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THE USE AND ENVIRONMENTAL IMPACT OF ORGANOPHOSPHOROUS COMPOUNDS IN THE MEDITERRANEAN REGION

Submitted by Greenpeace International to the Joint Meeting of the Scientific and Technical Committee and the Socio-Economic Committee of the Mediterranean Action Plan (MAP)

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1 Introduction

This report examines the use and environmental impact of organophosphorous (OP) pesticides in the Mediterranean region. Its objective is to highlight the need for a precautionary approach to OP pesticide contamination in the region in order to safeguard the environment and people's health.

OP pesticides are one of the older groups of pesticides with potent insecticidal properties. They were initially discovered as a result of military nerve gas research and since World War two were commercialised for agricultural uses. By their nature they are highly toxic substances and representatives of the group have been selected for priority, pollution control action in North Sea and European Community (EC) States.

It is demonstrated that OP pesticides are the main group of insecticides used on both staple and commercial crops in the Mediterranean region, with the result that hundreds of tonnes of OP compounds enter the Mediterranean environment each year. Information obtained from case studies commissioned by Greenpeace in four Mediterranean countries reveal that OP pesticide residues are present in the air and water systems, and on food. OP pesticides also appear to be the group of pesticides responsible for most human pesticide poisonings in the region.

The EC is a major producer and exporter of some of the most used pesticides in the Mediterranean region. Some of these pesticides are produced and exported from EC countries which do not allow their domestic use. Manufacturers are allowed to profit from exports at the expense of the environment and people's health in Mediterranean countries.

The potential risk of chemical compounds in the environment is frequently based on assessments of criteria such as *toxicity, persistence* and *bioaccumulation*. The limitations of relying on these criteria to assess the hazards of OP pollutants are discussed.

The difficulties with reduction strategies for selected pollutants are also discussed and found to be essentially unworkable. It is therefore concluded that a precautionary approach to OP inputs in agriculture is essential. Implementation of a precautionary approach must mean a shift in agricultural practices away from dependence on OP pesticide inputs altogether. Instead, ecological methods of farming should be the strategy for agriculture in the region.

It is found that environmentally sound production methods are already being successfully practised in Mediterranean agriculture. These need to be extended further with financial and technical support given to research, development and implementation of ecological agriculture throughout the region. In addition, the production, formulation and use of OP pesticides should be phased out and OP pesticides which are prohibited for use in the country of manufacture or export, banned from import into the Mediterranean region.

2 Background

2.1 The Mediterranean Action Plan

The Mediterranean Action Plan (MAP) is part of the United Nations Environment Programme's (UNEP) Regional Seas Programme. Its legal component, the Barcelona Convention, has established a regional regulatory framework for the protection of the Mediterranean Sea against pollution. One of the protocols to the Convention is the "Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-based Sources". OP compounds (with the exception of those which are biologically harmless or rapidly converted into biologically harmless substances) are listed in Annex I (Black List) to this Protocol.

In order to adopt common measures, the Contracting Parties to the Barcelona Convention asked the Secretariat to elaborate an assessment of the state of pollution in the Mediterranean Sea from OP compounds. (1) An assessment document (2) for OP compounds was duly prepared by the Secretariat in conjunction with the Food and Agricultural Organisation (FAO) and presented, with draft recommendations, to the joint meeting of the Scientific and Technical Committee and the Socio-Economic Committee held in Athens (28 May - 1 June 1990). The report reviewed the literature on OP compounds and in some cases identified levels of OP pesticides in marine waters which reached levels that could be damaging to marine life. (3) But it concluded that further research and monitoring was needed before specific marine pollution control measures should be implemented for the protection of marine life. (4)

The Joint Committee meeting agreed that more information was needed and recommended to the Contracting Parties that it be provided to the Secretariat by September 1990. Based on this information, the Secretariat would propose, if necessary, a new set of recommendations to the next Joint Committee meeting in May 1991.(5)

In response to the Committee's call for more information on OP compounds, Greenpeace International commissioned reports from independent experts in four Mediterranean countries: Morocco, (6) Tunisia, (7) Egypt, (8) and Greece. (9) The reports cover production, imports and use of OP pesticides in these countries together with evidence of environmental impact of OP pesticides in the Mediterranean region. Because of limited time, only information on quantities of OP pesticides used in these four countries could be submitted to the Secretariat. The full reports will be available at the Joint Committee meeting (May 1991).

2.2 The Precautionary Approach

The Contracting Parties to the Barcelona Convention have agreed to

> *fully adopt the principle of precautionary approach regarding prevention and elimination of contamination of the Mediterranean Sea area.* (10)

The adoption of the precautionary approach entails

> *preventing the release into the environment of substances which may cause harm to humans or the environment without waiting for scientific proof regarding such harm.* (11)

The implementation of a commitment to an approach based on precautionary, preventative action requires

> *the application of clean production methods, rather than a pursuit of a permissible emissions approach based on assimilative capacity assumptions.* (12)

The assumption that a receiving body of water can assimilate and detoxify a certain quantity of a harmful substance without sustaining damage, in practice, has all too often proven to be untrue. For many scientists, the assumption that pollution threshold levels can be calculated, below which there occurs no environmental hazard, is no longer considered to be acceptable. (13) The reason is that there is no way of predicting what levels of a substance are going to be harmful in the different compartments of the marine ecosystem. (14) At the moment, substantial quantities of OP pesticides are used in Mediterranean agriculture and there is evidence that they are contaminating the Mediterranean Sea. Greenpeace believes that their phase out is essential to the successful implementation of a precautionary approach to end contamination of the region.

2.3 "Clean" Agricultural Production

The message of this report is an optimistic one. It is possible to implement the precautionary principle by shifting away from agricultural practices which require huge inputs of pesticides towards reliance on alternative, ecological agricultural methods which do not require chemical inputs. In many parts of the world farmers have shown that it is possible to maintain and improve yields while using less chemicals and fertilisers and preserving soil and water resources. (15) Moreover the expertise already exists to ensure that an effective long term plan in support of ecological agriculture could be put into action.

2.4 Aims of this report

The primary aim of this report is to urge the Contracting Parties to adopt a precautionary approach to OP pesticide production and use in the Mediterranean region based on ecological agriculture in order to protect the environment and people's health. It also aims to demonstrate:

- that a sufficient level of concern for some OP compounds exists in other regions for the Contracting Parties to take immediate action in the Mediterranean region;
- problems with the assimilative approach to pollution control measures;
- that manufacturers in economically advanced countries in the European Community are profiting from production and export of hazardous, and in some cases domestically prohibited, OP pesticides to Mediterranean countries;
- some of the environmental and human health problems arising from the use of OP pesticides in four Mediterranean countries;
- examples of ecological alternatives to intensive chemical agriculture in the region.

