
Metsulfuron	74223-64-6	122010	Not Likely to be Carcinogenic to Humans	OPP (3/14/02)	NR	Not Applicable
MGK Repellent 326	136-45-8	047201	Group B2--Probable Human Carcinogen	OPP (11/12/02)	1.6 E-3 (3/4)	Multiple malignant & benign tumors [liver (M & F), kidney (M & F), testes (M) & uterine (F);

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						CD rats. Multiple malignant tumors [liver (M & F) & lung/bronchiolar tumors (M)]; CD-1 mice.
MGK-264	113-48-4	057001	Group C--Possible Human Carcinogen	OPP (6/7/95)	RfD Approach	Statistically significant increases in hepatocellular adenomas; CD-1 mice (M & F). Statistically significant increases for thyroid follicular cell adenomas; Crl:CDBR rats (M).
Molinate	2212-67-1	041402	Suggestive Evidence of Carcinogenicity to Humans	OPP (12/14/00)	NR	Statistically significant increase in combined adenomas & carcinomas in the kidney; Crl:CD(SD)BR rat (M). There was equivocal evidence that Molinate induced an increase in testicular tumors.
MON 4660	71526-07-3	600046	Likely to be Carcinogenic to Humans	OPP (12/9/99)	4.88 E-2 (3/4)	Hepatocellular adenomas, carcinomas & combined adenomas/carcinomas; (M&F) Sprague-Dawley rats & CD-1 mice. Stomach squamous cell papillomas & combined papillomas/carcinomas; M rats & M&F mice. Bile duct cholangiomas/carcinomas; M rats. Bronchio-alveolar adenomas, combined adenomas/ carcinomas; M mice.
MSMA	2163-80-6	013803	Not likely to Carcinogenic to Humans	OPP (7/26/00)	NR	Not Applicable
Myclobutanil	88671-89-0	128857	Group E--Evidence of Non-carcinogenicity for Humans	OPP (6/16/94)	NR	Not Applicable
Naled	300-76-5	034401	Group E--Evidence of Non-carcinogenicity for Humans	OPP (8/31/94)	NR	Not Applicable
Naptalam Naptalam, sodium salt	132-66-1 132-67-2	030702 030703	Group D--Not Classifiable as to Human Carcinogenicity	OPP (9/7/94)	NR	Not Applicable
Nicosulfuron	111991-09-4	129008	Group E--Evidence of Non-carcinogenicity for Humans	OPP (9/1/98)	NR	Not Applicable
Nitrapyrin	1929-82-4	069203	Likely to be Carcinogenic to Humans	OPP (3/26/05)	4.25 E-2 (3/4)	Increase in liver tumors in B6C3F mice (M & F); epididymal sarcomas in M mice.
Nitrobenzene	98-95-3	056501	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (11/8/89)	NR	Not Applicable
Norflurazon	27314-13-2	105801	Group C--Possible Human Carcinogen	OPP (11/2/90)	NR	Statistically significant increase in comparison to controls in liver adenomas & combined liver adenomas & carcinomas, as well as the statistically significant positive trend for these

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
						hepatocellular adenomas & combined adenomas & carcinomas; CD-1 mice (M).
Novaluron	116714-46-6	124002	Not Likely to be Carcinogenic to Humans	OPP (2/4/04)	NR	Not Applicable
Orthophenylphenol Sodium salt	90-43-7 132-27-4	064103 064104	Not Likely to be Carcinogenic to Humans	OPP (10/12/05)	NR	Not Applicable
Oryzalin	19044-88-3	104201	Likely to be Carcinogenic to Humans	OPP (5/14/03)	7.79 E-3 (3/4)	Multiple sites (thyroid, mammary); F344 rats (M & F).
Oxadiazon	19666-30-9	109001	Group C--Possible Human Carcinogen	OPP (5/1/01)	7.11 E-2 (3/4)	Liver tumors (malignant, combined malignant & benign); CD CD-1 mice (M & F), Wistar rats (M)
Oxadixyl	77732-09-3	126701	Group C--Possible Human Carcinogen	OPP (1/4/89)	5.3 E-2 (2/3)	Hepatocellular adenomas (by pair-wise comparison & with a dose- related trend); Han-Wistar rats (M & F).
Oxamyl	23135-22-0	103801	Group E--Evidence of Non-carcinogenicity for Humans	OPP (11/5/96)	NR	Not Applicable
Oxydemeton-methyl	301-12-2	058702	Not Likely to be Carcinogenic to Humans	OPP (7/24/97)	NR	Not Applicable
Oxyfluorfen	42874-03-3	111601	Group C--Possible Human Carcinogen	OPP (9/29/89)	7.32 E-2 (3/4)	Liver (adenomas, carcinomas & combined adenomas and/or carcinomas); CD-1 mice (M).
Oxytetracycline	2058-46-0	006308	Group D--Not Classifiable as to Human Carcinogenicity	OPP (12/18/92)	NR	Not Applicable
Oxythioquinox	2439-01-2	054101	Group B2--Probable Human Carcinogen	OPP (2/15/96)	3.42 E-2 (3/4)	Lung tumors; NMRI mice (M). Hepatocellular tumors (M & F) and rare kidney tumors (F); F344 rats. Data showing chemical has clastogenic activity provided additional support.
Paclobutrazol	76738-62-0	125601	Group D--Not Classifiable as to Human Carcinogenicity	OPP (6/23/94)	NR	Not Applicable
Paradichlorobenzene	106-46-7	061501	Group C--Possible Human Carcinogen	OPP (4/27/89)	NR	Liver (adenomas and carcinomas); B6C3F1 mice (M & F).
Paranitrophenol	100-02-7	056301	Group D--Not Classifiable as to Human Carcinogenicity	OPP (5/14/96)	NR	Not Applicable
Paraquat dichloride	1910-42-5	061601	Group E--Evidence of Non-carcinogenicity for Humans	OPP (3/15/89)	NR	Not Applicable
Parathion, ethyl	56-38-2	057501	Group C--Possible Human Carcinogen	OPP (9/11/91)	RfD Approach	Adrenal cortical tumors (adenomas + carcinomas; Thyroid follicular cell adenomas &

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
						pancreatic cell carcinomas; Osborne-Mendel rat (M) Benign pancreatic tumors; Wistar rat (M)
Pebulate	1114-71-2	041403	Not Likely to be Carcinogenic to Humans	OPP (12/7/98)	NR	Not Applicable
Pendimethalin	40487-42-1	108501	Group C--Possible Human Carcinogen	OPP (7/24/92)	RfD Approach	Thyroid follicular cell adenomas; Sprague-Dawley rats (M & F).
Penoxulam	219714-96-2	119031	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (3/24/2004)	NR	Mononuclear cell leukemia in Male Fischer 344 rats. Although dosing in male mice was not considered to be adequate, an additional mouse carcinogenicity study was <u>not</u> required.
Pentachloronitrobenzene	82-68-8	056502	Group C--Possible Human Carcinogen	OPP (12/18/92)	RfD Approach	Thyroid follicular cell adenomas (by both pair-wise and trend analysis) in males with a positive trend in females; CD rats.
Pentachlorophenol	87-86-5	063001	Group B2--Probable Human Carcinogen	OPP (1/3/91)	1.3 E-1 (2/3)	Hepatocellular adenomas & carcinomas, adrenal medulla pheochromo- cytomas & malignant pheochromocytomas, &/or hemangiosarcomas & hemangiomas in one or both sexes of B6C3F1 mice.
Permethrin	52645-53-1	109701	Likely to be Carcinogenic to Humans	OPP (10/23/02)	9.567 E-3 ⁻ (2/3)	Lung (benign) tumors in female and liver tumors in both sexes of CD-1 mice.
Phenmedipham	13684-63-4	098701	Group D--Not Classifiable as to Human Carcinogenicity	OPP (4/28/93)	NR	Not Applicable
Phenol	108-95-2	064001	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (8/2/89)	NR	Not Applicable
Phorate (Thimet)	298-02-2	057201	Group E--Evidence of Non-carcinogenicity for Humans	OPP (12/30/93)	NR	Not Applicable
Phosalone	2310-17-0	097701	Not Likely to be Carcinogenic to Humans	OPP (8/12/99)	NR	Not Applicable
Phosmet	732-11-6	059201	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (10/27/99)	NR	Increase (both trend & pair-wise) in combined liver adenomas/carcinomas in male B6C3F1 mice but only trends for increase of liver adenomas/carcinomas & mammary adenocarcinomas in female B6C3F1 mice. There was no Evidence of carcinogenicity in an acceptable study in Charles River rats.
Phosphamidon	13171-21-6	018201	Group C--Possible Human Carcinogen	OPP (5/31/89)	NR	Bladder transitional cell carcinoma; Hepatocellular carcinoma; Sprague-Dawley rats (M).

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Phosphine	7803-51-2	066500	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (3/31/92)	NR	Not Applicable
Phostebupirim (Bay mat 7484)	96182-53-5	129086	Group E--Evidence of Non-carcinogenicity for Humans	OPP (4/27/97)	NR	Not Applicable
Picloram Acid -triisopropanolamine salt -ethylhexyl ester -potassium salt	1918-02-1 6753-47-5 2545-60-0 35832-11-2	005101 005102 005103 005104	Group E--Evidence of Non-carcinogenicity for Humans	OPP (2/10/89)	NR	Not Applicable
Pinoxaden	243973-20-8	147500	Data are Inadequate for an Assessment of Human Carcinogenic Potential	OPP (5/18/05)	NR	Not Applicable
Piperonyl butoxide	51-03-6	067501	Group C--Possible Human Carcinogen	OPP (6/7/95)	RfD Approach	Increased incidence of hepatocellular tumors (M & F) (adenomas, carcinomas, combined adenomas/carcinomas in M and adenomas in F; CD-1 mice
Pirimicarb	23103-98-2	106101	Likely to be Carcinogenic to Humans	OPP (7/13/05)	3.526 E-2 (3/4)	Multiple benign and/or malignant tumors (liver, lung, ovary, mammary gland) seen in male and female Swiss mice; Lung tumors in female CD-1 mice
Pirimiphos-methyl	29232-93-7	108102	Not Yet Determined	OPP (1/29/98)	NR	Not Applicable
Poly(hexamethylenebiguanide) (PHMB)	32289-58-0	111801	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (4/9/03)	NR	Vascular tumors in female Wistar rats, male & female C5B1/10J,CD-1/Alpk mice following oral exposure; vascular tumors in female Alderley Park mice following dermal exposure.
Polychlorinated biphenyls	1336-36-3	017801	Group B2--Probable Human Carcinogen	CRAVE (4/22/87)	7.7 E+0 (Inhalation)	Hepatocellular carcinomas; Fischer 344, Sprague-Dawley & Wistar rat; dd & BALB/cJ mice. Inadequate yet suggestive Evidence of excess risk of liver cancer in humans by ingestion, inhalation or dermal contact.
Potassium dichromate	7778-50-9	068302	Not Likely to be Carcinogenic to Humans	OPP (8/28/01)	NR	Not Applicable
Prallethrin	23031-36-9	128722	Not Likely to be Carcinogenic to Humans	OPP (6/27/03)	NR	Not Applicable
Primisulfuron-methyl	86209-51-0	128973	Group D--Not Classifiable as to Human Carcinogenicity	OPP (5/3/90)	NR	Not Applicable
Prochloraz	67747-09-5	128851	Group C--Possible Human Carcinogen	OPP (7/1/88)	1.5 E-1 (2/3)	Hepatocellular adenoma & carcinoma, combined adenoma/carcinoma; CD-1 (M & F).
Procymidone	32809-16-8	129044	Group B2--Probable Human	OPP (4/5/91)	2.4 E-2 (2/3) (F);	Interstitial cell adenoma (M); Pituitary adenoma

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			Carcinogen		1.91 E-2 (2/3) (M)	(F); Osborne-Mendel rats. Liver adenomas & combined adenomas/carcinomas; B6C3F1 mice (F). Additionally, a rare variant of hepatocellular carcinoma, hepatoblastoma, had a significant increasing trend in M B6C3F1 mice.
Prodiamine	29091-21-2	110201	Group C BPossible Human Carcinogen	OPP (7/15/91)	RfD Approach	Thyroid follicular cell neoplasia (M & F); Pancreatic adenomas (F) in Sprague- Dawley rats. Fibrosarcomas; CD-1 mice (M).
Profenofos	41198-08-7	111401	Group E BEvidence of Non-carcinogenicity for Humans	OPP (2/6/95)	NR	Not Applicable
Prohexadione Calcium	127277-53-6	112600	Not Likely to be Carcinogenic to Humans	OPP (4/14/00)	NR	Not Applicable
Prometon	1610-18-0	080804	Group D--Not Classifiable as to Human Carcinogenicity	OPP (9/17/92)	NR	Not Applicable
Prometryn	7287-19-6	080805	Group E--Evidence of Non-carcinogenicity for Humans	OPP (7/25/94)	NR	Not Applicable
Pronamide (Kerb)	23950-58-5	101701	Group B2--Probable Human Carcinogen	OPP (5/26/93)	2.59 E-2 (3/4)	Benign testicular interstitial cell tumors (M); Uncommon thyroid follicular cell adenomas (M&F); CrI:CD(SD)BR rats. Hepatocellular carcinomas; B6C3F1 mice (M).
Propachlor	1918-16-7	019101	Likely to be Carcinogenic to Humans	OPP (10/16/97)	3.2 E-2 (3/4)	Multiple tumors/multiple sites; Rare stomach tumor; Fischer 344 rat (M); Thyroid tumors & ovarian granulosa/theca cell tumors; Sprague-Dawley rats (M & F). Hepatocellular tumors; CD-1 mice (M).
Propamocarb hydrochloride	25606-41-1	119302	Not Likely	OPP (5/31/00)	NR	Not Applicable
Propanil	709-98-8	028201	Suggestive Evidence of Carcinogenicity but Not Sufficient to Assess Human Carcinogenic Potential	OPP (6/19/01)	NR	Testicular interstitial cell adenomas in male rats. Hepatocellular adenomas in female rats at an excessively toxic doses
Propargite (Omite)	2312-35-8	097601	Group B2--Probable Human Carcinogen	OPP (7/23/92)	1.92 E-1 (3/4)	Statistically significant increases in undifferentiated sarcomas in the jejunum; CrI:CDBR rat (M & F).
Propazine	139-40-2	080808	Not Likely to be Carcinogenic to Humans	OPP (12/8/05)	NR	Neuroendocrine Disruption MOA
Propetamphos	31218-83-4	113601	Not Likely to be Carcinogenic to Humans	OPP (12/2/98)	NR	Not Applicable

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Propoxur	114-26-1	047802	Group B2BProbable Human Carcinogen	OPP (6/17/96)	3.69 E-3 (3/4)	Bladder carcinomas (rare), papillomas & combined combined carcinoma/ papilloma (M&F); Wistar rats. Statistically significant increases in hepatocellular adenomas & adenomas & combined adenoma/carcinoma; B6C3F1 mice (M).
Propoxycarbazone sodium	181274-15-7	122019	Not Likely to be Carcinogenic to Humans	OPP (4/6/04)	NR	Not Applicable
Propiconazole	60207-90-1	122101	Group CBPossible Human Carcinogen	OPP (9/14/92)	RfD Approach	Hepatocellular adenomas, carcinomas, & adenomas/carcinomas combined; CD-1 mice (M).
Propylene oxide	75-56-9	042501	Group B2BProbable Human Carcinogen	CRAVE (4/5/90)	2.4 E-1 (Oral); 3.7 E-6 (Inhalation)	Benign & malignant tumors at the site of exposure when exposed by subcutaneous injections (NMRI mice), by inhalation (F344/N, CpB:WU Wistar rats & B6C3F1 mice) & by gavage (Sprague-Dawley rats).
Prosulfuron	94125-34-5	129031	Data Are Inadequate for an Assessment of Human Carcinogenic Potential	OPP (1/24/00)	NR	Not Applicable
PT807-HC1 (Ecolyst)	NR	069089	Not Likely to be Carcinogenic to Humans	OPP (10/19/99)	NR	Not Applicable
Pymetrozine	123312-89-0	101103	Likely to be Carcinogenic to Humans	OPP (8/24/99)	1.19 E-2 (3/4)	Liver tumors- Hepatomas and combined adenomas and/or carcinomas; Tif:RAIf(SPF) Sprague-Dawley rats (F). Liver carcinomas and combined hepatomas and/or carcinomas; Tif:MAGf(SPF) mice (M & F).
Pyraclostrobin	175013-18-0	099100	Data Are Inadequate for an Assessment of Human Carcinogenic Potential	OPP (9/10/03)	NR	Not Applicable
Pyraflufen-Ethyl	129630-19-9	030090	Likely to be Carcinogenic to Humans	OPP (10/8/02)	3.32 E-2 (3/4)	Hepatocellular adenomas and combined adenomas, carcinomas and/or hepatoblastomas in male and female (SPF) ICR (Crj:CD-1) mice.
Pyrethrins	8003-34-7	069001	Suggestive Evidence of Carcinogenicity but Not Sufficient to Assess Human Carcinogenic Potential	OPP (6/22/04)	NR	Minimal, benign, liver tumors in CD rats (F). Thyroid Hormone Disruption MOA established.
Pyridaben	96489-71-3	129105	Group E--Evidence of Non-carcinogenicity for Humans	OPP (5/11/94)	NR	Not Applicable

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Pyrimethanil	53112-28-0	288201	Group C--Possible Human Carcinogen	OPP (2/12/97)	MOE Approach	Thyroid follicular cell adenomas & combined adenoma/carcinoma (M); Thyroid cell adenomas (F); Sprague-Dawley rats.
Pyriproxyfen	95737-68-1	129032	Group E--Evidence of Non-carcinogenicity for Humans	OPP (9/15/95)	NR	Not Applicable
Pyriproxyfen-sodium	123343-16-8	078905	Group C--Possible Human Carcinogen	OPP (9/5/95)	1.05 E-3 (3/4)	Liver adenomas, carcinomas & combined adenoma/carcinoma; CD-1 mice (M). Rare kidney tubular adenomas, carcinomas & combined adenoma/ carcinoma; Crl:CDBR rats (M).
Quinlorac	84087-01-4	128974	Group D--Not Classifiable as to Human Carcinogenicity	OPP (8/26/92)	NR	Not Applicable
Quinoxifen	124495-18-7	055459	Not Likely to be Carcinogenic to Humans	OPP (1/28/03)	NR	Not Applicable
Quizalofop ethyl	76578-14-8	128201	Group D--Not Classifiable as to Human Carcinogenicity	OPP (3/17/88)	NR	Not Applicable
Resmethrin	10453-86-8	097801	Likely to be Carcinogenic to Humans	OPP (5/25/05)	5.621 E-2 (3/4)	Increased incidence of benign and malignant liver tumors in SD Rats (F) and CD-1 Mice (M).
Rimsulfuron (DPX-E9636)	122931-48-0	129009	Not Likely to Be Carcinogenic to Humans	OPP (2/19/98)	NR	Not Applicable
RoteNone	83-79-4	071003	Group E--Evidence of Non-carcinogenicity for Humans	OPP (10/5/88)	NR	Not Applicable
Selenium and compounds	7782-49-2	072001	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (3/7/90)	NR	Not Applicable
Sethoxydim	74051-80-2	121001	Not Likely to Be Carcinogenic in Humans	OPP (3/19/03)	NR	Not Applicable
Silver	7440-22-4	072501	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (9/22/88)	NR	Not Applicable
Silvex (2,4,5-TP)	93-72-1	082501	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (12/2/87)	NR	Not Applicable
Simazine	122-34-9	080807	Not Likely to Be Carcinogenic to Humans	OPP (4/14/05)	NR	Neuroendocrine Disruption MOA
Sodium omadine	15922-78-8	088004	Group D--Not Classifiable as to Human Carcinogenicity	OPP (5/16/95)	NR	Not Applicable
Sodium dichromate	3173233	068304	Not Likely to be Carcinogenic to Humans	OPP (8/28/01)	NR	Not Applicable

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Spinosad (XDE-105)	131929-60-7	110003	Not Likely to be Carcinogenic to Humans	OPP (6/17/97)	NR	Not Applicable
Spirodiclofen	148477-71-8	124871	Likely to be Carcinogenic to Humans	OPP (6/10/04)	1.49 E-2 (3/4)	Tumors seen in both sexes of two species: testicular Leydig cell tumors in Wistar rat (M); uterine tumors in Wistar rat (F); and liver tumors in CD-1 mouse (M & F).
Spiroxamine	118134-30-8	120759	Not Likely to be Carcinogenic to Humans	OPP (11/14/03)	NR	Not Applicable
Sulfentrazone	122836-35-5	129081	Group E--Evidence of Non-carcinogenicity for Humans	OPP (5/7/96)	NR	Not Applicable
Sulfluramid	4151-50-2	128992	No Data Available		NR	Not Applicable
Sulfosulfuron	141776-32-1	085601	Likely to be Carcinogenic to Humans	OPP (10/28/98)	1.03 E-3 (3/4)	Rare transitional cell papilloma & carcinoma of the urinary bladder in females; Sprague-Dawley rats. Rare mesenchymaltumors of the urinary bladder in male as well as renal adenomas in male and female CD-1 mice.
Sulfuryl fluoride	2699-79-8	078003	Not Likely to be Carcinogenic to Humans	OPP (5/24/01)	NR	Not Applicable
Sulprofos	35400-43-2	111501	Group E--Evidence of Non-carcinogenicity for Humans	OPP (3/26/96)	NR	Not Applicable
Surfonic AGM-550	NR	870401	No Data Available	NR	NR	Not Applicable
TCMTB (Busan 72)	21564-17-0	035603	Group C--Possible Human Carcinogen	OPP (8/28/96)	RfD Approach	Testicular interstitial cell adenomas (M); Thyroid c-cell adenomas (F); Sprague-Dawley rats.
Tebuconazole	107534-96-3	128997	Group C--Possible Human Carcinogen	OPP (9/15/93)	RfD Approach	Statistically significant increase in the incidence of hepatocell- ular adenomas, carcinomas & combined adenomas/carcinomas both by positive trend & pairwise comparisons; NMRI mice (M & F).
Tebufozide	112410-23-8	129026	Group E--Evidence of Non-carcinogenicity for Humans	OPP (8/29/94)	NR	Not Applicable
Tebufenpyrad	119168-77-3	090102	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential	OPP (5/15/02)	NR	Hepatocellular adenomas in male and female F344 rats
Tebuthiuron	34014-18-1	105501	Group D--Not Classifiable as to	OPP (3/1/91)	NR	Not Applicable

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			Human Carcinogenicity			
Tefluthrin	79538-32-2	128912	Not Yet Evaluated	OPP (11/14/97)	NR	Not Applicable
Temephos	3383-96-8	059001	Not Yet Determined	OPP (5/12/98)	NR	Negative in rats; no data in second species. Non food use
Tepraloxymid	149979-41-9	121005	Data Are Inadequate for an Assessment of Human Carcinogenic Potential	OPP (2/26/01)	NR	Not Applicable
Terbacil	5902-51-2	012701	Group E--Evidence of Non-carcinogenicity for Humans	OPP (9/30/94)	NR	Not Applicable
Terbufos	13071-79-9	105001	Group E--Evidence of Non-carcinogenicity for Humans	OPP (2/1/94)	NR	Not Applicable
Terbuthylazine	5915-41-3	080814	Group D--Not Classifiable as to Human Carcinogenicity	OPP (8/24/94)	NR	Not Applicable
Terbutryn	886-50-0	080813	Group C--Possible Human Carcinogen	OPP (3/3/88)	NR	Mammary (adenomas/adenocarcinomas); Liver (adenomas/carcinomas) (F); Thyroid follicular (adenomas/carcinomas); Testicular interstitial cell adenoma (M); CR CD rat.
Terrazole	2593-15-9	084701	Group B2--Probable Human Carcinogen	OPP (1/9/91)	3.33 E-2 (M)	Multiple tumors (liver, bile duct, mammary gland, thyroid & testes) & cholangiocarcinoma (a rare tumor); Sprague-Dawley rats (M & F).
Tetrachloroethane, 1,1,2,2-	79-34-5	078601	Group C--Possible Human Carcinogen	CRAVE (6/26/86)	NR	Hepatocellular carcinomas; B6C3F1 mice (M & F).
Tetrachlorvinphos	961-11-5	083701	Likely to be Carcinogenic to Humans	OPP (3/7/02)	1.83 E-3 (3/4)	Hepatocellular carcinomas & combined adenomas/carcinomas; B6C3F1 mice (F). Thyroid C-cell adenomas & adrenal pheochromocytomas; Sprague-Dawley rats (M).
Tetraconazole	112281-77-3	120603	Likely to be Carcinogenic to Humans	OPP (1/11/00)	2.3 E-2 (3/4)	Hepatocellular adenomas, carcinomas and combined adenomas/carcinomas in both sexes; Crl:CD-1 (ICR) mice
Tetramethrin	7696-12-0	069003	Group C/Possible Human Carcinogen	OPP (12/11/89)	NR	Interstitial cell adenomas in the testes (M); CR CD-1 & CRCD Sprague-Dawley, Long-Evans Hooded rats.
Thallium(I) sulfate	7446-18-6	080001	Group D/Not Classifiable as to Human Carcinogenicity	CRAVE (11/8/89)	NR	Not Applicable
Thiabendazole	148-79-8	060101	Likely to be Carcinogenic to Humans at High Does; Not Likely to be Carcinogenic to	OPP (3/8/02)	MOE Approach	Thyroid follicular cell adenomas and combined adenomas/carcinomas; Sprague-Dawley Crl:CD BR rats (M & F)

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			Humans at Low Doses			
Thiacloprid	111988-49-9	014019	Likely to be Carcinogenic to Humans	OPP (3/26/03)	4.06 E-2 (3/4)	Thyroid follicular cell adenomas in male Wistar rats; uterine adenomas, adenocarcinomas and/or adenosquamous carcinomas in female Wistar rats; ovarian luteomas in female B6C3F mice.
Thiafluamide (FOE 5043)	142459-58-3	121903	Not Likely to be Carcinogenic to Humans	OPP (7/16/97)	NR	Not Applicable
Thiamethoxam	153719-23-4	060109	Not Likely to be Carcinogenic to Humans	OPP (6/13/05)	NR	Cytotoxicity and Regenerative Proliferation MOA established for mice liver tumors.
Thiazopyr (MON 13200)	117718-60-2	129100	Group CBPossible Human Carcinogen	OPP (5/25/94)	MOE Approach	Statistically significant increase in thyroid follicular cell tumors (M). Increases in renal tubular adenomas (M & F); however statistically significant positive trend in F only; Sprague-Dawley rats.
Thiobencarb (Bolero)	28249-77-6	108401	Group DBNot Classifiable as to Human Carcinogenicity	OPP (6/10/96)	NR	Not Applicable
Thiocyclam hydrogen oxalate	31895-22-4	128868	Group DBNot Classifiable as to Human Carcinogenicity	OPP (9/15/94)	NR	Not Applicable
Thiodicarb	59669-26-0	114501	Group B2BProbable Human Carcinogen	OPP (6/10/96)	1.88 E-2 (3/4)	Liver tumors (malignant & benign); CD-1 mice (M & F). Testicular interstitial cell tumors; Sprague-Dawley rat (M).
Thiophanate-methyl	23564-05-8	102001	Likely to be Carcinogenic to Humans	OPP (12/8/01)	1.16 E-2 (3/4)	Hepatocellular adenomas (M & F); Combined adenomas, carcinomas and/or hepatoblastomas (M); CD-1 mice. Thyroid follicular cell adenomas (M & F); Thyroid follicular cell carcinomas as well as combined adenomas and/or carcinomas (M); F344 rats.
Thiram	137-26-8	079801	Not Likely to be Carcinogenic to Humans	OPP (4/14/03)	NR	Not Applicable
Toluene	108-88-3	080601	Group DBNot Classifiable as to Human Carcinogenicity	CRAVE (9/15/87)	NR	Not Applicable
Tolylfluanid	731-27-1	309200	Likely to be Carcinogenic to Humans	OPP (5/01/02)	1.59 E-3 (3/4)	Thyroid tumors in male and female Wistar rats. Linear low-dose extrapolation approach recommended.
Toxaphene	8001-35-2	080501	Group B2--Probable Human Carcinogen	CRAVE (3/5/87)	1.1 E+0 (Oral); 3.2 E-4 (Inhalation)	Hepatocellular carcinomas & neoplastic nodules (adenomas); B6C3F1 B6C3F1 mice (M & F). Thyroid tumors (adenomas & carcinomas); Osborne-Mendel rats (M & F).

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
Tralkoxydim	87820-88-0	121000	Likely to be Carcinogenic to Humans	OPP (10/22/98)	1.68 E-2 (3/4)	Benign Leydig cell tumors at all dose levels with the incidences at the high dose exceeding the concurrent & historical control; Wistar rats (M).
Triadimefon	43121-43-3	109901	Group C--Possible Human Carcinogen	OPP (12/4/96)	RfD Approach	Borderline statistically significant increase thyroid adenomas; Wistar rats (M). Hepatocellular adenomas; NMRI mice (M & F).
Triadimenol	55219-65-3	127201	Group C--Possible Human Carcinogen	OPP (1/29/88)	NR	Liver (hepatocellular adenomas); CF1/W74 mice (F).
Tralkoxydim	87820-88-0	121000	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential Likely to be Carcinogenic to Humans	OPP (6/30/04)	NR	Benign testicular tumors in male rats and equivocal evidence of benign sex cord stromal tumors in female hamsters.
Triallate	2303-17-5	078802	Group C--Possible Human Carcinogen	OPP (1/12/94)	7.17 E-2 (3/4)	Hepatocellular carcinomas (M); Positive trend & a borderline significant increase in these tumors in females; B6C3F1 mice. Increased incidence of renal tubular cell adenoma (rare tumor type); Sprague-Dawley rat (M)
Triasulfuron	82097-50-5	128969	Group E--Evidence of Non-carcinogenicity for Humans	OPP (3/11/91)	NR	Not Applicable
Triazamate	112143-82-5	128100	Not Likely to be Carcinogenic to Humans	OPP (12/1/97)	NR	Not Applicable
Tribenuron methyl	101200-48-0	128887	Group C--Possible Human Carcinogen	OPP (7/14/89)	NR	Mammary gland adenocarcinomas; Sprague-Dawley rats (F).
Tribufos (Tribuphos/DEF)	78-48-8	074801	Likely to be Carcinogenic to Humans (High Doses); Not Likely to be Carcinogenic to Humans (Low Doses)	OPP (5/22/97)	8.38 E-2 (3/4)	Liver (hemangiosarcoma) (M), Lung (alveolar/bronchiolar adenoma) (F), Small intestine (adenocarcinoma) (M & F); CD-1 mice.
Trichlorfon (Trichlorphon)	52-68-6	057901	Likely to be Carcinogenic to Humans (High Doses), Not Likely to be Carcinogenic to Humans (Low Doses)	OPP (7/15/99)	NR	Tumors of the kidneys (adenomas) in male F344 rats & tumors of the lungs in both sexes (adenomas/carcinomas in M; carcinomas in F). Mammary tumors in female CD-1 mice.
Trichlorobenzene, 1,2,4-	120-82-1	081101	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (10/19/88)	NR	Not Applicable
Trichloroethane, 1,1,2-	79-00-5	081203	Group C--Possible Human Carcinogen	CRAVE (7/26/86)	NR	Hepatocellular carcinomas (M & F) and pheochromocytomas (F); B6C3F1 mice.
Trichloroethane, 1,1,1-	71-55-6	081201	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (8/5/87)	NR	Not Applicable

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
Trichlorophenol, 2,4,6-	88-06-2	064212	Group B2--Probable Human Carcinogen	CRAVE (9/7/89)	1.1 E-2 (Oral); 3.1 E-6 (Inhalation)	Lymphomas or leukemias; F344 rats (M). Hepatocellular adenomas or carcinomas; B6C3F1 mice (M & F).
Triclopyr (salts & esters)	55335-06-3	116001	Group D--Not Classifiable as to Human Carcinogenicity	OPP (5/8/96)	NR	Not Applicable
Triclosan	3380-34-5	054901	Not Yet Determined.	OPP (10/22/98)	NR	Negative in rats; no second data in second species.
Tridiphan	58138-08-2	123901	Group C--Possible Human Carcinogen	OPP (4/22/86)	NR	Liver (hepatocellular adenomas, adenomas/carcinomas combined); B6C3F1 mice (F).
Triforine	26644-46-2	107901	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential Likely to be Carcinogenic to Humans	OPP (6/29/04)	NR	Liver tumors in CD-1 mice (M) and lung tumors (F) only at the limit dose.
Trifloxystrobin	141517-21-7	129112	Not Likely to be Carcinogenic to Humans	OPP (6/16/99)	NR	Not Applicable
Trifloxysulfuron-sodium	290332-10-4	119009	Not Likely to be Carcinogenic to Humans	OPP (7/22/03)	NR	Not Applicable
Triflumizole	68694-11-1	128879	Group E--Evidence of Non-carcinogenicity for Humans	OPP (8/10/93)	NR	Not Applicable
Trifluralin (Treflan)	1582-09-8	036101	Group C--Possible Human Carcinogen	OPP (4/11/86)	2.93 E-3 (3/4)	Thyroid (follicular cell adenomas & carcinomas); Neoplasms of the renal pelvis (M); Benign urinary bladder tumors (F); Fischer 344 rats.
Triflurosulfuron-methyl	126535-15-7	129002	Group C--Possible Human Carcinogen	OPP (5/28/96)	RfD Approach	Testicular interstitial cell adenomas; CD-1 rat (M).
Triphenyltin hydroxide	76-87-9	083601	Group B2--Probable Human Carcinogen	OPP (5/24/90)	1.83 E-1 (3/4)	Pituitary gland adenoma (F); Leydig cell tumors (M); Wistar rat. Hepatocellular adenomas (M & F); combined hepatocellular (adenomas and/or carcinoma) (F); NMRI mice.
Troysan polyphase (IPBC)	55406-53-6	107801	Not Likely to be Carcinogenic to Humans	OPP (12/4/96)	NR	Not Applicable
UDMH	57-14-7	600018	Group B2--Probable Human Carcinogen	OPP (7/26/91)	4.6 E-1 (2/3) (M); 3.1 E-1 (2/3) (F)	Multiple sites (eg. lungs, vessels, liver & kidney); Multiple species, strains & studies.
UMP-488 (PAL 6000)	111578-32-6	129025	Group E--Evidence of Non-carcinogenicity for Humans	OPP (5/6/94)	NR	Not Applicable

CHEMICAL	CAS No.	PC CODE	CANCER CLASSIFICATION ¹	REPORT DATE	QUANTIFICATION METHOD ²	SPECIES & TUMOR-TYPES
Uniconazole	83657-22-1	128976	Group C--Possible Human Carcinogen	OPP (10/11/90)	NR	Hepatocellular adenomas, carcinomas & adenomas/carcinomas combined; CD-1 mice (M).
Vinclozolin	50471-44-8	113201	Group C--Possible Human Carcinogen	OPP (6/20/00)	MOE Approach	Leydig cell adenomas; Wistar rats (M)
White phosphorus	7723-14-0	066502	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (6/15/90)	NR	Not Applicable
Xylene	1330-20-7	086802	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (12/2/87)	NR	Not Applicable
Zinc and compounds	7440-66-6	129015	Group D--Not Classifiable as to Human Carcinogenicity	CRAVE (6/15/90)	NR	Not Applicable
Ziram	137-30-4	034805	Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential Likely to be Carcinogenic to Humans	OPP (2/6/03)	NR	Hemangiomas in male CD(SD)BR rats; increasing trend in preputial gland adenomas in male F344 rats
Zoxamide	156052-68-5	101702	Not Likely to be Carcinogenic to Humans	OPP (12/16/99)	NR	Not Applicable

FOOTNOTES

- 1 = CANCER CLASSIFICATION:** Unless otherwise indicated, chemicals were evaluated and classified by one of the Office of Pesticide Programs (OPP) HED peer review committees (e.g., CARC, CPRC., HIARC, etc.).
- 2 = QUANTIFICATION METHOD:** Indicates the method used to quantify the human cancer risk. The terms used to describe the quantification method are: Not Required (NR); RfD Approach; MOE Approach; or Low Dose Linear Extrapolation (Q1*).
- Not Required:* *Term used when a chemical is classified as Group D, Group E, Not Likely, Group C with no Q1*, or Suggestive Evidence of Carcinogenicity*
- RfD Approach:* *Term used when a comparison of the chronic dietary exposure level is made to the Chronic Reference Dose (cRfD) for that chemical.*
- MOE Approach* *Term used when Margins of Exposure are calculated using estimated human exposure levels and the Points of Departure (i.e, NOAEL) for cancer or pre-neoplastic effects.*
- Low Dose Linear (Q1*):* *The Q_1^* is the human equivalency potency factor for cancer risk and is based on oral exposure unless otherwise indicated. The units used to express the Q_1^* for oral exposure are $(\text{mg/kg/day})^{-1}$. The units used to express the Q_1^* for inhalation exposure are $(\Phi\text{g/cu m})^{-1}$.*
- The 2/3 or 3/4 powers (shown in parenthesis following the Q_1^*) indicate the interspecies scaling factor used to extrapolate from animal to human. The 3/4 scaling factor has been the Agency standard since 7/8/94. Prior to that time, the 2/3 scaling factor was used. The animal body weight is raised to the 3/4 power before the estimates are put through the appropriate model(s) to determine cancer potency and generate the unit risk, or Q_1^* . Chemicals with values based on the old 2/3 scaling factors will be converted to 3/4 only if/when the chemical is re-reviewed by the Cancer Assessment Review Committee.*
- 3 = CRAVE/CAG:** Chemicals were evaluated and classified by other Peer Review Committees within the US EPA: the Carcinogen Risk Assessment Validation Effort (CRAVE); or the Cancer Assessment Group (CAG).



**US Environmental Protection Agency
Office of Pesticide Programs**

**Chemicals Evaluated for Carcinogenic
Potential Annual Cancer Report 2019**

Chemicals Evaluated for Carcinogenic Potential Office of Pesticide Programs U.S. Environmental Protection Agency

Annual Cancer Report 2019

BACKGROUND

What is this list? The following list provides an overview of pesticide chemicals evaluated for carcinogenic potential by EPA's Pesticide Program through September 2019. The evaluation of many of these chemicals is an ongoing process. Therefore, the information in this list may be subject to change as new and/or additional data are submitted to EPA. This list will be updated annually.

How should the information provided in this list be used? Although this list is available to the public, note that the list represents only the potential carcinogenicity hazard for the chemical with no consideration of exposure information. This list is not intended to be used independent of the full risk assessment for the chemical. When EPA completes a risk assessment on a pesticide, a variety of toxicity information, including potential for noncancer effects (e.g., neurotoxicity, developmental and reproductive toxicity, immunotoxicity, etc.) and carcinogenicity, are considered in determining whether to register a pesticide and what requirements for use of the pesticide need to be in place to protect human health. The simple fact of being listed here does not imply that the pesticide poses a significant cancer hazard to the public from use.

What does the report date mean?

The date included in the list for each chemical is the date of the most recent review of potential carcinogenicity hazard for that chemical. This date provides a key as to which set of cancer guidelines were used in the review. Note that the classification of potential carcinogenicity generally is not reevaluated unless new data are submitted.

How does EPA review pesticides for potential carcinogenicity? In evaluating and describing the potential carcinogenicity of a pesticide, EPA's Pesticide Program follows the Agency's Guidelines for Carcinogen Risk Assessment (see <https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment> for more information). The Health Effects Division of the Pesticide Program performs an independent review of all the available evidence to determine the carcinogenic potential of pesticides.

The results of the independent review are peer-reviewed by the Cancer Assessment Review Committee. This committee recommends a "descriptor" (e.g., likely to be carcinogenic to humans, not likely to be carcinogenic to humans, suggestive evidence of carcinogenic potential) to convey the cancer hazard potential of the compound. This descriptor is also referred to as the cancer classification. The evidence for the human cancer potential and the extent to which a person might be exposed (how much time and to what quantity of the pesticide) will determine how the Agency regulates the pesticide. In some cases, EPA may request a review by the FIFRA Scientific Advisory Panel.

What does EPA consider in its review of cancer risk?

In determining the cancer-causing potential of a chemical, EPA considers the full range of available evidence. This information includes

- laboratory animal findings,
- metabolism studies,
- structural relationships with other carcinogens, and
- if available, mode of carcinogenic action information and epidemiologic findings in humans.

All the information is considered in a weight-of-the-evidence approach. In this weight-of-evidence evaluation, EPA undertakes a critical analysis of each available study to determine its quality and reliability. Then the entire body of evidence is integrated and examined for consistency (repeatability of findings in studies), cohesiveness (a logical pattern of responses), and for biological plausibility (i.e., are the observed findings consistent with current understanding of carcinogenic processes). How the Agency determines the cancer potential of a compound can be found at:

<https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment>.

Most of the cancer determinations for pesticides are largely based on laboratory animal studies because, under its statutory authority, EPA requires registrants to submit an extensive range of laboratory studies on pesticides including long-term rodent cancer studies. The findings in laboratory animals are generally assumed to be relevant to humans unless there is evidence to the contrary. When human information is available, EPA would consider that information <https://www.epa.gov/risk/human-health-risk-assessment>.

When does EPA review pesticides for potential carcinogenicity?

EPA reviews studies submitted when a pesticide is proposed for registration. Studies are required in two species (mice and rats) and two sexes (males and females), as well as a battery of mutagenicity assays. These studies are required for all pesticides used on food and some non-food pesticides that could lead to long-term exposures in humans. In future reviews of the pesticide, the cancer classification may be reevaluated if new studies have been submitted.

All existing pesticide tolerances that were in place as of August 1996 were re-assessed for their human health and environmental risks by August 2006 as required by the Food Quality Protection Act of 1996. However, if there was no new information on carcinogenicity, the compound was not re-evaluated simply to determine how it would be described under the 2005 cancer guidelines.

How have the Agency's cancer assessment guidelines changed?

There have been a number of different documents issued by the Agency for cancer evaluation.

- In 1976, EPA issued its first set of principles and interim procedures to guide evaluation of human cancer potential.

- In 1986, EPA issued guidance, which included a letter system (A-E) for designating degree of carcinogenic potential.
 - In the 1986 guidelines, hazard identification and the weight-of evidence process focused on tumor findings.
 - See <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54933> for a detailed description of this classification system.

- In 1996, EPA released “Proposed Guidelines for Carcinogen Risk Assessment,” which used a weight of evidence narrative and standardized descriptors to replace the 1986 alpha numeric classification to classify carcinogenic potential.
 - In the 1996 proposal, emphasis was placed on available mode of carcinogenic action information and discussing characterization of hazard, dose-response, and exposure assessments.
 - The hazard and weight of evidence process embraced an analysis of all relevant biological information and emphasized understanding the agent's mode of action in producing tumors to reduce the uncertainty in describing the likelihood of harm.
 - See 1996 - <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=55868>.

- In 1999, EPA issued a revised version of its 1996 proposal that responded to public and peer review comments, which included:
 - a framework approach to evaluate the mode of action in the assessment of potential carcinogenesis.
 - See- <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54932>.

- In March 2005, EPA released its final *Guidelines for Carcinogen Risk Assessment* (EPA/630/P-03/001B). These guidelines represent the culmination of a long development process, replacing EPA’s original cancer risk assessment guidelines (1986) and its interim final guidelines (1999). Key changes included:
 - Five weight of evidence descriptors chosen for use in narratives (“*Carcinogenic to Humans*,” “*Likely to Be Carcinogenic to Humans*,” “*Suggestive Evidence of Carcinogenic Potential*,” “*Inadequate Information to Assess Carcinogenic Potential*,” and “*Not Likely to Be Carcinogenic to Humans*.”)
 - Emphasis on analysis of data will precede use of defaults
 - Improved guidance on modeling and expanded discussions of sensitive subpopulations including children (supplemental guidance)
 - See <https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment>.

Why are there several different cancer classifications in the list?

As discussed above, EPA’s guidelines for evaluating the potential carcinogenicity of chemicals have been updated over the years to reflect increase transparency in describing the cancer potential of a compound and to reflect the understanding of ways chemicals may cause cancer.

Not all pesticides have been evaluated under EPA’s 2005 Cancer Guidelines. Agency policy states that for risk assessments that were completed before issuance of the 2005 Guidelines, the need for a re-assessment should be determined on a case-by-case basis by the program and that the existing assessment should continue to be considered

scientifically sound based on the guidance used when the assessment was completed (<https://www.epa.gov/risk/guidelines-carcinogen-risk-assessment>.)

How can I find the basis of EPA's decision regarding the carcinogenicity of a pesticide? The Reregistration Eligibility Decision for each pesticide contains a discussion of the available data and information used in the human health and environmental risk assessments, which includes a description of the evidence used to determine the cancer potential of the chemical. Also, the Cancer Assessment Review Committee report is available by requesting it through the Freedom of Information Act (FOIA) (<https://www.epa.gov/foia>).

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
1,3-Dibromo-5,5-dimethylhydantoin	77-48-5	006317	Not Likely to Be Carcinogenic to Humans.	8/28/2000
1,3-dichloro-5-methylhydantoin	89415-87-2	128826	Not Likely to Be Carcinogenic to Humans.	8/28/2000
2, 4 – DBA	94-82-6	030801	Not Likely To Be Carcinogenic To Humans.	6/13/2003
2,4-D + Salts & Esters	94-75-7	030001	Group D--Not Classifiable As To Human Carcinogenicity.	1/29/1997
2,4-D Choline	1048373-72-3	051505	Group D--Not Classifiable As To Human Carcinogenicity.	10/27/2011
2,4-DB DMA	2758-42-1	030819	Not Likely To Be Carcinogenic To Humans.	7/20/2004
2,4-DP-p Salts & Esters	15165-67-0	031402	Not Likely To Be Carcinogenic To Humans.	12/5/2013
2-Benzyl-4-chlorophenol	120-32-1	062201	Group C--Possible Human Carcinogen.	9/5/1995
4-aminopyridine	504-24-5	069201	Group D--Not Classifiable As To Human Carcinogenicity.	8/6/2007
4-Chlorophenoxyacetic	122-88-3	019401	Cancer Classification Not Evaluated (Waivers Granted).	7/17/2014

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Acephate	30560-19-1	103301	Group C--Possible Human Carcinogen.	5/8/1985
Acequinocyl	57960-19-7	006329	Not Likely To Be Carcinogenic To Humans.	11/13/2003
Acetamide	63114-77-2	111101	Group C--Possible Human Carcinogen.	5/29/1990
Acetamiprid	135410-20-7	099050	Not Likely To Be Carcinogenic To Humans.	12/11/2001
Acetochlor	34256-82-1	121601	Suggestive Evidence Of Carcinogenic Potential.	1/3/2007
Acibenzolar-S-methyl	135158-54-2	061402	Not Likely To Be Carcinogenic To Humans.	12/9/1999
Acifluorfen sodium	62476-59-9	114402	Likely To Be Carcinogenic To Humans: At High Doses; Not Likely To Be Carcinogenic To Humans At Low Doses.	7/9/2003
Acrinathrin	101007-06-1	129141	Group D--Not Classifiable As To Human Carcinogenicity.	7/15/1996
ADBAC	68424-85-1	069105	Not Likely To Be Carcinogenic To Humans.	12/8/1999
Afidopyropen	915972-17-7	026200	Suggestive Evidence Of Carcinogenic Potential.	1/24/2018

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Alachlor	15972-60-8	090501	Likely To Be Carcinogenic To Humans: At High Doses; Not Likely To Be Carcinogenic To Humans At Low Doses.	6/27/1997
Aldicarb	116-06-3	098301	Group E--Evidence Of Non-Carcinogenicity For Humans.	7/17/2002
Alpha-Cypermethrin	67375-30-8	209600	Group C--Possible Human Carcinogen.	9/11/2012
Ametoctradin	865318-97-4	119210	Not Likely To Be Carcinogenic To Humans.	5/24/2017
Ametryn	834-12-8	080801	Suggestive Evidence Of Carcinogenic Potential.	12/20/2017
Amicarbazone	129909-90-6	114004	Not Likely To Be Carcinogenic To Humans.	8/10/2005
Aminocyclopyrachlor	858956-08-8, 858956-35-1, 858954-83-3, 124423-84-3, 1759-53-1	288008	Not Likely To Be Carcinogenic To Humans.	11/9/2011
Aminopyralid	150114-71-9	005100	Not Likely To Be Carcinogenic To Humans.	7/12/2005
Amisulbrom	348635-87-0	016330	Suggestive Evidence Of Carcinogenic Potential.	12/2/2010
Amitraz	33089-61-1	106201	Suggestive Evidence Of Carcinogenic Potential.	7/18/2006

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Amitrole	61-82-5	004401	Not Likely to Be Carcinogenic to Humans: at Doses that Do Not Alter Rat Thyroid Hormone Homeostasis.	5/11/2006
Anthraquinone	84-65-1	122701	Likely to Be Carcinogenic to Humans.	10/31/2012
Aquashade	2650-18-2	110301	Not Likely To Be Carcinogenic To Humans.	9/27/2005
Asulam	3337-71-1	106901	Group C--Possible Human Carcinogen.	12/6/2001
Atrazine	1912-24-9	080803	Not Likely To Be Carcinogenic To Humans.	12/13/2000
Avermectin (see Emamectin Benzoate)	65195-55-3	122804	Group E--Evidence Of Non-Carcinogenicity For Humans.	6/27/1996
Azafenidin	68049-83-2	119016	Data Are Inadequate For An Assessment Of Human Carcinogenic Potential.	10/18/1999
Azinphos-methyl	86-50-0	058001	Not Likely To Be Carcinogenic To Humans.	4/20/1998
Azoxystrobin	131860-33-8	128810	Not Likely To Be Carcinogenic To Humans.	1/14/1997
Bendiocarb	22781-23-3	105201	Group E--Evidence Of Non-Carcinogenicity For Humans.	12/16/1997

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Benfluralin	1861-40-1	084301	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	12/27/2001
Benomyl	17804-35-2	099101	Group C--Possible Human Carcinogen.	9/21/2000
Bensulide	741-58-2	009801	Not Likely To Be Carcinogenic To Humans.	6/10/1999
Bentazon	25057-89-0	275200	Group E--Evidence Of Non-Carcinogenicity For Humans.	1/14/1992
Benthiavalicarb-isopropyl	177406-68-7	098379	Likely To Be Carcinogenic To Humans.	10/18/2005
Benzobicyclon	156963-66-5	215101	Not Likely To Be Carcinogenic To Humans.	4/5/2017
Benzyl Benzoate	120-51-4	009501	Not Likely To Be Carcinogenic To Humans.	6/28/2007
Beta Cyfluthrin	68359-37-5	118831	Not Likely To Be Carcinogenic To Humans.	1/27/2010
Bicyclopyrone	365400-11-9	018986	Suggestive Evidence Of Carcinogenic Potential.	9/10/2014
Bifenazate	149877-41-8	000586	Not Likely To Be Carcinogenic To Humans.	8/28/2001
Bifenthrin	82657-04-3	128825	Group C--Possible Human Carcinogen.	2/19/2003
Bixafen	581809-46-3	128400	Not Likely To Be Carcinogenic To Humans.	7/18/2018

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Bioallethrin	584-79-2	004003	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	12/2/2003
Bispyrabac Sodium	125401-92-5	078906	Not Likely To Be Carcinogenic To Humans.	8/2/2001
Bitertanol	55179-31-2	117801	Not Likely To Be Carcinogenic To Humans.	11/30/2005
Borax	1303-96-4	011102	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/24/1993
Boric acid	10043-35-3	011001	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/24/1993
Boron	7440-42-8	128945	Group E--Evidence Of Non-Carcinogenicity for Humans.	11/24/1993
Boron Sodium Oxide	12008-41-2	011107	Not Likely To Be Carcinogenic To Humans.	12/1/2015
Boron Sodium Oxide, Tetrahydrate	12280-03-4	011103	Not Likely To Be Carcinogenic To Humans.	12/1/2015
Boscalid	188425-85-6	128008	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	11/14/2002
Bromacil	314-40-9	012301	Group C--Possible Human Carcinogen.	1/13/1993
Bromacil, lithium salt	53404-19-6	012302	Group C--Possible Human Carcinogen.	05/09/2012
Bromoxynil	1689-84-5	035301	Group C--Possible Human Carcinogen.	3/12/1997

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Bromoxynil octanoate	1689-99-2	035302	Group C--Possible Human Carcinogen.	4/20/2011
Bromuconazole	116255-48-2	120503	Group E--Evidence Of Non-Carcinogenicity For Humans.	4/24/1995
Bronopol	52-51-7	216400	Group E--Evidence Of Non-Carcinogenicity for Humans.	6/12/1995
Buprofezin	69327-76-0	275100	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	3/15/2000
Butachlor	23184-66-9	112301	Likely to Be Carcinogenic to Humans.	2/24/1999
Butafenacil	134605-64-4	122004	Not Likely To Be Carcinogenic To Humans.	7/11/2003
Butralin	33629-47-9	106501	There Are Insufficient Data To Characterize The Cancer Risk Of Butralin.	9/5/1996
Butylate	2008-41-5	041405	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/25/1992
Cacodylic acid	75-60-5	012501	Not Likely To Be Carcinogenic To Humans at doses that do not result in enhanced cell proliferation.	6/21/2006
Cadusafos	95465-99-9	128864	Group E--Evidence Of Non-Carcinogenicity For Humans.	5/28/1992

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Captafol	2939-80-2	081701	Group B--Probable Human Carcinogen.	5/19/1987
Captan	133-06-2	081301	Likely To Be Carcinogenic To Humans: At Prolonged, High-Level Exposures; Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause Cytotoxicity And Regenerative Cell Hyperplasia.	9/22/2004
Carbaryl	63-25-2	056801	Likely To Be Carcinogenic To Humans.	2/12/2002
Carbendazim (MBC)	10605-21-7	128872	Group C--Possible Human Carcinogen.	4/7/1989
Carbofuran	1563-66-2	090601	Not Likely To Be Carcinogenic To Humans.	6/17/1997
Carboxin	5234-68-4	090201	Not Likely To Be Carcinogenic To Humans.	6/5/2003
Carfentrazone-ethyl	128639-02-1	128712	Not Likely To Be Carcinogenic To Humans.	5/16/2001
Chlorantraniliprole	500008-45-7	090100	Not Likely To Be Carcinogenic To Humans.	3/4/2009
Chlordimeform	6164-98-3	059701	Group B--Probable Human Carcinogen.	12/20/1985
Chlorethoxyfos	54593-83-8	129006	Group D--Not Classifiable As To Human Carcinogenicity.	3/9/1995

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Chlorfenapyr	122453-73-0	129093	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	3/18/2003
Chlorflurenol Methyl Ester	2536-31-4	098801	Not Likely To Be Carcinogenic To Humans.	7/10/2006
Chlorimuron-ethyl	90982-32-4	128901	Not Likely To Be Carcinogenic To Humans.	2/5/2009
Chlormequat chloride	999-81-5	018101	Not Likely To Be Carcinogenic To Humans.	6/12/2007
Chloroaniline, p-	106-47-8	017203	Group B--Probable Human Carcinogen.	4/27/1995
Chloroneb	2675-77-6	027301	Data Are Inadequate For An Assessment Of Human Carcinogenic Potential.	12/18/2003
Chloropicrin	76-06-2	081501	Not Likely To Be Carcinogenic To Humans.	6/30/2010
Chlorothalonil	1897-45-6	081901	Likely To Be Carcinogenic To Humans.	10/20/1997
Chlorpropham	101-21-3	018301	Group E--Evidence Of Non-Carcinogenicity For Humans.	10/11/1994
Chlorpyrifos	2921-88-2	059101	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/23/1993
Chlorpyrifos methyl	5598-13-0	059102	Not Likely To Be Carcinogenic To Humans.	5/17/1999

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Chlorsulfuron	64902-72-3	118601	Group E--Evidence Of Non-Carcinogenicity For Humans.	7/17/2002
Chlorthal-dimethyl (DCPA)	1861-32-1	078701	Group C--Possible Human Carcinogen.	2/10/1995
Clethodim	99129-21-2	121011	Not Likely To Be Carcinogenic To Humans.	9/28/2007
Clodinafop-propargyl	105512-06-9	125203	Suggestive Evidence Of Carcinogenic Potential.	2/8/2006
Clofencet (MON 21200)	82697-71-0	128726	Group C--Possible Human Carcinogen.	7/23/1996
Clofentezine	74115-24-5	125501	Group C--Possible Human Carcinogen.	4/3/1990
Clomazone	81777-89-1	125401	Not Likely To Be Carcinogenic To Humans.	1/31/2001
Clopyralid	1702-17-6	117403	Not Likely To Be Carcinogenic To Humans.	12/20/1999
Cloquintocet-mexyl	99607-70-2	700099	Not Likely To Be Carcinogenic To Humans.	8/31/1999
Cloransulam-methyl	147150-35-4	129116	Group E--Evidence Of Non-Carcinogenicity for Humans.	9/30/1997
Clothianidin	210880-92-5	044309	Not Likely To Be Carcinogenic To Humans.	1/6/2003
CMNP (Pyrazachlor)	6814-58-0	207100	Likely To Be Carcinogenic To Humans.	9/20/2011
Cocamide Diethanolamine	68603-42-9	224600	Likely to Be Carcinogenic to Humans.	10/17/2001
Copper Compounds	20427-59-2	023401	Group D--Not Classifiable As To Human Carcinogenicity.	6/13/2006

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Coumaphos	56-72-4	036501	Not Likely To Be Carcinogenic To Humans.	6/25/1999
Cresol, p-Chloro-m-	59-50-7	064206	Group D--Not Classifiable As To Human Carcinogenicity.	11/28/1995
Cryolite	15096-52-3	075101	Group D--Not Classifiable As To Human Carcinogenicity.	12/22/1995
Cumyluron	99485-76-4	027902	Suggestive Evidence Of Carcinogenic Potential.	6/11/2008
Cyanazine	21725-46-2	100101	Group C--Possible Human Carcinogen.	7/30/1991
Cyantraniliprole	736994-63-1	090098	Not Likely To Be Carcinogenic To Humans.	3/7/2013
Cyazofamid	120116-88-3	085651	Not Likely To Be Carcinogenic To Humans.	6/3/2009
Cyclanilide	113136-77-9	026201	Not Likely To Be Carcinogenic To Humans.	4/9/1997
Cyclaniliprole	1031756-98-5	026202	Not Likely To Be Carcinogenic To Humans.	4/25/2017
Cycloate	1134-23-2	041301	Not Likely To Be Carcinogenic To Humans.	9/25/2003
Cyflufenamid	180409-60-3	555550	Suggestive Evidence Of Carcinogenic Potential.	12/2/2014
Cyflumetofen	400882-07-7	138831	Suggestive Evidence Of Carcinogenic Potential.	12/30/2013
Cyfluthrin	68359-37-5	128831	Not Likely To Be Carcinogenic To Humans.	5/21/2002

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Cyhalofop-butyl	122008-85-9	082583	Not Likely To Be Carcinogenic To Humans.	12/20/2007
Cyhalothrin	68085-85-8	128867	Group D--Not Classifiable As To Human Carcinogenicity.	8/25/1993
Cyhexatin	13121-70-5	101601	Data Are Inadequate For An Assessment Of Human Carcinogenic Potential.	4/7/2005
Cymoxanil	57966-95-7	129106	Not Likely To Be Carcinogenic To Humans.	1/2/2003
Cypermethrin	52315-07-8	109702	Group C--Possible Human Carcinogen.	9/27/1988
Cyphenothrin	39515-40-7	129013	Not Likely To Be Carcinogenic To Humans.	12/16/2016
Cyproconazole	94361-06-5	128993	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause A Mitogenic Response In The Liver.	12/4/2007
Cyprodinil	121552-61-2	288202	Not Likely To Be Carcinogenic To Humans.	1/14/1998
Cyprosulfamide	221667-31-8	877400	Not Likely To Be Carcinogenic To Humans.	2/29/2008
Cyromazine	66215-27-8	121301	Group E--Evidence Of Non-Carcinogenicity For Humans.	1/6/1995
Daminozide	1596-84-5	035101	Group B--Probable Human Carcinogen.	7/26/1991

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Dantochlor (BCDMH)	118-52-5	028501	Not Likely To Be Carcinogenic To Humans.	8/14/2000
Dazomet	533-74-4	035602	Group D--Not Classifiable As To Human Carcinogenicity.	12/7/1993
DEET	134-62-3	080301	Group D--Not Classifiable As To Human Carcinogenicity.	1/4/1996
Deltamethrin	52918-63-5	097805	Not Likely To Be Carcinogenic To Humans.	9/9/2003
Demiditraz	944263-65-4	577501	Not Required (Nonfood).	4/11/2013
Desmedipham	13684-56-5	104801	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/20/1995
Diazinon	333-41-5	057801	Not Likely To Be Carcinogenic To Humans.	6/17/1997
Dicamba	1918-00-9	029801	Not Likely To Be Carcinogenic To Humans.	8/16/2005
Dicamba BAPMA Salt	1918-00-9	100094	Group D--Not Classifiable As To Human Carcinogenicity.	3/29/2016
Dichlobenil	1194-65-6	027401	Group C--Possible Human Carcinogen.	7/18/1995
Dichlormid	37764-25-3	900497	Not Likely To Be Carcinogenic To Humans.	11/15/2005
Dichlorobenzamide, 2,6-	2008-58-4	027402	Group D--Not Classifiable As To Human Carcinogenicity.	11/28/1995

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Dichlorvos	62-73-7	084001	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	3/1/2000
Diclofop-methyl	51338-27-3	110902	Likely To Be Carcinogenic To Humans.	5/24/2000
Dicloran	99-30-9	031301	Suggestive Evidence Of Carcinogenic Potential.	9/5/2006
Diclosulam	145701-21-9	129122	Not Likely To Be Carcinogenic To Humans.	11/9/1999
Dicofol	115-32-2	010501	Group C--Possible Human Carcinogen.	6/24/1992
Dicrotophos	141-66-2	035201	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	10/18/1999
Didecyl dimethyl ammonium chloride (DDAC)	7173-51-5	069149	Group E--Evidence Of Non-Carcinogenicity For Humans.	4/11/2000
Difenoconazole	119446-68-3	128847	Suggestive Evidence Of Carcinogenic Potential.	3/1/2007
Difenzoquat methyl sulfate	43222-48-6	106401	Group E--Evidence Of Non-Carcinogenicity For Humans.	5/24/1994
Diflubenzuron	35367-38-5	108201	Group E--Evidence Of Non-Carcinogenicity For Humans.	4/27/1995
Diflufenzopyr	109293-97-2	005108	Not Likely To Be Carcinogenic To Humans.	3/7/2017

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Diflufenzopyr Sodiiium	109293-98-3	005107	Not Likely To Be Carcinogenic To Humans.	10/6/1998
Dimethenamid	87674-68-8	129051	Group C--Possible Human Carcinogen.	9/3/2014
Dimethenamid-P	163515-14-8	120051	Group C--Possible Human Carcinogen.	9/3/2014
Dimethipin	55290-64-7	118901	Group C--Possible Human Carcinogen.	1/5/1990
Dimethoate	60-51-5	035001	Group C--Possible Human Carcinogen.	3/26/2002
Dimethomorph	110488-70-5	268800	Not Likely To Be Carcinogenic To Humans.	5/13/1998
Dimethoxane	828-00-2	001001	Suggestive Evidence Of Carcinogenic Potential.	12/21/2000
Dimethyl Disulfide, DMDS	624-92-0	029088	Not Required.	4/20/2010
Dimethylhydantoin	16079-88-2	006315	Not Likely to Be Carcinogenic to Humans.	8/28/2000
Dinocap	39300-45-3	036001	Group E--Evidence Of Non-Carcinogenicity For Humans.	6/22/1994
Dinoseb	88-85-7	037505	Group C--Possible Human Carcinogen.	6/19/1986
Dinotefuran	165252-70-0	044312	Not Likely To Be Carcinogenic To Humans.	3/5/2004
Diphenylamine	122-39-4	038501	Not Likely To Be Carcinogenic To Humans.	4/1/1997
Diquat dibromide	85-00-7	032201	Group E--Evidence Of Non-Carcinogenicity For Humans.	5/12/1994
Disodium methanearsonate	144-21-8	013802	Not Likely To Be Carcinogenic To Humans.	7/26/2000

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Disulfoton	298-04-4	032501	Group E--Evidence Of Non-Carcinogenicity For Humans.	4/21/1997
Dithianon	3347-22-6	099201	Suggestive Evidence Of Carcinogenic Potential.	2/23/2006
Dithiopyr (MON 7200)	97886-45-8	128994	Group E--Evidence Of Non-Carcinogenicity for Humans.	5/29/1997
Diuron	330-54-1	035505	Known/Likely.	5/8/1997
Dodine	2439-10-3	044301	Not Likely To Be Carcinogenic To Humans.	1/24/2008
Ecolyst	274671-61-3	069089	Not Likely To Be Carcinogenic To Humans.	10/19/1999
Emamectin Benzoate (Deoxy Avermectin)	137512-74-4	122806	Not Likely To Be Carcinogenic To Humans.	3/19/1998
Endosulfan	115-29-7	079401	Not Likely To Be Carcinogenic To Humans.	1/31/2000
Endothall	145-73-3	038901	Not Likely To Be Carcinogenic To Humans.	10/23/2008
Endothall Amine Salt	66330-88-9	038905	Not Likely To Be Carcinogenic To Humans.	12/09/2015
Endothall dipotassium salt	2164-07-0	038904	Not Likely To Be Carcinogenic To Humans.	12/09/2015
Epoxiconazole	106325-08-0, 133855-98-8	123909	Likely To Be Carcinogenic To Humans.	1/24/2001

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Esbiothrin	28434-00-6	004007	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	12/2/2003
Esfenvalerate	66230-04-4	109303	Group E--Evidence Of Non-Carcinogenicity For Humans.	7/1/1996
Ethaboxam	162650-77-3	090205	Suggestive Evidence Of Carcinogenic Potential.	3/23/2006
Ethalfuralin	55283-68-6	113101	Group C--Possible Human Carcinogen.	9/14/1994
Ethephon	16672-87-0	099801	Group D--Not Classifiable As To Human Carcinogenicity.	8/15/1994
Ethion	563-12-2	058401	Group E--Evidence Of Non-Carcinogenicity For Humans.	1/26/1994
Ethiprole	181587-01-9	005550	Suggestive Evidence Of Carcinogenic Potential.	10/28/2010
Ethofumesate	26225-79-6	110601	Group D--Not Classifiable As To Human Carcinogenicity.	2/24/1994
Ethoprop	13194-48-4	041101	Likely To Be Carcinogenic To Humans.	10/7/1998
Ethoxyquin	91-53-2	055501	Data Are Inadequate For An Assessment Of Human Carcinogenic Potential.	9/11/2019

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Ethyl dipropylthiocarbamate (EPTC)	759-94-4	041401	Not Likely To Be Carcinogenic To Humans.	8/31/1999
Ethylene thiourea (ETU)	96-45-7	600016	Group B--Probable Human Carcinogen.	7/7/1999
Etofenprox	80844-07-1	128965	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Alter Rat Thyroid Hormone Homeostasis.	2/8/2006
Etoxazole	153233-91-1	107091	Not Likely To Be Carcinogenic To Humans.	8/7/2003
Famoxadone	131807-57-3	113202	Not Likely To Be Carcinogenic To Humans.	4/16/2003
Fenamidone	161326-34-7	046679	Not Likely To Be Carcinogenic To Humans.	7/12/2002
Fenamiphos	22224-92-6	100601	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/23/1993
Fenarimol	60168-88-9	206600	Not Likely To Be Carcinogenic To Humans.	9/5/2001
Fenazaquin	120928-09-8	044501	Not Likely To Be Carcinogenic To Humans.	5/15/2007
Fenbuconazole	114369-43-6	129011	Group C--Possible Human Carcinogen.	4/15/1996
Fenbutatin-oxide	13356-08-6	104601	Group E--Evidence Of Non-Carcinogenicity For Humans.	3/2/1993
Fenhexamide	126833-17-8	090209	Not Likely To Be Carcinogenic To Humans.	3/4/1999

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Fenitrothion	122-14-5	105901	Group E--Evidence Of Non-Carcinogenicity For Humans.	7/13/1993
Fenoxaprop-ethyl	9015-56-9	128701	Suggestive Evidence Of Carcinogenic Potential.	7/29/2013
Fenoxycarb	72490-01-8	125301	Likely To Be Carcinogenic To Humans.	12/22/1997
Fenpropathrin	39515-41-8	127901	Not Likely To Be Carcinogenic To Humans.	12/22/2003
Fenpropidin	67306-00-7	012305	Suggestive Evidence Of Carcinogenic Potential.	6/9/2009
Fenpropimorph	67564-91-4	121402	Not Likely To Be Carcinogenic To Humans.	10/19/2005
Fenpyrazamine	473798-59-3	090109	Not Likely To Be Carcinogenic To Humans.	10/31/2012
Fenpyroximate	134098-61-6	129131	Not Likely To Be Carcinogenic To Humans.	2/19/1997
Fenthion	55-38-9	053301	Group E--Evidence Of Non-Carcinogenicity For Humans.	3/11/1996
Fenvalerate	51630-58-1	109301	Group E--Evidence Of Non-Carcinogenicity For Humans.	2/10/2003
Ferbam	14484-64-1	034801	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential; Based On Ziram Studies.	4/6/2000
Fipronil	120068-37-3	129121	Group C--Possible Human Carcinogen.	7/18/1995

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Flazasulfuron	104040-78-0	119011	Not Likely To Be Carcinogenic To Humans.	11/16/2005
Flonicamid	158062-67-0	128016	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	2/24/2005
Florasulam	145701-23-1	129108	Not Likely To Be Carcinogenic To Humans.	5/31/2007
Florpyrauxifen-benzyl	1390661-72-9	030093	Not Likely To Be Carcinogenic To Humans.	6/1/2017
Fluazifop-P-Butyl	79241-46-6	122809	Not Likely To Be Carcinogenic To Humans.	9/19/2008
Fluazinam	79622-59-6	129098	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	3/29/2001
Flubendiamide	272451-65-7	027602	Not Likely To Be Carcinogenic To Humans.	4/3/2008
Flucarbazone-sodium	181274-17-9	114009	Not Likely To Be Carcinogenic To Humans.	7/19/2000
Fludioxonil	131341-86-1	071503	Group D--Not Classifiable As To Human Carcinogenicity.	9/19/1996
Fluensulfone	318290-98-1	050410	Suggestive Evidence Of Carcinogenic Potential.	5/7/2014
Flufenacet (Thiaflumide)	142459-58-3	121903	Not Likely To Be Carcinogenic To Humans.	7/16/1997

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Flufenoxuron	101463-69-8	108203	Not Likely To Be Carcinogenic To Humans.	8/15/2006
Flufenpyr-ethyl	188489-07-8	108853	Not Likely To Be Carcinogenic To Humans.	6/8/2003
Flumethrin	69770-45-2	036007	Not Likely To Be Carcinogenic To Humans.	3/6/2012
Flumetralin	62924-70-3	123001	Not Likely To Be Carcinogenic To Humans.	6/21/2007
Flumetsulam (XRD-498)	98967-40-9	129016	Group E--Evidence Of Non-Carcinogenicity For Humans.	3/24/1993
Flumiclorac pentyl	87546-18-7	128724	Group E--Evidence Of Non-Carcinogenicity For Humans.	9/7/1994
Flumioxazin	103361-09-7, 141490-50-8	129034	Not Likely To Be Carcinogenic To Humans.	2/22/2001
Fluometuron	2164-17-2	035503	Group C--Possible Human Carcinogen.	8/28/1996
Fluopicolide	239110-15-7	027412	Not Likely To Be Carcinogenic To Humans.	12/12/2006
Fluopyram	658066-35-4	080302	Not Likely To Be Carcinogenic To Humans.	5/8/2014
Fluoxastrobin	361377-29-9	028869	Not Likely To Be Carcinogenic To Humans.	1/24/2005
Flupyradifurone	951659-40-8	122304	Not Likely To Be Carcinogenic To Humans.	8/5/2014
Fluridone	59756-60-4	112900	Group E--Evidence Of Non-Carcinogenicity For Humans.	7/1/1985

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Fluroxypyr	81406-37-3	128968	Not Likely To Be Carcinogenic To Humans.	6/26/2003
Fluroxypyr acid (see also PC Code 128968)	69377-81-7	128959	Not Likely To Be Carcinogenic To Humans.	6/26/2003
Flurprimidol	56425-91-3	125701	Not Likely To Be Carcinogenic To Humans.	9/29/2005
Fluthiacet methyl	117337-19-6	108803	Likely To Be Carcinogenic To Humans.	11/20/1998
Flutianil	958647-10-4	014018	Not Likely To Be Carcinogenic To Humans.	11/1/2017
Flutolanil	66332-96-5	128975	Group E--Evidence Of Non-Carcinogenicity For Humans.	6/9/1994
Flutriafol	76674-21-0	128940	Not Likely To Be Carcinogenic To Humans.	6/1/2009
Fluxapyroxad	907204-31-3	138009	Not Likely To Be Carcinogenic To Humans: Below A Defined Dose Range.	6/9/2011
Folpet	133-07-3	081601	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause An Irritation Response In The Mucosal Epithelium.	10/13/2010
Fomesafen	108731-70-0	123802	Not Likely To Be Carcinogenic To Humans.	11/3/2005
Fonofos	944-22-9	041701	Group E--Evidence Of Non-Carcinogenicity for Humans.	11/10/1993

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Forchlorfenuron	68157-60-8	128819	Not Likely To Be Carcinogenic To Humans.	3/11/2008
Formasulfuron	173159-57-4	122020	Not Likely To Be Carcinogenic To Humans.	9/19/2001
Formetanate hydrochloride	23422-53-9	097301	Group E--Evidence Of Non-Carcinogenicity For Humans.	5/20/1996
Fosetyl-Al	39148-24-8	123301	Not Likely To Be Carcinogenic To Humans.	4/22/1999
Fosthiazate	98886-44-3	129022	Not Likely To Be Carcinogenic To Humans.	9/15/2003
Furfural	98-01-1	043301	Likely To Be Carcinogenic To Humans.	2/6/2014
Furilazole (MON 13900)	121776-33-8	911596	Likely To Be Carcinogenic To Humans.	10/15/1999
Furmecyclox	60568-05-0	122601	Group B--Probable Human Carcinogen.	7/3/1985
G77 (Urea)	1373256-33-7	128662	Not Required (Nonfood).	5/23/2018
Gamma Cyhalothrin	76703-62-3	128807	Not Likely To Be Carcinogenic To Humans.	3/1/2004
Gardona	22248-79-9	083702	Group C--Possible Human Carcinogen.	12/21/2016
Gentamicin Sulfate	1405-41-0	006325	Not Likely To Be Carcinogenic To Humans.	3/21/2007
Glufosinate-ammonium	77182-82-2	128850	Not Likely To Be Carcinogenic To Humans.	5/17/1999
Glutaraldehyde	111-30-8	043901	Not Likely to Be Carcinogenic to Humans.	5/18/2006

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Glyphosate	1071-83-6	417300	Not Likely To Be Carcinogenic To Humans.	12/12/2017
Halauxifen-methyl	943831-98-9	117501	Not Likely To Be Carcinogenic To Humans.	3/21/2016
Halosulfuron methyl (MON 1200)	100784-20-1	128721	Not Likely To Be Carcinogenic To Humans.	2/26/1998
Haloxypop-methyl	69806-40-2	125201	Group B--Probable Human Carcinogen.	9/18/1989
Hexaconazole	79983-71-4	128925	Group C--Possible Human Carcinogen.	1/21/1999
Hexavalent Chromium (CrVI)	18540-29-9	021101; 068302	Likely to Be Carcinogenic to Humans.	7/1/2009
Hexazinone	51235-04-2	107201	Group D--Not Classifiable As To Human Carcinogenicity.	7/27/1994
Hexythiazox	78587-05-0	128849	Likely To Be Carcinogenic To Humans.	9/2/2009
HOE107892	135590-91-9	811800	Not Likely To Be Carcinogenic To Humans.	11/24/1998
Hydramethylnon	67485-29-4	118401	Group C--Possible Human Carcinogen.	3/28/1991
Hydrogen cyanamide	420-04-2	014002	Group C--Possible Human Carcinogen.	9/15/1993
Hydroprene	41096-46-2	486300	Group D--Not Classifiable As To Human Carcinogenicity.	6/8/1995
Hymexazol	10004-44-1	129107	Not Likely To Be Carcinogenic To Humans.	12/3/2015
Imazalil	35554-44-0	111901	Likely To Be Carcinogenic To Humans.	12/7/1999

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Imazalil sulfate	58594-72-2	111902	Likely To Be Carcinogenic To Humans.	12/7/1999
Imazamethabenz	81405-85-8	128842	Group D--Not Classifiable As To Human Carcinogenicity.	6/11/1987
Imazamox	114311-32-9	129171	Not Likely To Be Carcinogenic To Humans.	2/27/1997
Imazapic	81334-60-3	129041	Group E--Evidence Of Non-Carcinogenicity For Humans.	9/27/1995
Imazapyr	81334-34-1	128821	Group E--Evidence Of Non-Carcinogenicity For Humans.	10/5/1995
Imazaquin Acid	81335-37-7	128848	Not Likely To Be Carcinogenic To Humans.	10/31/2005
Imazethapyr	81335-77-5	128922	Not Likely To Be Carcinogenic To Humans.	1/31/2002
Imazosulfuron	122548-33-8	118602	Not Likely To Be Carcinogenic To Humans.	3/13/2009
Imidacloprid	105827-78-9	129099	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/10/1993
Imiprothrin	72963-72-5	004006	Not Required (Nonfood).	8/31/2016
Indaziflam	950782-86-2	080818	Not Likely To Be Carcinogenic To Humans.	4/22/2010
Indoxacarb	173584-44-6	067710	Not Likely To Be Carcinogenic To Humans.	7/17/2000

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Iodomethane	74-88-4	000011	Not Likely to Be Carcinogenic To Humans: At Doses That Do Not Alter Rat Thyroid Hormone Homeostasis.	11/10/2005
Iodosulfuran	144550-36-7	122021	Not Likely To Be Carcinogenic To Humans.	1/5/2004
Ipoconazole	125225-28-7	125618	Not Likely To Be Carcinogenic To Humans.	5/28/2008
Iprodione	36734-19-7	109801	Likely To Be Carcinogenic To Humans.	2/26/1998
Iprovalicarb	140923-17-7	098359	Likely To Be Carcinogenic To Humans.	4/11/2002
Isofenphos	25311-71-1	109401	Group E--Evidence Of Non-Carcinogenicity For Humans.	1/13/1998
Isofetamid	875915-78-9	270000	Not Likely To Be Carcinogenic To Humans.	9/24/2014
Isophorone	78-59-1	047401	Group C--Possible Human Carcinogen.	9/2/1999
Isopyrazam	881685-58-1	129222	Likely To Be Carcinogenic To Humans.	2/2/2011
Isoxaben	82558-50-7	125851	Suggestive Evidence Of Carcinogenic Potential.	10/7/2008
Isoxadifen-ethyl	163520-33-0	823000	Not Likely To Be Carcinogenic To Humans.	1/29/2001
Isoxaflutole	141112-29-0	123000	Likely To Be Carcinogenic To Humans.	9/30/1997

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Kasugamycin	6980-18-3	230001	Not Likely To Be Carcinogenic To Humans.	8/17/2005
Kathon 886	55965-84-9	107106	Group D--Not Classifiable As To Human Carcinogenicity.	5/18/1995
KBR 3023	119515-38-7	070705	Not Likely To Be Carcinogenic To Humans.	6/9/1999
Kresoxim-methyl	143390-89-0	129111	Likely To Be Carcinogenic To Humans.	8/19/1999
Lactofen	77501-63-4	128888	Likely To Be Carcinogenic To Humans: At High Doses; Not Likely To Be Carcinogenic To Humans At Low Doses.	10/17/2006
Lambda cyhalothrin	91465-08-6	128897	Group D--Not Classifiable As To Human Carcinogenicity.	9/12/2002
Lindane	58-89-9	009001	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	11/29/2001
Linuron	330-55-2	035506	Group C--Possible Human Carcinogen.	11/20/2001
Malathion	121-75-5	057701	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	4/28/2000
Maleic hydrazide	123-33-1	051501	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/10/1993

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Mancozeb	8018-01-7	014504	Group B--Probable Human Carcinogen.	7/7/1999
Mandestrobin	173662-97-0	036603	Not Likely To Be Carcinogenic To Humans.	4/25/2016
Mandipropamid	374726-62-2	036602	Not Likely To Be Carcinogenic To Humans.	1/21/2009
Maneb	12427-38-2	014505	Group B--Probable Human Carcinogen.	7/7/1999
MB46513 (photodegradate of Fipronil)	120067-83-6	600050	Not Likely to Be Carcinogenic to Humans.	12/6/2000
MCPA + Salts	94-74-6	030501	Not Likely To Be Carcinogenic To Humans.	10/29/2003
MCPB Acid	94-81-5	019201	Not Likely To Be Carcinogenic To Humans.	10/1/2008
MCPB Sodium Salt	6062-26-6	019202	Not Likely To Be Carcinogenic To Humans.	10/24/2005
Mecoprop-P	16484-77-8	129046	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	3/13/2003
Mefenoxam	70630-17-0	113502	Not Likely To Be Carcinogenic To Humans.	5/17/2000
Mefentrifluconazole	1417782-03-6	122000	Not Likely To Be Carcinogenic To Humans.	4/11/2019
Mefluidide	53780-34-0	114001	Not Likely To Be Carcinogenic To Humans.	5/30/2007

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Melamine	108-78-1	777201	Group D--Not Classifiable As To Human Carcinogenicity.	7/21/1993
Mepaniprim	110235-47-7	288203	Likely To Be Carcinogenic To Humans.	4/20/2004
Mepiquat Chloride	24307-26-4	109101	Not Likely To Be Carcinogenic To Humans.	2/19/2003
Meptyldinocap (DE-126/Dinocap II)	131-72-6	036000	Group E--Evidence Of Non-Carcinogenicity For Humans.	3/17/2009
Mercaptobenzothiazole, 2-	149-30-4	051701	Group C--Possible Human Carcinogen.	11/19/1992
Mesosulfuron methyl	208465-21-8	122009	Not Likely To Be Carcinogenic To Humans.	3/4/2004
Mesotrione	104206-82-8	122990	Not Likely To Be Carcinogenic To Humans.	4/12/2001
Metaflumizone	139968-49-3	281250	Not Likely To Be Carcinogenic To Humans.	1/24/2006
Metalaxyl	57837-19-1	113501	Group E--Evidence Of Non-Carcinogenicity for Humans.	4/20/1994
Metaldehyde	108-62-3	053001	Suggestive Evidence Of Carcinogenic Potential.	6/23/2005
Metam sodium	137-42-8	039003	Likely To Be Carcinogenic To Humans.	5/14/2009
Metconazole	125116-23-6	125619	Not Likely To Be Carcinogenic To Humans.	4/14/2006
Methamidophos	10265-92-6	101201	Not Likely To Be Carcinogenic To Humans.	2/12/1998

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Methidathion	950-37-8	100301	Group C--Possible Human Carcinogen.	2/19/1988
Methiocarb	2032-65-7	100501	Group D--Not Classifiable As To Human Carcinogenicity.	3/2/1993
Methiozolin	403640-27-7	090088	Not Required (Non-Food).	5/30/2019
Methomyl	16752-77-5	090301	Group E--Evidence Of Non-Carcinogenicity For Humans.	10/25/1996
Methoxyfenozide	161050-58-4	121027	Not Likely To Be Carcinogenic To Humans.	7/1/1999
Methyl bromide	74-83-9	053201	Not Likely To Be Carcinogenic To Humans.	6/20/2001
Methyl isothiocyanate (MITC)	6317-18-6	068103	There Are Insufficient Data To Characterize The Cancer Risk Of MITC.	4/30/2009
Methyl parathion	298-00-0	053501	Not Likely To Be Carcinogenic To Humans.	12/1/1997
Metiram	9006-42-2	014601	Group B--Probable Human Carcinogen.	7/7/1999
Metofluthrin	240494-70-6	109709	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause A Mitogenic Response In The Liver.	7/26/2007

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Metolachlor	51218-45-2	108801	Not Likely To Be Carcinogenic To Humans.	11/6/2017
Metrafenone	220899-03-6	000325	Suggestive Evidence Of Carcinogenic Potential.	7/6/2006
Metribuzin	21087-64-9	101101	Group D--Not Classifiable As To Human Carcinogenicity.	5/16/1995
Metsulfuron methyl	74223-64-6	122010	Not Likely To Be Carcinogenic To Humans.	3/14/2002
Mevinphos	7786-34-7	015801	Not Likely To Be Carcinogenic To Humans.	5/17/2000
MGK 264	113-48-4	057001	Group C--Possible Human Carcinogen.	6/7/1995
Molinate	2212-67-1	041402	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	12/14/2000
Momfluorothrin	609346-29-4	016331	Not Likely To Be Carcinogenic To Humans.	12/2/2014
MON 4660	71526-07-3	600046	Likely To Be Carcinogenic To Humans.	12/9/1999
Monosodium acid methanearsonate (MMA)	2163-80-6	013803	Not Likely To Be Carcinogenic To Humans.	7/26/2000
Morpel 326	136-45-8	047201	Not Likely To Be Carcinogenic To Humans.	5/12/2015

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MSMA-calcium salt	5902-95-4	013806	Not Likely To Be Carcinogenic To Humans.	12/14/2000
Myclobutanil	88671-89-0	128857	Group E--Evidence Of Non-Carcinogenicity For Humans.	6/16/1994
NAA potassium salt	15165-79-4	056003	Not Likely to Be Carcinogenic to Humans.	3/14/2012
Naled	300-76-5	034401	Group E--Evidence Of Non-Carcinogenicity For Humans.	8/31/1994
Naphthalene	91-20-3	055801	Classification Not Available.	12/26/2018
Napropamide	15299-99-7	103001	Not Likely To Be Carcinogenic To Humans.	7/7/2005
Naptalam Sodium Salt	132-67-2	030703	Group D--Not Classifiable As To Human Carcinogenicity.	9/7/1994
Napthalene Acetates	2122-70-5	056008	Not Likely To Be Carcinogenic To Humans.	3/5/2009
Nicarbazin	330-95-0	085712	Not Likely To Be Carcinogenic To Humans.	12/2/2015
Nicosulfuron	111991-09-4	129008	Group E--Evidence Of Non-Carcinogenicity For Humans.	9/1/1998

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Nitrapyrin	1929-82-4	069203	Not Likely To Be Carcinogenic To Humans at doses that do not result in CAR activation as indicated by Cyp2b10 expression.	5/8/2018
Norflurazon	27314-13-2	105801	Group C--Possible Human Carcinogen.	11/2/1990
Novaluron	116714-46-6	124002	Not Likely To Be Carcinogenic To Humans.	2/4/2004
Noviflumuron	121451-02-3	118204	Likely To Be Carcinogenic To Humans.	10/17/2017
Orthophenylphenol (see also PC 064104)	90-43-7	064103	Not Likely To Be Carcinogenic To Humans: Quantification Of Cancer Risk Is Not Required Since The NOAEL Selected For The Chronic RfD Would Address The Concerns For The Precursor Events Leading To Development Of Bladder And Liver Tumors.	10/12/2005

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Orthophenylphenol, Sodium salt (see also PC 064103)	132-27-4	064104	Not Likely To Be Carcinogenic To Humans: Quantification Of Cancer Risk Is Not Required Since The NOAEL Selected For The Chronic RfD Would Address the Concerns For The Precursor Events Leading To Development Of Bladder And Liver Tumors.	10/12/2005
Orthosulfamuron	213464-77-8	108209	Suggestive Evidence Of Carcinogenic Potential.	10/26/2006
Oryzalin	19044-88-3	104201	Likely To Be Carcinogenic To Humans.	6/25/2003
Oxadiazon	19666-30-9	109001	Likely To Be Carcinogenic To Humans.	5/1/2001
Oxadixyl	77732-09-3	126701	Group C--Possible Human Carcinogen.	1/4/1989
Oxamyl	23135-22-0	103801	Group E--Evidence Of Non-Carcinogenicity For Humans.	11/5/1996
Oxydemeton-methyl	301-12-2	058702	Not Likely To Be Carcinogenic To Humans.	7/24/1997
Oxyfluorfen	42874-03-3	111601	Likely To Be Carcinogenic To Humans.	4/20/2010
Oxytetracycline	2058-46-0	006308	Group D--Not Classifiable As To Human Carcinogenicity.	12/18/1992

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Oxytetracycline Calcium	7179-50-2	006321	Group D--Not Classifiable As To Human Carcinogenicity.	11/1/2016
Oxythioquinox	2439-01-2	054101	Group B--Probable Human Carcinogen.	2/15/1996
Paclobutrazol	76738-62-0	125601	Group D--Not Classifiable As To Human Carcinogenicity.	6/23/1994
Paradichlorobenzene	106-46-7	061501	Not Likely To Be Carcinogenic To Humans.	6/5/2007
Paraformaldehyde	30525-89-4	043002	Group B--Probable Human Carcinogen.	9/24/2008
Paranitrophenol	100-02-7	056301	Group D--Not Classifiable As To Human Carcinogenicity.	5/14/1996
Paraquat dichloride	1910-42-5	061601	Group E--Evidence Of Non-Carcinogenicity For Humans.	4/19/2000
Parathion, ethyl-	56-38-2	057501	Group C--Possible Human Carcinogen.	9/11/1991
Pebulate	1114-71-2	041403	Not Likely To Be Carcinogenic To Humans.	12/7/1998
Pendimethalin	40487-42-1	108501	Group C--Possible Human Carcinogen.	7/24/1992
Penflufen	494793-67-8	100249	Suggestive Evidence Of Carcinogenic Potential.	3/30/2011
Penoxulam	219714-96-2	119031	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	3/24/2004
Pentachloronitrobenzene (PCNB)	82-68-8	056502	Group C--Possible Human Carcinogen.	12/18/1992

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Pentachlorophenol	87-86-5	063001	Group B--Probable Human Carcinogen.	1/3/1991
Penthiopyrad	183675-82-3	090112	Suggestive Evidence Of Carcinogenic Potential.	10/18/2011
Permethrin	52645-53-1	109701	Likely To Be Carcinogenic To Humans.	10/23/2002
Phenmedipham	13684-63-4	098701	Group D--Not Classifiable As To Human Carcinogenicity.	4/28/1993
PHMB	32289-58-0	111801	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	7/16/2003
Phorate	298-02-2	057201	Group E--Evidence Of Non-Carcinogenicity For Humans.	12/30/1993
Phosalone	2310-17-0	097701	Not Likely To Be Carcinogenic To Humans.	8/12/1999
Phosmet	732-11-6	059201	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	10/27/1999
Phosphamidon	13171-21-6	018201	Group C--Possible Human Carcinogen.	5/31/1989
Phostebupirim	96182-53-5	129086	Group E--Evidence Of Non-Carcinogenicity For Humans.	4/27/1993
Picloram Acid	1918-02-1	005101	Group E--Evidence Of Non-Carcinogenicity For Humans.	4/1/1994

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Picloram Acid Ethylhexyl Ester	26952-20-5	005103	Group E--Evidence Of Non-Carcinogenicity for Humans.	4/1/1994
Picloram Acid Potassium Salt	2545-60-0	005104	Group E--Evidence Of Non-Carcinogenicity for Humans.	4/1/1994
Picloram Acid Triisopropanolamine Salt	6753-47-5	005102	Group E--Evidence Of Non-Carcinogenicity for Humans.	4/1/1994
Picoxystrobin	117428-22-5	129200	Suggestive Evidence Of Carcinogenic Potential.	11/15/2011
Pinoxaden	243973-20-8	147500	Data Are Inadequate For An Assessment Of Human Carcinogenic Potential.	5/18/2005
Piperonyl butoxide	51-03-6	067501	Group C--Possible Human Carcinogen.	6/7/1995
Pirimicarb	23103-98-2	106101	Likely To Be Carcinogenic To Humans.	7/13/2005
Pirimiphos-methyl	29232-93-7	108102	Cannot Be Determined.	1/29/1998
Polymeric Betaine	214710-34-6	103679	Data Are Inadequate for an Assessment of Human Carcinogenic Potential.	10/3/2006
Potassium dichromate	7778-50-9	068302; 021101	Likely To Be Carcinogenic To Humans: See Hexavalent Chromium (CrVI).	7/1/2009
Prallethrin	23031-36-9	128722	Not Likely To Be Carcinogenic To Humans.	6/27/2003

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Primisulfuron-methyl	86209-51-0	128973	Group D--Not Classifiable As To Human Carcinogenicity.	5/3/1990
Prochloraz	67747-09-5	128851	Group C--Possible Human Carcinogen.	7/1/1988
Procymidone	32809-16-8	129044	Group B--Probable Human Carcinogen.	4/5/1991
Prodiamine	29091-21-2	110201	Group C--Possible Human Carcinogen.	6/10/1991
Profenofos	41198-08-7	111401	Group E--Evidence Of Non-Carcinogenicity For Humans.	2/6/1996
Prohexadione	127277-53-6	112600	Not Likely To Be Carcinogenic To Humans.	4/14/2000
Prometon	1610-18-0	080804	Group D--Not Classifiable As To Human Carcinogenicity.	11/25/1992
Prometryn	7287-19-6	080805	Group E--Evidence Of Non-Carcinogenicity For Humans.	7/26/1994
Pronamide	23950-58-5	101701	Not Likely To Be Carcinogenic To Humans.	12/2/2014
Propachlor	1918-16-7	019101	Likely To Be Carcinogenic To Humans.	10/16/1997
Propamocarb hydrochloride	25606-41-1	119302	Not Likely To Be Carcinogenic To Humans.	5/31/2000
Propanil	709-98-8	028201	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	6/19/2001

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Propargite	2312-35-8	097601	Group B--Probable Human Carcinogen.	7/23/1992
Propazine	139-40-2	080808	Not Likely To Be Carcinogenic To Humans.	12/8/2005
Propetamphos	31218-83-4	113601	Not Likely To Be Carcinogenic To Humans.	10/31/1998
Propiconazole	60207-90-1	122101	Group C--Possible Human Carcinogen.	9/11/1992
Propineb	12071-83-9	522200	Likely to Be Carcinogenic to Humans.	2/11/2013
Propoxur	114-26-1	047802	Group B--Probable Human Carcinogen.	6/17/1996
Propoxycarbazone-Sodium	181274-15-7	122019	Not Likely To Be Carcinogenic To Humans.	4/6/2004
Propylene Oxide	75-56-9	042501	Group B--Probable Human Carcinogen.	7/31/2006
Proquinazid	189278-12-4	044502	Suggestive Evidence Of Carcinogenic Potential.	4/24/2013
Prosulfuron	94125-34-5	129031	Data Are Inadequate For An Assessment Of Human Carcinogenic Potential.	1/24/2000
Prothioconazole	178928-70-6	113961	Not Likely To Be Carcinogenic To Humans.	12/31/2007