3 Existing Measures to Control OP Pesticide Inputs

In recent years, OP compounds have come under increasing scrutiny by international and national regulating bodies in Europe as their environmental impacts have come to be better understood. (See Table 1, below).

Table 1:
OP Pesticides Identified for Priority Action by International and/or National Fora.

	Rhine (1989)	North Sea (1990)	Red List (UK)	Red List Candidate	1990 EC Directive
azinphos-ethyl		+		+	+
azinphos-methyl	+	+	+		+
fenitrothion		+	+		+
fenthion	+	+		+	+
malathion		+	+		+
parathion-ethyl	+	+		+	+
parathion-methyl	+	+			+
dichlorvos	+	+	+		+
demeton-o				+	
mavinphos				+	
dimethoate				+	

In 1989 the International Rhine Commission, concerned with excessive pollution of the Rhine River, agreed to reduce inputs of five OP pesticides. (16)

Eight representative OP pesticides have been identified as substances requiring priority action in the 1990 North Sea Ministerial Declaration. The North Sea Ministers agreed

> *to achieve a significant reduction (of 50% or more) of inputs via rivers and estuaries between 1985-1995 for each of the substances contained in annex 1A.* (17)

The Declaration also makes specific reference to pesticides:

to aim for a substantial reduction in the quantities of pesticides reaching the North Sea and to this end by 31 December 1992, to control strictly the use and application of pesticides and to reduce, where necessary, emissions to the environment. (18)

In addition, OP pesticides are on the British government's "Red List" of hazardous substances (19) which are to be reduced by 50%. Other OP pesticides are identified as Red List *first priority candidate substances*, that is, substances identified as candidates for the Red List. (20) Red List and Red List candidate substances were selected using a process based upon criteria of acute toxicity, long term environmental persistence and propensity to bioaccumulate in food chains. (21)

In 1990, the European Commission proposed an amendment to a former (1976) Directive concerned with "pollution caused by certain dangerous substances discharged into the aquatic environment by the Community" (76/464/EEC) (22). The proposed amendment is concerned with direct discharges of eight OP compounds from production and formulation sites. (23) The chemicals were chosen on the basis of criteria adopted in the 1976 Directive: toxicity, persistence and bioaccumulativity.

4 Problems with Criteria based on Toxicity, Persistence and Bioaccumulation and the Setting of Reduction Strategies

The pointed words of the above mentioned Rhine Commission, 1990 North Sea Declaration, the U.K. Red List proposal, and EC's emissions Directive, all sound like good news for the North Sea regional environment. But the question is whether the rhetoric can be translated into effective action which can alleviate the threat to the marine environment of hazardous substances including OP compounds.

In practice, the business of ranking substances according to persistence, toxicity and bioaccumulation and the subsequent setting of reduction levels requires accepting certain assumptions about the assimilative capacity of the environment. There are two main problems with this. First, the quantity of substances that can be assimilated in any given compartment of the receiving environment cannot be calculated (except perhaps for oxygen depleting substances). Secondly, even if the quantities could be calculated, the techniques simply do not exist which are sensitive enough to monitor the degree of damage being done, and even crude monitoring efforts are typically prohibitively expensive. (24)

In fact, the failure of the concept of assimilative capacity to effectively deal with current pollution problems is indicative of its subjective rather than scientific nature. In practice our ability to assess the threat of chemicals using criteria based on toxicity, persistence and bioaccumulativity has proved unable to cope with the diversity of chemical and biological species found in a marine coastal area such as the North Sea. Indeed, nearshore plant and animal communities - whether in the North Sea or Mediterranean - are bewilderingly complex and it would be dangerous to think that they could be protected or "managed" by simply reducing inputs of hazardous substances selected for their potential risk to the environment.

The following is a brief look at some of the problems with these selection criteria.

4.1 Toxicity

4.1.1 LD50 Tests

Much of the discussion of potential environmental effects of OP compounds is based upon evaluation of relative LD50 values obtained from laboratory experiments. While these are most useful for determining the acute toxicity hazard to the particular target species tested, it is not possible to reliably extrapolate the results of these tests to entire ecological communities. Although there are few data to illustrate this point for OP pesticides, there do exist practical illustrations of the problem for other pesticides. Recent research on the herbicide atrazine has shown that the community response may occur at levels well below those at which effects are observed in test species. In this study, community responses were observed at levels of 0.1 ug/l of pesticide whereas the effective concentrations using just one species of Daphnia in sublethal tests were at least an order of magnitude higher at 2 mg/l. (25)

The relevance of toxicity tests, therefore depends on the test conditions and species used. In many cases, full evaluation of the toxicity of a substance in a complex ecosystem will be deficient and often these shortcomings are not highlighted in the literature used. But since much of the discussion on ecological effects depends upon toxicity test data, it would seem desirable to draw attention to this fact.

4.1.2 Enzyme Inhibition

The major path of activity of OP pesticides is the inhibition of a group of enzymes called esterases, which includes acetylcholinesterase. Inhibition of this enzyme reduces the capacity of nerve cells to fire properly and is associated with the most important effects in humans. A number of other enzymes, however, are also known to be phosphorylated. These include acid phosphatase, aliesterases, lipases, trypsin, chymotrypsin, succinoxidase and dehydrogenase. While there is no known clinical significance attached to these interactions in humans, the possible impacts of similar reactions with enzyme systems of organisms in the marine environment remain unknown. (26)

4.1.3 Synergistic Effects of Chemical Mixtures

Most studies which have tested the potential hazards of pesticides to organisms are restricted to the effects of a single chemical in isolation. This is usually the only legal requirement made of the manufacturer. However, in the natural environment, organisms may be exposed simultaneously to a number of chemicals. Despite the potential importance of possible interactions, little work has been done on the synergistic effects of compound mixtures on receiving ecosystems.

Studies have shown that certain organochlorine pesticides promote the activation of some OP pesticides. (27) For example, the pre-treatment of mice with DDT or dieldrin results in increased susceptibility to parathion and dimethoate respectively. (28) It has also been shown that the toxicity of malathion, dimethoate and chlorpyriphos increases in partridges following exposure to some fungicides. (29) Partridges exposed to malathion and then to carbaryl show a strong amplification of carbaryl toxicity, greater than the toxic effects of the two pesticides added together. (30)

Simple toxicity testing, therefore, cannot be taken as an indicator of likely environmental effect. Indeed, ecotoxicological community based studies appear to be largely incapable of separating the effects of the vast array of variables in operation.