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Pydiflumetofen	1228284-64-7	090110	Not Likely To Be Carcinogenic To Humans.	12/13/2017
Pymetrozine	123312-89-0	101103	Likely To Be Carcinogenic To Humans.	9/22/1999
Pyraclostrobin	175013-18-0	099100	Not Likely To Be Carcinogenic To Humans.	2/15/2007
Pyraflufen ethyl	129630-19-9	030090	Likely To Be Carcinogenic To Humans.	10/8/2002
Pyrasulfotole	365400-11-9	000692	Suggestive Evidence Of Carcinogenic Potential.	5/17/2007
Pyrazon	1698-60-8	069601	Not Likely To Be Carcinogenic To Humans.	7/28/2005
Pyrethrins	8003-34-7	069001	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause A Mitogenic Response In The Liver.	2/14/2008
Pyridaben	96489-71-3	129105	Group E--Evidence Of Non-Carcinogenicity For Humans.	5/11/1994
Pyridalyl	179101-81-6	295149	Not Likely To Be Carcinogenic To Humans.	8/3/2004
Pyridate	55512-33-9	128834	Not Likely To Be Carcinogenic To Humans.	1/24/2000
Pyrifluquinazon	337458-27-2	555555	Not Likely To Be Carcinogenic To Humans: At Levels That Do Not Alter Rodent Hormone Homeostasis.	6/21/2012

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Pyrimethanil	53112-28-0	288201	Not Likely To Be Carcinogenic To Humans at Doses that Do Not Alter Rat Thyroid Hormone Homeostasis.	1/3/2012
Pyriofenone	688046-61-9	028828	Not Likely To Be Carcinogenic To Humans.	12/14/2011
Pyriproxyfen	95737-68-1	129032	Group E--Evidence Of Non-Carcinogenicity For Humans.	8/15/1995
Pyrithiobac-sodium	123343-16-8	078905	Group C--Possible Human Carcinogen.	9/5/1995
Pyroxasulfone	447399-55-5	090099	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause Urinary Bladder Calculi Formation Resulting In Cellular Damage Of The Urinary Tract.	5/17/2011
Pyroxsulam	422556-08-9	108702	Not Likely To Be Carcinogenic To Humans.	7/12/2007
Quinchlorac	84087-01-4	128974	Group D--Not Classifiable As To Human Carcinogenicity.	8/26/1992
Quinoxifen	124495-18-7	055459	Not Likely To Be Carcinogenic To Humans.	1/28/2003
Quizalofop ethyl	76578-14-8	128711	Group D--Not Classifiable As To Human Carcinogenicity.	3/17/1988

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Quizalofop-P-ethyl	100646-51-3	128709	Group D--Not Classifiable As To Human Carcinogenicity.	8/18/2016
Resmethrin	10453-86-8	097801	Likely To Be Carcinogenic To Humans.	5/25/2005
Rimsulfuron	122931-48-0	129009	Not Likely To Be Carcinogenic To Humans.	2/19/1998
RoteNone	83-79-4	071003	Group E--Evidence Of Non-Carcinogenicity For Humans.	10/5/1988
Saflufenacil (BAS 800 H)	372137-35-4	118203	Not Likely To Be Carcinogenic To Humans.	7/22/2009
S-Bioallethrin	28434-00-6	004004	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	12/2/2003
Sedaxane	874967-67-6	129223	Suggestive Evidence Of Carcinogenic Potential.	5/4/2017
Sethoxydim	74051-80-2	121001	Not Likely To Be Carcinogenic To Humans.	3/19/2003
Simazine	122-34-9	080807	Not Likely To Be Carcinogenic To Humans.	4/14/2005
s-Metolachlor	87392-12-9	108800	Not Likely To Be Carcinogenic To Humans.	11/6/2017

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
s-Metolachlor	87392-12-9	108800	Not Likely To Be Carcinogenic To Humans.	11/6/2017
Sodium bentazon	50723-80-3	103901	Group E--Evidence Of Non-Carcinogenicity For Humans.	1/14/1992
Sodium Cyanide	143-33-9	074002	Classification Not Available.	9/18/2018
Sodium Fluoroacetate	62-74-8	075003	Not Required (Non-Food).	9/20/2018
Sodium Metaborate	011104	1330-20-7	Not Likely To Be Carcinogenic To Humans.	12/1/2015
Sodium omadine	15922-78-8	088004	Group D--Not Classifiable As To Human Carcinogenicity.	5/16/1995
Sodium Tetraborate Pentahydrate	12179-04-3	011110	Not Likely To Be Carcinogenic To Humans.	12/1/2015
Solatenol	1072957-71-1	122305	Suggestive Evidence Of Carcinogenic Potential.	9/30/2014
Spinetoram	187166-40-1 +187166-15-0	110008	Not Likely To Be Carcinogenic To Humans.	9/20/2007
Spinosad	131929-60-7	110003	Not Likely To Be Carcinogenic To Humans.	7/18/2002
Spirodiclofen	148477-71-8	124871	Likely To Be Carcinogenic To Humans.	6/10/2004

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Spiromesifen	283594-90-1	024875	Not Likely To Be Carcinogenic To Humans.	5/21/2008
Spirotetramat	203313-25-1	392201	Not Likely To Be Carcinogenic To Humans.	3/26/2009
Spiroxamine	118134-30-8	120759	Not Likely To Be Carcinogenic To Humans.	11/14/2003
Starlicide	7745-89-3	009901	Not Required (Nonfood).	7/17/2018
Streptomycin Sesquisulfate	3810-74-0	006310	Classification Not Available.	12/12/2017
Sulfentrazone	122836-35-5	129081	Group E--Evidence Of Non-Carcinogenicity For Humans.	5/7/1996
Sulfosate	81591-81-3	128501	Group E--Evidence Of Non-Carcinogenicity For Humans.	7/26/1994
Sulfosulfuron	141776-32-1	085601	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause Urinary Bladder Calculi Formation Resulting In Cellular Damage Of The Urinary Tract.	12/16/2008
Sulfoxaflor	946578-00-3	005210	Suggestive Evidence Of Carcinogenic Potential.	4/26/2012
Sulfuryl fluoride	2699-79-8	078003	Not Likely To Be Carcinogenic To Humans.	5/24/2001
Sulprofos	35400-43-2	111501	Group E--Evidence Of Non-Carcinogenicity for Humans.	3/26/1996

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Sumithrin	26002-80-2	069005	Not Likely To Be Carcinogenic To Humans.	5/30/2006
Tau-fluvalinate	102851-06-9	109302	Not Likely To Be Carcinogenic To Humans.	9/29/2005
TCMTB (Busan 72)	21564-17-0	035603	Group C--Possible Human Carcinogen.	8/28/1996
Tebuconazole	107534-96-3	128997	Group C--Possible Human Carcinogen.	9/15/1993
Tebufenozide	112410-23-8	129026	Group E--Evidence Of Non-Carcinogenicity For Humans.	8/29/1994
Tebufenpyrad	119168-77-3	090102	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	7/15/2002
Tebuthiuron	34014-18-1	105501	Group D--Not Classifiable As To Human Carcinogenicity.	3/1/1993
Tefluthrin	79538-32-2	128912	Not Likely To Be Carcinogenic To Humans.	5/30/2012
Telone	542-75-6	029001	Group B--Probable Human Carcinogen.	3/19/2002
Tembotrione	335104-84-2	012801	Suggestive Evidence Of Carcinogenic Potential.	5/22/2007
Tepraloxydim	149979-41-9	121005	Data Are Inadequate For An Assessment Of Human Carcinogenic Potential.	2/27/2001
Terbacil	5902-51-2	012701	Group E--Evidence Of Non-Carcinogenicity For Humans.	9/30/1994

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Terbufos	13071-79-9	105001	Group E--Evidence Of Non-Carcinogenicity For Humans.	3/9/1994
Terbuthylazine	5915-41-3	080814	Group D--Not Classifiable As To Human Carcinogenicity.	8/24/1994
Terbutryn	886-50-0	080813	Group C--Possible Human Carcinogen.	3/3/1988
Terrazole	2593-15-9	084701	Group B--Probable Human Carcinogen.	6/29/1999
Tetrachlorvinphos	961-11-5	083701	Likely To Be Carcinogenic To Humans.	3/7/2002
Tetraconazole	112281-77-3	120603	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause A Mitogenic Response In The Liver.	4/2/2013
Tetramethrin	7696-12-0	069003	Group C--Possible Human Carcinogen.	12/11/1989
Thiabendazole	148-79-8	060101	Likely To Be Carcinogenic To Humans: At High Doses; Not Likely To Be Carcinogenic To Humans At Low Doses.	3/8/2002
Thiacloprid	111988-49-9	014019	Likely To Be Carcinogenic To Humans.	10/31/2012
Thiamethoxam	153719-23-4	060109	Not Likely To Be Carcinogenic To Humans.	6/13/2005
Thiazopyr (MON 13200)	117718-60-2	129100	Suggestive Evidence Of Carcinogenic Potential.	12/6/2007

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Thidiazuron	51707-55-2	120301	Not Likely To Be Carcinogenic To Humans.	8/31/2005
Thiencarbazone-methyl	317815-83-1	015804	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Cause Urinary Bladder Calculi Formation Resulting In Cellular Damage Of The Urinary Tract.	2/29/2008
Thifensulfuron methyl	79277-27-3	128845	Not Likely To Be Carcinogenic To Humans.	12/12/2006
Thiobencarb (Bolero)	28249-77-6	108401	Group D--Not Classifiable As To Human Carcinogenicity.	6/10/1996
Thiocyclam hydrogen oxalate	31895-22-4	128868	Group D--Not Classifiable As To Human Carcinogenicity.	9/15/1994
Thiodicarb	59669-26-0	114501	Group B--Probable Human Carcinogen.	6/10/1996
Thiophanate-methyl	23564-05-8	102001	Likely To Be Carcinogenic To Humans.	8/24/1999
Thiram	137-26-8	079801	Not Likely To Be Carcinogenic To Humans.	4/14/2003
Tioxazafen (MON 102100)	330459-31-9	074752	Likely to Be Carcinogenic to Humans.	9/20/2016
Tolclofos-methyl	57018-04-9	128905	Not Required (Nonfood).	3/22/2012

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Tolfenpyrad	129558-76-5	090111	Not Likely To Be Carcinogenic To Humans.	6/3/2010
Tolpyralate	928783-29-3	573101	Suggestive Evidence Of Carcinogenic Potential.	1/18/2017
Tolyfluanid	731-27-1	309200	Likely To Be Carcinogenic To Humans.	6/18/2002
Topramezone	210631-68-8	123009	Not Likely To Be Carcinogenic To Humans: At Doses That Do Not Alter Rat Thyroid Hormone Homeostasis.	5/19/2005
Tralkoxydim	87820-88-0	121000	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	6/30/2004
Transfluthrin	118712-89-3	129140	Not Required (Nonfood).	6/1/2018
Triadimefon	43121-43-3	109901	Group C--Possible Human Carcinogen.	12/4/1996
Triadimenol	55219-65-3	127201	Group C--Possible Human Carcinogen.	1/29/1988
Triallate	2303-17-5	078802	Group C--Possible Human Carcinogen.	1/12/1994
Triasulfuron	82097-50-5	128969	Group E--Evidence Of Non-Carcinogenicity For Humans.	2/27/1991
Triazamate	112143-82-5	128100	Not Likely To Be Carcinogenic To Humans.	12/1/1997
Tribenuron methyl	101200-48-0	128887	Group C--Possible Human Carcinogen.	7/14/1989

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Tribufos	78-48-8	074801	Likely To Be Carcinogenic To Humans: At High Doses; Not Likely To Be Carcinogenic To Humans At Low Doses.	5/22/1997
Tributyltin maleate	14275-57-1	083118	Group D--Not Classifiable As To Human Carcinogenicity.	3/31/2005
Trichlorfon	52-68-6	057901	Likely To Be Carcinogenic To Humans: At High Doses; Not Likely To Be Carcinogenic To Humans At Low Doses.	7/15/1999
Triclopyr	55335-06-3	116001	Group D--Not Classifiable As To Human Carcinogenicity.	5/9/1996
Triclosan	3380-34-5	054901	Not Likely To Be Carcinogenic To Humans.	1/4/2008
Tricyclazole	41814-78-2	120201	Not Likely To Be Carcinogenic To Humans.	4/1/2014
Tridiphane	58138-08-2	123901	Group C--Possible Human Carcinogen.	4/22/1986
Trifloxystrobin	141517-21-7	129112	Not Likely To Be Carcinogenic To Humans.	6/16/1999
Trifloxysulfuron	290332-10-4	119009	Not Likely To Be Carcinogenic To Humans.	7/22/2003
Triflumizole	68694-11-1	128879	Group E--Evidence Of Non-Carcinogenicity For Humans.	8/10/1993
Trifluralin	1582-09-8	036101	Group C--Possible Human Carcinogen.	4/11/1986

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Triflusulfuron-methyl	126535-15-7	129002	Group C--Possible Human Carcinogen.	5/28/1996
Triforine	26644-46-2	107901	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	6/29/2004
Trinexapac-Ethyl	95266-40-3	112602	Not Likely To Be Carcinogenic To Humans.	9/5/2008
Triphenyltin hydroxide (TPTH)	76-87-9	083601	Group B--Probable Human Carcinogen.	5/24/1990
Triticonazole	131983-72-7	125620	Not Likely To Be Carcinogenic To Humans.	6/15/2006
Troysan polyphase (IPBC)	55406-53-6	107801	Not Likely to Be Carcinogenic to Humans.	12/4/1996
UDMH	57-14-7	600018	Group B--Probable Human Carcinogen.	7/26/1991
UMP-488 (PAL 6000)	111578-32-6	129025	Group E--Evidence Of Non-Carcinogenicity for Humans.	5/6/1994
Uniconazole	83657-22-1	128976	Group C--Possible Human Carcinogen.	10/11/1990
Uniconazole-P	83657-17-4	138976	Group C--Possible Human Carcinogen.	10/11/1990
Valifenalate	283159-90-0	128200	Not Likely To Be Carcinogenic To Humans.	5/2/2019
Vinclozolin	50471-44-8	113201	Group C--Possible Human Carcinogen.	6/20/2000
Xylene (dimethyl-benzene)	7775-19-1	086802	Not Likely To Be Carcinogenic To Humans.	3/6/2009
Zeta-Cypermethrin	52315-07-8	129064	Group C--Possible Human Carcinogen.	9/27/1988

CHEMICAL	CAS NO.*	PC CODE**	CANCER CLASSIFICATION***	REPORT DATE****
Ziram	137-30-4	034805	Suggestive Evidence Of Carcinogenicity, But Not Sufficient To Assess Human Carcinogenic Potential.	2/6/2003
Zoxamide	156052-68-5	101702	Not Likely To Be Carcinogenic To Humans.	2/7/2001

*CAS No: a chemical identifier designated by the Chemical Abstracts Service

**PC Code: a unique chemical identifier used by the Office of Pesticide Programs

***Cancer Classification: Simple descriptors used to express conclusions regarding the carcinogenic hazard potential of a chemical based on all relevant information, which is usually laboratory studies. These phases changed over time, as the Agency's guidance for carcinogenicity assessment was updated and revised.

CONTENTS

PARTICIPANTS	v
ABBREVIATIONS	xiii
1. INTRODUCTION	1
2. GENERAL CONSIDERATIONS	3
2.1 Modifications to the agenda	3
2.2 Prediction of dietary intake.....	3
2.2.1 Revised guidelines for predicting the dietary intake of pesticide residues.....	3
2.2.2 Calculation of dietary intake of pesticide residues	4
2.2.3 Estimation of supervised trials median residue levels.....	4
2.2.4 Example of STMR estimation: parathion-methyl	5
2.3 Relationship between Codex Maximum Residue Limits (MRLs) for pesticide residues, good agricultural practice (GAP), and food safety	6
2.4 Estimation of extraneous residue limits (ERLs).....	7
2.5 Estimation of group maximum residue levels	9
2.6 Use by the WHO Core Assessment Group of national evaluations of studies.....	12
2.7 Interactions of pesticides	13
2.8 Environmental Core Assessment Group.....	14
3. SPECIFIC PROBLEMS.....	15
3.1 Definition of residues of fat-soluble compounds.....	15
4. EVALUATION OF DATA FOR ACCEPTABLE DAILY INTAKE FOR HUMANS, SUPERVISED TRIALS MEDIAN RESIDUE LEVELS ¹ AND MAXIMUM RESIDUE LIMITS ²	17
4.1 Acephate (R)	17
4.2 Aldicarb (R)	18
4.3 Bifenthrin (R).....	19
4.4 Carbaryl (T)**	20
4.5 Carbofuran (T)**	26
4.6 Chlorfenvinphos (R)**	29

¹See Section 2.2

²T = Toxicology

* New compound

R = Residue and analytical aspects** Evaluation in CCPR periodic review programme

4.7 2,4-D (T)**	31
4.8 DDT (R)	38
4.9 Diazinon (R)	39
4.10 Dimethoate, omethoate, and formothion (T)**	40
4.11 Disulfoton (T)	45
4.12 Dithiocarbamates (R)	47
4.13 Fenarimol (R)	47
4.14 Ferbam (T,R)**	48
4.15 Flumethrin (T,R)*	52
4.16 Haloxyfop (R)	56
4.17 Maleic hydrazide (T)**	57
4.18 Methamidophos (R)	60
4.19 Mevinphos (T)**	61
4.20 Phorate (T)	64
4.21 Propoxur (R)	65
4.22 Tebufenozide (T,R)*	66
4.23 Teflubenzuron (R)*	71
4.24 Thiram (R)**	72
4.25 Ziram (T,R)**	73
 5. RECOMMENDATIONS	 81
 6. FUTURE WORK	 83
6.1 1997 Meeting	83
6.2 1998 Meeting	84
 7. REFERENCES	 85
 CORRECTIONS TO REPORT OF 1995 JMPR	 91
 ANNEX I: ADIs, MRLs and STMRs	 93
 ANNEX II: Index of reports and evaluations	 101
 ANNEX III: Intake predictions	 113
 ANNEX IV: Report of Workshop on Data Evaluation	 115

**1996 JOINT MEETING OF THE FAO PANEL OF EXPERTS ON
PESTICIDE RESIDUES IN FOOD AND THE ENVIRONMENT
AND THE WHO CORE ASSESSMENT GROUP**

Rome, 16-25 September 1996

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ABBREVIATIONS WHICH MAY BE USED

Ache	acetylcholinesterase
ADI	acceptable daily intake
AFI(D)	alkali flame-ionization (detector)
ai	active ingredient
ALAT	alanine aminotransferase
	approx. approximate
ASAT	aspartate aminotransferase
BBA	Biologische Bundesanstalt für Land- und Forstwirtschaft
bw	body weight
(not b.w.)	
c	centi- ($\times 10^{-2}$)
CA	Chemical Abstracts
CAS	Chemical Abstracts Services
CCN	Codex Classification Number (this may refer to classification numbers for compounds or for commodities).
CCPR	Codex Committee on Pesticide Residues
ChE	cholinesterase
CNS	central nervous system
cv	coefficient of variation
CXL	Codex Maximum Residue Limit (Codex MRL). See MRL.
DFG	Deutsche Forschungsgemeinschaft
DL	racemic (optical configuration, a mixture of dextro- and laevo-)
DP	dustable powder
DS	powder for dry seed treatment
EBDC	ethylenebis(dithiocarbamate)
EC	(1) emulsifiable concentrate
(2)	electron-capture [chromatographic detector]
ECD	electron-capture detector
EMDI	estimated maximum daily intake
EPA	Environmental Protection Agency
ERL	extraneous residue limit
ETU	ethylenethiourea
F ₁	filial generation, first
F ₂	filial generation, second
f.p.	freezing point
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration

Abbreviations

FID	flame-ionization detector
FPD	flame-photometric detector
g (not gm)	gram
µg	microgram
GAP	good agricultural practice(s)
GC-MS	gas chromatography - mass spectrometry
G.I.	gastrointestinal
GL	guideline level
GLC	gas-liquid chromatography
GLP	Good Laboratory Practice
GPC	gel-permeation chromatography
GSH	glutathione
h (not hr)	hour(s)
ha	hectare
Hb	haemoglobin
hl	hectolitre
HPLC	high-performance liquid chromatography
HPLC-MS	high-performance liquid chromatography - mass spectrometry
IBT	Industrial Bio-Test Laboratories
i.d.	internal diameter
i.m.	intramuscular
i.p.	intraperitoneal
IPCS	International Programme on Chemical Safety
IR	infrared
IRDC	International Research and Development Corporation (Mattawan, Michigan, USA)
i.v.	intravenous
JMPR	Joint FAO/WHO Meeting on Pesticide Residues (Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group)
LC	liquid chromatography
LC ₅₀	lethal concentration, 50%
LC-MS	liquid chromatography - mass spectrometry
LD ₅₀	lethal dose, median
LOAEL	lowest observed adverse effect level
LOD	limit of determination (see also "*" at the end of the Table)
LSC	liquid scintillation counting or counter
MFO	mixed function oxidase
µm	micrometre (micron)
min	minute(s)

MLD	minimum lethal dose
M	molar
mo	month(s)
(not mth.)	
MRL	Maximum Residue Limit. MRLs include <u>draft</u> MRLs and <u>Codex</u> MRLs (CXLs). The MRLs recommended by the JMPR on the basis of its estimates of maximum residue levels enter the Codex procedure as draft MRLs. They become Codex MRLs when they have passed through the procedure and have been adopted by the Codex Alimentarius Commission.
MS	mass spectrometry
MTD	maximum tolerated dose
n	normal (defining isomeric configuration)
NCI	National Cancer Institute (United States)
NMR	nuclear magnetic resonance
NOAEL	no-observed-adverse-effect level
NOEL	no-observed-effect level
NP(D)	nitrogen-phosphorus (detector)
NTE	neuropathy target esterase
OP	organophosphorus pesticide
PHI	pre-harvest interval
ppm	parts per million. (Used only with reference to the concentration of a pesticide in an experimental diet. In all other contexts the terms mg/kg or mg/l are used).
PT	prothrombin time
PTDI	provisional tolerable daily intake. (See 1994 report, Section 2.3, for explanation)
PTT	partial thromboplastin time
PTU	propylenethiourea
RBC	red blood cell
s.c.	subcutaneous
SC	suspension concentrate (= flowable concentrate)
SD	standard deviation
SE	standard error
SG	water-soluble granule
SL	soluble concentrate
SP	water-soluble powder
sp./spp.	species (only after a generic name)
sp gr	specific gravity
(not sp. gr.)	
STMR	supervised trials median residue
t	tonne (metric ton)

Abbreviations

T ₃	tri-iodothyronine
T ₄	thyroxine
TADI	Temporary Acceptable Daily Intake
<i>tert</i>	tertiary (in a chemical name)
TLC	thin-layer chromatography
TMDI	theoretical maximum daily intake
TMRL	Temporary Maximum Residue Limit
TPTA	triphenyltin acetate
TPTH	triphenyltin hydroxide
TSH	thyroid-stimulating hormone (thyrotropin)
UDMH	1,1-dimethylhydrazine (unsymmetrical dimethylhydrazine)
USEPA	United States Environmental Protection Agency
USFDA	United States Food and Drug Administration
UV	ultraviolet
v/v	volume ratio (volume per volume)
WG	water-dispersible granule
WHO	World Health Organization
WP	wettable powder
wt/vol	weight per volume
w/w	weight ratio (weight per weight)
<	less than
≤	less than or equal to
>	greater than
≥	greater than or equal to
*	(following residue levels, e.g. 0.01* mg/kg): level at or about the limit of determination

PESTICIDE RESIDUES IN FOOD

REPORT OF THE 1996 JOINT FAO/WHO MEETING OF EXPERTS

1. INTRODUCTION

A Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group (JMPR) was held in Rome, Italy, from 16 to 25 September 1996. The FAO Panel of Experts had met in preparatory sessions on 11-14 September.

The Meeting was opened by Dr. A. Sawadogo, Assistant Director-General of FAO, and Dr. F. Riveros, Chief of the Crop and Grassland Service of FAO, on behalf of the Directors-General of FAO and WHO.

The opening address recalled that maximum residue limits for pesticide residues in food were recommended for the first time by the Joint FAO/WHO Meeting on Pesticide Residues thirty years ago, and noted a number of salient features of the development of the work of the Joint Meeting since that time.

In the context of current work, the importance of the recent development of methods for estimating more accurately the dietary intake of pesticide residues was stressed. These methods were being applied by the Joint Meeting to facilitate and improve the annual calculations of dietary intakes undertaken by WHO.

A further important aspect of the application of pesticides was the possible risk to the environment from their use. This had been recognised by the inclusion in the Joint Meeting held in Geneva last year of the Environmental Core Assessment Group. Further elaboration of the principle of joint assessment by this Group and the FAO Panel should be encouraged and it was to be hoped that every effort would be made to hold Joint Meetings of all three groups, the Toxicological and Environmental Core Assessment Groups and the FAO Panel, in the future.

The Meeting was held in pursuance of recommendations made by previous Meetings and accepted by the governing bodies of FAO and WHO that studies should be undertaken jointly by experts to evaluate possible hazards to man arising from the occurrence of residues of pesticides in foods. The reports of previous Joint Meetings (see References, Section 7) contain information on acceptable daily intakes (ADIs), maximum residue limits (MRLs) and general principles for the evaluation of the various pesticides. The supporting documents (Residue and Toxicological Evaluations) contain detailed monographs on these pesticides and include comments on analytical methods. The present Meeting was convened to consider a further number of pesticides together with items of a general or a specific nature. These include items for clarification of recommendations made at previous Meetings or for reconsideration of previous evaluations in the light of findings of subsequent research or other developments.

During the Meeting the FAO Panel of Experts was responsible for reviewing residue and analytical aspects of the pesticides considered, including data on their metabolism, fate in

the environment, and use patterns, and for estimating the maximum residue levels that might occur as a result of the use of the pesticides according to good agricultural practices. The WHO Toxicological Core Assessment Group was responsible for reviewing toxicological and related data and for estimating, where possible, ADIs for humans of the pesticides. The recommendations of the Joint Meeting, including those for further research and the provision of additional information, are proposed for use by national governments, international organizations and other interested parties.

The Joint Meeting was saddened to hear of the recent deaths of two former Members of the WHO Expert Group, Professor W. Almeida, University of Campinas, Campinas, S_o Paulo, and Professor U.G. Ahlborg, Karolinska Institute, Stockholm. Both made significant contributions to the science of toxicology and to the work of the JMPR, which are gratefully acknowledged. They will be missed.

2. GENERAL CONSIDERATIONS

2.1 MODIFICATIONS TO THE AGENDA

The re-evaluation of residue and analytical aspects of phosmet within the CCPR periodic review programme was postponed until 1997 at the request of the manufacturer.

2.2 PREDICTION OF DIETARY INTAKE

2.2.1 Revised guidelines for predicting the dietary intake of pesticide residues

The WHO Secretariat reviewed the development of methods for predicting the dietary intake of pesticide residues. The revision of existing guidelines (WHO, 1989) was the subject of an FAO/WHO Consultation held 2-6 May 1995 in York, United Kingdom. The report of that Consultation (WHO/FNU/FOS/95.11) contained recommendations for improving estimates of dietary intake, most notably the use of supervised trials median residue (STMR) levels in lieu of MRLs in the calculation of International Estimated Daily Intakes (IEDIs). The Consultation also recommended a method for assessing acute hazards posed by the consumption of large portions of food containing pesticide residues. The report was considered at the twenty-eighth Session of the CCPR, which agreed (ALINORM 97/24, para 23) that the draft revised guidelines be included on the agenda for their Session in 1997. The draft revised guidelines will be available in English, French and Spanish to governments before that time.

The WHO Secretariat provided a draft of the revised guidelines to the JMPR and requested comment on the inclusion of the National Theoretical Maximum Daily Intakes (TMDIs), which parallel the international intake assessments. The Meeting agreed that, conceptually, this would be useful, particularly for developing countries; however, it also emphasized that when information was available a best estimate of intake should be derived, using the IEDI method. The Meeting endorsed the report of the York Consultation and noted that many of the recommendations had already been implemented by the JMPR.

The Meeting was also informed of the report of an FAO Panel Workshop held in The Hague in April 1996, where integration of the recommendations of the York Consultation into the work of the JMPR was discussed. Further details of the recommendations of the Workshop are given in Section 2.2.3.

The WHO Secretariat also reported on planning for a Joint FAO/WHO Consultation on Food Consumption and Exposure Assessment of Chemicals, which will be held 10-14 February 1997 at WHO Headquarters in Geneva. The Consultation will follow up certain recommendations of the York Consultation, particularly in the development of regional diets and in addressing issues related to implementation of the recommendation on intake assessment for acute hazards. In addition, the Consultation will consider approaches for extending the methods used for assessing the intake of pesticides to other chemicals considered

by Codex, including food additives, contaminants, veterinary drug residues, and nutrients.

2.2.2 Calculation of dietary intake of pesticide residues

TMDIs were calculated for the JMPR by WHO (GEMS/Food) using the methods described in *Guidelines for predicting dietary intake of pesticide residues* (WHO, 1989), as revised by the recommendations of the York Consultation. When information was available IEDIs were also calculated. The results are summarized in Annex III and will be made available to the 29th Session of the CCPR in April 1997.

The JMPR has established acute reference doses for eight pesticides. While the York Consultation recommended a simple method for assessing short-term intake to compare with acute reference doses, the data and policy decisions that would allow such calculations require further clarification. The Meeting noted that the topic would be discussed at the Joint FAO/WHO Consultation on Food Consumption and Exposure Assessment of Chemicals to be held in February 1997 in Geneva and looked forward to receiving the recommendations of that Consultation.

The Meeting noted that the risk assessment of acutely toxic pesticides required further refinement and invited governments to make available relevant information on national approaches. The Meeting agreed that, when appropriate, the risk assessment of acute hazards should take into account any variability in the individual units in composite samples on which the MRL is based.

2.2.3 Estimation of supervised trials median residue levels

1. The main objectives of the Joint FAO/WHO Consultation on Guidelines for predicting the Dietary Intake of Pesticide Residues, held in York, United Kingdom, 2-6 May 1995, were to review the existing guidelines and to recommend feasible approaches for improving the reliability and accuracy of methods for predicting the dietary intake of pesticide residues. The final published report of this Consultation became available in February 1996.
2. An informal Workshop was convened in The Hague, Netherlands, 11-12 April 1996, at the request of FAO Panel members, to consider the consequences of the recommendations of the York Consultation for individual reviewers and for the JMPR, and to convert the recommendations into practical methods for evaluating data.
3. The Workshop focused on the reviews of data undertaken by FAO Panel members and the estimation of supervised trials median residue (STMR) levels. Several general recommendations and 27 specific recommendations for the evaluation of data were made.
4. The present Meeting recognized that as pesticides are used in a wide variety of situations methods for evaluating data must be developed to take into account cases that are not already covered by the suggested procedures. The Meeting considered the report of the Workshop and agreed to support its recommendations, while recognizing that data evaluation is evolving. Most of the recommendations have already been implemented in the work of the FAO Panel.

5. On the basis of practical examples, the Meeting concluded that the recommendations on acute dietary intake and ectoparasite treatments of farm animals might require further development. In addition, the Meeting agreed that the recommendation on the estimation of STMRs and MRLs in animal commodities arising from residues in feed required further consideration. The Meeting agreed that examples and more specific guidance in this area should be developed at the 1997 JMPR.

6. The Meeting agreed that STMR levels that had already been estimated should be used by the JMPR in estimating consumer intakes resulting from long-term dietary exposure. The need for more realistic estimates of the dietary intake of pesticide residues was pointed out in the opening address to the Meeting.

7. Methods for presenting estimated STMR levels are still being developed. The aim is to communicate the results as clearly and unambiguously as possible; experience may indicate that further changes are necessary.

8. A copy of the report of the Workshop (*Report of an informal workshop on data evaluation in the estimation of dietary intake of pesticide residues for the JMPR*) is included as Annex IV to this report. The Meeting agreed that wide availability of the report of the Workshop would improve the transparency of the JMPR evaluation process and would also provide guidance to national governments.

9. The Meeting recommended that both the general and the specific recommendations of the Workshop be included in future FAO and WHO guidelines.

2.2.4 Example of STMR estimation: parathion-methyl

The 28th Session of the CCPR (ALINORM 97/24, para 46) welcomed the proposal that a fully worked example of intake assessment, prepared by the Codex Secretariat, be presented to the next Session. At the request of the CCPR, the Meeting considered the worked example of parathion-methyl (*Parathion-methyl, Estimation of Dietary Intake*), which demonstrates the methods used for estimating STMR levels. The STMR levels were combined with information on cultural diets in order to estimate chronic dietary intakes. The example was based on the methods recommended at the Workshop in The Hague, April 1996 (see Section 2.2.3 and Annex IV) and the Meeting confirmed that it reflected the methods used by the FAO Panel at the current Meeting. The Meeting recommended that the example be forwarded to the 1997 Session of the CCPR.

2.3 RELATIONSHIP BETWEEN CODEX MAXIMUM RESIDUE LIMITS (MRLS) FOR PESTICIDE RESIDUES, GOOD AGRICULTURAL PRACTICE (GAP), AND FOOD SAFETY

The World Trade Organization (WTO) agreement on the Application of Sanitary and Phytosanitary Measures brought the Codex MRLs for pesticides to the attention of a wide range of government officials and representatives of non-governmental organizations. The questions and comments raised during various discussions indicated that the relationship between Codex MRLs for pesticide residues and the safety of food was not always clear. In order to assist the uniform, correct interpretation of the role and the use of MRLs for pesticide residues in food, the Meeting was requested to clarify the matter.

The ‘Codex maximum residue limit for pesticide residues’ is the maximum concentration of a pesticide residue (expressed as mg/kg) recommended by the Codex Alimentarius Commission to be legally permitted in or on food commodities and animal feeds. MRLs are based on data from trials conducted according to GAP and foods derived from commodities that comply with the respective MRLs are considered to be toxicologically acceptable (*Codex Alimentarius Commission procedural manual*, 9th ed. p.61.)

Codex standards, one of which is the MRL for pesticide residues, aim to protect the health of consumers and ensure fair practices in food trade.

The Codex MRLs for pesticide residues are elaborated by the Codex Committee on Pesticide Residues on the basis of the advice of the JMPR, which scientifically evaluates all relevant information on pesticides: their toxicology, metabolism in laboratory and farm animals and plants, environmental fate, and residues in food resulting from their use according to national GAP. The JMPR recommends, when possible, ADIs and Acute Reference Doses (acute RfDs) of pesticides for humans and MRLs for pesticide residues in food and feed commodities.

The residue levels that the JMPR recommends for use as MRLs are estimated by identifying the highest population (range and magnitude) of pesticide residues resulting from treatments according to GAP for which sufficient data are available. MRLs generally apply to primary food commodities when they enter the market.

Good Agricultural Practice (GAP) in the use of pesticides includes the nationally authorised safe uses of pesticides under actual conditions necessary for effective pest control. It encompasses a range of levels of pesticide applications up to the highest authorised use, applied in a manner which leaves a residue which is the smallest amount practicable. (*Codex*

Alimentarius Commission procedural manual, 9th ed., p. 60). Owing to differences in pest infestation, the resistance of pests, and growing conditions, the level of residues remaining in or on food and feed commodities may differ significantly according to geographical location.

Codex MRLs are intended primarily to enforce and control compliance with nationally authorized uses of pesticides on commodities moving in international trade. The definition of a residue for enforcement purposes may rely on only one component of the total residue if it sufficiently reflects the use of the given pesticide, while the inclusion of additional residue components may be necessary for estimating dietary intake or assessing risk.

The procedure used for estimating maximum residue levels means that MRLs are based on the registered uses of a pesticide and are not directly related to the ADI or acute RfD of the pesticide. The acceptability of the recommended limits for a pesticide from the point of view of food safety is assessed by the JMPR by estimating the dietary intake of that pesticide. In estimating the dietary intake all relevant information, such as the residues in each individual commodity for which MRLs are recommended, regional diets, and the effects of processing and cooking, is taken into account. The estimated daily intake is compared with the permissible intake of the residue, calculated from the ADI or acute RfD.

The Meeting noted that the WTO had decided to use Codex MRLs as criteria for the acceptability of food in international trade, and emphasized that it would continue to base its recommendations on the critical assessment of all available scientific knowledge and information based on experimental data. One of its basic scientific principles is to protect human health and the quality of the environment by recommending MRLs that are no higher than necessary to reflect national GAP and to keep residue levels as low as practicable in order to reduce the exposure of consumers and the environment resulting from the use of pesticides.

2.4 ESTIMATION OF EXTRANEEOUS RESIDUE LIMITS (ERLS)

An Extraneous Residue Limit (ERL) for JMPR purposes refers to a pesticide residue arising from environmental sources (including former agricultural uses) other than the use of the pesticide directly or indirectly on the commodity containing the residue. It is the maximum concentration of a pesticide residue that is recommended by the Codex Alimentarius Commission to be legally permitted or recognized as acceptable in or on a food, agricultural commodity, or animal feed (1990 JMPR report, Section 2.7).

The 1995 report of the JMPR (Section 2.8.2) includes a summary of the general JMPR principles for estimating ERLs. Two views were expressed by governments at the 1996 CCPR on the estimation of ERLs (CX/PR 96/5 Add. 1); a conflicting view was subsequently expressed by a third government. The views emphasized the inclusion or exclusion of 'outliers'.

The Meeting concluded that the meaning of the term 'outlier' should be clear in the context of its use. In the context of ERLs, the JMPR does not consider extreme values to be outliers in a statistical sense, because high residue levels are usually not true statistical outliers but values on the tail of a large distribution. The challenge is to decide when it is reasonable to discard those values in order to reflect the expected gradual decline in the levels of chemicals that are typically subject to ERL estimates, while not creating unnecessary barriers to trade.

Generally, the JMPR considers that the databases needed for estimating ERLs should be significantly larger than those required for the estimation of MRLs, because ERL data do not fit a normal distribution. For example, samples from 598 animals are needed to ensure that the estimated ERLs cover 99.5% of a population, allowing a 0.5% violation rate with 95% confidence (Codex Alimentarius, Vol. II, 2nd Ed., p. 372). As ERL data are derived from the random monitoring of different populations, the JMPR does not normally consider a ‘world’ population of data, but gives independent consideration to different populations, e.g. of different geographical regions or of different animals, before deciding which data populations might be combined. As noted above, the intention is to avoid unnecessary restrictions to trade.

The JMPR compares data distributions in terms of the likely percentages of violations that might occur if a given ERL is proposed. The JMPR is unaware of any internationally agreed level of violations that is recognised as unacceptable. Generally, the JMPR assumes that violation rates of 0.2-0.5% or greater are unacceptable. The JMPR would welcome views from governments on the levels of violation that are considered unacceptable.

For the reasons given above and on the basis of the approaches to estimating ERLs described in the report of the 1995 JMPR, the JMPR chooses not to endorse the country proposals to include or exclude high values. It is unlikely that governments will give consistent guidance on the use of outliers, and the JMPR cannot be a referee. Another reason is that compounds for which ERLs are estimated are no longer approved for use on agricultural commodities because of existing or previous health or environmental concerns.

It is to be expected that there will be a gradual reduction and/or elimination of residues of the chemicals for which ERLs have been proposed. The JMPR considers that the case-by-case approach described in its 1995 report already accommodates issues that might lead to concern. The 1995 report notes that the reasons for estimating ERLs below the maximum residues reported include discouraging unauthorized uses and encouraging the submission of adequate data. This approach is more likely to be used when the higher residues occur infrequently, and the JMPR attempts to balance its use against unnecessary restrictions to trade if health concerns permit.

Although the JMPR does not use targeted monitoring data for estimating ERLs, it agrees that follow-up studies are important when high residues are found in random monitoring to give a clearer view of the significance of the high levels. If properly conducted, such studies may indicate whether or not the higher residues resulted from intentional unauthorized uses and may allow the identification of areas in which production should be limited or where residue reduction strategies should be implemented.

The above discussion gives some of the reasons for the emphasis placed by the JMPR on the importance of providing complete information for ERL estimates, including possible impacts on trade. For example a better ERL estimate, taking into account trade concerns, was possible in the case of DDT when more extensive data were available. This example also illustrates some of the reasoning and approaches used by the JMPR in estimating ERLs (see DDT, Section 4.8).

2.5 ESTIMATION OF GROUP MAXIMUM RESIDUE LEVELS

The 28th (1996) Session of the CCPR retained a proposal of 2 mg/kg for residues of bromopropylate in citrus fruits at Step 7B, to await an opinion from the JMPR on its general policy on recommending group MRLs as opposed to MRLs for individual commodities (ALINORM 97/24, para 50). Similar issues arose in relation to the proposed MRL for fenbutatin oxide in citrus fruits.

In addition to the purely technical questions on general policy and the adequacy of data for group rather than individual MRLs, the 1996 CCPR also invited the JMPR to comment on the possibility of extrapolating residue data to cover minor crops, especially those of interest to developing countries (ALINORM 97/24, para 101). Although this issue was considered by the 1989 JMPR (report, Section 2.11), it can probably best be further addressed by other means, e.g. the development of minimum data requirements under consideration by governments, industry and the Organisation for Economic Co-operation and Development (OECD) (1994 JMPR report, Section 2.4; ALINORM 97/24, para 101) or the FAO guidelines on data evaluation (1992 JMPR report, Section 2.7), which are being developed. It will therefore not be considered further in this discussion.

The establishment of group MRLs as opposed to MRLs for individual commodities has long been recognized as an acceptable procedure at both the national and international levels. The use of the approach is a recognition that economics may not justify residue trials on all of the many cultivars and varieties of crops, and health protection will not usually require it. In principle the approach recognizes that adequate data for the major crops of a group may be sufficient.

Historically the JMPR has always approached the issue of group or individual MRLs on a case-by-case basis and that approach is unchanged. The main reasons for this are the many factors which can affect a decision on whether or not to propose a group MRL and the lack of international consensus on criteria. These considerations have prevented the JMPR from developing specific guidance for estimating group MRLs which might be applied at the international level in all situations.

Although such specific guidance is not yet available, some general guidance has been developed and recorded by the JMPR over the years. The JMPR proposed group MRLs at least as early as 1966, but principles for estimating group maximum residue levels were first addressed in some detail by the 1970 Meeting and amplified somewhat in 1973. This was before the existence of any internationally recognized classification of food and feed commodities by groups. The 1974, 1976, 1977 and 1979 Joint Meetings were encouraged by the on-going development of the Codex classification of foods and feeds and recognized the importance of this to the issue of group MRLs. The 1979 JMPR for the first time recorded the use of the Codex Definition and Classification of Food and Feed Groups to define individual commodities and those to which group MRLs should apply.

The 1981 JMPR (report, Section 2.3) expounded in some detail the concepts involved in the extrapolation of data from one crop to another, for both group and individual MRLs. The 1985, 1986 and 1988 Joint Meetings acknowledged the availability of, and reported the continued use of, a new edition of the Codex Classification (CAC/PR 4-1985). The continued

General considerations

use of the system by the JMPR since that time is widely recognized.

In order to respond to the request of the CCPR for an explanation of the general policy for estimating group MRLs, the Meeting took into account previous consideration of the issue by the JMPR (particularly the reports of the 1970, 1973 and 1981 Meetings) as well as the collective experience of its members. From these it was possible to summarize a number of general principles and observations which reflect the current views of the JMPR on estimating group MRLs. The following list is intended to supersede previous general guidance by the JMPR for estimating such MRLs.

(a) The JMPR continues to rely on the Codex Classification of Foods and Feeds as the primary definitional basis for recommending MRLs for individual or grouped commodities.

(b) The JMPR now generally refrains from estimating maximum residue levels for large Codex 'classes' of foods or feeds such as fruits, vegetables, grasses, nuts and seeds, herbs and spices, or mammalian products, which it has done in the past. Residue data and approved uses are usually more likely to refer to smaller Codex 'groups' such as pome fruits, citrus fruits, root and tuber vegetables, pulses, cereal grains, cucurbit fruiting vegetables, milks, meat of cattle, pigs and sheep, etc. As well as being more likely to be justified by the available data on residues and information on GAP, this is judged to be more in line with national approaches and to afford more accurate estimates of dietary intake.

(c) When adequate residue data are available for only a few primary commodities in a food group, separate MRLs should generally be recommended for each commodity on which the data are considered to be adequate.

(d) In some cases the JMPR may, in the absence of sufficient data for one commodity, use data from a similar crop for which GAP is similar to support estimates of maximum residue levels (e.g. pears and apples or broccoli and cauliflower).

(e) If other considerations permit, data on residues in all or most of the major commodities with the potential for high residues within a group may allow estimates of maximum residue levels to be extrapolated to minor crops in the group. An example of a situation in which other considerations do not permit is that in which the variability of the residue levels is too great, even though data on the major crops within the group are available. A group limit cannot then be established.

(f) When residue levels in a number of commodities in a group vary widely, separate recommendations should be made for each commodity. A limit for a group 'except one or more commodities' which are known to deviate from the norm may be justified (e.g. citrus fruits, except mandarins); in such cases separate MRLs should be estimated for the exceptional commodities.

(g) In order for a group limit to be proposed, not only must residue levels in the major commodities in the group not be too different, but the physical nature and other characteristics of the crops that might influence residue levels, as well as cultural practices and GAP for the individual commodities, must also be taken into account.

(h) Residue data for a crop growing quickly in summer cannot be extrapolated to the same or

related crops growing slowly under less favourable conditions (e.g. from summer to winter squash).

(i) In establishing group MRLs, detailed knowledge of the metabolism or mechanism of disappearance of a pesticide in one or more crops must be taken into account.

(j) Group MRLs recommended by the JMPR that generally appear to be acceptable include those for cereal grains (based on data for maize, wheat barley, oats and rice), stone fruits, poultry meat, milks, meat from mammals other than marine mammals, and oilseed.

(k) A group MRL is generally preferred in the case of citrus fruits, but care must be used in estimating a maximum level for the group because of the large variations in fruit size and in the ratio of peel to pulp in view of the propensity for residues of many pesticides to concentrate in the peel. Data on major members of the group are especially important.

Historically, many more Codex limits have been established for citrus fruits as a group (45 pesticides) than for individual citrus fruits (19 pesticides): lemons (2 pesticides); lemons and limes (1); mandarins (4), sweet and sour oranges (8), sweet oranges (1); shaddocks or pomelos (1); and grapefruit (2).

(l) All else being equal, data on a crop picked when immature may sometimes be extrapolated to a closely related species with a lower surface area:weight ratio at the time of the pesticide application which grows quickly to maturity, resulting in a rapid decrease in the ratio of residue to crop weight (dilution by crop growth). Thus estimates of maximum residue levels can be extrapolated from gherkins to cucumbers, but not *vice versa*.

(m) Individual MRLs can be extrapolated more readily to groups when there is no expectation that terminal residues will occur and when this is supported by studies of metabolism. Examples are early treatments, seed treatments, and treatments of orchard crops with herbicides.

While the JMPR generally adheres to these principles on a case-by-case basis, it recognizes certain difficulties or limitations in the acceptance of group limits at the international level. A primary weakness is the lack of formal criteria or an agreed mechanism to determine the members of a group for which data are needed before a group MRL can be established. One approach that is sometimes used effectively at the national level is to identify commodities of a group (often botanical) that represent both major crops within the group and those most likely to contain the highest residues. The factors used to determine whether a crop is a major or representative member of the group include whether some part or growth stage of it is used for animal feed and its dietary significance as a food or feedstuff.

The premise of this approach is that if data are available for representative crops, and if GAP and cultural practices among the individual members are similar, the residue levels will not vary widely and a maximum residue level can be estimated that will suffice for other members of the group for which no data are available. As noted earlier, this approach constitutes the use of common sense and is more or less dictated by the economics of data generation and evaluation.

While the JMPR recognizes real advantages in this approach, there is unfortunately no

consensus at the international level on the selection of representative commodities for estimating maximum residue levels for groups. Similarly, while the JMPR bases its recommendations on the Codex Classification of Foods and Feeds, this classification has not been fully adopted at the national level in most countries.

There is also no international agreement about which are major and minor commodities. The proposed development by the OECD of minimum database requirements may resolve some of these difficulties, and the JMPR would welcome such a development within the framework of Codex or the OECD.

Until there is more international agreement in this area, the JMPR will continue to make judgements on a case-by-case basis, using the general policy summarized above or as it may be subsequently amended.

2.6 USE BY THE WHO CORE ASSESSMENT GROUP OF NATIONAL EVALUATIONS OF STUDIES

To make use of work that has been performed by other agencies and organizations and to minimize duplication of effort, the Joint Meeting has been encouraged in recent years to make better use of evaluations of studies that have been prepared by national authorities and other organizations. The Meeting agreed that such evaluations should be used to the extent possible.

Detailed evaluations of toxicological studies have been prepared on four substances addressed by the present Meeting: on tebufenozide by the Canadian Pest Management Regulatory Agency, on 2,4-D by the United States Environmental Protection Agency, and on dimethoate and omethoate by the United Kingdom Pesticides Safety Directorate. Preparation of the monographs on these substances for the Meeting was based on the original reports of the studies and other pertinent information and was aided by reference to the national evaluations. However, the Joint Meeting came to independent conclusions about the substances.

The Meeting encouraged the availability of comprehensive evaluations prepared by national authorities and organizations and recommended that they be used to the extent possible by the WHO Core Assessment Group in the future.

2.7 INTERACTIONS OF PESTICIDES

The Meeting was requested at the Twenty-eighth Session of the Codex Committee on Pesticide Residues (ALINORM 97/24, paragraph 97) to consider the possible combined effects of pesticides.

The significance of interactions of pesticides was reviewed by the 1967 JMPR. The 1981 Joint Meeting (report, Section 3.6) gave further consideration to interactions between pesticide residues and concluded that:

- (1) Not only could pesticides interact, but so could all compounds (including those in food) to which man could be exposed. This leads to unlimited possibilities, and there is no special reason why the interactions of pesticide residues (which

are at very low levels) should be highlighted as being of particular concern; (2) very few data on these interactions are available; and (3) the data obtained from acute potentiation studies are of little value in assessing ADIs for man.

The present Meeting noted that effects are not only potentiated, but sometimes mitigated, when two or more pesticides are administered simultaneously to experimental animals. Although a number of studies addressing this issue has been performed since 1981, those that show non-additive effects have been performed at 'effect doses', which are not relevant to mixtures of residues that may be present on food commodities at levels several-fold lower than effect levels.

A reportⁱ was published recently in which a number of compounds with weak oestrogenic activity were screened in a yeast oestrogen system containing human oestrogen receptor. In this assay, combinations of weak environmental oestrogens were up to 1000 times more potent in human oestrogen receptor-mediated transactivation than any chemical alone. While these results are preliminary, possible potentiation should be investigated further to see if the results can be confirmed and, if so, to ascertain their significance in intact biological systems. It should be kept in mind that the food supply contains many pharmacologically active substances, including phyto-oestrogens. The structures and activities of pesticides give no reason to conclude that they have more oestrogenic activity than many naturally occurring phyto-oestrogens. In addition, any interactions that may occur could result in either antagonistic or synergistic effects.

The Meeting concluded that interactions between pesticide residues, other dietary constituents, and environmental contaminants could occur. The results of such interactions depend on many factors, including the chemical and physical nature of the substances, the dose, and conditions of exposure. The outcome, which cannot be predicted reliably, may be enhanced, mitigated, or additive toxicity. The safety factors that are used for establishing ADIs should provide a sufficient margin of safety to account for potential synergism.

2.8 ENVIRONMENTAL CORE ASSESSMENT GROUP

The Environmental Core Assessment Group could not convene with the Toxicological Core Assessment Group and the FAO Panel of Experts on Pesticide Residues in Food and the Environment at the present Meeting because of budgetary restrictions within the International Programme on Chemical Safety (IPCS). Consequently, the assessments of the environmental fate and ecotoxicity of the pesticides that were scheduled have been delayed until 1997.

The Meeting expressed its regret that the Environmental Core Assessment Group was unable to meet in 1996. Because of the importance of the environmental assessments as an integral component of the comprehensive assessment of pesticides, the Meeting recommended to IPCS that it make every effort to obtain the funds necessary for convening the Environmental Core Assessment Group with the JMPR in the future.

3. SPECIFIC PROBLEMS

3.1 DEFINITION OF RESIDUES OF FAT-SOLUBLE COMPOUNDS

The Meeting has for many years included the qualification ‘fat-soluble’ in the definition of the residues of fat-soluble pesticides, using the expression

‘Definition of the residue: [pesticide] (fat-soluble)’

Although previous Meetings recognized that fat-solubility is a property of the residue and not a part of its definition in chemical terms, the practice of treating it as part of the definition had been continued because expression in this way was succinct and because fat-solubility has implications for sampling and analysis, especially of meat and dairy products. As different definitions of residues may be needed for estimating dietary intake and for assessing compliance with MRLs however, the Meeting agreed that ‘fat-soluble’ should no longer be included in the definition of the residue. In order to avoid confusion while conveying the information that a residue is fat-soluble, the Meeting agreed that the definition of a residue should include only the chemical species of concern and a separate sentence should indicate that the residue is fat-soluble.

Example:

Definition of the residue for compliance with MRLs and for estimation of dietary intake:
diazinon.

The residue is fat-soluble.

If the definition of a residue for compliance with MRLs differs from its definition for the estimation of dietary intake, both definitions will be given.

4. EVALUATION OF DATA FOR ACCEPTABLE DAILY INTAKE FOR HUMANS, SUPERVISED TRIALS MEDIAN RESIDUE LEVELS¹ AND MAXIMUM RESIDUE LIMITS

Note

The residue and analytical aspects of the compounds evaluated are reported more briefly than in recent years. The reasons for the change were given in the report of the 1995 JMPR (Section 2.9.3). Full details of the considerations which led to the estimates and recommendations of the Meeting will be given, as before, in the appraisals accompanying the monographs on the individual compounds in the 1996 Evaluations.

4.1 ACEPHATE (095)

RESIDUE AND ANALYTICAL ASPECTS

Acephate was first evaluated in 1976. The 1994 JMPR withdrew the previous recommendations for the MRLs for broccoli, Brussels sprouts, head cabbages, cauliflowers, citrus fruits and tomato which had been held at Step 7B by the 1989 CCPR (ALINORM 89/24A, para 126). The manufacturer indicated that information on GAP and data on residues found in supervised trials would be available to support new MRLs for these commodities.

The Meeting received data on residues from supervised trials on the commodities mentioned above and information on GAP, the stability of residues in stored analytical samples, methods of residue analysis, and the fate of residues during food processing.

The residues of the metabolite methamidophos were also evaluated and separate MRLs recommended to accommodate methamidophos residues arising both from the use of acephate and the use of methamidophos.

The revised recommendations are listed in Annex I.

4.2 ALDICARB (117)

RESIDUE AND ANALYTICAL ASPECTS

Residue aspects of aldicarb were last evaluated in 1994 within the CCPR periodic review programme. In response to the request of the 1994 Meeting extensive new information was provided on residues resulting from the currently recommended uses on bananas and potatoes, the stability of residues in potatoes during commercial storage, the effect of processing on residues in potatoes, and on the revised GAP for potatoes in the USA. The Meeting was informed about ongoing trial programmes on bananas and potatoes.

The trials were with granular formulations of aldicarb. The samples were mainly analyzed by HPLC methods which determined aldicarb, its sulfoxide and its sulfone individually. In some cases the residues were oxidized to, and determined as, the sulfone. The typical limit of determination was about 0.01-0.02 mg/kg for each residue component. The main residue in bananas and potatoes was aldicarb sulfoxide.

In US trials residues were measured in over 6000 individual potato tubers to determine the effects of the mode of application, irrigation method and climatic conditions on the magnitude and distribution of residues in the middle and end sections of the rows. The data showed that the residues in individual tubers could be much higher than in composite samples on which the MRL is based. Since the between-fields variance of residue levels was much larger than the within-field variance, the Meeting could estimate the maximum residue levels on the basis of the averages of residues found in the sites.

The Meeting could not evaluate the results of South African trials as they were provided only in a summarized form.

The available information enabled the Meeting to estimate a maximum residue level and STMR level for potatoes, and to estimate the maximum residues likely to occur in individual potato tubers. STMRs were also estimated for several potato products. The data were insufficient to estimate a maximum residue level for bananas.

FURTHER WORK OR INFORMATION

Desirable

1. Results of supervised trials according to maximum Spanish and South African GAP on potatoes.
2. Residue data on whole bananas and banana pulp reflecting current GAP.
3. Data on the effect of boiling (cooking) on aldicarb residues in potatoes.

4.3 BIFENTHRIN (178)

RESIDUE AND ANALYTICAL ASPECTS

Bifenthrin was first evaluated at the 1992 JMPR and MRLs of 0.05* mg/kg were recommended for barley, maize and wheat to cover field applications. The 1995 JMPR reviewed information about the use of bifenthrin as a grain protectant but made no recommendations and sought further clarification on a number of points.

Information on milling and baking studies on wheat treated with bifenthrin was made available to the Meeting.

No specific information was available on the efficiency of extraction of aged bifenthrin residues from grain by hexane/acetone, but the fact that the bifenthrin residue levels on wheat in storage trials at day 1 were unchanged by week 12 suggests that the solvent adequately extracts aged residues from grain.

Bifenthrin residues were stable on grain stored at 20°C and 25°C and their levels on the grain at the beginning of storage were essentially the same as at the end.

Approximately 16% of the bifenthrin residues were lost in producing wholemeal flour from uncleaned wheat. The bifenthrin level in white flour was about 30% (26-36%), and the level in bran about 3.5 times (3.1-3.8) the level in the uncleaned wheat.

Wholemeal bread and white bread were baked from the wholemeal and white flour produced in the milling studies. The results from these baking trials suggest that about 70% of the bifenthrin disappears on baking wholemeal or white bread. This is not consistent with the behaviour of other pyrethroids, which are mostly retained through the baking process.

The Meeting was reluctant to draw a firm conclusion on the fate of bifenthrin during baking until some aspects of the analytical method had been clarified. Validation of analytical recoveries from bread at the bifenthrin residue levels which occur in practice and at the LOD is needed, as is investigation into the possibility that bifenthrin residues are bound in the bread and not extractable by the current method.

Recommendations for MRLs and estimated STMR levels are listed in Annex I.

FURTHER WORK OR INFORMATION

Desirable

1. Validation of the analytical method for recoveries of bifenthrin residues from bread at the levels occurring in practice and at the LOD.

2. Information on the degree of extraction of bifenthrin residues from bread by the current procedure.
3. Information on national registrations and MRLs for bifenthrin covering its use on stored grain.
4. Information on the fate of bifenthrin during the commercial malting of barley treated with it post-harvest. The studies should simulate the commercial process (from 1995 JMPR).

4.4 CARBARYL (008)

TOXICOLOGY

Carbaryl was evaluated for toxicological effects by the Joint Meeting in 1963, 1965, 1966, 1967, 1969, and 1973. An ADI of 0-0.02 mg/kg bw was established in 1963 on the basis of a one-year study in dogs, and this ADI was confirmed in 1965, 1966, and 1967. In 1969, a temporary ADI of 0-0.01 mg/kg bw was established, using an extra safety factor because of concern about effects on the male reproductive system seen in a one-year study by gavage in rats with an NOAEL of 2 mg/kg bw per day, and because a dose of 0.12 mg/kg bw per day may have affected renal function in a six-week study in volunteers. In 1973, the Meeting established an ADI of 0-0.01 mg/kg bw.

The toxicology of the compound was reviewed by the present Meeting within the CCPR periodic review programme. The evaluation is based on a recent Environmental Health Criteria monograph on carbaryl (EHC 153)ⁱⁱ

MAXIMUM RESIDUE LIMITS

Note

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TOXICOLOGY

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The toxicology of the compound was reviewed by the present Meeting within the CCPR periodic review programme. The evaluation is based on a recent Environmental Health Criteria monograph on carbaryl (EHC 153)ⁱⁱⁱ and is supplemented by newly received studies on metabolism, dermal absorption, chronic toxicity and/or oncogenicity in rats and mice, mechanistic studies, and a report of an epidemiological study on exposed workers.

Carbaryl is rapidly and almost completely absorbed after oral administration. Excretion is rapid and occurs predominantly via the urine; enterohepatic cycling of carbaryl metabolites is also considerable. There were no significant dose-related or sex-specific differences in elimination patterns, and there was no evidence of bioaccumulation. Dermal absorption in rats was slow; after 24 h, 16-34% of the administered radioactivity had been absorbed. Higher doses were less readily absorbed. In volunteers, 45% of a dose applied to the skin in acetone was absorbed within 8 h. Carbaryl was rapidly absorbed in the lungs.

The metabolism of carbaryl has been studied in various mammals, including humans. The principal metabolic pathways are ring hydroxylation, hydrolysis, and conjugation. There were no species differences. The principal metabolite in humans is 1-naphthol. The hydrolysis product, *N*-methylcarbamic acid, spontaneously decomposes to methylamine and carbon dioxide. The methylamine is later converted to carbon dioxide and formate, the latter being excreted mainly in the urine. Carbaryl metabolites are also found at small percentages of the absorbed doses in saliva and milk.

Carbaryl is moderately toxic after acute oral administration, the LD₅₀ in rats being 225-721 mg/kg bw. Interspecies differences in toxicity were found, cats (LD₅₀, 150 mg/kg bw) being the most sensitive. The LD₅₀ was increased threefold when animals were pretreated with small doses of carbaryl. The compound is slightly toxic after acute dermal administration, with an LD₅₀ > 2000 mg/kg bw. No LC₅₀ for acute exposure by inhalation was available, but the effects observed in dogs, cats, and rats exposed to dusts or formulations of carbaryl were typical of those resulting from inhibition of cholinesterase activity. In cats exposed to carbaryl dust for 6 h, a concentration of 20 mg/m³ inhibited cholinesterase activity in plasma and erythrocytes. Carbaryl was weakly irritating to the eye but not the skin and was not considered to be a sensitizer. WHO has classified carbaryl as 'moderately hazardous'.

After the oral administration of carbaryl in capsules to dogs at doses of 0.45, 1.8, or 7.2 mg/kg bw per day for one year, slight effects were observed on the kidney at 7.2 mg/kg bw per day; the NOAEL was 1.8 mg/kg bw per day. In two studies in which dogs were fed diets containing carbaryl at 20-125 ppm for five weeks and 125-1250 ppm for one year, the NOAEL was 125 ppm, equivalent to 3.1 mg/kg bw per day, on the basis of effects on liver weight and inhibition of acetylcholinesterase activity in erythrocytes and brain at 400 ppm.

In cats exposed to carbaryl by inhalation, cholinergic signs were observed at 30 mg/m³ after exposure for 30 days; the NOAEL was 16 mg/m³ after exposure for 120 days. In a study in rats, no effects were observed after exposure to 10 mg/m³ for 90 days.

Several studies of long-term toxicity or carcinogenicity in mice cited in EHC 153 were not considered to be suitable for evaluation of carcinogenicity by either the Environmental

Health Criteria Task Force or the present Meeting, although they were suitable for assessing long-term toxicity. In a recent study of carcinogenicity, mice were given diets providing 0, 100, 1000, or 8000 ppm carbaryl for 104 weeks. Tumours were observed in the liver in females and the kidney in males, and vascular tumours were found in animals of both sexes at the highest dose, which exceeded the maximum tolerated dose (MTD). In male mice, increases in the incidences of vascular tumours were also seen at the two lower doses; after considering all of the available data, the Meeting could not identify an NOAEL for this neoplastic lesion. The NOAEL for non-neoplastic lesions was 100 ppm (equal to 15 mg/kg bw per day), on the basis of inhibition of erythrocyte and brain acetylcholinesterase activity and histopathological changes in the urinary bladder at 1000 ppm. This NOAEL is consistent with the results of the earlier studies. The Meeting concluded that the compound is carcinogenic in mice.

In several studies cited in EHC 153, carbaryl was administered in the diet of rats for 96 days to two years. The most obvious effects were in the kidney at doses of 400 ppm and above. In two one-year studies in rats treated by gavage, effects on the thyroid and on male and female reproductive organs and/or function were observed at doses of 5 mg/kg bw per day and above; the NOAEL was 2 mg/kg bw per day. None of these studies was considered suitable for evaluating carcinogenicity.

In a recent study of long-term toxicity and carcinogenicity, rats were fed diets containing 0, 250, 1500, or 7500 ppm carbaryl for 104 weeks. In animals at the highest dose, which exceeded the MTD, tumours were found in the thyroid in males, in the liver in females, and in the urinary bladder in animals of both sexes. The NOAEL for non-neoplastic findings was 250 ppm, equal to 10 mg/kg bw per day, on the basis of inhibition of erythrocyte and brain acetylcholinesterase and a decrease in mean body weight at 1500 ppm. This NOAEL is consistent with the results of earlier dietary studies. The Meeting concluded that carbaryl is carcinogenic in rats only at levels that exceed the MTD.

The available studies on reproductive toxicity were conducted some time ago and had some deficiencies in relation to currently acceptable scientific standards. In three-generation studies, dietary administration of carbaryl to rats induced reproductive effects (impaired fertility and reduced postnatal survival and growth) at doses above 2000 ppm (equal to 125 mg/kg bw per day); a dose of 100 mg/kg bw per day did not induce maternal toxicity. When carbaryl was administered by gavage, maternal toxicity was not observed at 25 mg/kg bw per day, but both maternal and reproductive toxicity (reduced litter size and viability) were observed at 100 mg/kg bw per day. The Meeting recommended that a new two-generation study of reproductive toxicity be carried out in rats, with special attention to the male reproductive system since effects on this system were observed in some studies of long-term toxicity at gavage doses significantly lower than those evaluated in the dietary studies of reproductive toxicity.

The available studies on developmental toxicity suffered from small group size and had some deficiencies in relation to currently acceptable scientific standards. In two studies in mice, the NOAEL for maternal toxicity was 100 mg/kg bw per day; at 150 mg/kg bw per day, increased litter resorption was found. In rats, administration of carbaryl in the diet for part or all of the gestation period resulted in maternal toxicity at 100 mg/kg bw per day. No overt signs of

fetotoxicity were seen at this dose. In a study in which rats were exposed to carbaryl by gavage and then mated, maternal and embryotoxicity were observed at 100 mg/kg bw per day; no effects were observed at 10 mg/kg bw per day. In guinea-pigs, administration of carbaryl during gestation in the diet or by gavage resulted in an NOAEL for maternal toxicity of 100 mg/kg bw per day. No embryo- or fetotoxicity was observed at 300 mg/kg bw per day, the highest dose tested. In rabbits, teratogenic effects were reported after administration of 200 mg/kg bw per day orally; maternal toxicity was also seen at this dose. In two studies in dogs, maternal toxicity (dystocia, at parturition only) was observed at doses of 3.1 mg/kg bw per day. A variety of birth defects was found after exposure to 5 mg/kg bw per day and above. Thus, the LOAEL for maternal toxicity was 3.1 mg/kg bw per day, and this was the NOAEL for birth defects in the offspring.

The Meeting concluded that carbaryl induces developmental toxicity, manifested as deaths *in utero*, reduced fetal weight, and malformations, but only at doses that cause overt maternal toxicity. The shortcomings of these studies made them inadequate for identifying NOAELs for developmental toxicity that could be used for assessing risk under conditions of exposure other than in the diet.

Carbaryl has been adequately tested in a series of assays *in vitro* and *in vivo*. While chromosomal aberrations have been induced *in vitro* and carbaryl has been shown to disturb spindle fibre mechanisms *in vitro*, there was no evidence from well-conducted experiments that carbaryl is clastogenic *in vivo*. The Meeting concluded that carbaryl is not genotoxic.

The effects of carbaryl on the nervous system are primarily related to cholinesterase inhibition and are usually transitory.

Dietary exposure to doses of 10-20 mg/kg bw per day for 50 days was reported to disrupt learning and performance in rats. In chickens given high doses of carbaryl there was no histological evidence of neurotoxicity.

In controlled studies in volunteers, single oral doses of < 2 mg/kg bw were well tolerated. A single oral dose of 250 mg (about 2.8 mg/kg bw) produced moderate cholinergic symptoms.

In volunteers given repeated daily oral doses over six weeks, the NOAEL was 0.06 mg/kg bw per day, on the basis of an increased ratio of amino acid nitrogen to creatinine in the urine at a dose of 0.13 mg/kg bw per day. This effect may represent a decrease in the ability of the proximal convoluted tubule to reabsorb amino acids. The change was reversible. No inhibition of plasma or erythrocyte cholinesterase activity was observed.

An epidemiological study on carbaryl production workers employed between 1960 and 1978 showed no increase in cancer mortality.

An ADI of 0-0.003 mg/kg bw was established on the basis of the LOAEL of 15 mg/kg bw per day in the study of carcinogenicity in mice, using a safety factor of 5000, which includes an extra safety factor of 50 to account for the presence of vascular tumours at all doses

in male mice. The resulting ADI provides an adequate margin of safety, taking into account the LOAEL in the study of developmental toxicity in dogs and the uncertainties about the effects on the male reproductive system.

A toxicological monograph was prepared, summarizing the data received since the previous Meeting and information from EHC 153.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: NOAEL not identified. Lowest effective dose: 100 ppm, equal to 15 mg/kg bw per day (two-year study of toxicity and carcinogenicity).

Rat: 250 ppm, equal to 10 mg/kg bw per day (two-year study of toxicity and carcinogenicity).

2 mg/kg bw per day (one-year study of toxicity).

Dog: NOAEL not identified. Lowest effective dose: 3.1 mg/kg bw per day (study of developmental toxicity).

1.8 mg/kg bw per day (one-year study of toxicity).

Human: 0.06 mg/kg bw per day (six-week study of toxicity).

Estimate of acceptable daily intake for humans

0-0.003 mg/kg bw

Studies that would provide information useful for the continued evaluation of the compound

1. Study of reproductive toxicity, with special attention to the male reproductive system.
2. Studies of teratogenicity in rats and rabbits.
3. Completion of on-going studies to elucidate the mechanism of tumour formation.
4. Study of developmental neurotoxicity and/or screening for acute or subchronic neurotoxicity.
5. Follow-up of the epidemiological study in workers, taking into consideration the latent period before development of cancer.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to carbaryl

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULTS/REMARKS
Short-term (1-7 days)	Oral toxicity, rat	LD ₅₀ = 225-721 mg/kg bw
	Dermal toxicity, rat	LD ₅₀ > 2000 mg/kg bw
	Dermal irritation, rabbit	Not irritating
	Ocular irritation, rabbit	Slightly irritating
	Dermal sensitization, guinea-pig	Not sensitizing
Medium-term (1-26 weeks)	Repeated oral, five weeks, dog	NOAEL = 3.1 mg/kg bw per day (highest dose tested); no effects on acetylcholinesterase activity
	Repeated oral, six weeks, human	NOAEL = 0.06 mg/kg bw per day; increased ratio of amino acid nitrogen to creatinine in urine
	Inhalation, 90 days, rat	NOAEL = 10 mg/m ³ per day (highest dose tested)
	Inhalation, 120 days, cat	NOAEL = 16 mg/m ³ per day; cholinergic reactions at 30 mg/m ³ after a 30-day exposure
Long-term (≥ one year)	Repeated oral, two years, carcinogenicity, mouse	Vascular tumours in males at 15 mg/kg bw per day, the lowest dose tested
	Repeated oral (gavage), one year, toxicity and carcinogenicity, rat	NOAEL = 2 mg/kg bw per day, effects on thyroid and male and female reproductive organs and/or function
	Repeated oral, two years, toxicity and carcinogenicity, rat	NOAEL = 10 mg/kg bw per day, reduced brain acetylcholinesterase and reduced body weight. Tumours (thyroid, liver, bladder) at 350 mg/kg bw per day, which exceeded the MTD
	Repeated oral (gavage), one year, toxicity, dog	NOAEL = 1.8 mg/kg bw per day, effects on kidney

4.5 CARBOFURAN (096)**TOXICOLOGY**

Carbofuran was evaluated for toxicological effects by the Joint Meeting in 1976, 1979, 1980, and 1982. The 1980 Meeting established an ADI of 0-0.01 mg/kg bw, which was confirmed in 1982. The compound was re-evaluated at the present Meeting within the CCPR periodic review programme.

Carbofuran is rapidly absorbed, metabolized, and eliminated, mainly in the urine, after oral administration to mice and rats. After oral administration of [*phenyl*-¹⁴C]carbofuran to rats, 92% of the radiolabel was eliminated in the urine and 3% in the faeces. Most of the radiolabel was eliminated within 24 h after treatment. With the [¹⁴C]carbonyl-labelled compound, 45% was eliminated as [¹⁴C]carbon dioxide. The metabolic pathway involves hydroxylation, hydrolysis, oxidation and conjugation.

Carbofuran is highly toxic after acute oral administration. The oral LD₅₀ values in various species ranged from 3 to 19 mg/kg bw. Carbofuran had no sensitizing potential in guinea-pigs, and no local irritation was found in rabbits after repeated dermal applications over 7 or 21 days. WHO has classified carbofuran as 'highly hazardous'.

In a 13-week study in dogs fed diets providing 0, 10, 70, or 500/250 ppm carbofuran (dose reduced because of marked toxicity), an NOAEL was not identified because inhibition of erythrocyte acetylcholinesterase activity and some clinical signs were observed at the lowest dose. In a subsequent four-week study in dogs, the only dose administered was 5 ppm, equal to 0.22 mg/kg bw per day, which was the NOAEL for clinical signs, mortality, body weight, food consumption, and cholinesterase activity in plasma and erythrocytes. In a one-year study in dogs at dietary concentrations of 0, 10, 20, or 500 ppm, the NOAEL was 10 ppm, equal to 0.3 mg/kg bw per day, on the basis of histopathological testicular changes in a single male at 20 ppm; similar changes were observed in animals at 500 ppm. There was no inhibition of erythrocyte or brain acetylcholinesterase at concentrations of 10 or 20 ppm. The overall NOAEL in these short-term studies in dogs was 5 ppm, equal to 0.22 mg/kg bw per day.

In two-year studies of toxicity and carcinogenicity at dietary concentrations of 0, 20, 125, or 500 ppm in mice and 0, 10, 20, or 100 ppm in rats the NOAELs were 20 ppm, equal to 2.8 mg/kg bw per day, in mice and 20 ppm, equivalent to 1 mg/kg bw per day, in rats, on the basis of inhibition of erythrocyte and brain acetylcholinesterase activity. There was no evidence of tumorigenicity.

In a three-generation study of reproductive toxicity in rats at dietary concentrations of 0, 20, or 100 ppm, the NOAEL was 20 ppm, equal to 1.6 mg/kg bw per day, on the basis of reduced body-weight gain in parental animals and reduced pup growth and pup survival at 100 ppm.

In an early study of developmental toxicity, rats were given carbofuran at doses of 0, 0.1, 0.3, or 1 mg/kg bw per day by gavage. An NOAEL could not be identified in this study. Dose-dependent transient clinical signs (chewing motions) were observed in the dams. In a later study in rats at oral doses of 0, 0.25, 0.5, or 1.2 mg/kg bw per day the NOAEL for maternal and fetal toxicity was 1.2 mg/kg bw per day, the highest dose tested. In a further study of teratogenicity in rats, with dietary administration of 0, 20, 60, or 160 ppm carbofuran, the NOAEL for maternal toxicity was 20 ppm, equal to 1.5 mg/kg bw per day, on the basis of a reduction in body-weight gain at 60 ppm. The NOAEL for pup toxicity, based on reduced pup weight, was 60 ppm, equal to 4.4 mg/kg bw per day. None of the studies showed teratogenic potential.

The results of an early study of developmental toxicity in rabbits at oral doses of 0, 0.2, 0.6, or 2 mg/kg bw per day showed an NOAEL of 0.6 mg/kg bw per day for maternal toxicity on the basis of clinical signs, and an NOAEL of 2 mg/kg bw per day for fetotoxicity and teratogenicity. In a subsequent study in rabbits at doses of 0, 0.12, 0.5, or 2 mg/kg bw per day, the NOAEL was 0.5 mg/kg bw per day on the basis of slightly reduced body-weight gain in dams and a slightly increased incidence of skeletal variations in pups at 2 mg/kg bw per day. These studies provided no evidence of teratogenicity.

In a 90-day study of neurotoxicity in rats at dietary concentrations of 0, 50, 500, or 1000 ppm, systemic toxicity (reduction in body-weight gain) was observed at all doses. Clinical signs of neurotoxicity were observed at 500 and 1000 ppm. No histopathological lesions in the nervous system were observed.

In a study of developmental neurotoxicity, carbofuran was administered in the diet to provide concentrations of 0, 20, 75, or 300 ppm from gestation day 6 through lactation day 10. Reductions in body-weight gain in dams and pups and in pup survival and some evidence of delayed pup development were found at 75 ppm and higher. The NOAEL was 20 ppm, equal to 1.7 mg/kg bw per day, on the basis of reduced body-weight gain in dams and signs of fetotoxicity at higher doses.

Carbofuran has been tested for genotoxicity in a wide range of tests *in vivo* and *in vitro*. The Meeting concluded that it is not genotoxic.

An ADI of 0-0.002 mg/kg bw was allocated on the basis of the NOAEL for erythrocyte acetylcholinesterase inhibition of 0.22 mg/kg bw per day in a four-week study in the most sensitive species, the dog, using a 100-fold safety factor. The use of a short-term study to determine the ADI was justified because the effect observed was reversible and acute.

A toxicological monograph was prepared, summarizing the data received since the previous evaluation and including summaries from the previous monograph.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: 20 ppm, equal to 2.8 mg/kg bw per day (two-year study of toxicity and carcinogenicity)

Rat: 20 ppm, equivalent to 1 mg/kg bw per day (two-year study of toxicity and carcinogenicity)

20 ppm, equal to 1.2 mg/kg bw per day (three-generation study of reproductive toxicity)

1.2 mg/kg bw per day (highest dose tested in a study of developmental toxicity)

20 ppm, equal to 1.5 mg/kg bw per day (study of developmental toxicity)

20 ppm, equal to 1.7 mg/kg bw per day (study of developmental neurotoxicity)

Rabbit: 0.6 mg/kg bw per day (study of developmental toxicity)

Dog: 5 ppm, equal to 0.22 mg/kg bw per day (four-week study of toxicity)

Estimate of acceptable daily intake for humans

0-0.002 mg/kg bw

Studies that would provide information useful for the continued evaluation of the compound

Further observations in humans.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to carbofuran

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULT, REMARKS
Short-term (1-7 days)	Oral toxicity, rat	LD ₅₀ = 6-14 mg/kg bw
	Dermal toxicity, rat	LD ₅₀ >500 mg/kg bw
	Inhalation toxicity, rat	LC ₅₀ = 0.088-0.1 mg/litre
	Dermal irritation, rabbit	Not irritating
	Ocular irritation, rabbit	Not available
	Dermal sensitization, guinea-pig	Not sensitizing
Medium-term (1-26 weeks)	Repeated oral, 4 weeks, toxicity, dog	NOAEL = 0.22 mg/kg bw per day

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULT, REMARKS
	Repeated oral, reproductive toxicity, rat	NOAEL = 1.6 mg/kg bw per day, parental and pup toxicity
	Repeated oral (gavage), developmental toxicity, rat	NOAEL = 1.2 mg/kg bw per day (highest dose tested). No evidence of teratogenicity
	Repeated oral (feeding), developmental toxicity, rat	NOAEL = 1.5 mg/kg bw per day, maternal toxicity
	Repeated oral, developmental toxicity, rabbit	NOAEL = 0.6 mg/kg bw per day, maternal toxicity. No evidence of teratogenicity
	Repeated oral, developmental neurotoxicity, rat	NOAEL = 1.7 mg/kg bw per day
Long-term (≥ one year)	Repeated oral, two years, carcinogenicity, mouse	NOAEL = 2.8 mg/kg bw per day, cholinesterase inhibition. No evidence of carcinogenicity
	Repeated oral, two years, carcinogenicity, rat	NOAEL = 1 mg/kg bw per day, reduced body-weight gain and cholinesterase inhibition. No evidence of carcinogenicity.

4.6 CHLORFENVINPHOS (014)

RESIDUE AND ANALYTICAL ASPECTS

Chlorfenvinphos was evaluated for residues by the JMPR in 1971 and 1984 and is now being reviewed in the CCPR periodic review programme. It is a contact and soil-applied organophosphorus insecticide used for the control of various pests on a range of vegetable, cereal and oilseed crops. A use for cattle dipping was also reported.

The Meeting received information on physico-chemical properties of the technical material, metabolism, environmental fate in soil, methods of residue analysis, approved use patterns, supervised residue trials, animal transfer studies, the fate of residues during food processing, monitoring data and national MRLs.

Data on metabolism in humans, rats, dogs, lactating cattle, potatoes, cabbage, maize, carrots and onions were reviewed; in all cases the main residue was chlorfenvinphos. These studies, as well as those on the environmental fate, were old and briefly reported with limited

experimental detail. No data on the mobility of chlorfenvinphos in soil were submitted.

Analyses of crop and soil samples for chlorfenvinphos and its metabolites were based on GLC with FP, EC or NP detection. Only limited data on validation of the methods were presented. No information was provided on the stability of residues in stored analytical samples.

Data on residue trials on a number of crops were submitted. Several of the reports of the trials lacked important experimental details or were poorly presented. The Meeting estimated maximum residue levels for onion, head cabbage, cauliflower, carrot, parsnip and rape seed, but these estimates were based mainly on trials in which the duration of sample storage before analysis was not reported.

Summary data on residues in lettuce and lamb's lettuce grown as rotational crops indicated that significant residues may occur in rotational crops after soil applications of chlorfenvinphos.

In studies of ruminant grazing and external treatment, measurable residues were found only in samples of 'fat'.

Data on domestic preparation and processing indicated that most of the residue in carrots is associated with the top of the carrot including the crown.

The Meeting agreed that in view of the lack of studies according to modern standards on metabolism, the stability of residues in stored analytical samples, the mobility of chlorfenvinphos in soil and the residues found in following crops, the estimated maximum residue levels could not be recommended as MRLs. For any future consideration of MRLs, the submission of data on such studies would be needed. The Meeting recommended the withdrawal of the existing CXLs.

FURTHER WORK OR INFORMATION

Desirable

1. The following physico-chemical properties of the pure active ingredient:
vapour pressure, melting point, octanol/water partition coefficient, solubility in organic solvents, solubility in water, specific gravity.
2. If significant residues occur in relevant feed items, a study of metabolism and distribution in a lactating ruminant and/or in laying poultry carried out according to modern standards in which treatment is made through oral ingestion.
3. Data on metabolism in a ruminant after the external application of chlorfenvinphos to support the reported approved dipping use in Australia.
4. Plant metabolism and translocation studies carried out according to modern standards.

5. Studies on the stability of pesticide residues in representative analytical samples stored for at least two years. These would help to support data evaluated by the Meeting on residue trials for which the duration of sample storage was not reported.
6. Studies to assess the nature and levels of residues in representative rotational crops other than lettuce and lamb's lettuce.
7. If significant residues are found in animal feed, a transfer study on ruminants according to modern standards (see 1993 JMPR report, Section 2.7).
8. A study of the mobility of chlorfenvinphos in soil, including leaching, adsorption and desorption, according to modern standards.
9. Copies of the product labels supporting the information submitted on GAP.
10. The full reports of the rotational crop studies on lamb's lettuce and lettuce.

4.7 2,4-D (020)

TOXICOLOGY

2,4-D, 2,4-dichlorophenoxyacetic acid, was evaluated for toxicological effects by the JMPR in 1970, 1971, 1974, and 1975. The 1970 Joint Meeting did not establish an ADI because of the absence of long-term studies. The 1971 Meeting established an ADI of 0-0.3 mg/kg bw on the basis of an NOAEL of 31 mg/kg bw per day in a two-year dietary study in rats. The ADI was not changed by the 1974 Joint Meeting and was reaffirmed by the 1975 Meeting. The compound was reviewed at the present Meeting within the CCPR periodic review programme.

2,4-D was rapidly absorbed, distributed, and excreted after oral administration to mice, rats, and goats. At least 86-94% of an oral dose was absorbed from the gastrointestinal tract in rats. Once absorbed, 2,4-D was widely distributed throughout the body, but did not accumulate because of its rapid clearance from the plasma and rapid urinary excretion. 2,4-D was excreted rapidly and almost exclusively (85-94%) in urine by 48 h after treatment, primarily as unchanged 2,4-D. No metabolites have been reported apart from conjugates. Pharmacokinetic studies with salts and esters of 2,4-D have shown that the salts dissociate and the esters are rapidly hydrolysed to 2,4-D. The similarity in the fate of 2,4-D and its salts and esters explains their similar toxicities.

In humans who have ingested 2,4-D, it was quickly absorbed and excreted rapidly in the urine; about 73% of the administered dose was found in the urine after 48 h. No metabolites were detected.

After dermal applications of 2,4-D to volunteers, 5.8% of the dose was absorbed within 120 h. When the acid and its dimethylamine (DMA) salt were applied, 4.5% of the acid and 1.8% of the salt were absorbed, and of this 85% of the acid and 77% of the salt were recovered in the urine 96 h after application.

2,4-D, its amine salts and its esters are slightly toxic when administered orally or dermally, the oral LD₅₀ values being 400-2000 mg/kg bw and the dermal LD₅₀ value generally exceeding 2000 mg/kg bw. In rats exposed to 2,4-D at the maximum attainable concentration (up to 5.4 mg/litre) by inhalation for 4 h, no deaths were seen. While 2,4-D and its amine salts and esters do not induce dermal irritation in rabbits or dermal sensitization in guinea-pigs, they cause severe eye irritation in rabbits. WHO has classified 2,4-D as 'moderately hazardous'.

In mice fed diets that provided 2,4-D at doses of 0, 5, 15, 45, or 90 mg/kg bw per day for three months, renal lesions were observed in animals of both sexes at all doses. An NOAEL was not identified.

In mice fed diets that provided doses of 2,4-D of 0, 1, 15, 100, or 300 mg/kg bw per day for 90 days, treatment-related changes were observed in animals of both sexes at 100 mg/kg bw per day and above. These effects included decreases in glucose level in females, decreases in thyroxine activity in males, and increases in absolute and relative kidney weights in males. The NOAEL was 15 mg/kg bw per day.

In rats fed diets providing doses of 2,4-D of 0, 1, 5, 15 or 45 mg/kg bw per day for 90 days, renal lesions were observed at 5 mg/kg bw per day and above. The NOAEL was 1 mg/kg bw per day.

In rats fed diets providing doses of 2,4-D of 0, 1, 15, 100, or 300 mg/kg bw per day for 90 days, treatment-related changes were observed in animals of both sexes at 100 mg/kg bw per day and above. These effects included decreases in body-weight gain, haematological and clinical chemical alterations, changes in organ weights, and histopathological lesions in the adrenals, liver, and kidneys. The NOAEL was 15 mg/kg bw per day.

In six studies of toxicity rats fed diets containing the diethanolamine (DEA), DMA, isopropylamine (IPA), or tri-isopropanolamine (TIPA) salt or the butoxyethylhexyl (BEH) or 2-ethylhexyl (EH) ester at acid-equivalent doses of 0, 1, 15, 100, or 300 mg/kg bw per day for 13 weeks, the results demonstrated the comparable toxicity of the acid, salts and esters. The NOAEL was 15 mg acid equivalent per kg bw per day for all six compounds.

Dogs were given gelatin capsules containing 2,4-D at 0, 0.3, 1, 3, or 10 mg/kg bw per day or diets containing 2,4-D, the DMA salt, or the EH ester at acid-equivalent doses of 0, 0.5, 1, 3.8, or 7.5 mg/kg bw per day for 13 weeks. Treatment-related findings were observed in the three studies at 3 mg/kg bw per day and above. The NOAEL was 1 mg acid equivalent per kg bw per day in all three studies.

In a two-year study of toxicity and carcinogenicity, mice were fed diets providing doses of 2,4-D of 1, 15, or 45 mg/kg bw per day. Increases in absolute and/or relative kidney weights

and renal lesions were observed at 15 and 45 mg/kg bw per day. There was no evidence of carcinogenicity. The NOAEL was 1 mg/kg bw per day.

In another two-year study of toxicity and carcinogenicity, mice were fed diets providing doses of 2,4-D of 0, 5, 62, or 120 mg/kg bw per day (males) or 0, 5, 150, or 300 mg/kg bw per day (females). Dose-related increases in absolute and/or relative kidney weights and renal lesions were observed in animals of both sexes at 62 mg/kg bw per day and above. There was no evidence of carcinogenicity. The NOAEL was 5 mg/kg bw per day.

In another two-year study, rats received diets providing doses of 2,4-D of 0, 1, 5, 15, or 45 mg/kg bw per day. Renal lesions were observed in animals of both sexes at 5 mg/kg bw per day and above. There was no evidence of carcinogenicity. The NOAEL was 1 mg/kg bw per day.

In a further two-year study, rats were fed diets providing doses of 2,4-D of 0, 5, 75, or 150 mg/kg bw per day. Treatment-related effects were observed in animals of both sexes at 75 mg/kg bw per day and above. The effects included decreases in body-weight gain and food consumption, increases in serum alanine and aspartate aminotransferase activities, decreased thyroxine concentrations, increases in absolute and relative thyroid weights and histopathological lesions in the eyes, kidneys, liver, lungs, and mesenteric fat. There was no evidence of carcinogenicity. The NOAEL was 75 mg/kg bw per day in males and 5 mg/kg bw per day in females.

Dogs were fed diets providing doses of 2,4-D of 0, 1, 5, or 7.5 mg/kg bw per day for 52 weeks. At 5 and 7.5 mg/kg bw per day body-weight gain was decreased, increases were observed in blood urea nitrogen, creatinine, alanine aminotransferase activity, and cholesterol, and histopathological lesions were observed in the kidneys and liver. The NOAEL was 1 mg/kg bw per day.

In a two-generation study of reproductive toxicity, rats received dietary doses of 2,4-D of 0, 5, 20, or 80 mg/kg bw per day. Reduced body weight in F₁ dams and renal lesions in F₀ and F₁ adults were observed at 20 and 80 mg/kg bw per day. The NOAEL for parental and reproductive toxicity was 5 mg/kg bw per day.

In order to evaluate the dermal toxicity of 2,4-D and its salts and esters, rabbits received 15 dermal applications of the acid, the DEA, DMA, IPA, or TIPA salt or the BEH or EH ester at acid-equivalent doses of 0, 10, 100, or 1000 mg/kg bw per day for 6 h per day on five days per week for 21 days. No systemic toxicity was observed at any dose, and no dermal toxicity was observed with the acid, the TIPA salt, or the BEH ester. Dermal lesions were observed in rabbits treated with the DEA, DMA, or IPA salt, or the EH ester at 100 mg/kg bw per day and above. The lesions were characterized as acanthosis, hyperkeratosis, oedema, inflammation, and epidermal hyperplasia. The NOAEL was 10 mg acid equivalent per kg bw per day for dermal toxicity and 1000 mg acid equivalent per kg bw per day (the highest dose tested) for systemic toxicity.

In a study of developmental toxicity, pregnant Sprague-Dawley rats were given 2,4-D

in corn oil by gavage at doses of 12, 25, 50, 75, or 88 mg/kg bw per day during days 6-15 of gestation. There was no maternal toxicity. Fetotoxicity was manifested as decreased fetal body weights at 50 mg/kg bw per day and above. The NOAELs were 88 mg/kg bw per day for maternal toxicity and 25 mg/kg bw per day for developmental toxicity.

In a further study, pregnant Fischer 344 rats received 2,4-D in corn oil by gavage at doses of 8, 25, or 75 mg/kg bw per day during days 6-15 of gestation. Decreased body-weight gain of the dams during the dosing period and increased incidences of skeletal variations (7th cervical and 14th rudimentary ribs and missing sternbrae) were observed at 75 mg/kg bw per day. The NOAEL was 25 mg/kg bw per day for both maternal and developmental toxicity.

The developmental toxicity of the DEA, DMA, IPA, and TIPA salts and the BEH and EH esters was evaluated in pregnant rats after oral administration during days 6-15 of gestation. The acid-equivalent doses were 11, 55, or 110 mg/kg bw per day for the DEA salt; 12, 50, or 100 mg/kg bw per day for the DMA salt; 9, 25, or 74 mg/kg bw per day for the IPA salt; 12, 37, or 120 mg/kg bw per day for the TIPA salt; 17, 50, or 120 mg/kg bw per day for the BEH ester; and 10, 30, or 90 mg/kg bw per day for the EH ester. The maternal and developmental toxicities of the salts and esters of 2,4-D were comparable to those of the acid. Maternal toxicity, as evidenced by reduced body-weight gain during treatment, was observed in all dams at the high dose of each compound; in addition, mortality, clinical signs, and reduced food consumption were observed in dams given 120 mg/kg bw TIPA salt per day. Although embryo- and fetotoxicity and teratogenicity were observed with the high dose of the TIPA salt, this may be attributed to maternal toxicity; none of the other compounds had such effects. No external gross or visceral anomalies (malformations or variations) were observed in any of the fetuses, but skeletal variations were observed at the high dose of each compound except the IPA salt which were similar to those seen in the fetuses of dams given the acid. The overall NOAELs were approximately 10 mg acid equivalent per kg bw per day for maternal toxicity and 50 mg acid equivalent per kg bw per day for developmental toxicity.

In a study of developmental toxicity, pregnant rabbits were given 2,4-D orally at 0, 10, 30, or 90 mg/kg bw per day during days 6-18 of gestation. Maternal toxicity, which included clinical signs, abortions, and reduced body-weight gain during and after the treatment period, was observed only at the high dose. No gross, visceral, or skeletal malformations or variations were observed in the fetuses at any dose. The NOAELs were 30 mg/kg bw per day for maternal toxicity and 90 mg/kg bw per day (the highest dose tested) for developmental toxicity.

The developmental toxicity of the DEA, DMA, IPA, and TIPA salts and the BEH and EH esters was evaluated in rabbits after oral administration during days 6-18 of gestation. The acid-equivalent doses were 10, 30, or 60 mg/kg bw per day for the DEA salt; 10, 30, or 90 mg/kg bw per day for the DMA salt; 13, 38, or 95 mg/kg bw per day for the IPA salt; and 10, 30, or 75 mg/kg bw per day for the TIPA salt and the BEH and EH esters. Unlike 2,4-D, which produced maternal toxicity only at the high dose, most of the amine salts and the esters were maternally toxic at the middle and high doses, as evidenced by mortality, clinical signs of neurotoxicity, abortions, and decreases in body-weight gain. No gross, visceral, or skeletal malformations or variations were observed in the fetuses at any dose. The overall NOAELs

were approximately 10 mg acid equivalent per kg bw per day for maternal toxicity and 90 mg acid equivalent per kg bw per day (the highest dose tested) for developmental toxicity.

In summary, of the four salts tested for developmental toxicity only the TIPA salt exhibited developmental toxicity in rats and only at a maternally toxic dose; no developmental toxicity was observed in rabbits with this or the other salts. Consequently, the Meeting concluded that the developmental toxicity of the TIPA salt is of little concern.

The genotoxic potential of 2,4-D has been adequately evaluated in a range of assays *in vivo* and *in vitro*. Overall, the responses observed indicate that 2,4-D is not genotoxic, although conflicting results were obtained for mutation in *Drosophila*. In a more limited range of assays, the DEA, DMA, IPA, and TIPA salts and the BEH and the EH esters were not genotoxic *in vivo* or *in vitro*. The Meeting concluded that 2,4-D and its salts and esters are not genotoxic.