4.2 Persistence

The persistence of compounds in the environment is commonly used as a second index of potential environmental hazards. But it is here that control schemes reveal perhaps their most obvious shortcomings. *Persistence* is defined in terms of half-life in water. This assumes that disappearance from water equates with the removal of the hazard from the aquatic environment. It also appears to assume that a short half-life equates with compound degradation. These are astonishing assumptions. Examination of the literature makes it clear that they are unjustified and calls into question the credibility of the entire approach. (31)

4.2.1 Toxic Breakdown Products

In the first instance, disappearance of a substance from water may be accompanied by the production of further environmentally undesirable substances. For example, the OP pesticides demeton-o, fenthion and parathion all have breakdown products which are more toxic than the parent compound. (32)

There are, in any case, a large number of uncertainties attached to the mechanisms and degradation pathways for materials in the aquatic environment.

4.2.2 Effects of Partitioning in the Aquatic Environment

The failure to consider the effects of partitioning (distribution of contaminants in different environmental compartments) in the aquatic environment is another major drawback. For example, adsorption to particles in the sediments may modify the degradation process, leading to certain situations where concentrations of a substance may actually increase in the overall aquatic environment, despite apparently low concentrations in the water itself. (33) This phenomenon has been reported for the pesticides malathion, endosulfan and fenvalerate where the half-lives in seawater/sediment matrices may be as much as an order of magnitude greater than the half-lives of these pesticides in seawater. (34)

Another example is provided by the organochlorine pesticide lindane. The appearance and persistence of this pesticide in different compartments of the environment contradicts the manufacturers claims of a short half-life based on their sampling of only one compartment, the crop field. (35) Their assertion of lindane's rapid elimination from the environment by degradation is seriously misleading. (36)

4.2.3 Atmospheric Transport

In recent years, scientific awareness of pesticide volatility and transport via the atmosphere has increased dramatically. In studies performed in the open air by the West German Biologische Bundesanstalt, (37) it was found that 90% of lindane applied on leaves of different crops evaporated within twenty four hours (perhaps helping to account for industry claims that the substance "disappears" soon after application). Evaporation of other pesticides, including the OP pesticide mevinphos, was also studied, (38) and found to be almost independent of the vapour pressure (measure of volatility) of the pesticide ingredients. As a result of these new findings, the German Government has decided that evaporation experiments must be included in the authorisation procedure for pesticides. (39)

In yet another study (40) of the contribution of inputs to the contamination of the North Sea, it was calculated that 56 tonnes of parathion-ethyl, 140 tonnes of atrazine, and 36 tonnes of lindane enter the North Sea annually from the atmosphere. The key point here is that there is a real danger in assuming that the disappearance of a substance from one environmental medium precludes its subsequent activity in another or its eventual re-entry to the original environmental compartment.

4.2.4 Surface Microlayer

Persistence studies have to date failed to take account of the surface microlayers of either marine or freshwater systems. The microlayer is distinctly different from other portions of the aquatic environment, comprising an organic film associated with particles and organisms which can be detected by remote sensing. (41)

Enrichment of the microlayer with metals, poly chlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and chlorinated hydrocarbons has been recorded at levels between 10 and 10,000 times levels found in subsurface water. (42) Recent research (43) has been conducted on microlayer samples from the North Sea, where enrichment of a number of metals and of the organometallic compound tributyl-tin was found up to 200 km away from the coast. This mechanism for the concentration of so-called non-polar compounds from both the water and the atmosphere is due to the presence in the microlayer of lipids, fatty acids and polysaccharide/protein complexes. On the basis of the lipophilicity of OP compounds, it might be expected that the surface microlayer is a particularly vulnerable component of the environment.

The sea surface microlayer is vital to a wide variety of organisms since it provides the necessary environment for the eggs and developmental stages of many species and is of critical importance to decapods and fishes during the reproductive season. (44) This coincides with the period of maximal pesticide application in Spring and early Summer when aquatic pesticide concentrations are likely to be higher. Already a number of studies (45) have found developmental defects in pelagic fish embryos from polluted areas in the North Sea. In the German Bight, up to 50% of whiting embryos which undergo early development in association with the microlayer were deformed. No similar studies appear to have been carried out in the Mediterranean.

4.3 Bioaccumulation

It is generally noted that bioconcentration potentials are lower for OP compounds, despite their high lipophilicity, than for the organochlorines. This is attributed to their relative instability in water and organisms due to mechanisms of hydrolysis and ester cleavage. This is not true for all OP compounds, however. U.K. Red List proposal documents, for example, provide a fish bioconcentration factor of 335 for parathion (46) and similar bioconcentration factors for other OP pesticides are detailed in the relevant sections of the Red List documents. (47)

4.4 Difficulties with 50% Reductions

The North Sea Declaration has set substantial reduction targets of 50% or more for hazardous inputs as a strategy for controlling pollution in the North Sea. At first glance, the setting of binding international targets in terms of percentage cuts appears to be an attractive way of countering pollution problems which are caused by a variety of sources in numerous countries. But there exists two key problems which serve to render such measures essentially unworkable. (48)

- The first is the poverty of baseline data. How can the extent of reductions be assessed if there is little or no baseline data against which to measure variation?
- The second issue is the problem of monitoring reductions. This is difficult enough for point sources such as industrial plants, but is near to being impossible for diffuse sources such as pesticide inputs to agriculture.

A particular problem in the Mediterranean, as indicated in the 1990 MAP assessment, is the lack of reliable data on quantities of OP compounds produced or used in the region. Without a sufficiently intense monitoring programme, 50 per cent reductions of a target chemical are not likely to be detectable and verifiable using rigorous statistical techniques. (49)

4.4.1 Poverty of Baseline Data

These problems exist even for the relatively well monitored North Sea areas. Between 1988 and 1990 Greenpeace commissioned from independent experts, a series of reports on the degree of success or failure in meeting the requirements of the 1987 North Sea Ministerial Declaration for fifty per cent reduction in emissions of the most toxic, persistent and bioaccumulative pollutants. (50) The studies were conducted in Belgium, the Netherlands, the Federal Republic of Germany, the U.K., Denmark, Norway and Sweden. They found that the quality of baseline data varied between non-existent and limited for these countries. Given that calls for improved monitoring practice have been repeated internationally for the past twenty years or more, including at the first North Sea Conference, these results are hardly reassuring.