In rats given single doses of 2,4-D of 0, 15, 75, or 250 mg/kg bw by gavage, there were no treatment-related gross or neuropathological changes at any dose. Animals of both sexes at the highest dose exhibited inco-ordination and gait abnormalities on day 1, but the signs disappeared by day 5. The NOAEL was 75 mg/kg bw. When rats were fed diets containing 2,4-D at doses of 0, 5, 75, or 150 mg/kg bw per day for 12 months neurotoxicity, manifested as increased relative forelimb grip strength, was observed in animals of both sexes at 150 mg/kg bw per day. The NOAEL was 75 mg/kg bw per day.

Epidemiological studies have suggested an association between the development of soft-tissue sarcoma and non-Hodgkin's lymphoma and exposure to chlorophenoxy herbicides, including 2,4-D. The results of these studies are not, however, consistent; the associations found are weak, and conflicting conclusions have been reached by the investigators. Most of the studies did not provide information on exposure specifically to 2,4-D, and the risk was related to the general category of phenoxy herbicides, a group that includes 2,4,5-T which can be contaminated with dioxins. Case-control studies provide little evidence of an association between the use of 2,4-D and soft-tissue sarcomas. Although some case-control studies have shown a relationship with non-Hodgkin's lymphoma others (even the positive studies) have produced inconsistent results, raising doubt about the causality of the relationship. Cohort studies of exposed workers have not confirmed the hypothesis that 2,4-D causes either neoplasm.

The Meeting was informed of the on-going "Agricultural Health Study" initiated in North Carolina and Iowa, and of a study of pesticide applicators in Finland. The Agricultural Health Study addresses both cancer and non-cancer risks, including neurotoxicity, reproductive effects, immunological effects, kidney disease, non-malignant respiratory disease, and growth and development of children, in men and women directly exposed to pesticides and other agricultural agents.

The Meeting concluded that the toxicities of the salts and esters of 2,4-D were comparable to that of the acid. An ADI was therefore established for the sum of 2,4-D and its salts and esters, expressed as 2,4-D. An ADI of 0-0.01 mg/kg bw was established on the basis of the NOAEL of 1 mg/kg bw per day in the one-year study of toxicity in dogs and the two-

year study in rats, using a safety factor of 100.

A toxicological monograph was prepared, summarizing the data received since the previous evaluation and including summaries from the previous monograph and monograph addenda.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: 15 mg/kg bw per day (13-week study of toxicity)

5 mg/kg bw per day (two-year study of toxicity and carcinogenicity)

Rat: 1 mg/kg bw per day (two-year study of toxicity and carcinogenicity)

5 mg/kg bw per day (two-generation study of reproductive toxicity)

10 mg acid-equivalent/kg bw per day (maternal toxicity in a series of studies of developmental toxicity with salts and esters)

15 mg acid-equivalent/kg bw per day (series of 13-week studies of toxicity with salts and esters)

25 mg/kg bw per day (maternal and developmental toxicity in a study of developmental toxicity)

Rabbit: 10 mg acid-equivalent/kg bw per day (maternal toxicity in a series of studies of developmental toxicity with salts and esters)

30 mg/kg bw per day (maternal toxicity in a study of developmental toxicity)

90 mg acid-equivalent/kg bw per day (highest dose tested in studies of developmental toxicity with the acid and its salts and esters)

Dog: 1 mg/kg bw per day (13-week and one-year studies of toxicity)

Estimate of acceptable daily intake for humans

0-0.01 mg/kg bw (sum of 2,4-D and its salts and esters expressed as 2,4-D)

Studies that would provide information useful for the continued evaluation of the compound

1. Follow-up of the Agricultural Health Study in North Carolina and Iowa in the USA.
2. Follow-up of the study of pesticide applicators in Finland.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to 2,4-dichlorophenoxyacetic acid and its amine salts and esters.

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULTS, REMARKS
Short-term (1-7 days)	Oral toxicity, rat (acid, salts and esters)	LD ₅₀ = 400-2000 mg/kg bw
	Dermal toxicity, rabbit (acid, salts and esters)	LD ₅₀ >2000 mg/kg bw
	Inhalation toxicity, rat (acid, salts and esters)	LC ₅₀ >0.84-5.4 mg/litre
	Dermal irritation, rabbit (acid, salts and esters)	Not irritating
	Ocular irritation, rabbit (acid, salts and esters)	Severely irritating
	Dermal sensitization, guinea-pig (acid, salts and esters)	Not sensitizing
	Oral, single dose, neurotoxicity, rat (acid)	NOAEL = 75 mg/kg bw
Medium-term (1-26 weeks)	Dietary, three months, toxicity, mouse	NOAEL = 15 mg/kg bw per day, renal toxicity
	Dietary, three months, toxicity, rat	NOAEL = 1 mg/kg bw per day, renal lesions
	Dietary, three months, toxicity, rat (salts and esters)	NOAEL = 15 mg/kg acid-equivalent/kg bw per day, renal toxicity
	Dietary or capsule, three months, toxicity, dog	NOAEL = 1 mg acid-equivalent/kg bw per day, reduced body-weight gain and other systemic toxicity
	Dermal, 21 days, repeated dose, rabbit (acid, salts and esters)	NOAEL = 1000 mg acid-equivalent/kg bw per day, highest dose tested
	Dietary, two generations, reproductive toxicity, rat	NOAEL = 5 mg/kg bw per day, reduced body weights in F ₁ dams and renal lesions in F ₀ and F ₁ adults
	Oral, gavage, developmental toxicity, rat	NOAEL = 25 mg/kg bw per day, maternal and developmental toxicity
	Oral, gavage, developmental toxicity, rat (salts and esters)	NOAEL = 10 mg acid-equivalent/kg bw per day for maternal toxicity and 50 mg acid-equivalent/kg bw per day for developmental toxicity
	Oral, gavage, developmental toxicity, rabbit	NOAEL = 30 mg/kg bw per day, maternal toxicity; >90 mg/kg bw per day, developmental toxicity
	Oral, gavage, developmental toxicity, rabbit (salts and esters)	NOAEL = 10 mg acid-equivalent/kg bw per day for maternal toxicity; 90 mg acid-equivalent/kg bw per day (highest dose

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULTS, REMARKS
		tested) for developmental toxicity
Long-term (≥ one year)	Dietary, two years, toxicity and carcinogenicity, mouse	NOAEL = 5 mg/kg bw per day, renal effects; no evidence of carcinogenicity
	Dietary, two years, toxicity and carcinogenicity, rat	NOAEL = 1 mg/kg bw per day, renal lesions; no evidence of carcinogenicity
	Dietary, one year, toxicity, dog	NOAEL = 1 mg/kg bw per day, changes in serum chemistry and lesions in kidneys and liver

4.8 DDT (021)

RESIDUE AND ANALYTICAL ASPECTS

DDT was first evaluated in 1966 and has been reviewed several times since. The 1993 and 1994 Meetings proposed ERLs for carrots, eggs, meat and milks and confirmed the existing ERL for cereal grains. The 1995 CCPR was informed that additional data on residues in meat were available from Australia, New Zealand and the USA and decided to keep the proposal for meat (1 mg/kg in the fat) at Step 3 pending the evaluation of these data by the 1996 JMPR. The 28th Session of the CCPR (1996) advanced all ERLs except that for meat to Step 8. The existing temporary CXL for meat (from mammals other than marine mammals) is 5 mg/kg (fat).

The Meeting received data on residues in meat from national residue surveys in Australia, Germany, New Zealand, Norway, Thailand, the UK and the USA.

In all, 162,102 samples of meat fat were analyzed in Australia, Germany, Norway, Thailand, the UK and the USA, and residues above 1 mg/kg were found in 85 samples (0.05%). Residues found in New Zealand were of another data population: 1.6% of the 4682 samples analyzed (lambs, adult sheep, adult bovines, suckling calves, pigs, deer and goats) were higher than the proposed ERL of 1 mg/kg, 0.53% were higher than 2 mg/kg and 0.04% higher than 5 mg/kg.

On the basis of the data on residues received from the government of New Zealand, the Meeting concluded that the temporary CXL of 5 mg/kg for meat (fat) should be confirmed.

4.9 DIAZINON (022)

RESIDUE AND ANALYTICAL ASPECTS

Diazinon was first evaluated by the 1965 JMPR and has been reviewed several times since. In 1993 a periodic review was conducted and in 1994 a new MRL was recommended for hops. The 1993 JMPR recommended, among other items, an increase in the CXL for pome fruits from 0.5 to 2 mg/kg and the withdrawal of the CXLs for animal commodities in the absence of animal transfer studies and data from uses to control ectoparasites.

The CCPR in 1995 and 1996 endorsed most of the recommendations of the 1993 JMPR with the exception of the proposed MRL for pome fruits and the recommended withdrawal of the CXLs for milks and the meat of cattle, pigs and sheep. The main focus of the present evaluation was the review of new submissions in support of MRLs for animal products: the Meeting also estimated STMR levels for pome fruits, tomatoes and cabbages (0.12, 0.12 and 0.16 mg/kg respectively) for dietary intake predictions, on the basis of data published in the 1993 Evaluations, in response to concerns raised at the CCPR. The Meeting understood that new trials according to current (revised) US GAP might support a lower MRL for pome fruits than the 1993 JMPR recommendation. The manufacturer expects to be able to submit data from these trials together with the relevant GAP when reports of new supervised trials with diazinon used for the control of ectoparasites are submitted in 1998.

The Meeting reviewed information on current GAP, new and previously submitted metabolism studies and analytical methods, new residue transfer studies with poultry and cattle, and new and previously submitted data from supervised trials of ectoparasite control in cattle and sheep using a variety of application methods. Many of the older supervised trials were not acceptable by current standards and in most cases acceptable data were available only for single treatments whereas GAP allows multiple applications. The Meeting was able to estimate a number of maximum residue levels, but considered additional information on GAP to be highly desirable.

Maximum residue levels recommended for use as MRLs, together with estimated STMR levels, are recorded in Annex I.

FURTHER WORK OR INFORMATION

Desirable

1. Studies of the stability of diazinon, diazoxon and hydroxydiazinon in stored analytical samples of meat, fat, edible offal, milk and eggs.
2. Modern dipping and spray trials on sheep and cattle at maximum GAP rates and including multiple dips and sprays. Analyses for diazinon residues in milk, muscle, edible offal and fat (kidney, omental and especially subcutaneous fat) would be desirable, as well as analyses for diazoxon and hydroxydiazinon in addition to diazinon.
3. Data from monitoring analyses of subcutaneous fat of sheep for diazinon, ideally sheep known to have received multiple dip or spray applications at maximum GAP rates.

4. Submission, when the new supervised trials of ectoparasite control are submitted in 1998, of information on current US GAP for pome fruits and cabbages and data from recently completed US supervised trials reflecting that GAP.

4.10 DIMETHOATE, OMETHOATE, AND FORMOTHION (027, 055, 042)

TOXICOLOGY

Dimethoate was previously evaluated for toxicological effects by the Joint Meeting in 1963, 1965, 1967, 1984, and 1987. In 1987, an ADI of 0-0.01 mg/kg bw was established, on the basis of a no-effect level of 0.2 mg/kg bw per day for the inhibition of erythrocyte acetylcholinesterase in volunteers. The compound was reviewed at the present Meeting within the CCPR periodic review programme.

Omethoate (the oxygen analogue of dimethoate, which has been used as a pesticide in its own right) was evaluated for toxicological effects by the Joint Meeting in 1971, 1975, 1978, 1979, 1981, and 1985. An ADI of 0-0.0003 mg/kg bw was allocated in 1985. The Meeting was informed that the primary manufacturer is no longer producing omethoate; however, since the use of dimethoate on agricultural crops can lead to residues of omethoate in treated produce, the toxicity of omethoate is important in the context of the potential use of dimethoate. Information on the absorption, distribution, excretion, metabolism, and toxicity of omethoate was therefore also considered by the Meeting. These data were taken from published sources such as previous JMPR evaluations of omethoate and national reviews; the original reports were not available for detailed evaluation.

Formothion (an aldehyde derivative of dimethoate, which has also been used as a pesticide in its own right, but is no longer supported by the manufacturer) was evaluated for toxicological effects in 1969 and 1973. An ADI of 0-0.02 mg/kg bw was allocated in 1973. Since the use of dimethoate does not lead to residues of formothion in treated produce, the toxicity of formothion was not considered at the present Meeting.

Preparation of this review was aided by reference to the results of previous reviews conducted by the Pesticides Safety Directorate, United Kingdom.

Dimethoate

Dimethoate was rapidly and extensively absorbed from the gut and rapidly excreted. There was no accumulation in fat tissue. In rats and humans up to 90% of radiolabel was found in the urine within 24 h. The report of a study with methylcarbamoyl-labelled dimethoate indicated that up to 18% of the administered label was excreted in expired air. Four metabolites with anticholinesterase activity have been identified in rats and humans. One seems to result from thiono oxidation, leading to the formation of the oxygen analogue of dimethoate, omethoate; this step was followed by hydrolysis to a thiocarboxyl product, said to be the main metabolite in rats and humans.

Data on the acute oral toxicity of dimethoate gave LD₅₀ values of about 310 mg/kg bw in rats, 150 mg/kg bw in mice, and 55 mg/kg bw in hens. The signs of toxicity were those

typical of cholinesterase inhibition. WHO has classified dimethoate as "moderately hazardous".

In short-term and long-term studies at dietary concentrations of 75 ppm or above, there were minor reductions in body-weight gain and food consumption. Apart from the inhibition of cholinesterase activity, dimethoate had no effect on the composition of the blood or urine. The liver weights of animals treated at the higher doses tended to be lower than those of the control groups; there were however no microscopic changes, and the effect is unlikely to be of toxicological significance. Investigations of toxicity at higher doses were limited by effects due to cholinesterase inhibition. The NOAELs were thus generally based on reductions in acetylcholinesterase activity in the brain or erythrocytes. On the basis of minimal reductions in acetylcholinesterase activity of 10-20%, the NOAEL in a 12-month study in dogs at doses of 0, 5, 20, or 125 ppm was 5 ppm, equal to 0.2 mg/kg bw per day; in rats the NOAEL in a life-span study at doses of 0, 1, 5, 25, or 100 ppm was 1 ppm, equal to 0.04 mg/kg bw per day. In mice, an NOAEL was not identified, as cholinesterase activity was depressed at all doses after 52 weeks of treatment in a life-span study at doses of 0, 25, 100, or 200 ppm.

The results of long-term studies of toxicity and carcinogenicity in mice (at 0, 25, 100, or 200 ppm) and rats (at 0, 5, 25, or 100 ppm) reported in 1986 and studies reported in 1977 indicate that dimethoate is not carcinogenic to rodents.

In a multigeneration study of reproductive toxicity conducted in 1989-1990 with doses of 0, 1, 15, or 65 ppm, the reproductive performance of rats was impaired at the high dose. The NOAEL for reproductive toxicity appeared to be 15 ppm (equal to 1.2 mg/kg bw per day) and that for parental toxicity was 1 ppm (equal to 0.08 mg/kg bw per day) on the basis of cholinesterase inhibition, but the Meeting noted that there was some indication that reproductive performance may have been affected at lower doses. In a multigeneration study of reproductive toxicity in mice in 1965 at doses of 0, 5, 15 or 50 ppm, there was no overt effect on reproductive capacity, even in the presence of cholinergic toxicity. In a poorly reported study in rabbits, sperm numbers and quality were adversely affected at doses equivalent to one-tenth and one-hundredth of the LD₅₀.

Studies of developmental toxicity in rats (at 0, 3, 6, or 18 mg/kg bw per day on days 6-15 of gestation) and rabbits (at 0, 10, 20, or 40 mg/kg bw per day on days 7-19 of gestation) provided no evidence of a teratogenic effect, although maternal toxicity was observed at the high dose in rats and at the high and middle doses in rabbits.

After reviewing the available data on genotoxicity the Meeting concluded that although *in-vitro* studies indicate that dimethoate has mutagenic potential, this potential does not appear to be expressed *in vivo*.

Undiluted dimethoate formulations were irritating to the eye in rabbits. Skin irritation was minimal and confined to slight, transient erythema. Dimethoate was not a skin sensitizer in guinea-pigs, but a 32.7% emulsifiable concentrate formulation induced sensitization in one of 10 guinea-pigs. In a published paper, dimethoate was cited in four human cases of contact dermatitis, and sensitization was confirmed in these individuals by patch testing.

In hens given a single dose of 55 mg/kg bw by subcutaneous injection or orally, dimethoate did not induce delayed neurotoxicity.

In a 39-day study in nine male and female volunteers, the NOAEL for cholinesterase

inhibition was 0.2 mg/kg bw per day. This NOAEL was supported in seven other studies, each involving 6-20 volunteers who received doses ranging from 0.04 to 1.0 mg/kg bw per day for periods up to 57 days.

Omethoate

The oral LD₅₀ of omethoate in rats was approximately 25 mg/kg bw. The signs of reaction to treatment with omethoate were those consistent with cholinesterase inhibition.

In short-term and long-term studies, the potential toxicity of omethoate was limited by the onset of cholinesterase inhibition. In a 12-month study of toxicity in dogs at doses of 0, 0.025, 0.12, or 0.62 mg/kg bw per day by gavage, the NOAEL was 0.025 mg/kg bw per day on the basis of the inhibition of acetylcholinesterase activity. In life-span studies in rats (at 0, 0.3, 1, 3, or 10 ppm) and mice (0, 1, 3, or 10 ppm), there was no evidence of oncogenic potential. The study in mice was unsuitable for deriving an NOAEL because acetylcholinesterase activity was not investigated; the NOAEL in rats was 0.3 ppm (equivalent to 0.015 mg/kg bw per day) on the basis of the inhibition of acetylcholinesterase activity.

In multigeneration studies of reproductive toxicity in rats at 0, 1, 3, or 10 ppm, a dietary concentration of 10 ppm was associated with reduced viability of the pups; there was evidence that this effect extended to animals treated at 3 ppm. The NOAEL was 1 ppm (equivalent to 0.05 mg/kg bw per day). In a further multigeneration study of reproductive toxicity in rats at doses of 0, 0.5, 3, or 18 ppm in the drinking-water, there was evidence of epididymal vacuolation and fewer pups per dam at the high dose; these pups had lower weight gains and were less viable. The precoital time was increased and the number of non-pregnant females was greater than among controls. The NOAEL for reproductive performance was 3 ppm (equivalent to 0.2 mg/kg bw per day), but cholinesterase inhibition was detected at the lowest dose of 0.5 ppm. In studies of developmental toxicity, there was no evidence of teratogenicity in rats given 0, 0.3, 1, or 3 mg/kg bw omethoate per day on days 6-15 of gestation or in rabbits given 0, 0.1, 0.3, or 1 mg/kg bw omethoate per day on days 6-18 of gestation.

Omethoate has been extensively investigated for genotoxicity *in vitro* and *in vivo*. The Meeting concluded that it has clear mutagenic potential but that the weight of the evidence observed *in vivo* was negative; however, the positive result obtained in a mouse spot test could not be completely disregarded.

In studies in hens given single oral doses of 20-300 mg/kg bw, omethoate did not induce delayed neurotoxicity.

Conclusions

An ADI of 0-0.002 mg/kg bw was established for dimethoate on the basis of the apparent NOAEL of 1.2 mg/kg bw per day for reproductive performance in the study of reproductive toxicity in rats, applying a safety factor of 500. Although a safety factor of 100 would normally be used in deriving an ADI from a study of this type, the Meeting was concerned about the possibility that reproductive performance may have been affected at 1.2 mg/kg bw per day in this study and therefore used a higher-than-normal safety factor. No data were available to assess whether the effects on reproductive performance were secondary to the inhibition of cholinesterase. The Meeting concluded that it was not appropriate to base the ADI on the results of the studies of volunteers since the crucial end-point (reproductive performance) has not been assessed in humans.

This ADI would usually be used only when assessing the intake of dimethoate itself. As the use of dimethoate on crops can give rise to residues of omethoate, and omethoate has been used as a pesticide in its own right, previous Joint Meetings have allocated an ADI to omethoate; however, the primary manufacturer is no longer producing omethoate. The Meeting noted that omethoate is considerably more toxic than dimethoate; however, the levels of residues of omethoate resulting from the use of dimethoate on crops are likely to be low. The Meeting therefore recommended that residues of dimethoate and omethoate resulting from the use of dimethoate be expressed as dimethoate and be assessed in comparison with the ADI for dimethoate.

As the primary manufacturer is no longer producing either omethoate or formothion, toxicological data on these compounds were not made available to the Meeting. The previous ADIs of 0-0.0003 mg/kg bw for omethoate and 0-0.02 mg/kg bw for formothion were therefore withdrawn.

There may be a need to re-evaluate the toxicity of dimethoate after the periodic review of the residue and analytical aspects of dimethoate has been completed if it is determined that omethoate is a major residue.

A toxicological monograph on dimethoate was prepared, summarizing the data received since the previous evaluation and including summaries of the data presented in previous monographs and monograph addenda.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect (dimethoate)

Rat: 1 ppm, equal to 0.04 mg/kg bw per day (two-year study of toxicity and carcinogenicity)

15 ppm, equal to 1.2 mg/kg bw per day (reproductive performance in a study of reproductive toxicity)

1 ppm, equal to 0.08 mg/kg bw per day (parental toxicity in a study of reproductive toxicity)

6 mg/kg bw per day (maternal toxicity in a study of developmental toxicity)

Rabbit: 10 mg/kg bw per day (maternal toxicity in a study of developmental toxicity)

Dog: 5 ppm, equal to 0.2 mg/kg bw per day (52-week study of toxicity)

Human: 0.2 mg/kg bw per day (39-day study of cholinesterase inhibition)

Estimate of acceptable daily intake for humans

0-0.002 mg/kg bw (sum of dimethoate and omethoate expressed as dimethoate)

Studies that would provide information useful for the continued evaluation of the compound:

- 1. Further multigeneration study of reproductive toxicity in rats using dimethoate.
- 2. Mouse spot test using dimethoate.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to dimethoate

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULT/REMARKS
Short term (1-7 days)	Oral toxicity, rat	LD ₅₀ = 310 mg/kg bw
	Dermal toxicity, rat	LD ₅₀ >7000 mg/kg bw
	Dermal irritation, rabbit	Slightly irritating
	Ocular irritation, rabbit	Slightly irritating
	Dermal sensitization, human	Positive
Medium term (1-26 weeks)	Repeated dermal, 21 days, toxicity, rabbit	NOAEL = 1000 mg/kg bw per day (highest dose tested)
	Repeated oral, reproductive toxicity, rat	NOAEL = 1.2 mg/kg bw per day, reproductive toxicity NOAEL = 0.08 mg/kg bw per day, parental toxicity
	Repeated oral, developmental toxicity, rat	NOAEL = 6 mg/kg bw per day, maternal toxicity. No evidence of embryotoxicity or teratogenicity at 18 mg/kg bw per day (highest dose tested)
	Repeated oral, developmental toxicity, rabbit	NOAEL = 10 mg/kg bw per day, maternal toxicity. No evidence of embryotoxicity or teratogenicity at 40 mg/kg bw per day (highest dose tested)
Long term (≥one year)	Repeated oral, toxicity and carcinogenicity, rat	NOAEL = 0.04 mg/kg bw per day, cholinesterase inhibition

4.11 DISULFOTON (074)

TOXICOLOGY - ACUTE DIETARY RISK

The twenty-eighth Session of the CCPR raised the issue of the acute toxicity of disulfoton residues and requested the JMPR to derive an acute reference dose.

An ADI of 0-0.0003 mg/kg bw was established for disulfoton by the 1991 Meeting on the basis of an NOAEL of 1 ppm, equal to 0.03 mg/kg bw per day, for the inhibition of brain acetylcholinesterase activity in a two-year study in dogs. This ADI was supported by an NOAEL of 1 ppm, equal to 0.06 mg/kg bw per day, for the inhibition of brain acetylcholinesterase activity in a two-year study in rats.

Disulfoton was not carcinogenic or teratogenic and caused no toxicity other than that associated with acetylcholinesterase inhibition.

Groups of 10 male and 10 female Sprague-Dawley rats, 8-9 weeks old, were given single doses of disulfoton dissolved in polyethylene glycol 400 at 5 ml/kg bw by gavage. The doses were 0, 0.25, 0.75, or 1.5 mg/kg bw for females and 0, 0.25, 1.5, or 5.0 mg/kg bw for males. A functional observational battery and testing of motor activity were carried out 1.5-4 h after treatment. Plasma cholinesterase and erythrocyte acetylcholinesterase activities were determined 24 h after treatment.

Erythrocyte acetylcholinesterase activity was inhibited by 10% in males at the middle dose and 21% in those at the high dose and by 12, 53, and 75% in females at the low, middle and high doses respectively. Plasma cholinesterase activity was inhibited to a similar extent in males but to a lesser extent than that of erythrocyte acetylcholinesterase in females. Clear cholinergic signs were observed in males at 5 mg/kg bw and in females at 1.5 and 0.75 mg/kg bw. The signs appeared on day 0 of dosing but had disappeared by day 3. Functional and motor activity testing showed treatment-related effects at the same doses (Sheets, 1993a). Since cholinesterase activity was not determined when the maximal clinical score was reached, another study was conducted.

Groups of six male and six female fasted Sprague-Dawley rats were given technical-grade disulfoton (purity 99.0%) at doses of 0, 0.25, 0.75 (females only), 1.5, or 5.0 (males only) mg/kg bw by gavage. Cholinesterase activity was determined in the plasma, erythrocytes and brain 3 h after treatment, i.e. approximately at the time of peak clinical signs. Brain acetylcholinesterase activity was inhibited less than that in erythrocytes and plasma. The results are shown in Table 1. The NOAEL for the inhibition of brain acetylcholinesterase activity was 0.25 mg/kg bw in both males and females (Sheets, 1996).

Table 1. Cholinesterase activity 3 h after a single dose of disulfoton¹

DOSE (mg/kg bw)	SEX	% OF CONTROL CHOLINESTERASE ACTIVITY		
		PLASMA	ERYTHROCYTES	BRAIN
0.25	Female	96	96	97
	Male	94	93	108
0.75	Female	28	55	51
1.50	Male	54	40	73

disulfoton

5.00	Female	13	21	38
	Male	28	18	42

¹ Percentages of activity of the concurrent controls. For plasma and erythrocyte cholinesterase activities similar percentages were obtained when calculated on the basis of pre-exposure activity

An acute reference dose of 0.003 mg/kg bw was established on the basis of the absence of inhibition of brain acetylcholinesterase activity and clinical signs at 0.25 mg/kg bw in rats treated with a single dose by gavage, applying a 100-fold safety factor.

References

Sheets, L.P. (1993) An acute oral neurotoxicity screening study with technical grade disulfoton (DI-SYSTON) in rats. Unpublished report No. 92-412-OB from Miles Inc., Stilwell, KS, USA. Submitted to WHO by Bayer AG, Wuppertal, Germany.

Sheets, L.P. (1996) Cholinesterase results from an acute oral study with technical grade disulfoton (DI-SYSTON). Summary report No. 96-412-JH from Miles Inc., Stilwell, KS, USA. Submitted to WHO by Bayer AG, Wuppertal, Germany.

4.12 DITHIOCARBAMATES (105)

RESIDUE AND ANALYTICAL ASPECTS

Ferbam, thiram and ziram were evaluated at the present Meeting within the CCPR periodic review programme. The information on these compounds is discussed under their respective headings.

Recommended MRLs for dithiocarbamates arising from the uses of thiram and ziram are consolidated under the dithiocarbamate heading. The dithiocarbamate MRLs which rely primarily on ziram data will be temporary until data on environmental fate are evaluated. No MRLs for dithiocarbamates arising from uses of ferbam were recommended.

4.13 FENARIMOL (192)

RESIDUE AND ANALYTICAL ASPECTS

Fenarimol was reviewed as a new compound by the 1995 JMPR and a number of maximum residue levels were estimated. However, since no data were submitted to the FAO Panel on the environmental fate of fenarimol in soil, the 1995 Meeting decided that the estimated levels should be recommended only as temporary MRLs.

The current Meeting received a study demonstrating the storage stability of fenarimol residues in dried hops and agreed to recommend the maximum residue level of 5mg/kg

estimated by the 1995 Meeting as an MRL.

The Meeting also received information on the environmental fate of fenarimol in soil. The data indicated that fenarimol was degraded slowly in field conditions with a half-life typically exceeding 100 days. Photodegradation of the compound occurs, especially in water. Fenarimol has a low mobility in soil with almost all the residue associated with the top layer.

The Meeting was informed that no data on the uptake from soil by crops, the bioavailability of fenarimol residues in soil, or the residues in rotational crops were currently available.

The Meeting considered the data on environmental fate to be satisfactory and hence that the maximum residue levels estimated by the 1995 Meeting should now be recommended as MRLs.

FURTHER WORK OR INFORMATION

Desirable

1. Full details of the methods of analysis used in all the residue studies where this information was not given. Validation of the methods of analysis for which validation data were not submitted (repeated from 1995 JMPR).
2. Information on the melting point, octanol/water partition coefficient, solubility and specific gravity of pure fenarimol (repeated from 1995 JMPR).
3. Submission of the study reports supporting the trials on apples, gooseberries, currants, gherkins and strawberries conducted in The Netherlands (repeated from 1995 JMPR).
4. Submission of the study on residues in rotational crops which the Meeting was informed would be completed in 1997.
5. An investigation into the uptake of fenarimol residues into crops from soil and their translocation. If the data indicate that measurable residues could occur in rotational crops, then a study to assess the nature of the residues in representative rotational crops.

4.14 FERBAM (DITHIOCARBAMATES, 105)

TOXICOLOGY

Ferbam was evaluated for toxicological effects by the Joint Meeting in 1965, 1967, 1970, 1974, 1977, and 1980. A temporary ADI of 0-0.025 mg/kg bw for ferbam or ferbam in combination with other dimethyldithiocarbamates was allocated in 1967, on the basis of a one-year study in dogs. This temporary ADI was lowered to 0.005 mg/kg bw in 1974. A group ADI of 0-0.02 mg/kg bw for ferbam and ziram was allocated in 1977 and confirmed in 1980. The compound was reviewed by the present Meeting within the CCPR periodic review programme.

Ferbam is well absorbed after oral administration to rats and is extensively metabolized. Most of the administered radiolabel was found in the urine, expired air, and bile. In pregnant rats, a small but significant amount crossed the placenta into the fetus. In lactating rats the radiolabel was secreted into the milk, absorbed by the pups, and excreted in the pups' urine. In expired air the main product was carbon disulfide; in the urine the main products were inorganic sulfate, a salt of dimethylamine, and the glucuronide conjugate of dimethyldithiocarbamic acid.

Ferbam has low acute toxicity and has been classified by WHO as unlikely to present an acute hazard in normal use.

In two four-week studies, rats were fed diets providing ferbam at concentrations of 0, 100, 500, 2500, or 5000 ppm or 0 or 2500 ppm. The NOAEL was 100 ppm, equivalent to 10 mg/kg bw per day, on the basis of growth depression at 500 ppm and above. Post-mortem examination revealed no thyroid abnormalities. In another four-week study in which one dog was given ferbam and ziram together, each at a dose of 5 mg/kg bw per day, the only adverse effect was slight anaemia. In another study a dog remained healthy, except for slight anaemia, when given ferbam alone at a dose of 25 mg/kg bw per day for one month or 50 mg/kg bw per day for one week. An attempt to raise the dose to 100 mg/kg bw per day immediately provoked severe vomiting and malaise.

In a study in which dogs were treated with ferbam at doses of 0.5, 5, or 25 mg/kg bw per day for one year, the NOAEL was 5 mg/kg bw per day, on the basis of convulsions at 25 mg/kg bw per day.

In a two-year study of toxicity and carcinogenicity in rats treated at dietary concentrations of 0, 25, 250, or 2500 ppm the NOAEL was 250 ppm, equivalent to 12 mg/kg bw per day, on the basis of depressed growth rate, shortened life span, neurological changes, cystic brain lesions, and testicular atrophy at 2500 ppm. Carcinogenicity was not demonstrated.

Sperm quality was investigated in mice given oral doses of 0, 250, 500, or 1000 mg/kg bw per day for five consecutive days. The NOAEL was 500 mg/kg bw per day, on the basis of an increased frequency of sperm abnormalities at 1000 mg/kg bw per day.

In a three-generation study of reproductive toxicity in rats fed dietary concentrations of 0 or 250 ppm, the NOAEL was 250 ppm, equivalent to 12 mg/kg bw per day.

Few data were available on genotoxicity. Ferbam did not induce reverse mutation in bacteria.

Ferbam was slightly irritating to the skin and eyes of rabbits. It has weak skin-sensitizing properties in guinea-pigs.

The Meeting concluded that the toxicological data specifically generated for ferbam were inadequate to estimate an ADI. However, because of the similarity of the chemical structure of ferbam to that of ziram and the comparable toxicological profile of the two compounds, ferbam was included in the group ADI of 0-0.003 mg/kg bw for ferbam and ziram, which was derived from the information available on ziram.

A toxicological monograph was prepared, summarizing the data received since the

previous evaluation and relevant data from the previous monograph and monograph addendum.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: 500 mg/kg bw per day (study of sperm quality)

Rat: 100 ppm, equivalent to 10 mg/kg bw per day (one-month study of toxicity)

250 ppm, equivalent to 12 mg/kg bw per day (two-year study of toxicity and carcinogenicity)

250 ppm, equivalent to 12 mg/kg bw per day (study of reproductive toxicity)

Dog: 5 mg/kg bw per day (one-year study of toxicity)

Estimate of acceptable daily intake for humans

0-0.003 mg/kg bw (group ADI for ferbam and ziram)

Studies that would provide information useful for the continued evaluation of the compound

1. Studies on dissociation in aqueous solutions.
2. Observations in humans.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to ferbam.

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULT, REMARKS
Short-term (1-7 days)	Oral toxicity, mouse	LD ₅₀ = 1000 mg/kg bw
	Oral toxicity, rat	LD ₅₀ = 11 000 mg/kg bw
	Inhalation toxicity, rat	LC ₅₀ = 0.3 mg/litre
	Dermal irritation, rabbit	Slightly irritating
	Ocular irritation, rabbit	Slightly irritating
	Dermal sensitization, guinea-pig	Weakly sensitizing
	Repeated oral, 5 days, testicular toxicity, mouse	NOAEL = 500 mg/kg bw per day, increased sperm abnormalities
Medium-term (1-26 weeks)	Repeated oral, 4 weeks, toxicity, rat	NOAEL = 10 mg/kg bw per day, reduced body weight
	Repeated oral, reproductive toxicity, rat	NOAEL = 12 mg/kg bw per day, reproductive toxicity
Long-term (≥ one year)	Repeated oral, two years, toxicity and carcinogenicity, rat	NOAEL = 12 mg/kg bw per day, reduced body weight, shortened life span, neurological changes, cystic brain lesions, and atrophied testes. No carcinogenicity
	Repeated oral, one year, toxicity, dog	NOAEL = 5 mg/kg bw per day, convulsions

RESIDUE AND ANALYTICAL ASPECTS

Ferbam was originally evaluated in 1965 (toxicology) and 1967 (toxicology and residues) and is included in the dithiocarbamate group of compounds. The compound was evaluated at the present Meeting within the CCPR periodic review programme.

Ferbam is a broad-spectrum fungicide used for the control of certain diseases in fruit trees, small fruits and berries, ornamentals, conifers and tobacco.

The Meeting received information on the metabolism of ferbam in goats and sheep, methods of residue analysis, the stability of residues in stored analytical samples, approved use patterns, notably on fruits and potatoes, and supervised residue trials on mangoes.

When lactating goats were dosed with radiolabelled ferbam the total residues in milk increased for 2 or 3 days and then reached a plateau. Levels of the radiolabel were higher in the liver than in other tissues.

The analytical methods for ferbam residues are the same as those for other dithiocarbamates. They rely on acid hydrolysis to release CS₂, which may then be measured by head-space gas chromatography or by spectrophotometry. These methods were used to analyse samples from the supervised trials. The Meeting agreed that the definition of the residue of the dithiocarbamates should apply also to ferbam.

Ferbam residues in macerated apples fortified at 1 mg/kg and stored at -20°C were stable for 22 weeks.

The Meeting received data from two supervised residue trials with ferbam on mangoes in the USA, but the data could not be evaluated because information on the relevant GAP was not available.

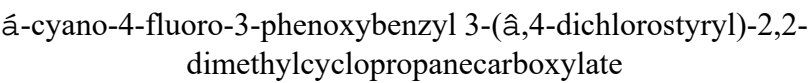
Generally, the information on ferbam was quite limited. Because of the lack of critical supporting studies the Meeting would not have been able to recommend MRLs for dithiocarbamates based on applications of ferbam even if adequate information on GAP and data from supervised trials were available for some commodities. Recommendations for MRLs for dithiocarbamates are derived from supervised trials with specific dithiocarbamate compounds applied according to the relevant GAP. The compounds for which data have been evaluated and found to be adequate to support the recommended MRLs are indicated in the Table in Annex I. Because of the lack of critical supporting studies ferbam is not included in the list of dithiocarbamates with adequate data to support recommended MRLs for dithiocarbamates.

FURTHER WORK OR INFORMATION

Desirable

1. An adequate set of critical supporting studies for ferbam is needed before it can be included in the list of compounds supporting recommended MRLs for dithiocarbamates (See report of 1995 JMPR, Section 2.5.2).
2. Information on attempts to develop specific methods of analysis for ferbam, whether successful or not.

4.15 FLUMETHRIN (195)



Flumethrin is a fat-soluble pyrethroid insecticide used in the control of ectoparasites on cattle, sheep, goats, horses, and dogs. It is also marketed for the diagnosis and control of varroatosis in bee hives. Flumethrin as currently produced and used is the result of optimization of the manufacturing process and consists of >90% *trans*-Z-1 and *trans*-Z-2 isomers (with <2% *cis*-Z and <1% *trans*-E isomers as by-products). Flumethrin was evaluated for the first time by the present Meeting.

TOXICOLOGY

The development of flumethrin first led to a substance which was a mixture of 30-45% *trans*-Z-1 and *trans*-Z-2 isomers and 45-63% *trans*-E-1 and *trans*-E-2 isomers, the corresponding *cis*-isomers occurring as by-products at <6%. This material was used in a long-term study of toxicity and carcinogenicity in rats and is referred to as flumethrin (low *trans*-Z content).

Flumethrin was absorbed rapidly, but not completely, after oral administration in all species investigated. The concentrations in the tissues of rats two days after dosing were three- to 50-fold lower than those in the blood; the lung contained higher concentrations than other tissues, and the central nervous system had the lowest concentrations. Elimination was mainly in the faeces. The main metabolite was flumethrin acid, which was distinctly less toxic than the parent substance in acute and four-week dietary studies in rats and did not induce reverse mutations in bacteria.

The acute oral toxicity of flumethrin in laboratory animals is moderate to low. The reported manifestations of its toxicity are largely consistent with those known collectively as the choreoathetosis with salivation (CS) syndrome, which is produced by other insecticidal pyrethroids containing an α -cyano-3-phenoxybenzyl group. After dermal application, the acute toxicity of flumethrin was low; the clinical signs were the same as those seen after oral administration. There was no evidence of acute toxicity after dermal application of 5 ml/kg bw of a 1% pour-on formulation. In tests for dermal and ocular irritancy, the active substance proved not to be irritating. In tests for local irritancy with the 1% pour-on formulation, slight, transient skin changes (mainly barely perceptible erythema and/or swelling), but no changes in the mucous membrane of the eye, were observed. WHO has not classified flumethrin for acute toxicity.

After the oral administration of flumethrin for three months to rats at dietary concentrations of 0, 10, 40, or 160 ppm and to dogs at dietary concentrations of 0, 25, 50, 100, or 200 ppm, the NOAELs were 10 ppm (equal to 0.7 mg/kg bw per day) in rats and 25 ppm (equal to 0.88 mg/kg bw per day) in dogs. In both species the most obvious findings were skin alterations, but these were not due to primary dermatitis caused by flumethrin but to frequent scratching with attendant bleeding and, in some instances, inflammation. α -Cyano pyrethroids are known to produce paraesthesia, which is considered to be the most likely cause of the observed skin lesions. The toxicological studies provided no evidence of immunotoxicity, e.g. effects on leucocyte counts or on other relevant organs (thymus and spleen).

The results of studies of developmental toxicity in rats at doses of 0, 0.5, 1, or 2 mg/kg bw per day on days 6-15 of gestation and in rabbits at doses of 0, 0.5, 1.7, or 6 mg/kg bw per day on days 7-19 of gestation provided no evidence that flumethrin is teratogenic at doses extending into the range that is toxic to the dams. Some fetotoxicity was observed at doses that also induced maternal toxicity in both species. The NOAELs were 0.5 mg/kg bw per day in rats and 1.7 mg/kg bw per day in rabbits.

A two-generation study of reproductive toxicity in rats exposed to flumethrin at dietary concentrations of 0, 1, 5, or 50 ppm did not indicate primary reproductive toxicity; the reduced pup survival and body-weight gain, and certain postural and behavioural changes in the pups at the highest dose may have been secondary to maternal toxicity. The NOAEL was 5 ppm, equal to 0.36 mg/kg bw per day.

No studies of long-term toxicity or carcinogenicity have been conducted with the currently used isomeric mixture of flumethrin. A 24-month study was available, however, in which rats were fed diets containing flumethrin with a low *trans-Z* content at concentrations of 0, 2, 10, 50, or 250 ppm. Skin lesions developed in rats at 50 and 250 ppm, and there was slight proliferation of the bile ducts in male rats at 250 ppm. Neither the number of tumour-bearing rats nor the incidence of any specific neoplasm was increased. The Meeting considered the following toxicological findings. (i) Flumethrin with a low *trans-Z* content has no carcinogenic potential. (ii) Other pyrethroids, such as cyhalothrin, cypermethrin, fenvalerate and the resmethrins also have no carcinogenic potential. (iii) Treatment with permethrin resulted in small increases in the incidence of lung tumours in female mice in three studies, but no increases were found in either rats or male mice. (iv) Treatment with deltamethrin was associated with unspecified thyroid adenomas in rats in one study, but no tumours were induced in mice or in either species in other studies. (v) Flumethrin had no genotoxic potential in a number of well-conducted tests covering a variety of end-points. (vi) Flumethrin showed no sensitizing potential. (vii) No preneoplastic responses were observed in studies up to 13 weeks in duration. The Meeting considered that the carcinogenic potential of the *trans-Z* isomers that are present in the currently used isomeric mixture of flumethrin had been assessed in the study in rats in which the low *trans-Z* product was tested.

Oral administration of highly toxic doses of flumethrin to rats can cause dysfunction of the nervous system, but the effect is rapidly reversible and is not accompanied by morphological damage to the central or peripheral nervous system.

Pharmacological tests in experimental animals gave no evidence of impairment of vital functions. Studies to establish the tolerance of calves and cattle to flumethrin showed no significant effects, even when animals licked the application site.

An ADI of 0-0.004 mg/kg bw was allocated, on the basis of the NOAEL of 0.36 mg/kg bw per day in the two-generation study of reproductive toxicity in rats, using a 100-fold safety factor.

A toxicological monograph was prepared, summarizing the data that were reviewed at the present Meeting.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

- Rat: 10 ppm, equal to 0.7 mg/kg bw per day (13-week and 15-week studies of toxicity)
- 5 ppm, equal to 0.36 mg/kg bw per day (two-generation study of reproductive toxicity)
- 0.5 mg/kg bw per day (maternal toxicity in a study of developmental toxicity)
- Rabbit: 1.7 mg/kg bw per day (maternal and fetal toxicity in a study of developmental toxicity)
- Dog: 25 ppm, equal to 0.88 mg/kg bw per day (13-week study of toxicity)

Estimate of acceptable daily intake for humans

0-0.004 mg/kg bw

Studies that would provide information useful for the continued evaluation of the compound

Results of any studies that are planned or in progress in rodents, dogs, or exposed human subjects.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to flumethrin.

EXPOSURE	RELEVANT ROUTE, STUDY, TYPE, SPECIES	RESULT, REMARKS
Short-term (1-7 days)	Oral, toxicity, rat	LD ₅₀ = 41-3800 mg/kg bw, depending on the vehicle
	Dermal toxicity, rat	LD ₅₀ >2000 mg/kg bw
	Inhalation toxicity, rat	LC ₅₀ = 225 mg/m ³
	Dermal irritation, rabbit	Not irritating
	Ocular irritation, rabbit	Not irritating
	Dermal sensitization, guinea pig	Not sensitizing
Medium-term (1-26 weeks)	Repeated oral, 15-week, toxicity, rat	NOAEL = 0.7 mg/kg bw per day
	Repeated oral, 13-week, toxicity,	NOAEL = 0.88 mg/kg bw per day

EXPOSURE	RELEVANT ROUTE, STUDY, TYPE, SPECIES	RESULT, REMARKS
	dog	
	Repeated oral, reproductive toxicity, rat	NOAEL = 0.36 mg/kg bw per day, reduced body-weight gain of adults
	Repeated oral, developmental toxicity, rat	NOAEL = 1 mg/kg bw per day, developmental toxicity
	Repeated oral, developmental toxicity, rabbit	NOAEL = 1.7 mg/kg bw per day, maternal and developmental toxicity
Long-term (≥ one year)	Repeated oral, two-year, toxicity and carcinogenicity, rat	NOAEL = 0.5 mg/kg bw per day, skin lesions; no carcinogenicity

RESIDUE AND ANALYTICAL ASPECTS

The Meeting reviewed extensive studies of metabolism in rats and cattle, information on GAP, methods of analysis, and the results of national monitoring. Data from supervised trials of ectoparasite control on cattle, sheep and goats and of the use of flumethrin in honey-bee colonies were evaluated.

Analysis for residues is usually by HPLC which can determine flumethrin *per se* and in some cases also the predominant metabolite flumethrin acid (BFN 5533A). The residue is defined as the parent compound for regulatory purposes and recommended MRLs for meat apply to the carcass fat.

Although no residues (<0.002 mg/kg) were detected in honey, low residues were found in beeswax. Recommended MRLs for the meat and milk of cattle and, at the limit of determination, for honey are recorded in Annex I, where STMR levels are also recorded for the estimation of dietary intake.

FURTHER WORK OR INFORMATION

Desirable

1. Information on the stability of flumethrin residues in stored analytical samples of liver and kidney in relation to the periods and conditions of storage of the samples from supervised trials.
2. Submission of data from new supervised trials on animals expected to be available in June 1996 (Webster *et al.*, 1996).
3. Results of analyses of tissues and milk from additional supervised trials on cattle in which multiple, especially pour-on, applications have been made in accordance with approved uses.
4. Studies on the fate of flumethrin in the environment, especially its persistence and mobility in soil.

4.16 HALOXYFOP (194)

RESIDUE AND ANALYTICAL ASPECTS

Haloxyfop has been developed as a selective herbicide for the control of grass weeds in broad-leaf crops. It was evaluated for the first time by the 1995 JMPR.

The 1995 Meeting could not complete the evaluation of the studies of ruminant and poultry metabolism which were provided in the time available and the evaluation was postponed until the present Meeting. The estimation of a maximum residue level for peas (legume vegetables and their fodders) was also postponed to await clarification of the exact Codex commodities to which the data applied. The 1995 Meeting estimated a number of maximum residue levels but could not recommend them for use as MRLs because of the lack of critical supporting data on the uptake by plants of haloxyfop and its degradation products from soil.

The present Meeting received information on the commodity described as ‘peas’ and data on the uptake of residue from soil. Metabolism studies on lactating goats and laying hens were evaluated.

The Meeting estimated supervised trials median residue levels for bananas, citrus fruits, cotton seed, crude cotton seed oil, fodder beet, grapes, peanuts, peas (pods and succulent seeds), pome fruit, dry pulses, potatoes, rape seed, rape seed meal, crude and edible rape seed oil, unprocessed rice bran, husked and polished rice, soya bean meal, crude and refined soya bean oil, sugar beet, refined sugar, pressed sugar beet pulp, sunflower seed, chicken meat, edible chicken offal and eggs.

The Meeting withdrew the provisionally estimated maximum residue levels for fodder crops and cattle products because information on the moisture content of the fodder crops was lacking and the calculated intake from cattle feed was higher than the highest dosing level in the submitted feeding studies.

FURTHER WORK ON INFORMATION

Desirable

1. Information on the moisture content of fodder crops.
2. Ruminant feeding studies at a feeding level comparable to the maximum residue level found in fodder crops.

4.17 MALEIC HYDRAZIDE (102)

TOXICOLOGY

Maleic hydrazide was previously evaluated for toxicological effects by the Joint Meeting in 1976, 1980, and 1984. In 1984, an ADI of 0-5 mg/kg bw was established for maleic hydrazide (sodium or potassium salt, 99.9% pure containing <1 mg hydrazine/kg).

The toxicology of the compound was reviewed at the present Meeting within the CCPR periodic review programme.

Maleic hydrazide was rapidly and extensively absorbed after oral administration of single doses of 2 or 100 mg/kg bw or 2 mg/kg bw per day for 15 days. Excretion is rapid (>80% in 24 h) after either oral or intravenous administration, with urinary excretion predominating (>80%). The metabolism of maleic hydrazide is minimal, the parent compound accounting for over 60% in males and 80% in females of the urinary radiolabel; conjugation to sulfate is the only significant reaction. There was no evidence that absorption or metabolism was affected by dose or by repeated administration in rats. The total tissue residues in rats represented < 1% of the administered dose after seven days.

The acute toxicity of maleic hydrazide after administration by the oral, dermal, or inhalation route is low, with LD₅₀ and LC₅₀ values greater than the limit doses (5 g/kg bw orally, 20 g/kg bw dermally, and 20 mg/litre by inhalation). No target organs were identified. Maleic hydrazide was only slightly irritating to the skin and eyes and is not a skin sensitizer. The compound has been classified by WHO as unlikely to present an acute hazard in normal use.

After administration of repeated oral doses of maleic hydrazide to rats (0, 30, 100, 300, or 1000 mg/kg bw per day or 0, 0.5, 1, 2 or 5% in the diet) and dogs (0, 750, 2500, or 25,000 ppm) for 12-13 weeks, no marked adverse effects were seen at doses up to 1000 mg/kg bw per day; however, the extent of the examinations performed in these studies was inadequate to permit a reliable NOAEL to be determined.

In rats treated dermally for three weeks, no significant effects were seen on gross or histopathological examination at doses up to 1000 mg/kg bw per day. An increased lymphocyte count in males at 500 or 1000 mg/kg bw per day was considered to be of questionable biological significance in the absence of similar findings in other studies. The NOAEL was 1000 mg/kg bw per day.

In a one-year study of toxicity in dogs treated in the diet at levels of 0, 750, 2500, or 25,000 ppm, reduced body-weight gain, thyroid hypertrophy, and inflammatory lesions of the liver were seen at 25,000 ppm (equal to 500 mg/kg bw per day), with changes in urinary pH, serum enzyme activities, and albumin level. As significant reductions in body-weight gain were seen at 25,000 ppm (35%) and 2500 ppm (20%), the NOAEL was 750 ppm, equal to 25 mg/kg bw per day. Earlier studies with limited protocols were inadequate for deriving reliable NOAELs for dogs but showed no marked effects at doses up to 500 mg/kg bw per day over two years.

In a 23-month study in mice fed diets containing 0, 1000, 3200 or 10,000 ppm, there was a dose-related increase in the prevalence of amyloidosis in males, which also occurred in females at the highest dose. The frequencies of adrenal hyperplasia and carditis or myocarditis were increased in females at the two higher doses. Increases in the frequencies of alveolar adenomas and uterine haemangiomas in females at the highest dose were not statistically significant and do not represent clear evidence of carcinogenic potential. The NOAEL was

1000 ppm (equal to 160 mg/kg bw per day) on the basis of cardiac and adrenal changes in females at 3200 ppm and above. A small increase in the frequency of amyloidosis at 1000 ppm was observed in males, which was not considered to be significant. An earlier long-term study in mice treated by oral or subcutaneous administration provided no evidence of carcinogenicity.

In a two-year study of toxicity and carcinogenicity in rats in which the levels incorporated in the diet were varied to give 0, 25, 500 or 1000 mg/kg bw per day, there was no evidence of an increase in tumour incidence. Reductions in body-weight gain, despite increased food consumption, were noted at 500 and 1000 mg/kg bw per day. An altered pattern of renal lesions, myocarditis, adrenal hyperplasia, and thyroid hyperplasia was seen at 1000 mg/kg bw per day. The NOAEL was 25 mg/kg bw per day on the basis of clear effects on weight gain at doses of 500 mg/kg bw per day and above. Earlier long-term studies in rats provided no evidence of carcinogenicity at doses up to 2% in the diet (equivalent to 1000 mg/kg bw per day).

In a two-generation study of reproductive toxicity in rats given 0, 1000, 10,000, 30,000 or 50,000 ppm in the diet, significant effects on the body-weight gain of parents and pups were evident at the two highest doses, to such an extent that the dose of 50,000 ppm was discontinued after the first generation. There were no adverse effects on reproductive parameters. Increases in organ weight and histological findings indicated a slight effect on the kidneys at 30,000 ppm. The NOAEL was 10,000 ppm (equivalent to 750 mg/kg bw per day).

In a study of developmental toxicity, rats were given 0, 30, 300, or 1000 mg maleic hydrazide/kg bw per day by gavage on days 6-16 of gestation. There was no clear evidence of effects on the fetus or of maternal toxicity, even at the highest dose tested. In a similar study in rabbits treated with 0, 100, 300, or 1000 mg/kg bw per day by gavage on days 7-27 of gestation, there was no clear evidence of fetotoxicity or teratogenicity. Reduced maternal body-weight gain and an increased frequency of late resorptions were seen at 1000 mg/kg bw per day. The NOAEL was 300 mg/kg bw per day.

A wide range of tests for genotoxicity *in vitro* with high concentrations of maleic hydrazide resulted in several positive findings. No positive findings were recorded in four studies *in vivo*. The Meeting concluded that maleic hydrazide is not genotoxic.

An ADI of 0-0.3 mg/kg bw was established on the basis of the NOAEL of 25 mg/kg bw per day in the two-year study of toxicity and carcinogenicity in rats and the one-year study of toxicity in dogs, using a 100-fold safety factor.

A toxicological monograph was prepared, summarizing the data reviewed since the previous evaluation and including summaries from the previous monograph and monograph addendum.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: 1000 ppm, equal to 160 mg/kg bw per day (toxicity in a 23-month study of toxicity and carcinogenicity)

Rat: 25 mg/kg bw per day (toxicity in a two-year study of toxicity and carcinogenicity)

1000 mg/kg bw per day (highest dose tested in a study of developmental toxicity)

10,000 ppm, equivalent to 750 mg/kg bw per day (toxicity in a two-generation study of reproductive toxicity)

Rabbit: 300 mg/kg bw per day (maternal toxicity in a study of developmental toxicity)

Dog: 750 ppm, equal to 25 mg/kg bw per day (one-year study of toxicity)

Estimate of acceptable daily intake for humans

0-0.3 mg/kg bw

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to maleic hydrazide

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULT/REMARKS
Short-term (1-7 days)	Oral toxicity, rat	LD ₅₀ >5000 mg/kg bw
	Dermal toxicity, rabbit	LD ₅₀ >20000 mg/kg bw
	Inhalation, 1 h, toxicity, rat	LC ₅₀ >20 mg/litre
	Dermal irritation, rabbit	Slightly irritating
	Ocular irritation, rabbit	Slightly irritating
	Dermal sensitization, guinea-pig	Not sensitizing
Medium-term (1-26 weeks)	Repeated dermal, 21 days, toxicity, rat	NOAEL = 1000 mg/kg bw per day (highest dose tested)
	Repeated oral, reproductive toxicity, rat	NOAEL = 750 mg/kg bw per day, reduced weight gain; no effects on reproduction
	Repeated oral, developmental toxicity, rat	NOAEL = 1000 mg/kg bw per day (highest dose tested),
	Repeated oral, developmental toxicity, rabbit	NOAEL = 1000 mg/kg bw per day (highest dose tested), embryotoxicity and teratogenicity NOAEL = 300 mg/kg bw per day, maternal toxicity (increased resorptions and decreased weight gain)
Long-term (≥one year)	Repeated oral, two years, toxicity and carcinogenicity, rat	NOAEL = 25 mg/kg bw per day, decreased weight gain, increased food intake, and clinical chemical changes
	Repeated oral, one year toxicity, dog	NOAEL = 25 mg/kg bw per day, reduced body-weight gain

4.18 METHAMIDOPHOS (100)

RESIDUE AND ANALYTICAL ASPECTS

Methamidophos is a systemic organophosphorus insecticide and also a metabolite of acephate. It was first evaluated in 1976. The 1994 JMPR recommended withdrawal of the CXL for melons except watermelon and the draft MRLs for broccoli, head cabbages, cauliflower, citrus fruits, egg plant, peach and tomato which had been held at Step 7B by the 1992 CCPR (ALINORM 93/24, paras 119-123). The manufacturer indicated that information on GAP and data on residues would be available to support new MRLs for these commodities.

The Meeting received data on supervised trials, and information on GAP, the stability of residues in stored analytical samples, methods of residue analysis, and the fate of residues during food processing. The supervised trials included applications of methamidophos to broccoli, head cabbages, cauliflowers, egg plants, melons, peaches and tomatoes; and of acephate to broccoli, Brussels sprouts, head cabbages, cauliflowers, citrus fruits and tomatoes. The Meeting estimated the residues of methamidophos arising from the use of each compound.

Since methamidophos has been listed by the CCPR as a candidate for periodic review but not yet scheduled, and in view of the difficulties encountered by the present Meeting in evaluating the available data without the original studies, the Meeting recommended that the CCPR should schedule methamidophos for periodic review.

4.19 MEVINPHOS (053)

TOXICOLOGY

Mevinphos was evaluated for toxicological effects by the JMPR in 1963 and 1965; in neither case was an ADI assigned. An ADI of 0-0.0015 mg/kg bw was established in 1972. The toxicology of the compound was reviewed at the present Meeting within the CCPR periodic review programme.

Mevinphos is almost completely absorbed when administered orally to rats; a large proportion of the absorbed compound is biotransformed to carbon dioxide. Both metabolites and unchanged mevinphos are observed in the urine but very little in the faeces. Mevinphos depresses cholinesterase activity in the plasma more than in erythrocytes in experimental animals.

The oral LD₅₀ values of mevinphos in laboratory rodents are 2-12 mg/kg bw. WHO has classified mevinphos as 'extremely hazardous'.

In a three-month range-finding study, mice were fed diets containing mevinphos at concentrations of 0, 0.5, 1, 2, or 10 ppm. The NOAEL was 2 ppm, equal to 0.4 mg/kg bw per day, on the basis of inhibition of brain acetylcholinesterase activity at 10 ppm.

In a 90-day study of toxicity, rats were administered mevinphos by gavage at doses of 0, 0.056, 0.56, 1.1 or 1.7 mg/kg bw per day in males (the highest dose was decreased to 1.1 mg/kg bw per day at day 36 because of high mortality) and at 0, 0.011, 0.056, 0.56, or 0.84 mg/kg bw per day in females. The NOAEL was 0.056 mg/kg bw per day, on the basis of clinical signs and depressed brain acetylcholinesterase activity at higher doses. Dose-related increases in mean cholesterol levels and increased relative liver weights were also observed.

In a one-year study of toxicity in dogs, mevinphos was administered in corn oil in gelatin capsules at doses of 0, 0.025, 0.25 or 0.5 mg/kg bw per day. The NOAEL was 0.25 mg/kg bw per day on the basis of clinical signs and a reduction in brain acetylcholinesterase activity at the highest dose.

In an 18-month study of toxicity and carcinogenicity, mice were fed dietary concentrations of 0, 1, 10, or 25 ppm. Acetylcholinesterase activities were not measured. There was no evidence of carcinogenicity.

In a two-year study of toxicity and carcinogenicity, rats were given mevinphos by gavage in water for five days per week at doses of 0, 0.025, 0.35, or 0.70 mg/kg bw per day. On day 83 of the study, the high dose of the females was reduced to 0.60 mg/kg bw per day because of signs of toxicity. The NOAEL was 0.025 mg/kg bw per day on the basis of inhibition of brain acetylcholinesterase activity and clinical signs at higher doses. There was no evidence of carcinogenicity.

A two-generation study of reproductive toxicity was carried out in which rats were treated by gavage at doses of 0, 0.05, 0.1, or 0.5 mg/kg bw mevinphos per day in water. The NOAEL was 0.1 mg/kg bw per day on the basis of clinical signs and reduced brain acetylcholinesterase activity at the highest dose. This dose also impaired growth and fertility indices and lowered testicular weights in males and ovarian weights in females.

In a study of developmental toxicity in rats, groups were given mevinphos at doses of 0, 0.2, 0.75, or 1.25 mg/kg bw per day on days 6-15 of gestation. High mortality (29%) was observed in the high-dose group, which was therefore terminated. Accordingly, a new high-dose group of 1.0 mg/kg bw per day was added. There were no adverse effects on uterine implantation or fetal weight, sex distribution or external appearance, nor visceral or skeletal malformations, in any group. It was concluded that mevinphos is not embryotoxic, fetotoxic, or teratogenic at doses up to 1 mg/kg bw per day. The NOAEL for maternal toxicity was 0.75 mg/kg bw per day on the basis of clinical signs at higher doses.

In a study of developmental toxicity, mevinphos was administered by gavage to pregnant rabbits at doses of 0, 0.05, 0.5, or 1.5 mg/kg bw per day on days 7-19 of gestation; surviving animals were killed. The NOAEL was 0.5 mg/kg bw per day, on the basis of maternal toxicity. Mevinphos was neither teratogenic nor fetotoxic.

There was some evidence of genotoxic potential *in vitro*, but the limited studies available indicate that such potential is not exhibited *in vivo*.

In a study in hens, the oral dose of 12 mg/kg bw that was administered was slightly greater than the oral LD₅₀ value, and antidotal treatment was required. There was no evidence of delayed polyneuropathy, either clinically or histopathologically, whereas characteristic

changes were seen in positive controls. Neurotoxic target esterase was not measured during this study.

Two studies of humans were available. In one study, in which male volunteers were given a dose of 0.025 mg/kg bw per day, plasma and erythrocyte cholinesterase activities decreased throughout the 28 days of the study to 13% and 19% less than the respective pre-dose levels. In the second study, daily doses of 1, 1.5, 2.0, or 2.5 mg were given to male volunteers for 30 days, and an NOAEL of 1 mg/day, equivalent to 0.016 mg/kg bw per day, was derived; however, only five people, per dose were studied.

An ADI of 0-0.0008 mg/kg bw was established on the basis of the NOAEL of 0.016 mg/kg bw per day in the 30-day study in volunteers using a 20-fold safety factor because of the small numbers in each group. This ADI is supported by the LOAEL in rats of 0.35 mg/kg bw per day and the NOAELs of 0.5 mg/kg bw per day in rabbits and 0.25 mg/kg bw per day in dogs.

An acute reference dose for humans was derived from the 28-day study in volunteers, on the basis of a dose of 0.025 mg/kg bw per day over four days, using a 10-fold safety factor.

A toxicological monograph was prepared, summarizing the data received since the previous evaluation and including summaries from the previous monograph.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: 2 ppm, equal to 0.4 mg/kg bw per day (inhibition of brain acetylcholinesterase in three-month study of toxicity)

Rat: 0.025 mg/kg bw per day (two-year study of toxicity and carcinogenicity)

0.1 mg/kg bw per day (study of reproductive toxicity)

Rabbit: 0.5 mg/kg bw per day (maternal toxicity in a study of developmental toxicity)

Dog: 0.25 mg/kg bw per day (one-year study of toxicity)

Human: 0.016 mg/kg bw per day (inhibition of cholinesterase activity in a 30-day study of toxicity)

Estimate of acceptable daily intake for humans

0-0.0008 mg/kg bw

Acute reference dose

0.003 mg/kg bw

Studies that would provide information useful for the continued evaluation of the compound

Study of micronucleus formation in mice *in vivo*.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to mevinphos

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULTS/REMARKS
Short-term (1-7 days)	Oral toxicity, rat	LD ₅₀ = 2.2-6.1 mg/kg bw
	Dermal toxicity, rat	LD ₅₀ >20 mg/kg bw
	Inhalation, 4 h, toxicity, rat	LC ₅₀ = 7.3-12 mg/m ³
	Dermal irritation, rabbit	Slightly irritating
	Ocular irritation, rabbit	Slightly irritating
	Dermal sensitization, guinea-pig	Not sensitizing
Medium-term (1-26 weeks)	Repeated oral, three months, mouse	NOAEL = 0.4 mg/kg bw per day, inhibition of brain acetylcholinesterase
	Repeated oral, 90 days, rat	NOAEL = 0.056 mg/kg bw per day
	Repeated dermal, 21 days, rabbit	NOAEL = 1 mg/kg bw per day
	Repeated oral, reproductive toxicity, rat	NOAEL = 0.1 mg/kg bw per day, maternal and reproductive toxicity
	Repeated oral, developmental toxicity, rat	NOAEL = 0.75 mg/kg bw per day, maternal toxicity; no developmental toxicity
	Repeated oral, developmental toxicity, rabbit	NOAEL = 0.5 mg/kg bw per day, maternal toxicity; no developmental toxicity
Long-term (≥ one year)	Repeated oral, two years, rat	NOAEL = 0.025 mg/kg bw per day; inhibition of brain acetylcholinesterase activity
	Repeated oral, one year, dog	NOAEL = 0.25 mg/kg bw per day; inhibition of brain acetylcholinesterase activity

4.20 PHORATE (112)

TOXICOLOGY

Phorate, an organophosphorus insecticide that inhibits cholinesterase, was first reviewed for toxicological effects by the Joint Meeting in 1977. A temporary ADI of 0-0.0002 mg/kg bw was established in 1982. In 1994, the Meeting re-evaluated phorate and allocated an ADI of 0-0.0005 mg/kg bw per day. Because in a limited study in rats it was reported that less than 40% of the administered ³²P label was excreted within 144 h, adequate studies on absorption, distribution, excretion, and metabolism in rats were requested for review in 1996.

Studies on the absorption, distribution, metabolism, and excretion of phorate in rats were reviewed by the present Meeting. ¹⁴C-labelled phorate was rapidly absorbed and excreted by rats after a single dose in corn oil by gavage. The urine was the primary route of elimination, with approximately 80% of the administered radiolabel excreted within 24 h; faecal elimination accounted for about 10% of the label.

The current studies showed essentially total excretion of ¹⁴C after 192 h. The Meeting concluded that phorate and its metabolites are rapidly excreted and that accumulation of a toxic metabolite is not a concern. Thus, the new data did not indicate that the ADI allocated in 1994 should be reassessed. The ADI of 0-0.0005 mg/kg bw allocated on the basis of a NOAEL of 0.05 mg/kg bw per day in a one-year study of toxicity in dogs and a two-year study of toxicity and carcinogenicity in rats, with a 100-fold safety factor, was confirmed.

An addendum to the toxicological monograph was prepared.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: 1 ppm, equal to 0.18 mg/kg bw per day (13-week study of toxicity)

Rat: 1 ppm, equal to 0.05 mg/kg bw per day (two-year study of toxicity and carcinogenicity)

Rabbit: 0.15 mg/kg bw per day (study of developmental toxicity)

Dog: 0.05 mg/kg bw per day (one-year study of toxicity)

Estimate of acceptable daily intake for humans

0-0.0005 mg/kg bw

Studies that would provide information useful for the continued evaluation of the compound

Further observations in humans.

4.21 PROPOXUR (075)

RESIDUE AND ANALYTICAL ASPECTS

The carbamate insecticide propoxur was first evaluated by the 1973 JMPR. Its residue and analytical aspects were reviewed in 1977, 1981, 1983 and 1991.

At the 1994 CCPR several delegations expressed the opinion that the MRLs recommended by the 1991 Meeting for head lettuce and potatoes were based on very old data.

The Meeting received data from supervised trials on lettuce and potatoes, information on analytical methods, and monitoring data.

The data from supervised trials were reviewed and MRLs were recommended for lettuce and potatoes, but the Meeting decided not to estimate STMR levels until the compound is evaluated in the CCPR periodic review programme since CXLs have already been established for many other commodities and metabolic studies were not available.

4.22 TEBUFENOZIDE (196)

N-tert-butyl-N'-(4-ethylbenzoyl)-3,5-dimethylbenzohydrazide

Tebufenozide is a fat-soluble insecticide used to control Lepidoptera pests in fruits, vegetables and other crops. It has a novel mode of action in that it mimics the action of the insect moulting hormone, ecdysone. Lepidoptera larvae cease to feed within hours of exposure and then undergo a lethal, unsuccessful moult.

Tebufenozide was evaluated for the first time by the present Meeting.

TOXICOLOGY

Oral administration to rats of single doses of 3 or 250 mg/kg bw of ^{14}C -labelled tebufenozide resulted in rapid absorption and excretion in urine and faeces, only trace amounts of ^{14}C being recovered in expired air. The excretion profiles were similar, regardless of the position of the ^{14}C label, the dose, the sex, or whether the rats had been pretreated with 30 ppm of unlabelled tebufenozide in the diet for two weeks. A mean total of 87-104% of the administered radioactivity was eliminated within 48 h, primarily via the faeces which accounted for 90% of the ^{14}C that was excreted; only minor amounts (1-8%) were excreted in urine and trace amounts (0.1-0.4%) in expired air. In animals at 3 mg/kg bw, absorption accounted for 35-39% of the administered radioactivity; 30-34% was excreted in the bile and about 5% in the urine. At 250 mg/kg bw, only about 4% of the administered dose was absorbed and metabolized. The highest levels of ^{14}C in the blood were measured 0.5-12 h after dosing, and clearance of the radiolabel from the circulation was rapid. Tissue retention of ^{14}C was low, suggesting that there is little or no bioaccumulation of tebufenozide in the body.

Most of the ^{14}C excreted in the faeces was in the form of unabsorbed (parent) tebufenozide, which accounted for about 60 and 90% of administered doses of 3 and 250 mg/kg bw per day respectively; no unchanged tebufenozide was detected in the urine. The absorbed [^{14}C]tebufenozide was extensively metabolized in rats. There were no significant qualitative differences in the metabolic profiles associated with the position of the ^{14}C label, the dose, the sex, or whether rats were pretreated with unlabelled tebufenozide. In general, the 13-

15 metabolites identified in the urine, faeces, and bile were identical. The main route of metabolism of tebufenozide appeared to be oxidation of the benzylic carbons (A- or B-ring), resulting in a number of metabolites with various combinations of oxidation state at the three oxidized carbon centres and one metabolite produced by oxidation of the non-benzylic, terminal carbon on the A-ring ethyl group.

Tebufenozide was of low acute toxicity after administration to mice orally or to rats by the oral, dermal or inhalation route. The oral LD₅₀ in mice and rats was >5000 mg/kg bw; the dermal LD₅₀ in rats was >5000 mg/kg bw, and the inhalation LC₅₀ in rats was > 4.3 mg/litre. The metabolites were also of low acute toxicity to mice after oral administration. Tebufenozide was not irritating to the skin and was minimally irritating to the eyes of male rabbits; it was not a skin sensitizer in guinea-pigs. WHO has not classified tebufenozide for acute toxicity.

Repeated short-term oral administration of tebufenozide to mice (2 and 13 weeks), rats (2, 4, and 13 weeks), and dogs (2, 6, 13, and 52 weeks) resulted primarily in haematotoxic effects (regenerative haemolytic anaemia and compensatory responses from the haematopoietic tissues). The NOAEL for these effects was 200 ppm, equal to 35 mg/kg bw per day, in mice in a 13-week study (0, 20, 200, 2000 and 20,000 ppm tested); 200 ppm, equal to 13 mg/kg bw per day, in rats in a 13-week study (0, 20, 200, 2000, and 20,000 ppm tested); 50 ppm, equal to 2.0 mg/kg bw per day, in dogs in a 13-week study (0, 50, 500, and 5000 ppm tested), and 50 ppm, equal to 1.8 mg/kg bw per day, in a one-year study of toxicity in dogs (0, 15, 50, 250, and 1500 ppm tested). Repeated dermal applications of tebufenozide to rats for four weeks caused no systemic toxicity at doses up to 1000 mg/kg bw per day. The dog appeared to be the most sensitive species for both short-term and long-term toxicity.

In an 18-month study of toxicity and carcinogenicity in mice administered tebufenozide in the diet at concentrations of 0, 5, 50, 500, or 1000 ppm, the NOAEL for systemic toxicity was 50 ppm, equal to 7.8 mg/kg bw per day, on the basis of a slightly reduced survival rate and mild regenerative haemolytic anaemia at higher doses. In a two-year study of toxicity and carcinogenicity in rats administered tebufenozide in the diet at 0, 10, 100, 1000, or 2000 ppm, the NOAEL was 100 ppm, equal to 4.8 mg/kg bw per day, on the basis of decreased body weight and food consumption and mild regenerative haemolytic anaemia at higher doses. Tebufenozide was not carcinogenic in mice or rats under the conditions of the studies.

Tebufenozide and its metabolites have been adequately tested for genotoxicity in a range of assays both *in vitro* and *in vivo*. The Meeting concluded that neither tebufenozide nor its metabolites were genotoxic.

In two two-generation studies of reproductive toxicity in rats, with one litter per generation, concentrations of 0, 10, 150, or 2000 ppm and 0, 25, 200, or 2000 ppm were administered. The NOAEL for systemic (parental) toxicity was 25 ppm, equal to 1.6 mg/kg bw per day, on the basis of a consistent increase in the incidence of gross and histopathological lesions in the spleens (congestion, pigment, and extramedullary haematopoiesis) of F₀ and F₁ parental animals at higher doses (200 and 2000 ppm). The NOAEL for reproductive toxicity was 13 mg/kg bw per day on the basis of potential or minor reproductive effects (decreased mean number of implantation sites, prolonged gestation, a slightly greater frequency of total resorptions, and a small increase in the number of dams that died during delivery) at the high dose of 2000 ppm in dams in the first study and in lactating pups (decreased mean weight gain on lactation days 14 and 21) in the second study.

In studies of developmental toxicity in rats and rabbits, doses of 0, 50, 250, or 1000 mg/kg bw per day were administered. There was no evidence of teratogenic potential. The NOAEL for maternal, embryo- and fetotoxicity and teratogenicity was 1000 mg/kg bw per day, the highest dose tested, in both species.

In a study of acute neurotoxicity in rats, no treatment-related effects were seen when single doses of 0, 500, 1000, or 2000 mg/kg bw were administered. The NOAEL for acute neurotoxicity and neuropathological effects was 2000 mg/kg bw, the highest dose tested.

In summary, exposure to tebufenozide by the oral route results primarily in haematotoxicity. The main target of its action is the peripheral haematopoietic system; the pivotal toxicological end-point of concern, which is seen consistently across all species tested, is mild regenerative haemolytic anaemia with compensatory responses from the haematopoietic tissues.

An ADI of 0-0.02 mg/kg bw was established for tebufenozide on the basis of the NOAELs for haematotoxicity of 1.8 mg/kg bw per day in the one-year study in dogs and 1.6 mg/kg bw per day in a two-generation study of reproductive toxicity in rats, using a safety factor of 100.

A toxicological monograph was prepared, summarizing the data that were reviewed at the present Meeting.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: 200 ppm, equal to 35 mg/kg bw per day (13-week study of toxicity)

50 ppm, equal to 7.8 mg/kg bw per day (haematotoxicity in an 18-month study of toxicity and carcinogenicity)

Rat: 200 ppm, equal to 13 mg/kg bw per day (13-week study of toxicity)

100 ppm, equal to 4.8 mg/kg bw per day (haematotoxicity in a two-year study of toxicity and carcinogenicity)

25 ppm, equal to 1.6 mg/kg bw per day (maternal haematotoxicity in a two-generation study of reproductive toxicity)

200 ppm, equal to 13 mg/kg bw per day (reproductive toxicity in a two-generation study)

1000 mg/kg bw per day, the highest dose tested (maternal, embryo-, and fetotoxicity and teratogenicity in a study of developmental toxicity)

Rabbit: 1000 mg/kg bw per day, the highest dose tested (maternal, embryo-, and fetotoxicity and teratogenicity in a study of developmental toxicity)

Dog: 50 ppm, equal to 1.8 mg/kg bw per day (haematotoxicity in a one-year study of

toxicity)

Estimate of acceptable daily intake for humans

0-0.02 mg/kg bw

Studies that would provide information useful for the continued evaluation of the compound

- 1. Observations in humans.
- 2. Studies on the mechanism of haematotoxicity.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to tebufenozide

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULT, REMARKS
Short-term (1-7 days)	Oral toxicity, rat	LD ₅₀ >5000 mg/kg bw
	Dermal toxicity, rat	LD ₅₀ >5000 mg/kg bw
	Inhalation, 4 h, toxicity, rat	LC ₅₀ >4.3 mg/litre
	Dermal irritation, rabbit	Not irritating
	Ocular irritation, rabbit	Minimally irritating
	Dermal sensitization, guinea-pig	Not sensitizing
Medium-term (1-26 weeks)	Repeated dietary, 90 days, toxicity, dog	NOAEL = 2.0 mg/kg bw per day, primarily haematotoxicity
	Repeated dermal, 28 days, toxicity, rat	NOAEL = 1000 mg/kg bw per day, highest dose tested
	Repeated dietary, reproductive toxicity, rat	NOAEL = 13 mg/kg bw per day, minor reproductive effects
	Repeated gavage, developmental toxicity, rat and rabbit	NOAEL = 1000 mg/kg bw per day (highest dose tested), maternal, embryo- and fetal toxicity and teratogenicity
Long-term (≥ one year)	Repeated dietary, one year, toxicity, dog	NOAEL = 1.8 mg/kg bw per day, primarily haematotoxicity

RESIDUE AND ANALYTICAL ASPECTS

The Meeting was provided with information on registered uses of tebuconazole on fruits, vegetables and other crops, and received extensive information on metabolism, environmental fate in soil, methods of residue analysis, the stability of residues in stored analytical samples, supervised residue trials, animal transfer studies and the fate of residues during processing. The metabolism studies were on rats, lactating goats, laying hens, fish, apples, grapes, rice and sugar beet. The information on environmental fate included studies of field dissipation and biodegradation in water/sediment systems.

Residues of tebufenozide can be determined by HPLC with UV detection or by GLC with NP detection after methylating the residues. Limits of determination are usually 0.01-0.05 mg/kg in a range of commodities, 0.02 mg/kg in soil and 0.1 µg/l in water.

The Meeting agreed that the residue should be defined as tebufenozide.

The Meeting evaluated residue data from supervised trials and estimated maximum residue levels for apples, grapes, walnuts, rice and pecans.

Information on the fate of tebufenozide during the processing of apples, grapes and tea was provided. In one study the total residue of tebufenozide in apple juice was about 15% of that in the apples. In a number of studies of vinification the mean residue in wine was 36% of that in the grapes. Infusions of tea contained 5-31% of the tebufenozide in the dry tea, with a mean of 17%.

Maximum residue levels estimated by the Meeting which are recommended for establishing MRLs are recorded in Annex I, together with STMR levels.

FURTHER WORK OR INFORMATION

Desirable

1. Information on tebufenozide residues in raisins, raisin culls and rice hulls.
2. Information on residues of tebufenozide in foods in commerce or at consumption.
3. A transfer study on poultry.
4. The results of a cow-feeding study which the Meeting was informed was in progress.
5. Data on residues in paddy rice and on the stability of residues in analytical samples of rice stored for longer periods than the 20-21 days already reported.
6. A detailed report of the completed study of uptake by rotational crops that the Meeting was informed was available.
7. Representative data on the storage stability of residues on leafy vegetables for the full duration of the studies that the Meeting was informed are in progress.

4.23 TEFLUBENZURON (190)

RESIDUE AND ANALYTICAL ASPECTS

Residue and analytical aspects of the compound were considered for the first time by the present Meeting.

Teflubenzuron, 1-(3,5-dichloro-2,4-difluorophenyl)-3-(2,6-difluorobenzoyl)urea, is a fat-soluble insecticide whose major use is for the control of a wide range of insect pests and some mites in fruits, vegetables, cereals and seeds. The Meeting received extensive information on metabolism in plants and animals, environmental fate in soil, including information on residues in rotational crops and biodegradation in water/sediment systems, methods of residue analysis, stability of residues in stored analytical samples, approved use patterns, supervised residue trials, animal transfer studies and the fate of residues during processing.

Metabolism studies on rats, lactating goats, laying hens, apples, potatoes, cotton and spinach were reviewed. Analytical methods (HPLC and GLC) are available for the determination of teflubenzuron in plant and animal materials, soil, water and air.

The Meeting evaluated residue data from supervised trials and estimated maximum residue levels for pome fruits, plums (including prunes), head cabbages, Brussels sprouts and potatoes. Insufficient data were available to estimate maximum residue levels for citrus fruits, cherries, nectarines, peaches, grapes, broccoli, cucumbers, egg plants, peppers, tomatoes, mushrooms, chinese cabbage, soya bean seeds, forage and hay, maize, cotton seed or coffee beans. Residue data were received from supervised trials on wild blackberries, blueberries and raspberries, kiwifruit, persimmons, peas (immature seeds), alfalfa forage and green grass, but no GAP was available to evaluate the data.

Animal transfer studies in which lactating dairy cows and laying hens were fed with teflubenzuron were reviewed, but as no maximum residue levels had been estimated for feed items the studies could not be evaluated.

Processing studies were available for apples, plums, cherries, grapes, potatoes, tomatoes, soya beans and cotton, but were insufficient to estimate transfer factors.

The residue should be defined as teflubenzuron. It is fat-soluble. Estimates of STMRS and of maximum residue levels which are recommended for use as MRLs are recorded in Annex I.

FURTHER WORK OR INFORMATION

Desirable

1. Physical and chemical properties of the pure active ingredient.
2. Further processing studies on apples and plums to allow the calculation of transfer factors.

4.24 THIRAM (DITHIOCARBAMATES, 105)

RESIDUE AND ANALYTICAL ASPECTS

Thiram was originally evaluated in 1965 (toxicology) and 1967 (toxicology and residues) and is included in the dithiocarbamate group of compounds. It was evaluated at the present Meeting within the CCPR periodic review programme.

Thiram is a protective dithiocarbamate fungicide used as a foliar treatment on fruits, vegetables and ornamentals and as a seed treatment to control a number of fungal diseases. The Meeting was provided with information on registered uses on fruits, vegetables and other crops.

The Meeting received extensive information on the metabolism of thiram in rats, farm animals, apples, grapes, soya beans, cotton, wheat and sugar beet; environmental fate in soil and water/sediment systems, methods of residue analysis, the stability of residues in stored analytical samples, approved use patterns, supervised residue trials and the fate of residues during processing.

When animals are dosed with radiolabelled thiram much of the dose is eliminated as volatile CS₂ and CO₂. Dimethyldithiocarbamic acid, the initial product in animals, plants and soil, forms conjugates with natural products. The intermediate dimethyldithiocarbamoylalanine is converted to different metabolites in plants and animals.

The analytical methods for dithiocarbamates which rely on CS₂ evolution may be used to determine thiram residues. Limits of determination for various commodities are usually 0.05-0.1 mg/kg (as CS₂). An HPLC method specific for thiram is available for the determination of residues on crops.

Data were available on the stability of thiram residues on plums, and of thiram added to apple juice and pomace, during frozen storage.

The Meeting agreed that the definition of the residue of the dithiocarbamates should apply to thiram. For estimates of dietary intake the supervised trials median residue (STMR) will be expressed as thiram for comparison with the thiram ADI. For estimates of acute intake a residue such as an MRL, which is expressed in terms of CS₂, must be multiplied by a factor of 1.58 for comparison with an acute reference dose expressed in terms of thiram.

The Meeting received data on thiram residues from supervised trials on apples, pears, peaches, plums, cherries, grapes, strawberries, dwarf French beans, French beans, Savoy cabbage, green peas, head lettuce, spinach and tomatoes. Thiram was determined by CS₂ evolution methods or by HPLC, and in some trials by both methods.

Information on the fate of thiram during the processing of apples and grapes was made available to the Meeting. The thiram level in apple juice was about 30% of its level in the apples. In processing studies with grapes containing thiram residues of 1.2-4.3 mg/kg, thiram was below the LOD of 0.1 mg/kg in the wine as determined by the HPLC analytical method.

Monitoring data for dithiocarbamate residues in commodities in trade were provided from The Netherlands, Belgium and Denmark. Dithiocarbamates were detected in fewer than 15-20% of the samples of most commodities.

FURTHER WORK OR INFORMATION

Desirable

The rates of hydrolysis of thiram at various pH values should be clarified. Full copies of the reports of the studies should be made available for review.

4.25 ZIRAM (DITHIOCARBAMATES, 105)

TOXICOLOGY

Ziram was evaluated for toxicological effects by the Joint Meeting in 1965, 1967, 1970, 1974, 1977, and 1980. A temporary ADI (0-0.025 mg/kg bw) for ziram or ziram in combination with other dimethyldithiocarbamates was allocated in 1967, on the basis of the NOAEL in a one-year study in dogs. This temporary ADI was lowered to 0.005 mg/kg bw in 1974. A group ADI of 0-0.02 mg/kg bw for ferbam and ziram was allocated in 1977 and confirmed in 1980. The compound was reviewed by the present Meeting within the CCPR periodic review programme.

In experiments with ¹⁴C-labelled ziram in rats, elimination was essentially complete within 48 h. Elimination occurred mainly in expired air, urine, and faeces. Less than 2% of the administered dose remained in the tissues. The biotransformation of ziram has not been studied in rodents. In goats, it is metabolized at least in part via a single-carbon pathway, which results in extensive radiolabelling of natural products.

The primary effect of short- and long-term treatment with ziram in mice, rats, and dogs was on the liver, thyroid gland, and testes. The hepatic effects were increased liver weight, degeneration, and focal-cell necrosis. Effects in the thyroid were C-cell hyperplasia and carcinomas, and that on the testes was sterility.

Ziram had moderate acute oral toxicity in rats and rabbits (LD₅₀ = 200-400 mg/kg bw). WHO has classified ziram as 'slightly hazardous'.

In a four-week study of toxicity in mice given dietary concentrations of 0, 3000, 4000, or 5000 ppm, an NOAEL was not identified. Reductions in body weight, food intake, efficiency of food use, and brain and heart weight occurred at all doses.

In a 13-week study of toxicity in mice given dietary concentrations of 0, 100, 300, 900, or 2700 ppm, the NOAEL was 100 ppm, equal to 15 mg/kg bw per day, on the basis of lowered spleen weight at higher doses. At 900 and 2700 ppm, the number of corpora lutea was reduced, which was consistent with cellular changes in the uterus.

In two four-week studies of toxicity in rats either given diets containing 0, 100, 500,

2500, or 5000 ppm or treated by gavage with 0, 3, 15 or 100 mg/kg bw per day, the NOAEL was 3 mg/kg bw per day, on the basis of degenerative liver changes. At 100 mg/kg bw per day, degenerative changes in the kidneys and reductions in body weight, food intake, efficiency of food use, and absolute weights of the liver, pituitary, testes, brain, and uterus were seen.

In a 13-week study of toxicity in which rats received dietary levels of 0, 100, 300, or 1000 ppm, the NOAEL was 100 ppm, equal to 7.4 mg/kg bw per day, on the basis of reduced body-weight gain, food intake, and food use and increased brain and spleen weights at higher doses.

In a four-week study of toxicity in dogs given diets providing doses of 0, 1000, 2000, or 5000 ppm, an NOEL was not identified. Increased liver weight occurred at all doses. At 2000 ppm, convulsive episodes were observed.

In a 13-week study of toxicity in dogs given diets providing 0, 100, 300, or 1000 ppm, the NOAEL was 100 ppm, equal to 4.1 mg/kg bw per day, on the basis of increased liver weight, focal liver necrosis, pigment in Kupffer cells, activated partial thromboplastin time, and elevated cholesterol level at higher doses.

In a one-year study of toxicity in which dogs were fed diets providing doses of 0, 50, 180, or 500 ppm, the NOAEL was 50 ppm, equal to 1.6 mg/kg bw per day, on the basis of reductions in body-weight gain, degeneration of hepatocytes, and increased activity of alanine and aspartate aminotransferases and alkaline phosphatase at 180 ppm and above. At 500 ppm, single liver-cell necrosis was observed, and the liver weight and cholesterol values were increased; albumin values were reduced. Inflammatory cell infiltration around the hepatic veins and its branches and aggregates of pigmented Kupffer cells were observed in the liver.

Two long-term studies of toxicity and carcinogenicity in mice have been reported. One was considered inadequate for evaluating the carcinogenicity of ziram. In the other, mice were given diets containing 0, 25, 75, 220, or 680 ppm for 80 weeks. The NOAEL was 25 ppm, equal to 3 mg/kg bw per day, on the basis of reduced brain weight at 75 ppm and above. There was no evidence of carcinogenicity.

In a two-year study of toxicity and carcinogenicity in rats at dietary concentrations of 0, 25, 250, or 2500 ppm, the NOAEL was 250 ppm, equivalent to 12 mg/kg bw per day, on the basis of testicular atrophy and thyroid hyperplasia at 2500 ppm. There was no evidence of carcinogenicity.

In a two-year study of toxicity and carcinogenicity in Fischer 344 rats with dietary concentrations of 0, 300, or 600 ppm, an NOAEL was not identified since the combined incidence of C-cell adenoma and carcinoma of the thyroid in males showed a positive trend. This finding was considered to represent an extension of the known toxicity of the compound to the thyroid, to which the rat is particularly sensitive, and not to indicate carcinogenic potential for humans.

In a study of toxicity and carcinogenicity in CD rats treated with 0, 60, 180, or 540 ppm in the diet for 12-24 months, an NOEL was not identified because dose-related changes in organ weights and histopathological and haematological changes were observed at 60 ppm, equal to 2.5 mg/kg per day. Other effects included reduced body weight, erythrocyte counts, and tri-iodothyronine and thyroxine activity. Cysts in the thyroids, epithelial hyperplasia,

hypertrophy with vacuolation, cortical cystic degeneration of the adrenals, and C-cell hyperplasia of the thyroid were also observed. The tumour incidence was not increased.

In a study of sperm quality in mice treated intraperitoneally with ziram at single doses of 0, 50, or 100 mg/kg bw or repeated doses of 25 mg/kg bw per day for five days, severe morphological abnormalities were observed. The frequency of abnormal sperm was 1.6% in the controls, 5.6% at 50 mg/kg bw, 8.2% at 100 mg/kg bw, and 8.4% after repeated doses of 25 mg/kg bw per day.

In a two-generation study of reproductive toxicity and developmental neurotoxicity, rats were fed ziram at concentrations of 0, 72, 210 or 540 ppm. The NOAEL for maternal toxicity was 210 ppm, equal to 10 mg/kg bw per day, based on reduced food consumption and body-weight gain at 540 ppm. The NOAEL for neonatal toxicity was 210 ppm, equal to 10 mg/kg bw per day, based on reduced body-weight gain at 540 ppm. The NOAEL for reproductive toxicity and developmental neurotoxicity was 540 ppm, equal to 25 mg/kg bw per day.

In a study of developmental toxicity, rats were administered ziram at 0, 1, 4, 16, or 64 mg/kg bw per day on days 6-15 of gestation. The NOAEL for maternal toxicity was 4 mg/kg bw per day, on the basis of decreased body-weight gain and food intake, and increased water intake and salivation at 16 mg/kg bw per day and above. The NOEL for developmental toxicity was 16 mg/kg bw per day, on the basis of decreased litter weight and fetal weight at 64 mg/kg bw per day. No teratogenicity was seen.

In a study of teratogenicity in hamsters treated with single oral doses of 0, 31, 63, 120, or 500 mg/kg bw per day on day 7 or 8 of gestation, the NOAEL was 63 mg/kg bw per day, on the basis of fused ribs and deformed tails and heads, including all degrees of exencephaly, at 120 mg/kg bw per day.

In a study of developmental toxicity in rabbits given ziram at doses of 0, 3, 7.5, or 15 mg/kg bw per day on days 7-19 of gestation, the NOAEL for maternal toxicity and developmental toxicity was 7.5 mg/kg bw per day, on the basis of decreased body-weight gain and food intake in the dams and post-implantation loss, reduced litter size, litter weight, fetal weight, and crown-rump length at 15 mg/kg bw per day. There was no evidence of developmental toxicity.

Ziram is mutagenic in bacteria. It induced chromosomal aberrations in some, but not all, studies with cultured mammalian cells but did not induce unscheduled DNA synthesis in hepatocytes. *In vivo*, ziram induced single-strand breaks of DNA in the livers of rats but not mice. Chromosomal aberrations were not induced in mice *in vivo* in bone-marrow cells or spermatogonia, and micronuclei were not induced in bone-marrow cells or peripheral erythrocytes. Studies for clastogenicity have not been conducted in rats *in vivo*. In an old study of nine workers exposed for three to five years to ziram at a concentration of 2-4 mg/m³ air, the percentage of peripheral leucocytes with chromosomal aberrations was 5.9%; in a control group the percentage was 0.75%. The Meeting was unable to reach a conclusion about the genotoxicity of ziram.

Ziram caused severe eye irritation but no dermal irritation in rabbits and moderate skin sensitization in guinea-pigs.

In two studies of neurotoxicity in rats treated with single doses of 0, 15, 300, or 600 mg/kg bw or 0, 72, 210, or 540 ppm for 91 days, behavioural effects indicative of neurotoxicity were apparent after single high doses but not after repeated dosing at a lower level. The NOAEL was 210 ppm, equal to 14 mg/kg bw per day, on the basis of reduced body weight and food consumption and inhibition of brain neuropathy target esterase activity at 540 ppm.

An ADI of 0-0.003 mg/kg bw was established on the basis of long-term toxicity in the rat. In this study, effects were seen at all doses, the LOAEL being 60 ppm, equal to 2.5 mg/kg bw per day. In view of the absence of an NOAEL, a safety factor of 1000 was used. The NOAEL of 1.6 mg/kg bw per day observed in a long-term study of toxicity in dogs supported this ADI, which served as the basis for the group ADI that was established for ziram alone or in combination with ferbam.

A toxicological monograph was prepared, summarizing the data received since the previous evaluation and relevant data from the previous monograph and monograph addendum.

TOXICOLOGICAL EVALUATION

Levels that cause no toxic effect

Mouse: 25 ppm, equal to 3 mg/kg bw per day (80-week study of toxicity and carcinogenicity)

210 ppm, equal to 10 mg/kg bw per day (maternal toxicity in a study of reproductive toxicity)

10 mg/kg bw per day (study of reproductive toxicity)

Rat: NOAEL could not be determined: lowest effective dose 60 ppm, equal to 2.5 mg/kg bw per day (12-24-month study of toxicity, various effects)

100 ppm, equal to 7.4 mg/kg bw per day (13-week study of toxicity)

250 ppm, equivalent to 12 mg/kg bw per day per day (two-year study of toxicity and carcinogenicity)

Hamster: 63 mg/kg bw per day (study of teratogenicity)

Rabbit: 7.5 mg/kg bw per day (maternal toxicity and embryotoxicity in a study of developmental toxicity)

Dog: 50 ppm, equal to 1.6 mg/kg bw per day (one-year study of toxicity)

100 ppm, equal to 4.1 mg/kg bw per day (13-week study of toxicity)

Estimate of acceptable daily intake for humans

0-0.003 mg/kg bw (group ADI for ferbam and ziram)

Studies that would provide information useful for the continued evaluation of the compound

- 1. Further studies on long-term toxicity in rats.
- 2. Further studies on genotoxicity in rats.
- 3. Further studies on male reproductive toxicity.
- 4. Further observations in humans.