4.4.2 Difficulties in Implementing reductions

Lastly, and perhaps most crucially, there is the issue of implementation. The Greenpeace studies showed that while the change in rhetoric at the 1984 North Sea Conference was dramatic, very little action has been taken by North Sea States to reduce emissions of hazardous substances to the North Sea environment. (51)

5 Production and Formulation

Production and formulation plants are a source of OP inputs into the environment. While, to Greenpeace's knowledge, there are no producers of OP pesticides in the Mediterranean, there are many formulating companies. Very little is known of the contribution of these plants to OP contamination in the Mediterranean region. But a lack of regulations to prevent pollution from OP compounds could make it attractive for companies to translocate their business to the Mediterranean region.

There is one company within the EC currently involved with the production of fenitrothion, malathion, parathion-ethyl and parathion-methyl (52) - some of the most used OP pesticides in the Mediterranean region according to the MAP assessment. The company is A/S Cheminova in Denmark. To Greenpeace's knowledge, none of these pesticides are produced in Mediterranean countries. Table 2 (below) gives an indication of the quantity of OP pesticides produced by Cheminova each year:

Table 2:
Quantities of OP pesticides produced by Cheminova in 1988 (t/y) after Haskoning 1989

Fenitrothion	1,000 *
Malathion	11,000
Parathion-ethyl	6,000
Parathion-methyl	6,000

* this figure represents plant capacity rather than the actual amount produced.

5.1 Toxic Emissions from Production Plants

In response to EC Directive 76/464/EEC on emissions from manufacturing plants, a study was conducted for the European Commission on *Technical and Economic Aspects of Measures to Reduce Water Pollution Caused by the Discharge of Certain Organophosphorous Compounds* (Haskoning 1989). (53) The study found that the discharge of phosphorous from Cheminova amounted to over three tonnes a day, and is threatening the vulnerable ecosystem of the Lim fjord. The company has been required to reduce discharges to a minimum by 1993, but even with new technology, Cheminova have expressed doubts that they will be able to meet the reduction target. (54)

5.2 Toxic Emissions from Formulating Plants

Many countries, both within and outside the EC, formulate OP pesticides. (55) Spain stands out as a country with a particularly large number of known companies formulating parathion and malathion (twenty-one in all). Companies in Italy, France Greece, Egypt, (56) and Morocco (57) also formulate OP pesticides. The European Commission's study found that there are a number of pathways by which waste water can be contaminated by formulating companies. These include the cleaning of process equipment, spilling and leakage losses, flushing of used raw material drums and the discharge of off-specification or old stocks of formulated end products.

While the European Commission's report claims that in the Netherlands measures implemented at formulation plants have reduced contamination of waste water to minimal levels, no information is given for other countries. It is not known, therefore, if formulating plants in Mediterranean countries are contributing to OP pollution in the Mediterranean region. The level of contaminated discharges at formulation and production sites will depend to a great extent on national legislation and the upholding of environmental laws.

5.3 Translocation of Polluting Technology

The lack of a regional commitment to prevent pollution from OP compounds could represent a serious discrepancy between the regulatory framework of northern European and Mediterranean countries. This could act to encourage the transfer of undesirable technologies from the Northern producing and exporting countries closer to the product markets in the Mediterranean in order to take advantage of less stringent environmental legislation. The German company Bayer, for example, already formulates parathion-ethyl and parathion-methyl in Morocco. (58)

6 Pesticide Exports

Cheminova is responsible for a large proportion of global production of malathion, fenitrothion, parathion-ethyl, and parathion-methyl. 99 per cent of this production is exported, mainly as technical products for formulation outside the EC. (Table 3, below).

Table 3:
Quantities of OP pesticides produced and exported by Cheminova in Denmark (t/y) after Haskoning, 1989.

	Malathion	Fenitrothion	Parathion
total EC production	11,000	-	12,000
total world production	25,000	< 5,000	40,000
EC import	0	-	0
EC export	10,000	-	10,000

6.1 Export of Banned Pesticides

The European Commission's study found that environmental law in some, mainly the northern, EC countries has resulted in reduced consumption of several OP compounds because of their high eco-, and sometimes human, toxicity. In Denmark, where malathion, parathion and fenitrothion are produced, the registration of parathion-ethyl was voluntarily withdrawn by industry in 1988 and parathion-methyl is not registered for use. (59) Fenitrothion is not registered for use in Germany but according to government statistics was exported in 1987. In fact, malathion, parathion- ethyl/methyl and fenitrothion are either banned, not registered for use or are on priority lists for re-evaluation in most EC States (Table 4, overleaf).

The consumption of these four OP pesticides in the Mediterranean region is still relatively high. There is a distinct North-South divide in consumption patterns of these pesticides, even within the EC itself. It is a repetition of the old double standard in which industrially advanced countries end the use of hazardous products while permitting domestic manufacturers to profit from exports to other countries at the expense of their health and environment.

Table 4:
Registration Status of Malathion, Parathion-ethyl, Parathion-methyl and Fenitrothion in EC States, after Haskoning, 1989 and European Commission.

	IRL	UK	DK	D	NL	B	LUX	F	ES	PO	IT	GR
Malathion	P	P	X	X	X	P	X	X	P	P	X	X
Parathion-ethyl	I	N	N	X	P	X	P	X	P	P	P	P
Parathion-methyl	I	N	N	X	X	N	P	X	P	N	P	X
Fenitrothion	P	P	X	N	X	X	N	X	P	P	X	X

Abreviations:

X = registered;
I = prohibited;
V = voluntarily withdrawn by manufacturer;
N = not registered for use;
P = priority for re- evaluation;

6.2 Trade in Toxic Waste

The environmental risks posed by OP pesticides may also be viewed in the light of the hazardous waste trade issue. OP compounds are classified as hazardous waste by the United Nations Environment Programme (UNEP)'s waste trade agreement, the Basel Convention. In January 1991, the Organisation of African Unity (OAU), representing all African countries except Morocco and South Africa, adopted an agreement known as the Bamako Convention, (60) which bans the import of toxic waste into member countries. The definition of toxic waste agreed also explicitly includes waste containing OP compounds.

It is a profound irony that while it is internationally agreed that OP compounds in waste are so dangerous that the international movements of such wastes are severely restricted and banned from import into almost all African countries, OP pesticides are still routinely traded and deliberately distributed into their environments.

7 Use of OP Pesticides in France, Spain and Italy

No information on OP pesticide use in Spain or Italy was submitted to the MAP Secretariat for their assessment. The information for France was very limited and refers to the use of formulated products in the whole country.

Some information on the use of malathion, parathion and fenthion in EC countries has been calculated in the European Commission's study referred to earlier, and are provided in Table 5 (overleaf). The general pattern is that OP pesticides are used more extensively in the Mediterranean countries than in northern European countries.

Research by Greenpeace Spain has found that the OP pesticide market in Spain is 12.15% of the total pesticide market. 68% of the total pesticides market in the entire country is used in the Mediterranean region (representing only 30.55% of the surface area of the country).

8 The Greenpeace Commissioned Studies - Use and Environmental Impact Of Op Pesticides In Morocco, Tunisia, Egypt And Greece.

The use and environmental impact of OP pesticides in four Mediterranean countries, Morocco, Tunisia, Egypt and Greece were the subject of studies commissioned by Greenpeace International from independent experts in these countries. (61) These reports contain details of OP pesticide imports, use and ecotoxicological data.

Information compiled on quantities used, air, water and soil contamination, human health effects and residues on food is considered below.

Table 5:
Estimated OP pesticide usage in EC countries (t/y) after Haskoning, 1989

Country	Malathion	Parathion	Fenitrothion
Belgium	<1	20 - 30	0
Denmark	5 - 10	20 - 30	2
France	0	250 - 400	20 - 40
Germany	0	120 - 230	0
United Kingdom	0	0	<5
Greece	50 - 100	200 - 300	<5
Ireland	4	0	<1
Italy	40 - 50	600 - 800	10 - 20
Luxemburg	0	2	0
Netherlands	1	55 - 70	3
Portugal	5 - 10	50	0
Spain	400 - 600	230 - 350	100 - 200

The information provided by these reports portray a disturbing regional picture. They reveal that hundreds of tonnes of OP pesticides are put into the Mediterranean environment every year. As a result, there is not only an important potential risk to the marine ecosystem, but a high cost in lives, people's health, loss of livestock and honey bees, and contamination of domestic and export crops all of which have serious economic implications. For example, the losses of bees and cattle from the use of one OP pesticide, fenitrothion, in the Cap Bon region of Tunisia alone were estimated to be in the order of one million dollars in 1988. (62)

8.1 Quantities of OP Pesticides Used

8.1.1 Morocco

The report from Morocco states that an average of one million hectares are treated every year. Crops produced for export, including citrus fruit, cotton, bananas and roses, are treated intensively with OP pesticides and receive the bulk of all pesticides.

OP pesticides are the main pesticides used on crops and about 20 are in common use. It is estimated that a total of 1,150 tonnes of OP pesticides (active ingredient) are used each year. Examples of use include nearly 22 tonnes of dimethoate and 34 tonnes of parathion-methyl on olives, 33 tonnes of azinphos-ethyl on roses, 14 tonnes of parathion-methyl on vines and 40 tonnes of phenamiphos on banana trees. Fenthion is used to control bird pests and fenthion, malathion, dichlorvos, and fenitrothian are used in locust control. The report states that during the Autumn of 1986, between 400-1000 km^2. were treated daily against locusts.

8.1.2 Tunisia

The report from Tunisia states that a total of 594,250 tonnes of 14 different OP pesticides were imported into Tunisia in 1988, and 316,180 tonnes of 13 different OP pesticides in 1989. These were the only figures given in official statistics and relate to the formulated product, not the quantity of active ingredient. Unfortunately, there exists no simple formula for determining the weight of active ingredient from this figure. Thus it cannot be directly compared to other countries.

The report also notes that smuggling of some particularly toxic pesticides into the country also takes place. Moreover, parathion-ethyl which is officially banned in Tunisia is still imported for use on fruit and olive trees. There is no production of OP pesticides and exports of pesticides are negligible. Pesticides imported in excess of usual requirements in 1988 are explained by the locust infestation in the country. Large amounts of fenitrothion, malathion, and phosphamidon were used in locust control. OP pesticides are otherwise used mainly on fruit and olive trees, cotton, and vegetables.

8.1.3 Egypt

In Egypt, it was calculated that over the past 47 years, 690,450 tonnes of formulated pesticides have been injected into the environment. 70% of all pesticides are used in cotton production. High quantities of OP pesticides have been imported for use since 1973 when there was a decrease in the use of organochlorine pesticides. 35 OP pesticides have been in use over the past 16 years. Although more recently, synthetic pyrethroids have come into extensive use, a total of 17,581 tonnes of formulated OP pesticides were applied to the environment in the last five years or 24% of total pesticide use. Dimethoate, a U.K. first priority candidate Red List substance, is the most widely used OP pesticide. Nearly 4,000 tonnes of this pesticide (formulated product) were used in the last five years.

8.1.4 Greece

The study reports that permits were given for quantities of OP pesticide active ingredients varying from 1,800 tonnes for 1987 to 2,870 tonnes for 1989. The most used OP pesticides according to 1989 import statistics are: azinphos-ethyl, chlorpyrifos, dimethoate, fenthion, methamidophos, methidathion, monocrotophos, parathion-methyl, and phorate.

Special mention was made of the intensive use of the OP pesticides fenthion and dimethoate to control pests in olive groves. The chemicals are sprayed from the air at an application rate of 90 g active ingredient/ha. An estimated amount of 140 tonnes of fenthion and 80-90 tonnes of dimethoate are used per year.

8.2 Environmental Impact of OP Pesticides

The Greenpeace commissioned reports reveal that in general there is a complete inadequacy of testing programmes in these countries for environmental impact of OP pesticides. Aerial spraying of OP pesticides, which is a major cause of environmental contamination due to drift, is common place. Yet the paucity of environmental impact studies means that the actual dimensions of the problems remain unknown. Although the few studies reported are only an indication of the problems, they are an insight into the scale of contamination from OP pesticide use which is occurring.

8.2.1 Morocco

Government programmes to test drinking water samples taken from regions where chemical campaigns against locusts have been carried out revealed detectable levels of malathion and fenthion at some sampling centres. No other information on environmental contamination was available.

8.2.2 Tunisia

It appears that about 75% of chemicals applied in Tunisian agriculture may be transported in the atmosphere and subsequently deposited in the Mediterranean Sea. There are no parts of the country which are more than 230 km from the sea and the most important fruit and olive growing areas are directly on the coast. Parathion is sprayed from the air onto some 55 million olive trees and spray drift is recognised to be a major problem in the country. Some years ago, a large fish kill in the sea was attributed to an accident with oleoparathion.

Pesticide contamination of water has barely been studied in Tunisia. Yet the biggest river in the country, the River Medjerda, crosses some of the most important agricultural areas of the country where cereals and vegetables are intensely grown, and provides drinking water to over 30% of the country's population.

Azinphos-methyl, dichlorvos, dimethoate, fenthion, malathion (all priority action chemicals in Northern European countries) and methidathion are used on orange tree groves (over three million trees). Since these groves are very common in the country, the report states that these chemicals must be widespread contaminants of the Tunisian ecosystem.

8.2.3 Egypt

Studies of atmospheric concentrations of OP pesticides during the cotton spraying season revealed high levels of OP pesticides at the time of spraying (up to 131.9 ng/m^3) and for some days after (up to 21.9 ng/m^3 after a week). Total solid materials in the air of the cultivated areas were found to be contaminated all through the year by detectable levels of OP pesticides.

It was also found that Nile River water, which empties into the Mediterranean, was contaminated during the cotton spraying season when about one million fedans are sprayed each year. The study calculates that between 6 to 53.2 tonnes of OP pesticides are potentially transported yearly by the River Nile to the Mediterranean.

Studies have indicated that of all the pesticides used about half find their way to pollute the Egyptian soils. Although it was found that OP pesticides were relatively less persistent, residues of parathion, chlorpyrifos, malathion and phenthoate were detected from trace amounts to quantities of the order of parts per million in soil samples.

8.2.4 Greece

The presence of OP compounds have been studied in the Thermaikos Gulf, in Northern Greece. Concentrations of malathion and parathion in sea water and sediment samples were measured from January to December in 1988. Concentrations ranging from 0.2 to 4.6 ng/l for the water samples and from 3 to 33 ng/l for the surface sediments were found. Peak concentrations occurred in Spring and Autumn. Particularly high concentrations were observed at the River Axios estuary which runs into the Thermaikos Gulf. OP residues were also detected in a study of the freshwater system of the Ioannina basin and Kalamas River. Concentrations of azinphos-methyl, parathion-methyl, and diazinon were found with peak levels in the Summer.

There appears to be a serious problem with the quality of freshwater surface waters in Greece due to pesticide contamination. In the Pinios river basin, for example, it is estimated that 1,000 tonnes of insecticides are used each year and that 200 tonnes of pesticides or their metabolites reach the nearby Pagasitikos Gulf in the Mediterranean Sea. The report draws attention to problems in the Pagasitikos region in recent years with respect to fisheries and marine ecosystem stability due to pollution and eutrophication. Problems with OP pesticide contamination of drinking water may also exist.

8.3 Effects of OP pesticides on Humans

According to a report of a WHO/UNEP Working Group (1989), (63) there are one million acute accidental or work related pesticide poisonings each year world-wide. Less information is available on chronic health effects of pesticides, yet the report calculates that world-wide there are about 50 million people who prepare or use pesticides intensely and a further 500 million exposed to pesticides to a lesser extent. The WHO does estimate that 37,000 cases of cancer occur annually as a result of pesticide exposure and that, specifically, the introduction of OP pesticides has raised the risk of adverse health effects in developing countries.

It is well known that most pesticide poisoning cases are not reported or identified as such and so it can be assumed that the figures quoted in the Greenpeace commissioned reports represent only the "tip of the iceberg" of pesticide poisoning problems in the Mediterranean.

8.3.1 Morocco

According to hospital statistics, about 112 cases of acute poisoning between 1983-85 were probably caused by pesticides. 19% of these were accidental and of these a third were work related. OP pesticides were responsible for 66% of these.

8.3.2 Tunisia

Parathion, phosdrine, dichlorvos and dimethoate as well as other OP pesticides have all been implicated in human poisoning cases. Spray drift from aerial spraying of OP pesticides is a real problem since it can cause contamination of foods traditionally left out to dry. In the Tunis region alone 444 deaths have been attributed to OP pesticides from 1976-1986.

8.3.3 Egypt

The report states that approximately 1,260,000 workers are potentially exposed to OP pesticides applied in agriculture. During 1988, a study of acute poisoning cases showed that insecticides were a cause of one third of the poisonings recorded. Poisoning symptoms were detected in workers engaged in formulation and packaging of pesticides and 31% of pesticides detected in the blood of these workers were OP compounds. While it is difficult to reach a definite conclusion with respect to possible carcinogenic risk caused by the extensive use of pesticides in Egypt, data showed that with continuous use of pesticides the cancer death rate started to increase steadily. This phenomenon was more prominent in the governerates where high amounts of pesticides were used. The death rate was higher among males than females, who have a higher occupational exposure to pesticides. Although other cancer-causing factors cannot be ruled out, the data gives much cause for concern.

8.3.4 Greece

Pesticides are the main cause of acute poisonings in Greece, and OP pesticides are the main class responsible. Between 1982-85 a total of 212 lethal poisonings were recorded in northern Greece and some 1,500 cases of acute pesticide poisonings are reported each year to the relevant agency in Athens. In a detailed epidemiological study on the island of Crete, a population of agricultural workers exposed to OP and carbamate pesticides was compared to a population not usually exposed to pesticides. The results of this study indicate that intensive utilisation of pesticides has had serious harmful effects on the health of the people studied.

8.4 Residues on Food

OP pesticide residues in olive oil were found in all the countries studied. Generally there is very little information on pesticide residues on food in the Mediterranean countries since official monitoring varies from non-existent to infrequent. Apart from the threat of residues to the health of consumers in the country of production, residues on export crops can cause consignments to be turned away because of residue levels which are illegal in the importing country. This economic risk is becoming more and more acute as the health conscious markets of the north are adopting more stringent laws on residue levels in food.

For example, the Greek Cypriot government was recently reported (64) to be concerned about excessive pesticide residues in food, particularly in food crops exported to the EC, the principle importer of Greek-Cypriot produce. Monitoring of food samples in 1989 revealed that 40% of one crop of Cypriot strawberries contained pesticide residues in excess of EC limits and a number of other crops, including cucumbers, tomatoes, green beans, lettuces and potatoes also contained high residue levels.

Ironically, sometimes a country that does not allow domestic use of a pesticide, exports it for use in other countries from which it imports food, creating what is commonly referred to as the "circle of poison". The pesticide importing country loses twice - first from the environmental and health damage caused by the use of these pesticides and secondly from lost revenue on contaminated exports which are rejected at the border.

8.4.1 Morocco

The report gives figures for OP pesticide residues in virgin olive oil, lamp oil, and olive cake. 0.1 ppm of dimethoate were found in the virgin oil and in olive oil cake while detectable amounts of parathion-methyl were found in all three olive oil products.

8.4.2 Tunisia

Analyses of foods sold in the local markets showed that 57% of citrus fruit samples were contaminated with malathion, 4% with parathion and 30% with methidathion. 17% of artichoke and 43% of carrot samples revealed the presence of parathion despite the fact that parathion is banned from use in Tunisia. The use of fat soluble OP pesticides on olives was also of great concern to the author since olive oil is a staple food in Tunisia and is also an important export product.

8.4.3 Egypt

Studies in Egypt monitoring pesticide residues in food revealed that some food samples were contaminated with organochlorine pesticides and the OP pesticides methoxychlore, malathion and pirimiphos-methyl.

8.4.4 Greece

Although pesticide residues in food are not monitored on a regular basis in Greece, OP pesticide residues in olive oil were monitored for the two year period, 1988-89. Residues of azinphos-ethyl, methidathion and parathion-methyl were detected in a few samples. Of these, the azinphos-ethyl residues appear to present a significant problem. Between 4% and 6% of samples had fenthion residue levels exceeding the Maximum Residue Limit set by the FAO/WHO Codex Alimentarius Commission, according to the report. Significantly, exports of Greek olive oil have been rejected from the EC because they were found to have residues of OP pesticides higher than EC standards allow.

9 The Alternatives

9.1 Ecological Agriculture and the Precautionary Approach

The reports commissioned by Greenpeace leave little doubt that extensive application of OP pesticides in the countries studied is causing pollution problems. The use of OP pesticides in other Mediterranean countries, notably in Spain, France and Italy, is likely to be having a similar impact on the environment. A precautionary approach towards their use throughout the Mediterranean region is therefore a high priority.

It is known that the air is being contaminated, fresh and marine waterways are polluted, people are being poisoned and staple and export food crops contain residues. What is not known, is the complete impact these OP residues are having on sensitive ecosystems. For example, their behaviour as they move through environmental pathways such as the marine surface microlayer (especially as a result of seasonal inputs via the atmosphere and rivers) or the extent of chronic effects on the health of people regularly exposed to residues in food and water.

If environmental degradation and people's health are considered a priority in the Mediterranean then a precautionary approach in agricultural production needs to be adopted and alternatives to intensive use of pesticides looked for. A true precautionary approach goes beyond simple substitution of one type of pesticide for another. By applying ecological principles to agricultural production it has been shown in case after case that it is possible to reduce pest damage and phase out pesticide use at the same time. (65)

Ecological agriculture means reducing reliance on non-renewable energy resources, phasing out use of chemical pesticides and fertilisers, ending nutrient pollution of water from animal wastes and promoting ecological production through soil management, alternative animal husbandry, recycling of organic material, crop rotation and the application of numerous biological and cultural pest control methods. Useful models for an ecological agriculture can be found in biological control programmes for pests and organic and traditional farming systems. (66)

9.2 Examples of Ecological Agriculture in the Mediterranean

According to a report in a recent FAO publication on *Biological Farming in Europe*, the major obstacles to ecological farming in the Mediterranean region are relevant food processing industries and distribution systems rather than a lack of effective ecological methods. (67) Indeed, numerous examples, some of which are reported below, demonstrate that ecological farming practices already exist in the Mediterranean.

9.2.1 Ecological Farming in Greece

The Greenpeace Commissioned report from Greece states that there are over eight hundred ecological or organic farmers in Greece and organic farming is practised on a regular basis in at least 20 different regions of the country. They produce vegetables, fruit, cereals, olives, grapes, and wine as well as olive oil, raisins and citrus fruits for export.

Particular efforts have been made in Greece to end the use of chemicals in olive groves. The report discusses research on alternative methods which have reduced chemical applications by 99% in some groves. One such method is mass trapping where the pests are caught on treated strips hung from the trees. At the moment such methods are most successful in isolated groves where pest species cannot migrate in from other areas. Direct costs of control appear to be somewhat higher than conventional control, due to the specialised equipment used for trapping. But the report anticipates that these costs could be reduced with mass production of materials and reduction of administrative and management costs. Already mass-trapping is used in 2.5 million olive trees covering an area equal to 2% of the entire Greek territory.

Mass trapping has also been used in cherry orchards with some degree of success and the report reveals that a large scale project for other crops is now in progress. It will focus on the reduction and/or elimination of pesticides and fertilisers in citrus fruits, apples, vines and vegetables.

9.2.2 Biological Pest Control in Tunisia

Orange trees in Tunisia produce 200,000 tonnes of fruit and earn 30 million dollars a year. (68) Orange production, however, is threatened by a species of white fly introduced into the country in the late 1960s. The chemical control of these flies is difficult and costly. Farmers already extensively use OP pesticides for a number of pests many of which are more or less resistant to the chemicals used. Pesticides have failed and the report states that the best solution is biological control.

A natural enemy of the fly is a parasite indigenous to Chile which has already been successfully introduced into France and Corsica. The parasite, however, will only thrive if pesticide use is stopped. But, farmers are "hooked" on chemicals and little incentive has been provided for them to stop. There is no real control of pesticide residues on the orange crops and chemical companies have pursued a vigorous marketing strategy in the country.

9.2.3 Ecological Pest Control for European Olives.

The EC is funding a substantial four year research and development programme (69) to look for alternatives to pesticides in olive production (ECLAIR 209). The budget is over $8 million and the project involves research institutions, farmers co-operatives and commercial companies producing olive oil from Spain, Italy, Greece and the U.K. The programme aims to involve the co-operation of growers in all aspects of the programme to ensure the research is targeted effectively. It is concerned only with the EC olive producing countries, Spain, Italy, and Greece which together produce 64% of the world production of olive oil and 50% of the production of picked olives. Farmers in these countries spend about $90 million a year on pest control of which half relates to pesticide use.

The stated objectives of the project are:

- to reduce the environmental effects of pesticides in European olive production so as to safeguard operators and consumers and to improve fruit and oil;
- to reduce chemical inputs in general in European olive production;
- by reducing these agricultural inputs, to increase profitability of high quality oil;
- to develop and test an integrated pest management (IPM) system in several countries and to develop a technology transfer package for general European use; and
- to maintain a long term aim to develop a system for the production of "biological" olive oil, with minimal chemical inputs.

9.2.4 Non-chemical Pesticides, Insect Viruses

Certain insect viruses called baculoviruses can be used to kill pests without the problems of toxic residues, pest resistance, or damage to the environment. They can be applied like pesticides and the cost of development is much lower than the cost of developing a chemical insecticide. In addition viruses can be produced and formulated locally using cheap ingredients. (70) The major disadvantage of baculoviruses is that some crop damage may occur before control is achieved.

The Egyptian cotton leafworm (*Spodoptera littoralis*) attacks a variety of vegetable, fodder and fibre crops and is regarded as a recurrent major pest problem in the Mediterranean region. The leafworm is notorious for its rapid development of resistance to chemicals and resistance has been reported in most classes of insecticides. The use of a baculovirus to control the leafworm has been assessed in field trials on a number of crops in Crete. (71) Results obtained showed that the application of the virus resulted in high levels of larval mortality.

Some problems remain, but research shows that limitations can be overcome.

9.2.5 Ecological Methods of Pest Control in Cotton in Egypt

About 60 percent of global pesticide use is on cotton. But, in many cases, this intensive chemical onslaught against cotton pests has led to an increase in pest numbers and species due to resistance and elimination of natural predators. This in turn has resulted in the application of ever increasing amounts of insecticides with the ensuing human and environmental costs. The development of a number of ecological pest control techniques has therefore become a priority in many cotton growing countries, including in Egypt.

Ecological methods currently being tested in Egyptian cotton fields, include the employment of insect pheromones for mass trapping and disruption of mating of pest species, (72) the application of baculovirus (73) and the collection of egg masses by children. (74) Different methods are effective against different pest species and the emphasis is on an integrated approach combined with preserving and building up natural predator populations.

Where these alternative methods have been practised in Egypt, the number of pesticide sprays per season have already been reduced by half from 4-6 sprays per season to 2-4 sprays, depending on the farmer. (75) An important, positive side-effect of alternative methods is the survival of honey bees which are badly effected by insecticides. Honey is an important export commodity in Egypt and the ability to allow honey-bees to forage in cotton lands is an added economic benefit of ecological pest control.

9.2.6 Locust Control

The case for OP pesticides and locust control cannot go unmentioned. Both the Moroccan and the Tunisian reports refer to OP pesticide imports (mainly malathion and fenitrothion) for locust control during the 1986-89 outbreak. Formidable amounts of pesticides were applied to the environment during this last infestation (11 million litres of insecticides in the four north-west African countries of the Maghreb region in 1988 alone). (76)

Recent studies, including one by the United States Congress' Office of Technology Assessment (OTA) (*A plague of Locusts - Special Report*, 1990), (77) have questioned the justification and effectiveness of these chemical control programmes. For example, the OTA study found that crop losses due to locust infestations amounted to a very small proportion (1.5% at the most) of a country's total crop output.

The OTA report also found that

> *generalisations regarding the effectiveness of locust control are highly suspect and some costly decisions are being made with little data to support them.* (78)

Some experts, the report states, find that control efforts have had negligible impacts on plague populations and that their decline is due almost entirely to natural causes such as the weather. Despite the locust being one of the best studied insect pests key data for resolving the question regarding the impact of control programmes are lacking.

Meanwhile, there are also serious indirect costs of control campaigns. The OTA assessment found that during the 1986-89 campaigns

> *human and environmental exposure were, at times, dangerously high.* (79)

Insufficient attention was paid to the danger of contamination of scarce food, ground, and surface water. Yet, as the report states

> *no systematic program exists for monitoring the control program's effects on humans or the environment, so the extent of damage is unknown* (80).

The OTA assessment strongly recommends that future control strategies move away from intensive chemical inputs towards the development of a *preparedness and prevention approach* in early warning systems and integrated pest management, including biological controls. Both technologies, it notes, require support for research and development but

> *starting down a different route now is likely to have long term benefits although the results of taking new directions are likely to be less visible, less dramatic, and perhaps less satisfying for donors in the short-term than spraying millions of hectares with insecticides.* (81)

10 Conclusions

Organophosphorous compounds are included in the Black List of the Barcelona Convention Land Based Sources Protocol, with the exception of those which may be considered to be biologically harmless or which are rapidly converted into biologically harmless substances. To date there is no scientific certainty that any of the OP compounds are environmentally benign. Information available on the toxicity, persistence and bioaccumulation of OP compounds, criteria used to assess their hazards, fails to take account of the complexity of the marine environment, the vulnerability of certain compartments such as the surface microlayer, or the role of atmospheric transport of OP pollutants.

In addition, analytical and monitoring difficulties are such that verification of toxic effects will not be possible with any certainty in the Mediterranean. Even crude monitoring efforts are prohibitively expensive. The adoption of percentage reduction strategies are therefore unlikely to succeed in curbing OP inputs.

A shift in agricultural practices away from dependence on OP pesticides to ecological methods, however, would eliminate the need for inputs of OP pesticides. Ecological methods of farming are already being implemented to different degrees in the Mediterranean region for the production of both staple and export crops.

There are, however, major inconsistencies in the development of alternative agricultural production methods and continued production, trade and use of hazardous OP pesticides. For example, while the EC is currently investing in the research and development of European pesticide-free olive oil, it is also one of the world's major exporters of hazardous OP pesticides and the main source of these chemicals in the Mediterranean region. These double standards must be addressed:

- the EC should end the production and export of hazardous OP pesticides;
- in addition, OP pesticides already identified for priority action or prohibited for domestic use in the country of manufacture or export should be banned from import into the Mediterranean region.

Greenpeace strongly supports the MAP assessment's recommendation that a precautionary approach to inputs of OP compounds in the Mediterranean region is necessary. (82) Greenpeace urges that "precautionary action" is interpreted as the phasing out of these chemicals altogether, and ecological methods of pest control are adopted for Mediterranean agriculture.

A strategy for ecological agriculture in the region requires greater financial and technical support. Specifically, support is necessary for extension and educational services to train farmers in ecologicamethods of pest control; farmer based research; and the long term development of sustainable, ecological agriculture.

A change in approach to OP inputs in the Mediterranean region from permissive to precautionary action will not only directly benefit the environment but also the health and economy of the farmers and the health of consumers throughout Europe and the Mediterranean.

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