Toxicological criteria for setting guidance values for dietary and non-dietary exposure to ziram

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULT, REMARKS
Short-term (1-7 days)	Oral toxicity, rat	LD ₅₀ = 270 mg/kg bw
	Inhalation toxicity, rat	LC ₅₀ = 0.06 mg/litre
	Dermal irritation, rabbit	Not irritating
	Ocular irritation, rabbit	Severely irritating
	Dermal sensitization, guinea-pig	Moderately sensitizing
Medium-term (1-26 weeks)	Repeated oral, 13 weeks, toxicity, mouse	NOAEL = 15 mg/kg bw per day, decreased spleen weight
	Repeated oral, 4 weeks, toxicity, rat	NOAEL = 3 mg/kg bw per day, reduced body weight, food consumption, and degenerative hepatic changes
	Repeated oral, 13 weeks, toxicity, dog	NOAEL = 4.1 mg/kg bw per day, hepatic toxicity
	Repeated oral, reproductive toxicity and developmental neurotoxicity, rat	NOAEL = 25 mg/kg bw per day, reproductive toxicity and development neurotoxicity NOAEL = 10 mg/kg bw per day, maternal and neonatal toxicity (reduced body weight)
	Repeated oral, developmental toxicity, rat	NOAEL = 16 mg/kg bw per day, developmental toxicity (reduced fetal weight) NOAEL = 4 mg/kg bw per day, maternal toxicity (reduced body weight)
	Repeated oral, developmental toxicity, hamster	NOAEL = 63 mg/kg bw per day, developmental toxicity (deformed fetuses)
	Repeated oral, developmental toxicity, rabbit	NOAEL = 7.5 mg/kg bw per day, developmental and maternal toxicity (reduced fetal and maternal weight)
	Repeated oral, neurotoxicity, rat	NOAEL = 14 mg/kg bw per day, inhibition of neuropathy target esterase activity
Long-term (≥)	Repeated oral, 18 months,	NOAEL = 3 mg/kg bw per day, reduced brain

EXPOSURE	RELEVANT ROUTE, STUDY TYPE, SPECIES	RESULT, REMARKS
one year)	toxicity, mouse	weight and hepatic toxicity
	Repeated oral, two years, toxicity and carcinogenicity, rat	No NOAEL identified, LOAEL = 2.5 mg/kg bw per day, haematological toxicity and toxic effects on the thyroid
	Repeated oral, one year, toxicity, dog	NOAEL = 1.6 mg/kg bw per day, reduced body weight and hepatic toxicity

RESIDUE AND ANALYTICAL ASPECTS

Ziram was originally evaluated in 1965 (toxicology) and 1967 (toxicology and residues) and is included in the dithiocarbamate group of compounds. It was evaluated at the present Meeting within the CCPR periodic review programme.

Ziram is a dithiocarbamate contact fungicide with protective action and is registered for use on fruit, vegetables, tree nuts and ornamentals in many countries. Ziram applied to dormant fruit trees is also used to repel hares and rabbits.

The Meeting received information on the metabolism of ziram in goats and apples, methods of residue analysis, the stability of residues in stored analytical samples, approved use patterns, supervised residue trials and the fate of residues during the processing of apples.

In a study on lactating goats with radiolabelled ziram the total residues in milk reached a plateau within 2-3 days. Levels of the radiolabel were higher in the liver than in other tissues.

The metabolism study on apples demonstrated that ziram residues are essentially on the surface. Most of the residue which becomes incorporated into the tissues no longer contains the CS₂ structure.

Studies of the environmental fate were not provided for review by the FAO Panel, but the Meeting was informed that such studies were available and had been supplied to the Environmental Core Assessment Group. They would be supplied for future evaluation by the FAO Panel. The Meeting agreed to recommend only temporary MRLs pending a review of the data on environmental fate by the FAO Panel.

The analytical methods for ziram rely on acid digestion and CS₂ evolution, as do those for other dithiocarbamates. The Meeting agreed that the definition of the residue of the dithiocarbamates should apply to ziram.

Ziram in fortified macerated apples and peaches stored at -20°C for 3 months was of marginal stability.

The Meeting received data on ziram residues from supervised trials on apples, pears, apricots, cherries, nectarines, peaches, plums, almonds (kernels and hulls analysed), and pecans.

In an apple-processing study, residue levels of ziram in apple juice were about 10% of those in the apples.

FURTHER WORK OR INFORMATION

Required (by 1997)

Information on the environmental fate of ziram in soil and in water/sediment systems.

Desirable

1. Information on the effect of washing on ziram residues on fruits.
2. Final reports of freezer storage stability studies now in progress on peaches, apples and almonds.
3. Information on attempts to develop specific methods of analysis for ziram, whether successful or not.

5. RECOMMENDATIONS

- 5.1 In the interests of public health and agriculture and in view of the needs of the Codex Committee on Pesticide Residues, the Meeting recommended that Joint Meetings on Pesticide Residues should continue to be held annually.
- 5.2 (Section 2.2.2). The Meeting agreed that risk assessments for acute hazards should take into account variability in individual units of composite samples upon which the MRL is based.
- 5.3 (Section 2.2.3). The Meeting:
- (1) agreed to support the recommendations of the informal workshop convened in The Hague, The Netherlands, 11-12 April 1996, on data evaluation, but recognized the need for further development.
 - (2) agreed that STMR levels that it had estimated should be used by the JMPR in estimating consumer intakes resulting from long-term (chronic) exposure.
 - (3) agreed to the need for wide availability of the report of the informal Workshop held in The Hague in April 1996 (*Report of an informal workshop on data evaluation in the estimation of dietary intake of pesticide residues for the JMPR*) which is included as Annex IV to this report.
 - (4) recommended that both the general and specific recommendations of the Workshop be included in future FAO and WHO guidelines.
- 5.4 (Section 2.2.4). The Meeting recommended that a worked example of calculations of Supervised Trials Median Residue (STMR) levels for parathion-methyl ('Parathion-methyl, Estimation of Dietary Intake') should be forwarded to the 1997 CCPR.
- 5.5 (Section 2.5). The Meeting recommended that national evaluations of pesticides should be used to the extent possible in the work of the WHO Core Assessment Group.
- 5.6 (Section 2.7). The Meeting recommended that IPCS make every effort to obtain the funds necessary for convening the Environmental Core Assessment Group simultaneously with the JMPR in the future.
- 5.7 (Section 4.18). Since methamidophos has been listed by the CCPR as a candidate for periodic review but not yet scheduled, and in view of the difficulties encountered by the present Meeting in evaluating the available data without the original studies, the Meeting recommended that the CCPR should schedule methamidophos for periodic review.
- 5.8 (Annex III). The Meeting agreed that a general method, with the inclusion of worked examples, should be developed for estimating dietary exposure to residues of pesticides that have common mechanisms of toxicity.

6. FUTURE WORK

The following items should be considered at the 1997 or 1998 Meeting.
The compounds listed include those recommended for priority attention by the 28th or earlier Sessions of the CCPR, as well as compounds scheduled for re-evaluation in the CCPR periodic review programme.

6.1 1997 Meeting (tentative)

Toxicological evaluation

New compounds

Chlorpropham
Fenbuconazole
Fipronil

Periodic review compounds

Fenamiphos (085)
Guazatine (114)
Malathion (049)
Triforine (116)

Other evaluations

Amitrole (079)
Chlormequat (015)
Ethephon (106)
Lindane (048)
Phosalone (060)

Residue evaluation

New compounds

Chlorpropham
Fenbuconazole

Periodic review compounds

Carbofuran (096)
Carbosulfan (145)
Demeton-S-methyl (073)
Guazatine (114)

Mevinphos (053)
Phosmet (103)
Thiabendazole (065)

Other evaluations

Abamectin (177)
Captan (007)
Chlorothalonil (081)
Clethodim (187)
Folpet (041)
Myclobutanil (181)
Tebuconazole (189)

6.2 1998 Meeting (tentative)

Toxicological evaluation

New compounds

—

Periodic review compounds

Amitraz (122)
Dicloran (083)
Diphenylamine (030)
Endosulfan (032)
Ethoxyquin (035)
Pyrethrins (063)
Thiometon (076)

Other Evaluations

Bentazone (172)
Dinocap (087)
Phosmet (103)

Residue evaluation

New compounds

—

Periodic review compounds

Amitrole (079)
Benomyl (069)
Carbaryl (008)
Carbendazim (072)
2,4-D (020)
Dicloran (083)
Dimethipin (151)
Dimethoate (027)
Formothion (042)
Maleic hydrazide (102)
Omethoate (055)
Thiophanate-methyl (077)
Triforine (116)

Other Evaluations

Aldicarb (117)
Captan (007)
Dinocap (087)
Disulfoton (074)
Glufosinate-ammonium (175)
Hexythiazox (176)
Procymidone (136)
Quintozene (064)

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CORRECTIONS TO REPORT OF 1995 JMPR

Additions and changes are shown **bold**. Minor typographical errors are not included.

P. 12 (Section 2.5.2), para 1, line 1

Insert "**fate**" to read "...data on environmental **fate** have been submitted..."

P. 52 (buprofezin), para 1, line 1

Change to read "...residues in food **in** commerce..."

P. 61 (dithianon), last full para, last line

Change to read "...supported the previous estimate of **5** mg/kg."

P. 63 Heading 4.15 FENARIMOL

Change Codex Classification Number to (192)

P. 86 Heading 4.17 FENPYROXIMATE

Change Codex Classification Number to (193)

P. 121 (fenthion), whole of para 6

Change to read

"Although the use pattern and data suggested a maximum residue level of 1 mg/kg, the Meeting could not support this value on the basis of the risk assessment conducted. The Meeting therefore recommended withdrawal of the existing CXL for milks (0.05 mg/kg, F V)."

P. 130 Heading 4.21 HALOXYFOP

Change Codex Classification Number to (194)

P. 213 (Annex I), Fenarimol

Change the recommendation for DF 0269 Dried grapes to **0.2** T mg/kg.

P. 227 (Annex II)

TEBUCONAZOLE

Change Codex Classification Number to (189)

TEFLUBENZURON

Insert Codex Classification Number **(190)**

TOLCLOFOS-METHYL

Change Codex Classification Number to **(191)**

ANNEX I

ACCEPTABLE DAILY INTAKES, RESIDUE LIMITS AND SUPERVISED TRIALS MEDIAN RESIDUES PROPOSED AT THE 1996 MEETING

The Table of recommendations includes maximum Acceptable Daily Intakes (ADIs) and Maximum Residue Limits (MRLs). It should be noted that MRLs include draft MRLs and Codex MRLs (CXLs). The MRLs recommended by the JMPR on the basis of its estimates of maximum residue levels enter the Codex procedure as draft MRLs. They become Codex MRLs when they have passed through the procedure and have been adopted by the Codex Alimentarius Commission.

In general, the recommended MRLs listed for compounds which have been reviewed previously are additional to, or amend, those recorded in the reports of earlier Meetings. For compounds re-evaluated in the CCPR periodic review programme however, both new and previous recommendations are listed because such re-evaluations are regarded as replacing the original evaluation rather than supplementing it.

Some ADIs may be temporary: this is indicated by the letter T and the year in which re-evaluation is scheduled in parenthesis below the ADI. All recommended MRLs for compounds with temporary ADIs are necessarily temporary, but some recommendations are designated as temporary (TMRLs) until required information has been provided and evaluated, irrespective of the status of the ADI. Such recommendations are followed by the letter T in the table. (See also the list of qualifications and abbreviations below.)

In response to recommendations of a Joint FAO/WHO Consultation on Guidelines for predicting the Dietary Intake of Pesticide Residues held in York, the UK, in 1995, the 1996 Meeting has extended its estimations of residues to include calculations of the median residues found in supervised trials (STMRLs) in order to provide a basis for the estimation of the dietary intake of the pesticides reviewed. The estimated STMRLs are included in the Table of ADIs and MRLs. Further details of the response of the Meeting to the York Consultation are given in Section 2.2.1 of this report, and information about an informal workshop held in The Hague, The Netherlands, in April 1996 to consider the implementation of its recommendations by the JMPR in Section 2.2.3. The report of this Workshop is reproduced as Annex IV.

Attention is drawn to Section 3.1 of this report: 'Definition of the residues of fat-soluble compounds'. Residues of such compounds are distinguished in the Table of Recommendations by the parenthetic note '(fat-soluble residue)' on a line below the residue definition.

The following qualifications and abbreviations are used.

* following At or about the limit of determination
recommended
MRL

* following name New compound
of pesticide

** following name Compound reviewed in CCPR periodic review programme
of pesticide

E Extraneous Residue Limit (ERL).

F following The residue is fat-soluble and MRLs for milk and milk
recommendations products are derived as explained in the introduction
for milk to Part 2 of the Guide to Codex Maximum Limits for Pesticide Residues
and to Volume II of the Codex Alimentarius.

(fat) following The recommendation applies to the fat of the meat.
recommendations
for meat

Po The recommendation accommodates post-harvest treatment of the
commodity.

PoP following The recommendation accommodates post-harvest treatment
recommendations of the primary food commodity.
for processed foods
(classes D and E in the
Codex Classification)

STMR Supervised Trial Median Residue (see explanation on previous page).

STMR-P An STMR for a processed commodity calculated by applying the mean
concentration or reduction factor for the process to the STMR calculated for the raw
agricultural commodity.

T following ADIs The ADI is temporary, and due for re-evaluation in the year indicated.

T following MRLs The MRL is temporary, irrespective of the status of the ADI,
until required information has been provided and evaluated.

V following The recommendation accommodates veterinary uses.
recommendations
for commodities
of animal origin

W in place of an The previous recommendation is withdrawn.

MRL

If a recommended MRL is an amendment, the previous value is also recorded. The absence of a figure in the "Previous" column indicates that the recommendation is the first for the commodity or group concerned.

The Table includes the Codex Classification Numbers (CCNs) of both the compounds and the commodities listed, to facilitate reference to the Guide to Codex Maximum Limits for Pesticide Residues and other Codex documents.

Commodities are listed in alphabetical order. This is a change from earlier practice where commodities were listed in the order of the "Types" in the Codex Classification of Foods and Animal Feeds, and in alphabetical order within each Type. The change was made to facilitate checking and comparison with the CCPR Tables of MRLs, which are in alphabetical order.

ACCEPTABLE DAILY INTAKES (ADIs), MAXIMUM RESIDUE LIMITS (MRLs)
AND SUPERVISED TRIALS MEDIAN RESIDUES (STMRs)^{iv}

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
Acephate (095)	0.03	VB 0400	Broccoli	2	- ¹	0.11
		VB 0041	Cabbages, Head	2	- ¹	0.33
		VB 0404	Cauliflower	2	- ¹	0.11
		VO 0448	Tomato	1	- ¹	0.38
			Tomato, canned			0.19 P ²
			Tomato, canned juice			0.35 P
			Tomato, bulk paste			1.52 P
			Tomato, canned puree			0.68 P
			Tomato, wet pomace			0.23 P
			Tomato, dry pomace			0.38 P

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	

Annex I

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		² STMR-P				
		Aldicarb	0.003	VR 0589	Potato	0.5
(117)			Potato chips			0.056 P ¹
			Potato fries			0.045 P
			Potato, microwaved			0.065 P
			Potato, baked			0.050 P

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Notes: ¹ STMR-P				
Bifenthrin	0.02	GC 0654	Wheat	0.5 Po	0.05*	0.255
(178)		CM 0654	Wheat bran, unprocessed	2 PoP	-	0.89 P ¹
		CF 1211	Wheat flour	0.2 PoP	-	0.076 P
		CF 1212	Wheat wholemeal	0.5 PoP	-	0.21 P

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		<u>Notes:</u> ¹ STMR-P				
Carbaryl** (008)	0.003					

Annex I

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Periodic review was only for toxicology				
Carbofuran** (096)	0.002					

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Periodic review was only for toxicology				
Chlorfenvinphos**	0.0005	VB 0400	Broccoli	W	0.05	
(014)		VB 0402	Brussels sprouts	W	0.05	
		VB 0041	Cabbages, head	W	0.05	
		VR 0577	Carrot	W	0.4	
		VB 0404	Cauliflower	W	0.1	
		VS 0624	Celery	W	0.4	
		FC 0001	Citrus fruits	W	1	
		SO 0691	Cotton seed	W	0.05	
		VO 0440	Egg plant	W	0.05	
		VR 0583	Horseradish	W	0.1	
		VA 0384	Leek	W	0.05	
		GC 0645	Maize	W	0.05	
		MM 0095	Meat (from mammals, other than marine mammals)	W	0.2 (fat) V	
		ML 0107	Milk of cattle, goats and sheep	W	0.008 F V	
		VO 0450	Mushrooms	W	0.05	
		VA 0385	Onion, bulb	W	0.05	
		SO 0697	Peanut	W	0.05	
		VR 0589	Potato	W	0.05	
		VR 0494	Radish	W	0.1	
		GC 0649	Rice	W	0.05	
		CM 1205	Rice, polished	W	0.05	
		VR 0497	Swede	W	0.05	
		VR 0508	Sweet potato	W	0.05	
		VO 0448	Tomato	W	0.1	
		VR 0506	Turnip, Garden	W	0.05	

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STM (mg/kg)
		CCN	Name	New	Previous	
		Periodic review was only for toxicology				
DDT (021)	0.02 (PTDI ¹)	MM 0095	Meat (from mammals other than marine mammals)	5 (fat) E	1 (fat) E	

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Notes: ¹ provisional tolerable daily intake. See 1994 report, Section 2.3				
Diazinon ¹	0.002	PO 0840	Chicken, Edible offal of	0.02*	-	0
(022)		PE 0840	Chicken eggs	0.02*	-	0
		PM 0840	Chicken meat	0.02*	-	0
		MM 0814	Goat meat	2 (fat) V	-	0.3 (fat) 0.02 (whole muscle)
		MO 0098	Kidney of cattle, goats, pigs and sheep	0.03 V	-	0.01
		MO 0099	Liver of cattle, goats, pigs and sheep	0.03 V	-	0.01
		MM 0097	Meat of cattle, pigs and sheep	2 (fat) V	W ¹	0.3 (fat) 0.02 (whole muscle)
		ML 0106	Milks	0.02 F V	W ¹	0.02
	Residue (for MRLs & STMRs): diazinon					

Annex I

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Notes: ¹ Withdrawal of existing CXL proposed by 1993 JMPR.				
Dimethoate** (027)	0.002					

Annex I

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Periodic review was only for toxicology				
Disulfoton (074)	0.0003	Acute RfD 0.003 mg/kg bw.				
Dithiocarbamates		AM 0660	Almond hulls	20 ¹ <u>mb</u> ² , <u>zm</u>	20	
(105)		TN 0660	Almonds	0.1* <u>mb</u> , <u>zm</u>	0.1*	
		TN 0672	Pecan	0.1* T <u>zm</u>	-	
		FP 0009	Pome fruits	5 <u>mz</u> , <u>mt</u> , <u>pb</u> , <u>th</u> , <u>zm</u>	5	
		FS 0012	Stone fruits	7 ³ T <u>th</u> , <u>zm</u>	-	
		FB 0275	Strawberry	5 <u>th</u>	-	

Annex I

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		³ The estimated maximum residue level for dithiocarbamates arising from the use of thiram to accommodate uses of ziram on stone fruits.				
Fenarimol	0.01	AB 0226	Apple pomace,dry	5	5 T	
(192)		VS 0620	Artichoke, Globe	0.1	0.1 T	
		FI 0327	Banana	0.2	0.2 T	
		MO 1280	Cattle, kidney	0.02*	0.02* T	
		MO 1281	Cattle, liver	0.05	0.05 T	

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		MM 0812	Cattle meat	0.02*	0.02* T	
		FS 0013	Cherries	1	1 T	
		DF 0269	Dried grapes (= Currants, Raisins and Sultanas)	0.2	0.2 T	
		FB 0269	Grapes	0.3	0.3 T	
		DH 1100	Hops, dry	5	-	
		VC 0046	Melons, except Watermelon	0.05	0.05 T	
		FS 0247	Peach	0.5	0.5 T	
		TN 0672	Pecan	0.02*	0.02* T	
		VO 0445	Peppers, Sweet	0.5	0.5 T	
		FP 0009	Pome fruits	0.3	0.3 T	
		FB 0275	Strawberry	1	1 T	
<u>Residue</u> (for MRLs & STMRs): fenarimol						
Ferbam** (Dithiocarbamates, 105)	0.003					

Annex I

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Previous ADI was 0.02 mg/kg bw, also for ferbam and ziram.				
Flumethrin* (195)	0.004	MM 0812	Cattle meat	0.2 (fat) ¹ V	-	0.01 (fat) 0.005 (whole muscle)
		ML 0812	Cattle milk	0.05 F V	-	0.01
			Honey	0.005*	-	0.005
	<u>Residue</u> (for MRLs & STMRs): flumethrin					
	<u>Notes:</u> ¹ maximum residue in whole meat (muscle) reflecting approved uses was 0.01 mg/kg. Recommended MRL is on carcase fat basis.					
Haloxyfop (194)	0.0003	AL 1021	Alfalfa forage (green)	W	Prov. ¹	
		FI 0327	Banana	0.05*	Prov. ¹	0
		MO 0812	Cattle, Edible offal of	W	Prov. ¹	
		MF 0812	Cattle fat	W	Prov. ¹	
		MM 0812	Cattle meat	W	Prov. ¹	
		ML 0812	Cattle milk	W	Prov. ¹	
		FM 0812	Cattle milk fat	W	Prov. ¹	
		PO 0840	Chicken, Edible offal of	0.1	Prov. ¹	0.01
		PE 0840	Chicken eggs	0.01*	Prov. ¹	0.01
		PM 0840	Chicken meat	0.01*	Prov. ¹	0.01

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		FC 0001	Citrus fruits	0.05*	Prov. ¹	0
		SO 0691	Cotton seed	0.2	Prov. ¹	0.09
		OC 0691	Cotton seed oil, crude	0.5	Prov. ¹	0.1 P ²
		AM 1051	Fodder beet	0.3	Prov. ¹	
		AV 1051	Fodder beet leaves or tops	W	Prov. ¹	
		FB 0269	Grapes	0.05*	Prov. ¹	0
		SO 0697	Peanut	0.05	Prov. ¹	0.03
		VP 0063	Peas (pods and succulent = immature seeds)	0.2	-	0.02
		FP 0009	Pome fruits	0.05*	Prov. ¹	0
		VD 0070	Pulses (dry)	0.2	Prov. ¹	0.03
		VR 0589	Potato	0.1	Prov. ¹	0.04
		SO 0495	Rape seed	2	Prov. ¹	0.17
			Rape seed meal			0.15 P
		OC 0495	Rape seed oil, crude	5	Prov. ¹	0.36 P
		OR 0495	Rape seed oil, edible	5	Prov. ¹	0.28 P
		CM 1206	Rice bran, unprocessed	0.02*	Prov. ¹	0.02 P
		CM 0649	Rice, husked	0.02*	Prov. ¹	0
		CM 1205	Rice, polished	0.02*	Prov. ¹	0
			Soya bean			0.03 (Pulses (dry))
			Soya bean meal			0.03 P
		OC 0541	Soya bean oil, crude	0.2	Prov. ¹	0.02 P
		OR 0541	Soya bean oil, refined	0.2	Prov. ¹	0.02 P
		VR 0596	Sugar beet	0.3	Prov. ¹	0.02
		AV 0596	Sugar beet leaves or tops	W	Prov. ¹	
			Sugar beet pressed pulp			0.008 P
			Sugar, refined			0.002 P
		SO 0702	Sunflower seed	0.2	Prov. ¹	0.05
	<u>Residue</u> (for MRLs & STMRs): haloxyfop esters, haloxyfop and its conjugates expressed as					

Annex I

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
	<div>Notes: ¹Provisional estimates of maximum residue levels were made by the 1995 JMPR, but were not or use as MRLs.</div> <div>²STMR-P</div>					

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
Maleic hydrazide** (102)	0.3	Periodic review was only for toxicology				
Methamidophos	0.004					
(100)						

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
	acephate					
Mevinphos** (053)	0.0008					

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Periodic review was only for toxicology				
Phorate (112)	0.0005	<u>Notes:</u> Previous ADI confirmed				
Propoxur (075)	0.02	VL 0482	Lettuce, Head	0.5	3	
		VR 0589	Potato	0.02*	0.1*	
	<u>Residue</u> (for MRLs): propoxur					
Tebufoenozide* (196)	0.02	FB 0269	Grapes	0.5	-	0.12
		FP 0009	Pome fruits	1	-	0.16
		CM 0649	Rice, husked	0.1	-	0.03
		TN 0678	Walnut	0.05	-	0.003
			Apple pomace, wet			0.4 P ¹
			Apple juice			0.02 P
			Apple puree			0.04 P
			Grape pomace, wet			0.36 P
			Wine			0.03 P
	<u>Residue</u> (for MRLs & STMRs): tebufoenozide					

Annex I

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Notes: ¹ STMR-P				
Teflubenzuron*	0.01	VB 0402	Brussels sprouts	0.5	-	0.21
(190)		VB 0041	Cabbages, Head	0.2	-	0.05
		FS 0014	Plums (including Prunes)	0.1	-	0.04
		FP 0009	Pome fruits	1	-	0.48
		VR 0589	Potato	0.05*	-	0
		Residue (for MRLs & STMRs): teflubenzuron				

[illegible]

Pesticide (Codex ref. No.)	ADI (mg/kg bw)	Commodity		Recommended MRL or ERL (mg/kg)		STMR (mg/kg)
		CCN	Name	New	Previous	
		Previous ADI was 0.02 mg/kg bw, also for ferbam and ziram.				

ANNEX II

INDEX OF REPORTS AND EVALUATIONS

Numbers in parentheses are Codex Classification Numbers.

ABAMECTIN (177)	1992 (T,R) ^v , 1994 (T,R), 1995 (T)
ACEPHATE (095)	1976 (T,R), 1979 (R), 1981 (R), 1982 (T), 1984 (T,R), 1987 (T), 1988 (T), 1990 (T,R), 1991 (corr. to 1990 R evaluation), 1994 (R), 1996 (R)
ACRYLONITRILE	1965 (T,R)
ALDICARB (117)	1979 (T,R), 1982 (T,R), 1985 (R), 1988 (R), 1990 (R), 1991 (corr. to 1990 evaluation), 1992 (T), 1993 (R), 1994 (R), 1996 (R)
ALDRIN (001)	1965 (T), 1966 (T,R), 1967 (R), 1974 (R), 1975 (R), 1977 (T), 1990 (R), 1992 (R)
ALLETHRIN	1965 (T,R)
	AMINOCARB (134) 1978 (T,R), 1979 (T,R)
AMITRAZ (122)	1980 (T,R), 1983 (R), 1984 (T,R), 1985 (R), 1986 (R), 1989 (R), 1990 (T,R), 1991 (R & corr. to 1990 R evaluation)
AMITROLE (079)	1974 (T,R), 1977 (T), 1993 (T,R)
	ANILAZINE (163) 1989 (T,R), 1992 (R)
	AZINPHOS-ETHYL 1973 (T,R), 1983 (R)
AZINPHOS-METHYL(068)	1965 (T), 1968 (T,R), 1972 (R), 1973 (T), 1974 (R), (002) 1991 (T,R), 1992 (corr. to 1991 rpt), 1993 (R), 1995 (R)
AZOCYCLOTIN (129)	1979 (R), 1981 (T), 1982 (R), 1983 (R), 1985 (R), 1989 (T,R), 1991 (R), 1994 (T)
BENALAXYL (155)	1986 (R), 1987 (T), 1988 (R), 1992 (R), 1993 (R)
BENDIOCARB (137)	1982 (T,R), 1984 (T,R), 1989 (R), 1990 (R)
	BENOMYL (069) 1973 (T,R), 1975 (T,R), 1978 (T,R), 1983 (T,R), 1988 (R), 1990 (R), 1994 (R), 1995 (T,E)
BENTAZONE (172)	1991 (T,R), 1992 (corr. to 1991 rpt, Annex I), 1994 (R), 1995 (R)
BHC (technical)	1965 (T), 1968 (T,R), 1973 (T,R) (see also lindane)
BIFENTHRIN (178)	1992 (T,R), 1995 (R), 1996 (R)

BINAPACRYL (003)	1969 (T,R), 1974 (R), 1982 (T), 1984 (R), 1985 (T,R)
BIORESMETHRIN (093)	1975 (R), 1976 (T,R), 1991 (T,R)
BIPHENYL	see diphenyl
	BITERTANOL (144) 1983 (T), 1984 (R), 1986 (R), 1987 (T), 1988 (R), 1989 (R), 1991 (R)
BROMIDE ION (047)	1968 (R), 1969 (T,R), 1971 (R), 1979 (R), 1981 (R), 1983 (R), 1988 (T,R), 1989 (R), 1992 (R)
BROMOMETHANE (052)	1965 (T,R), 1966 (T,R), 1967 (R), 1968 (T,R), 1971 (R), 1979 (R), 1985 (R), 1992 (R)
	BROMOPHOS (004) 1972 (T,R), 1975 (R), 1977 (T,R), 1982 (R), 1984 (R), 1985 (R)
BROMOPHOS-ETHYL (005)	1972 (T,R), 1975 (T,R), 1977 (R)
BROMOPROPYLATE (070)	1973 (T,R), 1993 (T,R)
BUTOCARBOXIM (139)	1983 (R), 1984 (T), 1985 (T), 1986 (R)
BUPROFEZIN (173)	1991 (T,R), 1995 (R), 1996 (corr.to 1995 rpt.)
sec-BUTYLAMINE (089)	1975 (T,R), 1977 (R), 1978 (T,R), 1979 (R), 1980 (R), 1981 (T), 1984 (T,R: withdrawal of TADI, but no evaluation)
CADUSAFOS (174)	1991 (T,R), 1992 (R), 1992 (R)
CAMPHECHLOR (071)	1968 (T,R), 1973 (T,R)
CAPTAFOL (006)	1969 (T,R), 1973 (T,R), 1974 (R), 1976 (R), 1977 (T,R), 1982 (T), 1985 (T,R), 1986 (corr. to 1985 rpt), 1990 (R)
CAPTAN (007)	1965 (T), 1969 (T,R), 1973 (T), 1974 (R), 1977 (T,R), 1978 (T,R), 1980 (R), 1982 (T), 1984 (T,R), 1986 (R), 1987 (R and corr. to 1986 evaluation), 1990 (T,R), 1991 (corr. to 1990 R evaluation), 1994 (R), 1995 (T)
CARBARYL (008)	1965 (T), 1966 (T,R), 1967 (T,R), 1968 (R), 1969 (T,R), 1970 (R), 1973 (T,R), 1975 (R), 1976 (R), 1977 (R), 1979 (R), 1984 (R), 1996 (T)
CARBENDAZIM (072)	1973 (T,R), 1976 (R), 1977 (T), 1978 (R), 1983 (T,R), 1985 (T,R), 1987 (R), 1988 (R), 1990 (R), 1994 (R), 1995 (T,E)
CARBOFURAN (096)	1976 (T,R), 1979 (T,R), 1980 (T), 1982 (T), 1991 (R), 1993 (R), 1996 (T)
CARBON DISULPHIDE (009)	1965 (T,R), 1967 (R), 1968 (R), 1971 (R), 1985 (R)
CARBON	1965 (T,R), 1967 (R), 1968 (T,R), 1971 (R), 1979 (R),

TETRACHLORIDE (010)	1985 (R)
CARBOPHENOTHION	1972 (T,R), 1976 (T,R), 1977 (T,R), 1979 (T,R), 1980 (011) (T,R), 1983 (R)
CARBOSULFAN (145)	1984 (T,R), 1986 (T), 1991 (R), 1992 (corr. to 1991 rpt), 1993 (R)
CARTAP (097)	1976 (T,R), 1978 (T,R), 1995 (T,R)
CHINOMETHIONAT (080)	1968 (T,R) (as oxythioquinox), 1974 (T,R), 1977 (T,R), 1981 (T,R), 1983 (R), 1984 (T,R), 1987 (T)
CHLORBENSIDE	1965 (T)
CHLORDANE (012)	1965 (T), 1967 (T,R), 1969 (R), 1970 (T,R), 1972 (R), 1974 (R), 1977 (T,R), 1982 (T), 1984 (T,R), 1986 (T)
CHLORDIMEFORM (013)	1971 (T,R), 1975 (T,R), 1977 (T), 1978 (T,R), 1979(T), 1980(T), 1985(T), 1986 (R), 1987 (T)
CHLORFENSON	1965 (T)
CHLORFENVINPHOS (014)	1971 (T,R), 1984 (R), 1994 (T), 1996 (R)
CHLORMEQUAT (015)	1970 (T,R), 1972 (T,R), 1976 (R), 1985 (R), 1994 (T,R)
CHLOROBENZILATE	1965 (T), 1968 (T,R), 1972 (R), 1975 (R), 1977 (R), (016) 1980 (T)
CHLOROPICRIN	1965 (T,R)
CHLOROPROPYLATE	1968 (T,R), 1972 (R)
CHLOROTHALONIL (081)	1974 (T,R), 1977 (T,R), 1978 (R), 1979 (T,R), 1981 (T,R), 1983 (T,R), 1984 (corr. to 1983 rpt and T evaluation), 1985 (T,R), 1987 (T), 1988 (R), 1990 (T,R), 1991 (corr. to 1990 evaluation), 1992 (T), 1993 (R)
CHLORPROPHAM	1965 (T)
CHLORPYRIFOS (017)	1972 (T,R), 1974 (R), 1975 (R), 1977 (T,R), 1981 (R), 1982(T,R), 1983 (R), 1989 (R), 1995 (R)
CHLORPYRIFOS-METHYL (090)	1975 (T,R), 1976 (R, Annex I only), 1979 (R), 1990 (R), 1991 (T,R), 1992 (T) and corr. to 1991, 1993 (R), 1994 (R)
CHLORTHION	1965 (T)
CLETHODIM (187)	1994 (T,R)
CLOFENTEZINE (156)	1986 (T,R), 1987 (R), 1989 (R), 1990 (R), 1992 (R)
COUMAPHOS (018)	1968 (T,R), 1972 (R), 1975 (R), 1978 (R), 1980 (T,R), 1983(R),1987 (T), 1990 (T,R)

CRUFOMATE (019)	1968 (T,R), 1972 (R)
CYANOFENPHOS (091)	1975 (T,R), 1978 (T: ADI extended, but no evaluation), 1980, (T), 1982 (R), 1983 (T)
CYCLOXYDIM (179)	1992 (T,R), 1993 (R)
CYFLUTHRIN (157)	1986 (R), 1987 (T and corr. to 1986 rpt), 1989 (R), 1990 (R), 1992 (R)
CYHALOTHRIN (146)	1984 (T,R), 1986 (R), 1988 (R)
CYHEXATIN (TRICYCLOHEXYLTIN HYDROXIDE) (067)	1970 (T,R), 1973 (T,R), 1974 (R), 1975(R), 1977 (T), 1978 (T,R), 1980 (T), 1981 (T), 1982 (R), 1983 (R), 1985 (R), 1988 (T), 1989 (T), 1991 (T,R), 1992 (R), 1994 (T)
CYPERMETHRIN (118)	1979 (T,R), 1981 (T,R), 1982 (R), 1983 (R), 1984 (R), 1985(R), 1986 (R), 1987 (corr. to 1986 evaluation), 1988 (R), 1990 (R)
CYROMAZINE (169)	1990 (T,R), 1991 (corr. to 1990 R evaluation), 1992 (R)
2,4-D (020)	1970 (T,R), 1971 (T,R), 1974 (T,R), 1975 (T,R), 1980 (R), 1985, (R), 1986 (R), 1987 (corr. to 1986 rpt, Annex I), 1996 (T)
DAMINOZIDE (104)	1977 (T,R), 1983 (T), 1989 (T,R), 1991 (T)
DDT (021)	1965 (T), 1966 (T,R), 1967 (T,R), 1968 (T,R), 1969 (T,R), 1978 (R), 1979 (T), 1980 (T), 1983 (T), 1984 (T), 1993 (R), 1994 (R), 1996 (R)
DELTAMETHRIN (135)	1980 (T,R), 1981 (T,R), 1982 (T,R), 1984 (R), 1985 (R), 1986, (R), 1987 (R), 1988 (R), 1990 (R), 1992 (R)
DEMETON (092)	1965 (T), 1967 (R), 1975 (R), 1982 (T)
DEMETON-S- METHYL (073)	1973 (T,R), 1979 (R), 1982 (T), 1984 (T,R), 1989 (T,R), 1992 (R)
DEMETON-S- METHYLSULPHON (164)	1973 (T,R), 1982 (T), 1984 (T,R), 1989 (T,R), 1992 (R)
DIALIFOS (098)	1976 (T,R), 1982 (T), 1985 (R)
DIAZINON (022)	1965 (T), 1966 (T), 1967 (R), 1968 (T,R), 1970 (T,R), 1975 (R), 1979 (R), 1993 (T,R), 1994 (R), 1996 (R)
1,2-DIBROMOETHANE (023)	1965 (T,R), 1966 (T,R), 1967 (R), 1968 (R), 1971 (R), 1979 (R), 1985 (R)
DICHLLOFLUANID (082)	1969 (T,R), 1974 (T,R), 1977 (T,R), 1979 (T,R), 1981 (R), 1982 (R), 1983 (T,R), 1985 (R)
1,2-DICHLOROETHANE (024)	1965 (T,R), 1967 (R), 1971 (R), 1979 (R), 1985 (R)

DICHLORVOS (025) (T), 1993 (T,R)	1965 (T,R), 1966 (T,R), 1967 (T,R), 1969 (R), 1970 (T,R), 1974 (R), 1977 (T), 1993 (T,R)
DICLORAN (083)	1974 (T,R), 1977 (T,R)
DICOFOL (026)	1968 (T,R), 1970 (R), 1974 (R), 1992 (T,R), 1994 (R)
DIELDRIN (001)	1965 (T), 1966 (T,R), 1967 (T,R), 1968 (R), 1969 (R), 1970, (T,R), 1974 (R), 1975 (R), 1977 (T), 1990 (R), 1992 (R)
DIFLUBENZURON (130) (T,R), 1988 (R)	1981 (T,R), 1983 (R), 1984 (T,R), 1985 (T,R), 1988 (R)
DIMETHIPIN (151)	1985 (T,R), 1987 (T,R), 1988 (T,R)
DIMETHOATE (027)	1965 (T), 1966 (T), 1967 (T,R), 1970 (R), 1973 (R in evaluation of formothion), 1977 (R), 1978 (R), 1983 (R) 1984 (T,R) 1986(R), 1987 (T,R), 1988 (R), 1990 (R), 1991 (corr. to 1990 evaluation), 1994 (R), 1996 (T)
DIMETHRIN	1965 (T)
DINOCAP (087)	1969 (T,R), 1974 (T,R), 1989 (T,R), 1992 (R)
DIOXATHION (028)	1968 (T,R), 1972 (R)
DIPHENYL (029)	1966 (T,R), 1967 (T)
DIPHENYLAMINE (030)	1969 (T,R), 1976 (T,R), 1979 (R), 1982 (T), 1984 (T,R)
DIQUAT (031)	1970 (T,R), 1972 (T,R), 1976 (R), 1977 (T,R), 1978 (R), 1994 (R)
DISULFOTON (074)	1973 (T,R), 1975 (T,R), 1979 (R), 1981 (R), 1984 (R), 1991 (T,R), 1992 (corr. to 1991 rpt, Annex I), 1994 (R), 1996 (T)
DITHIANON (180)	1992 (T,R), 1995 (R), 1996 (corr. to 1995 rpt.)
DITHIOCARBAMATES	1965 (T), 1967 (T,R), 1970 (T,R), 1983 (R propineb, thiram), 1984 (R (105) propineb), 1985 (R), 1987 (T thiram), 1988 (R thiram), 1990 (R), 1991 (corr. to 1990 evaluation), 1992 (T thiram), 1993 (T,R), 1995 (R), 1996 (T,R ferbam, ziram; R thiram)
DNOC	1965 (T)
DODINE (084)	1974 (T,R), 1976 (T,R), 1977 (R)
EDIFENPHOS (099)	1976 (T,R), 1979 (T,R), 1981 (T,R)
ENDOSULFAN (032)	1965 (T), 1967 (T,R), 1968 (T,R), 1971 (R), 1974 (R), 1975 (R), 1982 (T), 1985 (T,R), 1989 (T,R), 1993 (R)
ENDRIN (033)	1965 (T), 1970 (T,R), 1974 (R), 1975 (R), 1990 (R), 1992 (R)
ETHEPHON (106)	1977 (T,R), 1978 (T,R), 1983 (R), 1985 (R), 1993 (T), 1994 (R), 1995 (T)

ETHIOFENCARB (107)	1977 (T,R), 1978 (R), 1981 (R), 1982 (T,R), 1983 (R)
ETHION (034)	1968 (T,R), 1969 (R), 1970 (R), 1972 (T,R), 1975 (R), 1982 (T), 1983 (R), 1985 (T), 1986 (T), 1989 (T), 1990 (T), 1994 (R)
ETHOPROPHOS (149)	1983 (T), 1984 (R), 1987 (T)
ETHOXYQUIN (035)	1969 (T,R)
ETHYLENE DIBROMIDE	see 1,2-dibromoethane
ETHYLENE DICHLORIDE	see 1,2-dichloroethane
ETHYLENE OXIDE	1965 (T,R), 1968 (T,R), 1971 (R)
ETHYLENETHIOUREA (ETU) (108)	1974 (R), 1977 (T,R), 1986 (T,R), 1987 (R), 1988 (T,R), 1990 (R), 1993 (T,R)
ETOXENPROX (184)	1993 (T,R)
ETRIMFOS (123)	1980 (T,R), 1982 (T,R ³), 1986 (T,R), 1987 (R), 1988 (R), 1989 (R), 1990 (R)
FENAMIPHOS (085)	1974 (T,R), 1977 (R), 1978 (R), 1980 (R), 1985 (T), 1987 (T),
FENARIMOL (192)	1995 (T,R,E), 1996 (R & corr. to 1995 rpt.)
FENBUTATIN OXIDE (109)	1977 (T,R), 1979 (R), 1992 (T), 1993 (R)
FENCHLORPHOS (036)	1968 (T,R), 1972 (R), 1983 (R)
FENTROTHION (037)	1969 (T,R), 1974 (T,R), 1976 (R), 1977 (T,R), 1979 (R), 1982, (T) 1983 (R), 1984 (T,R), 1986 (T,R), 1987 (R and corr. to 1986 R evaluation), 1988 (T), 1989 (R)
FENPROPATHRIN (185)	1993 (T,R)
FENPROPIMORPH (188)	1994 (T), 1995 (R)
FENPYROXIMATE (193)	1995 (T,R), 1996 (corr. to 1995 rpt.)
FENSULFOTHION (038)	1972 (T,R), 1982 (T), 1983 (R)
FENTHION (039)	1971 (T,R), 1975 (T,R), 1977 (R), 1978 (T,R), 1979 (T), 1980 (T), 1983 (R), 1989 (R), 1995 (T,R,E), 1996 (corr. to 1995 rpt.)
FENTIN COMPOUNDS (040)	1965 (T), 1970 (T,R), 1972 (R), 1986 (R), 1991 (T,R), 1993 (R), 1994 (R)

³R evaluation omitted. Published 1986.

FENVALERATE (119)	1979 (T,R), 1981 (T,R), 1982 (T), 1984 (T,R), 1985 (R), 1986 (T,R), 1987 (R and corr. to 1986 rpt), 1988 (R), 1990 (R), 1991 (corr. to 1990 evaluation)
FERBAM	see dithiocarbamates, 1965 (T), 1967 (T,R), 1996 (T,R)
FLUCYTHRINATE (152)	1985 (T,R), 1987 (R), 1988 (R), 1989 (R), 1990 (R), 1993 (R)
FLUMETHRIN (195)	1996 (T,R)
FLUSILAZOLE (165)	1989 (T,R), 1990 (R), 1991 (R), 1993 (R), 1995 (T)
FOLPET (041)	1969 (T,R), 1973 (T), 1974 (R), 1982 (T), 1984 (T,R), 1986 (T), 1987 (R), 1990 (T,R), 1991 (corr. to 1990 R evaluation), 1993 (T,R), 1994 (R), 1995 (T)
FORMOTHION (042)	1969 (T,R), 1972 (R), 1973 (T,R), 1978 (R)
GLUFOSINATE-AMMONIUM (175)	1991 (T,R), 1992 (corr. to 1991 rpt, Annex I), 1994 (R)
GLYPHOSATE (158)	1986 (T,R), 1987 (R and corr. to 1986 rpt), 1988 (R), 1994 (R)
GUAZATINE (114)	1978 (T,R), 1980 (R)
HALOXYFOP (194)	1995 (T,R), 1996 (R & corr. to 1995 rpt.)
HEPTACHLOR (043)	1965 (T), 1966 (T,R), 1967 (R), 1968 (R), 1969 (R), 1970 (T,R), 1974 (R), 1975 (R), 1977 (R), 1987 (R), 1991 (T,R), 1992 (corr. to 1991 rpt, Annex I), 1993 (R), 1994 (R)
HEXACHLOROBENZENE (044)	1969 (T,R), 1973 (T,R), 1974 (T,R), 1978(T), 1985 (R)
HEXACONAZOLE (170)	1990 (T,R), 1991 (R and corr. to 1990 R evaluation), 1993 (R)
HEXYTHIAZOX (176)	1991 (T,R), 1994 (R)
HYDROGEN CYANIDE (045)	1965 (T,R)
HYDROGEN PHOSPHIDE (046)	1965 (T,R), 1966 (T,R), 1967 (R), 1969 (R), 1971 (R)
IMAZALIL (110)	1977 (T,R), 1980 (T,R), 1984 (T,R), 1985 (T,R), 1986 (T), 1988 (R), 1989 (R), 1991 (T), 1994 (R)
IPRODIONE (111)	1977 (T,R), 1980 (R), 1992 (T), 1994 (R), 1995 (T)
ISOFENPHOS (131)	1981 (T,R), 1982 (T,R), 1984 (R), 1985 (R), 1986 (T,R), 1988 (R), 1992 (R)
LEAD ARSENATE	1965 (T), 1968 (T,R)

	LEPTOPHOS (088)	1974 (T,R), 1975 (T,R), 1978 (T,R)
LINDANE (048)		1965 (T), 1966 (T,R), 1967 (R), 1968 (R), 1969 (R), 1970 (T,R) (publ. as Annex VI to 1971 evaluations), 1973 (T,R), 1974 (R), 1975 (R), 1977 (T,R), 1978 (R), 1979 (R), 1989 (T,R)
MALATHION (049)		1965 (T), 1966 (T,R), 1967 (corr. to 1966 R), 1968 (R), 1969 (R), 1970 (R), 1973 (R), 1975 (R), 1977 (R), 1984 (R)
MALEIC HYDRAZIDE (102)		1976 (T,R), 1977 (T,R), 1980 (T), 1984 (T,R), 1996 (T)
MANCOZEB (050)		1967 (T,R), 1970 (T,R), 1974 (R), 1977 (R), 1980 (T,R), 1993 (T,R)
MANEB		see dithiocarbamates, 1965 (T), 1967 (T,R), 1987 (T), 1993 (T,R)
MECARBAM (124)		1980 (T,R), 1983 (T,R), 1985 (T,R), 1986 (T,R), 1987 (R)
METALAXYL (138)		1982 (T,R), 1984 (R), 1985 (R), 1986 (R), 1987 (R), 1989 (R), 1990 (R), 1992 (R), 1995 (R)
METHACRIFOS (125)		1980 (T,R), 1982 (T), 1986 (T), 1988 (T), 1990 (T,R), 1992 (R)
METHAMIDOPHOS (100)		1976 (T,R), 1979 (R), 1981 (R), 1982 (T,R ⁴), 1984 (R), 1985 (T), 1989 (R), 1990 (T,R), 1994 (R), 1996 (R)
METHIDATHION (051)		1972 (T,R), 1975 (T,R), 1979 (R), 1992 (T,R), 1994 (R)
METHIOCARB (132)		1981 (T,R), 1983 (T,R), 1984 (T), 1985 (T), 1986 (R), 1987 (T,R), 1988 (R)
METHOMYL (094)		1975 (R), 1976 (R), 1977 (R), 1978 (R), 1986 (T,R), 1987 (R), 1988 (R), 1989 (T,R), 1990 (R), 1991 (R)
METHOPRENE (147)		1984 (T,R), 1986 (R), 1987 (T and corr. to 1986 rpt), 1988 (R), 1989 (R)
METHOXYCHLOR		1965 (T), 1977 (T)
METHYL BROMIDE (052)		See bromomethane
METIRAM (186)		1993 (T), 1995 (R)
MEVINPHOS (053)		1965 (T), 1972 (T,R), 1996 (T)
MGK 264		1967 (T,R)
MONOCROTOPHOS (054)		1972 (T,R), 1975 (T,R), 1991 (T,R), 1993 (T), 1994 (R)
MYCLOBUTANIL (181)		1992 (T,R)
NABAM		see dithiocarbamates, 1965 (T), 1976 (T,R)

⁴R evaluation omitted. Published 1989.

NITROFEN (140)	1983 (T,R)
OMETHOATE (055)	1971 (T,R), 1975 (T,R), 1978 (T,R), 1979 (T), 1981(T,R),1984 (R), 1985 (T), 1986 (R), 1987 (R), 1988 (R), 1990 (R)
ORGANOMERCURY COMPOUNDS	1965 (T), 1966 (T,R), 1967 (T,R)
OXAMYL (126)	1980 (T,R), 1983 (R), 1984 (T), 1985 (T,R), 1986 (R)
OXYDEMETON- (R)	1965 (T, as demeton-S-methyl sulphoxide), 1967 (T), 1968 (R), METHYL (166) 1973 (T,R), 1982 (T), 1984 (T,R), 1989 (T,R), 1992
OXYTHIOQUINOX	see chinomethionat
PACLOBUTRAZOL (161)	1988 (T,R), 1989 (R)
PARAQUAT (057)	1970 (T,R), 1972 (T,R), 1976 (T,R), 1978(R), 1981 (R), 1982 (T), 1985 (T), 1986 (T)
PARATHION (058)	1965 (T), 1967 (T,R), 1969 (R), 1970 (R), 1984 (R), 1991 (R), 1995 (T,R)
PARATHION-METHYL (R), 1995 (T)	1965 (T), 1968 (T,R), 1972 (R), 1975 (T,R), 1978 (T,R), 1979 (059) (T), 1980 (T), 1982 (T), 1984 (T,R), 1991 (R), 1992 (R), 1994
PENCONAZOLE (182)	1992 (T,R), 1995 (R)
PERMETHRIN (120)	1979 (T,R), 1980 (R), 1981 (T,R), 1982 (R), 1983 (R), 1984 (R), 1985 (R), 1986 (T,R), 1987 (T), 1988 (R), 1989 (R), 1991 (R), 1992 (corr. to 1991 rpt)
2-PHENYLPHENOL (056)	1969 (T,R), 1975 (R), 1983 (T), 1985 (T,R), 1989 (T), 1990 (T,R)
PHENOTHRIN (127)	1979 (R), 1980 (T,R), 1982 (T), 1984 (T), 1987 (R), 1988 (T,R)
PHENTHOATE (128)	1980 (T,R), 1981 (R), 1984 (T)
PHORATE (112)	1977 (T,R), 1982 (T), 1983 (T), 1984 (R), 1985 (T), 1990 (R), 1991 (R), 1992 (R), 1993 (T), 1994 (T), 1996 (T)
PHOSALONE (060)	1972 (T,R), 1975 (R), 1976 (R), 1993 (T), 1994 (R)
PHOSMET (103)	1976 (R), 1977 (corr. to 1976 evaluation), 1978 (T,R), 1979 (T,R), 1981 (R), 1984 (R), 1985 (R), 1986 (R), 1987 (R and corr. to 1986 evaluation), 1988 (R), 1994 (T)
PHOSPHINE	see hydrogen phosphide
PHOSPHAMIDON (061)	1965 (T), 1966 (T), 1968 (T,R), 1969 (R), 1972 (R), 1974 (R), 1982 (T), 1985 (T), 1986 (T)

PHOXIM (141)	1982 (T), 1983 (R), 1984 (T,R), 1986 (R), 1987 (R), 1988 (R)
PIPERONYL BUTOXIDE (062)	1965 (T,R), 1966 (T,R), 1967 (R), 1969 (R), 1972 (T,R), 1992 (T,R), 1995 (T)
PIRIMICARB (101)	1976 (T,R), 1978 (T,R), 1979 (R), 1981 (T,R), 1982 (T), 1985 (R)
PIRIMIPHOS-METHYL (086)	1974 (T,R), 1976 (T,R), 1977 (R), 1979 (R), 1983 (R), 1985 (R), 1992 (T), 1994 (R)
PROCHLORAZ (142)	1983 (T,R), 1985 (R), 1987 (R), 1988 (R), 1989 (R), 1990 (R), 1991 (corr. to 1990 rpt, Annex I, and evaluation), 1992 (R)
PROCYMIDONE (136) (R)	1981 (R), 1982 (T), 1989 (T,R), 1990 (R), 1991 (corr. to 1990 Annex I), 1993 (R)
PROFENOFOS (171)	1990 (T,R), 1992 (R), 1994 (R), 1995 (R)
PROPAMOCARB (148)	1984 (T,R), 1986 (T,R), 1987 (R)
PROPARGITE (113)	1977 (T,R), 1978 (R), 1979 (R), 1980 (T,R), 1982 (T,R)
PROPHAM (183)	1965 (T), 1992 (T,R)
PROPICONAZOLE (160)	1987 (T,R), 1991 (R), 1994 (R)
PROPINEB	1977 (T,R), 1980 (T), 1983 (T), 1984 (R), 1985 (T,R), 1993 (T,R)
PROPOXUR (075)	1973 (T,R), 1977 (R), 1981 (R), 1983 (R), 1989 (T), 1991 (R), 1996 (R)
PROPYLENETHIOUREA (PTU) (150)	1993 (T,R), 1994 (R)
PYRAZOPHOS (153)	1985 (T,R), 1987 (R), 1992 (T,R), 1993 (R)
PYRETHRINS (063)	1965 (T), 1966 (T,R), 1967 (R), 1968 (R), 1969 (R), 1970 (T), 1972 (T,R), 1974 (R)
QUINTOZENE (064)	1969 (T,R), 1973 (T,R), 1974 (R), 1975 (T,R), 1976 (Annex I, corr. to 1975 R), 1977 (T,R), 1995 (T,R)
2,4,5-T (121)	1970 (T,R), 1979 (T,R), 1981 (T)
TEBUCONAZOLE (189)	1994 (T,R), 1996 (corr. to Annex II of 1995 rpt.)
TEBUFENOZIDE (196)	1996 (T,R)
TECNAZENE (115)	1974 (T,R), 1978 (T,R), 1981 (R), 1983 (T), 1987 (R), 1989 (R), 1994 (T,R)
TEFLUBENZURON (190)	1994 (T), 1996 (R)
TERBUFOS (167)	1989 (T,R), 1990 (T,R)

THIABENDAZOLE (065)	1970 (T,R), 1971 (R), 1972 (R), 1975 (R), 1977 (T,R), 1979 (R), 1981 (R)
THIODICARB (154)	1985 (T,R), 1986 (T), 1987 (R), 1988 (R)
THIOMETON (076)	1969 (T,R), 1973 (T,R), 1976 (R), 1979 (T,R), 1988 (R)
THIOPHANATE-METHYL (077)	1973 (T,R), 1975 (T,R), 1977 (T), 1978 (R), 1988 (R), 1990 (R), 1994 (R), 1995 (T,E)
THIRAM (105)	see dithiocarbamates, 1965 (T), 1967 (T,R), 1970 (T,R), 1974 (T), 1977 (T), 1983 (R), 1984 (R), 1985 (T,R), 1987 (T), 1988 (R), 1989 (R), 1992 (T), 1996 (R)
TOLCLOFOS-METHYL (191)	1994 (T,R) 1996 (corr. to Annex II of 1995 rpt.)
TOLYLFLUANID (162)	1988 (T,R), 1990 (R), 1991 (corr. to 1990 rpt)
TOXAPHENE	see camphechlor
TRIADIMEFON (133)	1979 (R), 1981 (T,R), 1983 (T,R), 1984 (R), 1985 (T,R), 1986 (R), 1987 (R and corr. to 1986 evaluation), 1988 (R), 1989 (R), 1992 (R), 1995 (R)
TRIADIMENOL (168)	1989 (T,R), 1992 (R), 1995 (R)
TRIAZOLYLALANINE	1989 (T,R)
TRIAZOPHOS (143)	1982 (T), 1983 (R), 1984 (corr. to 1983 rpt, Annex I), 1986 (T,R), 1990 (R), 1991 (T and corr. to 1990 evaluation), 1992 (R), 1993 (T,R)
TRICHLORFON (066)	1971 (T,R), 1975 (T,R), 1978 (T,R), 1987 (R)
TRICHLORONAT	1971 (T,R)
TRICHLOROETHYLENE	1968 (R)
TRICYCLOHEXYLTIN HYDROXIDE	see cyhexatin
TRIFORINE (116)	1977 (T), 1978 (T,R)
TRIPHENYLTIN COMPOUNDS	see fentin compounds
VAMIDOTHION (078)	1973 (T,R), 1982 (T), 1985 (T,R), 1987 (R), 1988 (T), 1990 (R), 1992 (R)
VINCLOZOLIN (159)	1986 (T,R), 1987 (R and corr. to 1986 rpt and R evaluation), 1988 (T,R), 1989 (R), 1990 (R), 1992 (R), 1995 (T)
ZINEB (105)	see dithiocarbamates, 1965 (T), 1967 (T,R), 1993 (T)
ZIRAM (105)	see dithiocarbamates, 1965 (T), 1967 (T,R), 1996 (T,R)

ANNEX III

INTAKE PREDICTIONS

At the request of the Meeting, WHO (GEMS/Food) calculated the predicted intakes of residues of the pesticides on the agenda of the Joint Meeting using the methods described in *Guidelines for Predicting Dietary Intake of Pesticide Residues* (WHO, 1989) as revised by *Recommendations for the revision of the guidelines for predicting dietary intake of pesticide residues* (WHO/FNU/FOS/95.11).

Theoretical Maximum Daily Intakes (TMDIs) and, when information was available, International Estimated Daily Intakes (IEDIs) were calculated for those pesticides considered by the JMPR on the basis of the ADIs and MRLs proposed by the Meeting and existing and draft MRLs in the Codex system. For calculating IEDIs, Supervised Trials Median Residue (STMR) levels were available for newly evaluated pesticides and for some pesticide/commodity combinations of previously considered pesticides. In a few cases, processing data were also available for refining the assessments of dietary exposure.

The TMDI and/or the IEDI did not exceed the ADI for the following compounds:

acephate, aldicarb, bifenthrin, 2,4-D, diazinon, DDT, fenarimol, flumethrin, haloxyfop, maleic hydrazide, methamidophos, propoxur, tebufenozide, and teflubenzuron.

The TMDI exceeded the ADI for the following compounds, but information on STMR levels and processing factors must be reviewed before IEDIs can be calculated:

carbaryl, carbofuran, dimethoate, mevinphos, and phorate.

For thiram and ziram, the assessment covered the total intake of all dithiocarbamates, including mancozeb, maneb, metiram, propineb and zineb, and took into account the relative ADIs, molecular mass adjustments for residues expressed as carbon disulfide, and the relevance of individual dithiocarbamate compounds for each MRL. While the calculated IEDI for dithiocarbamates exceeded the ADI for three of the five regional diets considered, STMR levels were available for only a few pesticide/commodity combinations. Further refinement of the intake assessment will therefore be required. The Meeting agreed that a general method should be developed, with the inclusion of worked examples, for estimating the dietary intake of residues of pesticides that have common mechanisms of toxicity.

The dietary intake was not estimated for chlorfenvinphos because it was recommended that all existing MRLs should be withdrawn, or for ferbam because no MRLs were recommended.

It should be noted that the calculated TMDIs grossly over-estimate the true intake of

pesticide residues. It should, therefore, not be concluded that the MRLs recommended by the Meeting are unacceptable when the TMDI exceeds the ADI. Calculations of TMDIs can be used as a screening tool, and the IEDI should be calculated when data are available.

ANNEX IV

Report of an informal workshop on data evaluation in the estimation of dietary intake of pesticide residues for the JMPR

INTRODUCTION

A Joint FAO/WHO Consultation on Guidelines for predicting the Dietary Intake of Pesticide Residues was held in York, United Kingdom from 2-6 May 1995. The main objectives of the Consultation were to review the existing guidelines and to recommend feasible approaches for improving the reliability and accuracy of methods for predicting dietary intake of pesticide residues. The final published report of this Consultation^{vi} became available in February 1996.

An informal Workshop was convened in the Hague, Netherlands from 11th-12th April 1996. Dr W. H. van Eck, of the Netherlands Ministry of Health, Welfare and Sport served as chairman. The Workshop had been arranged at the request of the FAO Panel members in order to consider the consequences of the recommendations of the York Consultation for individual reviewers as well as for the JMPR.

The focus of the Workshop was on the issues relating to the reviews of residue data undertaken by the FAO Panel members.

A list of participants is given. The participants considered a number of working examples on quintozone, dithiocarbamates, parathion-methyl and fenpropimorph, which illustrated issues of interest to the FAO Panel.

OBJECTIVES

The chairman explained that the implementation of the York consultation recommendations would have practical consequences for the way the FAO Panel members carried out their evaluations, how those data would be presented and how consumer risk assessments would be carried out by the JMPR. Guidance was needed for the FAO Panel members as to how recommendations are to be implemented. In addition, criteria need to be established in order to ensure consistency and transparency in the work of the FAO Panel.

The Workshop focused mainly on practical considerations of the application of the York consultation recommendations to the work of the FAO Panel. Discussion centred on the following issues:

- the criteria for the selection of residues trials data used to calculate the Supervised Trials Median Residue (STMR) level.
- the presentation in the JMPR monographs of intake related information (eg. median residue levels).
- the approach for dealing with residues at the limit of determination (LOD), also referred to as the limit of quantitation (LOQ).
- practical considerations of the cases where the residue definition for consumer risk assessment is different from that recommended for enforcement

- evaluation of data on edible portion and processing (combined supervised trials data with processing information)
- identification of appropriate residue values for acute intake assessments

Guidelines were developed in order to give guidance to the FAO Panel reviewers. In addition, a few general recommendations were made. The Workshop recognised that additional guidelines will need to be developed by the JMPR in the future, as experience is gained by the reviewers.

GUIDANCE TO THE FAO PANEL REVIEWERS ON THE IMPLEMENTATION OF THE YORK CONSULTATION RECOMMENDATIONS

The Workshop recommended that:

Comparability

Residues data from countries are evaluated against the GAP in the country of the trials or a neighbouring country with similar climate and cultural practices.

In identifying the STMR, the trials values selected should be comparable with the maximum registered use (ie. maximum application rate, maximum number of treatments, minimum PHI) on which the MRL is based.

In establishing comparability of uses in the residue trials to the maximum registered use, the application rates in the trials should generally be no more than ± 25 to 30% of the maximum application rate. Deviations from this should be explained in the appraisal. Similarly, ± 25 to 30% should also be used as a guide for establishing comparability of PHI; however, in this case the latitude of acceptable PHIs will also depend on the rate of decline of residues of the compound under evaluation. Consideration as to whether the number of treatments reported in trials are comparable to the registered maximum number of treatments will depend on the persistence of the compound and the interval between applications. Nevertheless, when a large number of treatments are made in the trials (more than 5 or 6) the residue level should be considered very little influenced by further treatments unless the compound is persistent or the treatments are made with unusually short intervals.

In establishing comparability of residue trials data in which more than one parameter (i.e application rate, number of treatments or PHI) deviate from the maximum registered use, consideration should be given to the combination effect on the residue value which may lead to an underestimation or overestimation of the STMR. For example, a trial result should not normally be selected for the estimation of the STMR if both the application rate is lower (perhaps 0.75 kg/ha in the trial; 1kg ai/ha GAP) than the maximum rate registered and the PHI is longer (perhaps 18 days in the trial, 14 days GAP) than the minimum registered PHI, since these parameters would combine to underestimate the residue. When results are selected for the estimation of STMRs, despite combination effects, the reasons should be explained in the appraisal.

If the residue value arising from a use considered comparable with the maximum registered use is lower than another residue value from the same trial which is within GAP, then the higher residue value should be selected in identifying the STMR. For example, if the GAP specified a

minimum PHI of 21 days and the residue levels in a trial reflecting GAP were 0.7, 0.6 and 0.9 mg/kg at 21, 28 and 35 days respectively, then the residue value of 0.9 mg/kg would be selected.

Trials with more than one residue value

In identifying the STMR only one data point should be taken from each trial (ie. site location)

Where several residue values have been reported from replicate plots from a single trial (ie. site location) the highest residue should be selected for the purpose of identifying the STMR.

Where several residue values have been reported from replicate analyses of the same field sample taken from a single trial (ie. site location) the mean residue should be selected for the purpose of identifying the STMR.

Rounding of results

In identifying the STMR from a residue trial the actual residue value should be used in the estimation of dietary intake without rounding up or down. This would even be the case where the actual results were below the practical limit of determination considered appropriate for enforcement purposes. Rounding of residue values is inappropriate since the STMRs are used at an intermediate stage in the dietary intake calculation.

Residue definition

The WHO Panel consider routinely indicating in their evaluations which metabolites should be included in the dietary risk assessment.

If it is recommended that the residue definition for the risk assessment is different from that for enforcement, then this is clearly stated in the appraisal.

Close communication should be established between the FAO Panel reviewers and the respective reviewers on the Toxicological and Environmental Groups, on questions such as which metabolites are of toxicological significance, prior to the JMPR meeting.

In tabulating the residue trials data the FAO Panel reviewer should indicate the levels of relevant metabolites separately from those of the parent compound, but in a way which would allow subsequent combination, in order to ensure that changes in the residue definition can be accommodated at the JMPR meeting.

In those cases where it is not possible to finalise the risk assessment at the JMPR (September, year 1) usually because of a change in residue definition, then the MRLs would still be recommended to the CCPR (by way of Codex circular letter for comment at step 3) and the compound would be rediscussed at the following years JMPR meeting (September, year 2). The recommended MRLs together with the conclusion of the risk assessment would be available for the next CCPR (April, year 3).

If two compounds, for which STMRs can be calculated, produce the same analyte in compliance monitoring (eg. CS₂ for dithiocarbamates) it is possible to separate the intake assessments, if required, because the intake assessment is no longer based on the MRL but is based on residue data specific to the individual compounds.

Combining of populations of data for the calculation of STMRs

In identifying the STMR, residue data reflecting different countries GAPs would normally be combined. However, if the trials data reflecting different countries GAPs appear to give rise to different populations of data then these data sets should not be combined. In these cases the STMR should be calculated from the population(s) of data which is (are) driving the MRL. In deciding whether the results of trials reflecting different countries GAPs give rise to different populations of residues data, the size of the database reflecting the different countries GAPs should be taken into account.

Residues below the limit of determination

That as a general rule, where all residue trials data are <LOD, the STMR would be assumed to be at the LOD, unless there is scientific evidence that residues are "essentially zero". Such supporting evidence would include residues from related trials at shorter PHIs, exaggerated, but related, application rates or a greater number of applications, expectations from metabolism studies or data from related commodities.

Where there are two or more sets of trials with different LODs, and no determinable residues have been reported in the trials, then the lowest LOD should normally be used for the purpose of STMR selection (unless the residues can be assumed to be essentially zero as given above). The size of the trials database supporting the lowest LOD value should be taken into account in the decision.

Processing, cooking factors and edible portion residue data

In using data on the effects on residue levels of processing or cooking practices, the mean reduction or concentration factor should be applied to the STMR estimated for the raw agricultural commodity as already described. The STMR value estimated in this way for the processed commodity should be referred to as the STMR-P.

If data are available for the residues in the edible portion of the commodity (eg. banana pulp) then a STMR should be estimated directly using the edible portion residue values from maximum registered use trials (as opposed to using pesticide values for the whole commodity).

Acute dietary intake

The attention of the FAO Panel members is drawn to the recommendation that for the purpose of acute risk assessment the MRL, or the highest residue in the edible portion, should be used in estimating dietary intake.

Estimation of MRLs for products of animal origin

In estimating MRLs for products of animal origin, theoretical feed intakes for domestic animals should be calculated using the STMR for each feed item (derived from supervised trials comparable with the maximum registered use), rather than the MRL, together with the maximum feed incorporation rates. This is in conformity with past JMPR decisions.

Estimation of STMRs for commodity groups

Where there are adequate trials data the STMRs should, in principle, be identified for the individual commodities and these values used for the intake assessment. However, where the MRL has been established for a group of commodities (eg. pome fruit) a single STMR should be calculated for the group of commodities.

Presentation of STMRs in the JMPR monographs and report

The GAP(s) on which trials data have been selected for the purpose of identifying the STMR should be clearly identified in the monographs.

In tabulating trials data in the monographs the reviewer should ensure that in addition to the normal underlining of trials data that are within GAP (and therefore have been used for the MRL evaluation), the single residue values selected for the estimation of the STMR should be double underlined.

Information on the residue values on which the STMR is based should not only be identified in the tabulated trials data (see above) but a list of the residue values selected should be included in the appraisal, in numerical order, with the median residue underlined. Where the residue situation is complex (eg. a number of metabolites to be considered) these data may best be tabulated in the appraisal. In addition, the STMR values should be included in the recommendation table in the appraisal and in Annex 1 of the report.

The range for the rates and PHIs used in the selection of residue values for STMR should be clearly identified in the appraisal (eg. trials data with application rates from 1.8 - 3.0 kg ai/ha have been selected).

RECOMMENDATIONS

The Workshop recommended that:

- a) The recommendations of the York Joint FAO/WHO Consultation are implemented in full into the work of the JMPR.
- b) The acronym "STMR" be used in the JMPR monographs and report for the Supervised Trials Median Residue level.
- c) The FAO Panel identify STMRs routinely for each commodity as part of all future evaluation of compounds in order to facilitate more realistic estimates of long-term dietary intake.
- d) The guidance given in section 3 above is used by the FAO Panel reviewers in their evaluations for the 1996 JMPR.
- e) The report of the York Consultation be considered by 1996 JMPR together with worked examples that demonstrate the FAO Panel guidance given in section 3.
- f) GAP information when submitted by either the manufacturer or member governments, clearly identify which of the rates and PHIs are statutory conditions of use or taken directly from the product label and which are estimates made by the manufacturer or member governments (eg. whether the application rates in kg ai/ha have been calculated from the kg ai/hl application concentrations).
- g) The concepts contained in the FAO Panel guidance, as given in section 3, be incorporated into the draft document currently entitled "FAO Guidelines in the evaluation of pesticide residues data and the estimation of the Maximum Residue Limits in Food and Feed".

OTHER CONSIDERATIONS

As a result of the examination of a worked example for STMR estimation, the Workshop noted that significant residues of HCB may result in commodities following applications of quintozone. When quintozone is re-evaluated by the JMPR, consideration should be given to the risk associated with the residues of the impurity HCB.

The WHO informed the Workshop that in revising the Guidelines for the prediction of dietary intake of pesticide residues, they would include hypothetical worked examples of intake calculations in order to give further guidance to member governments.

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^{i..}Arnold, S.F., Klotz, D.M., Collins, B.M., Vonier, P.M., Guillette, L.J. Jr., & McLachlan, J.A. (1996). *Synergistic activation of estrogen receptor with combinations of environmental chemicals*. Science **272**, 1489-1492.

^{ii..}See Section 2.2.3

^{iii..}WHO (1994) *Carbaryl* (Environmental Health Criteria 153), Geneva

^{iv..}See explanation on p. 93

^{v..} T = Toxicology

R = Residue and analytical aspects

E = Environmental Fate evaluation by the Environmental Core Assessment Group

^{vi..}‘Recommendations for the revision of the guidelines for predicting dietary intake of pesticide residues’, Report of a FAO/WHO Consultation; World Health Organisation 1995.

Carbaryl (Ref: UC 7744)

(Also known as: sevin; OMS 29; OMS 629; ENT 23969; NMC)



Last updated:
25/06/2019



SUMMARY

Carbaryl is an obsolete carbamate insecticide that is not approved for use in the EU. It has a low aqueous solubility and is volatile. It is not persistent in either soil or water systems. It is highly toxic to mammals but it is not expected to bioaccumulate. It is a suspected endocrine disruptor. Carbaryl is moderately toxic to birds, fish and algae but less toxic to aquatic plants.



GENERAL INFORMATION

Descripon	An insecticide with a variety of uses including worm removal and fruit thinning
Example pests controlled	Beetles; Caterpillars; Adelgids
Example applicaons	Fruit including citrus; Cotton; Forestry; Lawns; Forage crops; Ornamentals
Efficacy & acvity	-
Availability status	Current
Introducon & k ey dates	circa 1957

UK regulatory status

UK approval status	Not approved
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EC Regulaon 1107/2009 (r epealing 91/414)

EC Directive 91/414 Status	Not approved								
Dossier rapporteur/co-rapporteur	Spain								
Date inclusion expires	Expired								
EU Candidate for substitution (CfS)	Not applicable								
Listed in EU database	Yes								
Approved for use (✓) or known to be used (#) in the following EU-27 Member States	AT	BE	BG	CY	CZ	DE	DK	EE	EL
	ES	FI	FR	HR	HU	IE	IT	LT	LU
	LV	MT	NL	PL	PT	RO	SE	SI	SK

Also used in

Also used in	Australia, USA
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Chemical structure

Isomerism	None
Chemical formula	C ₁₂ H ₁₁ NO ₂
Canonical SMILES	CNC(=O)OC1=CC=CC2=CC=CC=C21
Isomeric SMILES	No data

International Chemical Identifier key (InChIKey)	CVXBEEMKQHEXEN-UHFFFAOYSA-N
International Chemical Identifier (InChI)	InChI=1S/C12H11NO2/c1-13-12(14)15-11-8-4-6-9-5-2-3-7-10(9)11/h2-8H,1H3,(H,13,14)
2D structure diagram/image available?	Yes

General status

Pesticide type	Insecticide, Plant growth regulator
Substance group	Carbamate
Minimum active substance purity	990 g kg ⁻¹
Known relevant impurities	EU dossier - 2-Naphthol <0.5 g kg ⁻¹ , 2-naphthyl methylcarbamate <0.5 g/Kg
Substance origin	Synthetic
Mode of action	Stomach and contact activity with slight systemic properties. Cholinesterase inhibitor.
CAS RN	63-25-2
EC number	200-555-0
CIPAC number	26
US EPA chemical code	056801
PubChem CID	6129
Molecular mass	201.22
PIN (Preferred Identification Name)	naphthalen-1-yl methylcarbamate
IUPAC name	1-naphthyl methylcarbamate
CAS name	1-naphthalenyl methylcarbamate
Other status information	Marine Pollutant; Chemical subject to PIC regulations
Relevant Environmental Water Quality Standards	-
Herbicide Resistance Classification (HRAC)	Not applicable
Herbicide Resistance Classification (WSSA)	Not applicable
Insecticide Resistance Classification (IRAC)	1A
Fungicide Resistance Classification (FRAC)	Not applicable
Examples of recorded resistance	<i>Adoxophyes orana</i> , <i>Chrysoperla carnea</i> , <i>Helicoverpa armigera</i> , <i>Psylla pyricola</i> , plus others
Physical state	White-grey powder

Formulae

Property	Value
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Property	Value
Example manufacturers & suppliers of products using this active now or historically	<ul style="list-style-type: none"> • Sevin XLR • Septene • Karbaspray • Devicarb
Example products using this active	<ul style="list-style-type: none"> • Scotts Company • Bonide Products • Bayer CropScience • BASF • Union Carbide
UK LERAP status	No UK approval for use as a pesticide under EC Regulation 1107/2009
Formulaion and applicaon details	Often formulated as a suspension concentrate that is mixed with water and applied using an orchard sprayer



ENVIRONMENTAL FATE

Property		Value	Source; quality score; and other informaon	Interpretaon
Solubility - In water at 20 °C (mg l ⁻¹)		9.1	A5	Low
Solubility - In organic solvents at 20 °C (mg l ⁻¹)		250	A5 n-Heptane	-
		9860	A5 Xylene	-
		87500	A5 Methanol	-
		175000	A5 Ethyl acetate	-
Melng poin t (°C)		138	A5	-
Boiling point (°C)		210	A5	-
Degradaon poin t (°C)		254	A5	-
Flashpoint (°C)		Not expected to self ignite; Not highly flammable	A5	-
Octanol-water paron coefficient at pH 7, 20 °C	P	2.29 X 10 ⁰²	Calculated	-
	Log P	2.36	A5	Low
Bulk density (g ml ⁻¹)		1.21	A5	-
Dissociaon c onstant pKa) at 25 °C		10.4	A5	-
		Very weak acid		
Vapour pressure at 20 °C (mPa)		0.0416	A5	Low volatility
Henry's law constant at 25 °C (Pa m ³ mol ⁻¹)		9.20 X 10 ⁻⁰⁵	A5	Non-volatile
GUS leaching potenal inde x		2.02	Calculated	Transition state
SCI-GROW groundwater index (µg l ⁻¹) for a 1 kg ha ⁻¹ or 1 l ha ⁻¹ applicaon rate	Value	5.85 X 10 ⁻⁰²	Calculated	-
	Note	-		

Property	Value	Source; quality score; and other information	Interpretation
Potential for particle bound transport index			
Maximum UV-vis absorption $L \text{ mol}^{-1} \text{ cm}^{-1}$	Neutral solution: 220nm = 82696, 270nm = 5743, 279nm = 6434, 291nm = 4211 Acidic solution: 221.5nm = 18362, 280.0nm = 6703, 295nm <2743	A5	-
Surface tension (mN m^{-1})	65.5	A5 at 20°C	-

Degradation

Property		Value	Source; quality score; and other informaon	Interpretaon
General biodegradability		-		
Soil degradaon (days) (aerobic)	DT ₅₀ (typical)	16	A5	Non-persistent
	DT ₅₀ (lab at 20 °C)	16	A5	Non-persistent
	DT ₅₀ (field)	-	-	-
	DT ₉₀ (lab at 20 °C)	107	A5	Persistent
	DT ₉₀ (field)	-	-	-
	DT ₅₀ modelling endpoint	-	-	-
	Note	EU dossier lab studies DT ₅₀ range 2.3-98.7 days, DT ₉₀ range 13.3-328.6 days		
Dissipaon r ate RL ₅₀ on plant matrix	Value	5.4	R4	-
	Note	Published literature RL ₅₀ range 1.3-22.0 days, 17 field and undercover grown crops, various matrices, n=23		
Dissipaon r ate RL ₅₀ on and in plant matrix	Value	6.0	R4	-
	Note	Published literature RL ₅₀ range 0.5-16.9 days, 11 field and undercover grown crops, various matrices, n=20		
Aqueous photolysis DT ₅₀ (days) at pH 7	Value	10	A5	Moderately fast
	Note	-		
Aqueous hydrolysis DT ₅₀ (days) at 20 °C and pH 7	Value	12	A5	Non-persistent
	Note	pH sensitive: stable at pH 5; 3 hrs at pH 9		
Water-sediment DT ₅₀ (days)		5.8	A5	Fast
Water phase only DT ₅₀ (days)		3.1	A5	Moderately fast

Soil adsorption and mobility

Property	Value	Source; quality score; and other information	Interpretation
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Property		Value	Source; quality score; and other informaon	Interpretaon
Linear	K _d	-	DW3	Moderately mobile
	K _{oc}	300		
	Notes and range	-		
Freundlich	K _f	2.6	A5	Moderately mobile
	K _{foc}	211		
	1/ _n	0.814		
	Notes and range	EU dossier K _f range 1.74-3.52 mL g ⁻¹ , K _{foc} range 177-249 mL g ⁻¹ , 1/ _n range 0.784-0.840, Soils=4; Literature data: K _f range 0.31-3.52 mL g ⁻¹ , kfoc range 134-320 mL g ⁻¹ , 1/ _n range 0.78-2.10, Soils = 8		
pH sensitivity		No		

Key metabolites

Metabolite	Formaon medium	Esma ted maximum occurrence fracon	1107/2009 relevancy
1-naphthol	Soil	0.346	Major fraction, Relevant
methylamine	Soil	-	-

Other known metabolites

Metabolite name and reference	Aliases	Formaon medium / Rate	Esma ted maximum occurrence fracon	Metabolising enzymes
phthalic acid hydrated:	-	Water	0.063	-
- Note: Cholinesterase inhibitor	2-hydroxycarbaryl	Plant	-	-
- Note: Cholinesterase inhibitor	4-hydroxycarbaryl	Plant	-	-
- Note: Cholinesterase inhibitor; Rat LD50 (oral) = 297 mg/kg bw	5-hydroxycarbaryl	Plant	-	-
phthalic acid	-	Water	0.064	-

ECOTOXICOLOGY



Property		Value	Source; quality score; and other informaon	Interpretaon
Bio-concentraon factor	BCF (l kg ⁻¹)	44	A5 (Whole fish Other literature Log BCF range 0.4-4.3 (R3))	Low potential
	CT ₅₀ (days)	32-144		-
Mammals - Acute oral LD ₅₀ (mg kg ⁻¹)		614	A5 Rat	Moderate
		(mg kg ⁻¹)	A4 Dog 1 year	High

Property		Value	Source; quality score; and other informaon	Interpretaon
Mammals - Short term dietary NOEL	(ppm diet)	-		-
Birds - Acute LD ₅₀ (mg kg ⁻¹)		> 2000	A5 <i>Anas platyrhynchos</i>	Low
Birds - Short term dietary (LC ₅₀ /LD ₅₀)		> 1000 mg kg bw ⁻¹ day ⁻¹	A5 <i>Colinus virginianus</i>	-
Fish - Acute 96 hour LC ₅₀ (mg l ⁻¹)		2.6	A5 <i>Pimephales promelas</i>	Moderate
Fish - Chronic 21 day NOEC (mg l ⁻¹)		0.21	A3 <i>Pimephales promelas</i> 34 day	Moderate
Aquac in vertebrates - Acute 48 hour EC ₅₀ (mg l ⁻¹)		0.0064	A5 <i>Daphnia pulex</i>	High
Aquac in vertebrates - Chronic 21 day NOEC (mg l ⁻¹)		0.25	A5 <i>Daphnia magna</i>	Moderate
Aquac crus taceans - Acute 96 hour LC ₅₀ (mg l ⁻¹)		0.0057	A5 <i>Americamysis bahia</i>	High
Sediment dwelling organisms - Acute 96 hour LC ₅₀ (mg l ⁻¹)		0.13	F3 <i>Chironomus riparius</i> 1 day	Moderate
Sediment dwelling organisms - Chronic 28 day NOEC, stac, w ater (mg l ⁻¹)		-	-	-
Sediment dwelling organisms - Chronic 28 day NOEC, sediment (mg kg ⁻¹)		-	-	-
Aquac plan ts - Acute 7 day EC ₅₀ , biomass (mg l ⁻¹)		13.7	A5 <i>Lemna gibba</i>	Low
Non-target plants		-	-	-
		-	-	-
Algae - Acute 72 hour EC ₅₀ , growth (mg l ⁻¹)		0.6	F4 <i>Chlorella spp.</i>	Moderate
Algae - Chronic 96 hour NOEC, growth (mg l ⁻¹)		-	-	-
Honeybees (<i>Apis</i> spp.)	Contact acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg bee ⁻¹)	0.14	A5 <i>Apis mellifera</i>	High
	Oral acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg bee ⁻¹)	> 0.21	A5 <i>Apis mellifera</i>	High
	Unknown mode acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg bee ⁻¹)	-	-	-

Property		Value	Source; quality score; and other informaon	Interpretaon
Bumblebees (<i>Bombus</i> spp.)	Contact acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg bee ⁻¹)	41.2	R4 <i>Bombus terrestris</i> 48 hr	Moderate
		-		
	Oral acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg bee ⁻¹)	> 3.84	R3 <i>Bombus terrestris</i> 72hr	Moderate
		Literature range LD ₅₀ 3.84-3.96 µg bee ⁻¹		
Mason bees (<i>Osmia</i> spp.)	Contact acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg bee ⁻¹)	-	-	-
	Oral acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg bee ⁻¹)	-	-	-
Other pollinators (1)	Acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg insect ⁻¹)	0.543	R4 <i>Andrena erythronii</i>	High
	Mode of exposure	Contact		
Other pollinators (2)	Acute LD ₅₀ (worst case from 24, 48 and 72 hour values - µg insect ⁻¹)	0.747	R4 <i>Trigona spinipes</i>	High
	Mode of exposure	Contact		
Earthworms - Acute 14 day LC ₅₀ (mg kg ⁻¹)		< 4	A5 <i>Allolobophora caliginosa</i>	High
Earthworms - Chronic NOEC, reproducon (mg kg ⁻¹)		-	-	-
Other soil macro-organisms	Acute LC ₅₀ (mg kg ⁻¹)	-	-	-
	Chronic NOEC (mg kg ⁻¹)	-	-	-
Other arthropod (1)	LR ₅₀ g ha ⁻¹	0.0247	48 hour A5 <i>Aphidius rhopalosiphi</i> adult	-
	% Effect	-	-	-

Property		Value	Source; quality score; and other informaon	Interpretaon
Other arthropod (2)	LR ₅₀ g ha ⁻¹	457	7 day A5 <i>Typhlodromus pyri</i> protonymph	-
	% Effect	-	-	-
Soil micro-organisms		Nitrogen mineralisation: No significant adverse effect Carbon mineralisation: No significant adverse effect	A5 Dose: 6.5 mg kg ⁻¹ soil	-
Mesocosm study data	NOEAEC mg l ⁻¹	0.020	A1 Aquatic community inappropriate test conditions	-
	NOEAEC mg l ⁻¹	-	-	-



HUMAN HEALTH AND PROTECTION

General

Property		Value	Source; quality score; and other informaon	Interpretaon
Threshold of Toxicological Concern (Cramer Class)		High (class III)	-	-
Mammals - Acute oral LD ₅₀ (mg kg ⁻¹)		614	A5 Rat	Moderate
Mammals - Dermal LD ₅₀ (mg kg ⁻¹ body weight)		5000	A5 Rat	-
Mammals - Inhalaon L C ₅₀ (mg l ⁻¹)		2.4	A5 Rat	-
Other Mammal toxicity endpoints		-	-	-
ADI - Acceptable Daily Intake (mg kg ⁻¹ bw day ⁻¹)		0.0075	A5 SF=2000	-
ARfD - Acute Reference Dose (mg kg ⁻¹ bw day ⁻¹)		0.01	A5 SF=100	-
AAOEL - Acute Acceptable Operator Exposure Level (mg kg ⁻¹ bw day ⁻¹)		-	-	-
AOEL - Acceptable Operator Exposure Level - Systemic (mg kg ⁻¹ bw day ⁻¹)		0.01	A5 SF=1000	-
Dermal penetraon s tudies (%)		0.5-10	A5 concentration dependent	-
Dangerous Substances Direcve 76/464		-	-	-
Exposure Routes	Public	-		
	Occupaonal	-		
European MRLs		EU MRL pesticide database		
Drinking Water Standards		-	-	-
Drinking Water MAC (µg l ⁻¹)		-	-	-

Health issues

Specific human health issues	Carcinogen	Genotoxic	Endocrine disruptor
	?	A3; B3; C3; D0; E3	✓
	Reproducon / development effects	Acetyl cholinesterase inhibitor	Neurotoxicant
	✓	?	?
	Respiratory tract irritant	Skin irritant	Skin sensiser
	X	X	No data found
	Eye irritant	Phototoxicant	
	X	No data found	
General human health issues	Highly toxic, may be fatal if inhaled, swallowed or absorbed through skin IARC Group 3 carcinogen; USEPA - possible human carcinogen May be estrogenic and progesteronc Endocrine issues - Weak estrogen effect		

Handling issues

Property	Value and interpretaon
General	Not explosive but containers may explode when heated Corrosive IMDG Transport Code is usually 6.1
CLP classificaon 2013	Health: H302, H332, H351 Environment: H400
EC Risk Classificaon	Carcinogen category 3: R40 Xn - Harmful: R20/22 N - Dangerous for the environment: R50
EC Safety Classificaon	S2, S36/37, S46, S61
WHO Classificaon	II (Moderately hazardous)
UN Number	2757
Waste disposal & packaging	Packaging Group III (minor danger)

TRANSLATIONS



Language	Name
English	carbaryl
French	carbaryl
German	Carbaryl
Danish	carbaryl
Italian	carbaril
Spanish	carbaril
Greek	carbaryl
Polish	karbaryl
Swedish	-

Language	Name
Hungarian	karbaril
Dutch	carbaryl

Record last updated: 25/06/2019

Contact: aeru@herts.ac.uk

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**CARBARYL**

ICSC: 0121

1-Naphthalenol methylcarbamate
 1-Naphthyl methylcarbamate
 Methyl carbamic acid 1-naphthyl ester
 1-Naphthalenyl methylcarbamate

April 2004

CAS #: 63-25-2

UN #: 2757

EC Number: 200-555-0

	ACUTE HAZARDS	PREVENTION	FIRE FIGHTING
FIRE & EXPLOSION	Combustible. Liquid formulations containing organic solvents may be flammable.	NO open flames.	Use water spray, powder, foam, carbon dioxide. In case of fire: keep drums, etc., cool by spraying with water.

PREVENT DISPERSION OF DUST! AVOID EXPOSURE OF ADOLESCENTS AND CHILDREN! IN ALL CASES CONSULT A DOCTOR!

	SYMPTOMS	PREVENTION	FIRST AID
Inhalation	Nausea. Vomiting. Pupillary constriction, muscle cramp, excessive salivation.	Use local exhaust or breathing protection.	Fresh air, rest. Refer for medical attention.
Skin	Redness. Pain. See Inhalation.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
Eyes	Redness. Pain.	Wear safety goggles or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then refer for medical attention.
Ingestion	Abdominal cramps. Diarrhoea. Nausea. Vomiting. Pupillary constriction. Muscle cramps. Excessive salivation.	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Give one or two glasses of water to drink. Refer for medical attention. See Notes.

SPILLAGE DISPOSAL	CLASSIFICATION & LABELLING
Personal protection: particulate filter respirator adapted to the airborne concentration of the substance. Remove all ignition sources. Do NOT let this chemical enter the environment. Sweep spilled substance into covered sealable containers. If appropriate, moisten first to prevent dusting. Carefully collect remainder. Then store and dispose of according to local regulations.	According to UN GHS Criteria Transportation UN Classification UN Hazard Class: 6.1; UN Pack Group: III
STORAGE	
Separated from oxidants and food and feedstuffs. Well closed. Keep in a well-ventilated room.	
PACKAGING	
Do not transport with food and feedstuffs. Marine pollutant.	



International
Labour
Organization



World Health
Organization

Prepared by an international group of experts on behalf of ILO and WHO, with the financial assistance of the European Commission.
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European
Commission

CARBARYL

ICSC: 0121

PHYSICAL & CHEMICAL INFORMATION

Physical State; Appearance

ODOURLESS WHITE CRYSTALS OR SOLID IN VARIOUS FORMS.

Physical dangers**Chemical dangers**

Decomposes on heating and on burning. This produces toxic fumes including nitrogen oxides. Reacts violently with strong oxidants. This generates fire and explosion hazard.

Formula: $C_{12}H_{11}NO_2$

Molecular mass: 201.2

Decomposes

Melting point: 142°C

Density: 1.2 g/cm³

Solubility in water, g/100ml at 30°C: 0.004-0.012 (very poor)

Vapour pressure at 20°C: negligible

Flash point: 193-202°C

Octanol/water partition coefficient as log Pow: 1.59

EXPOSURE & HEALTH EFFECTS

Routes of exposure

The substance can be absorbed into the body by inhalation of its aerosol, through the skin and by ingestion.

Effects of short-term exposure

The substance is irritating to the eyes and skin. The substance may cause effects on the nervous system. This may result in convulsions and respiratory depression. Cholinesterase inhibition. The effects may be delayed. Medical observation is indicated.

Inhalation risk

A harmful contamination of the air will not or will only very slowly be reached on evaporation of this substance at 20°C; on spraying or dispersing, however, much faster.

Effects of long-term or repeated exposure

Cholinesterase inhibition. Cumulative effects are possible. See Acute Hazards/Symptoms. This substance is possibly carcinogenic to humans.

OCCUPATIONAL EXPOSURE LIMITS

TLV: 0.5 mg/m³, as TWA; (skin); A4 (not classifiable as a human carcinogen); BEI issued.

MAK: (inhalable fraction): 5 mg/m³; peak limitation category: II(4); skin absorption (H)

ENVIRONMENT

The substance is very toxic to aquatic organisms. This substance may be hazardous to the environment. Special attention should be given to birds and bees. This substance does enter the environment under normal use. Great care, however, should be taken to avoid any additional release, for example through inappropriate disposal.

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. Specific treatment is necessary in case of poisoning with this substance; the appropriate means with instructions must be available. If the substance is formulated with solvents also consult the ICSCs of these materials. Carrier solvents used in commercial formulations may change physical and toxicological properties.

ADDITIONAL INFORMATION

EC Classification

Symbol: Xn, N; R: 22-40-50; S: (2)-22-24-36/37-46-61

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See Also:

[Toxicological Abbreviations](#)
[Carbaryl \(EHC 153, 1994\)](#)
[Carbaryl \(HSG 78, 1993\)](#)
[Carbaryl \(PIM 147\)](#)
[Carbaryl \(FAO Meeting Report PL/1965/10/1\)](#)
[Carbaryl \(FAO/PL:CP/15\)](#)
[Carbaryl \(FAO/PL:1967/M/11/1\)](#)
[Carbaryl \(FAO/PL:1968/M/9/1\)](#)
[Carbaryl \(FAO/PL:1969/M/17/1\)](#)
[Carbaryl \(AGP:1970/M/12/1\)](#)
[Carbaryl \(WHO Pesticide Residues Series 3\)](#)
[Carbaryl \(WHO Pesticide Residues Series 5\)](#)
[Carbaryl \(Pesticide residues in food: 1976 evaluations\)](#)

Carbaryl (Pesticide residues in food: 1977 evaluations)
Carbaryl (Pesticide residues in food: 1979 evaluations)
Carbaryl (Pesticide residues in food: 1984 evaluations)
Carbaryl (Pesticide residues in food: 1996 evaluations Part II Toxicological)
Carbaryl (JMPR Evaluations 2001 Part II Toxicological)
Carbaryl (IARC Summary & Evaluation, Volume 12, 1976)
