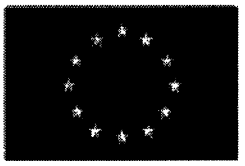

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'POSSIBILITIES FOR FUTURE E.U. ENVIRONMENTAL POLICY ON PLANT PROTECTION PRODUCTS'

SYNTHESIS REPORT

1997

Report prepared by:
Oppenheimer Wolff & Donnelly
Avenue Louise 240
Box 5
1050 Brussels
Belgium

'POSSIBILITIES FOR FUTURE E.U. ENVIRONMENTAL POLICY ON PLANT PROTECTION PRODUCTS'

SYNTHESIS REPORT

Table of Contents

Section / Reference

1. Introduction

   Sub-Report Summaries

2. Possible Arguments and Objectives of an Additional EC Policy on Plant Protection Products (Report prepared by Oppenheimer Wolff & Donnelly 'OWD')

3. Additional EU Policy Instruments for Plant Protection Products (Report Prepared b Wageningen Agricultural University (Mansholt Institute) 'WAU')

4. Analysis of Agricultural Policy in Relation to the Use of Plant Protection products (Report prepared by Produce Studies Limited)

5. Assessment of the Benefits of Plant Protection Products (Report prepared by Eyre Associates)

6. Regional Analysis of Use Patterns of Plant Protection Products in Six EU Countries (Report prepared by Landell Mills Market Research Limited)

7. Further Analysis of Presence of Residues and Impact of Plant Protection Products in the EU (Report prepared by Soil Survey and Land Research Centre ('SSLRC') and sub-contractors

'POSSIBILITIES FOR FUTURE EU ENVIRONMENTAL POLICY ON PLANT PROTECTION PRODUCTS'

1.1 BACKGROUND

This Report is a consolidation of six sub-Reports forming part of PES - A / Phase 2 of a joint project addressing the development and evaluation of strategies for future plant protection policy in the EU. The project has been conducted under the aegis of DG XI of the European Commission, and the Dutch Ministry of the Environment (VROM). The total project has been divided into several phases, and into two sections addressing respectively agricultural uses (plant protection products) and non-agricultural uses (biocides) and has been directed by a Steering Committee.

The first Phase of the project on agricultural uses was concluded early in 1994, and resulted in two reports: *Towards a future E.U. Plant Protection Product Policy*', and *'Pesticide Use in the E.U.*'.[1] A Workshop on a *Framework for the Sustainable Use of Plan Protection Products in the European Union*' was also held, in June 1994, the results of which were embodied in a Report by DHV/Environment and Infrastructure.

Following the Workshop and the DHV Report it was decided that more specialised investigations were required into the different problem areas identified from Phase 1. These Phase 2 sub-Reports draw expertise from Member States, research institutions, the European Commission itself and from parties involved in the plant protection sector.

The starting point for the project (both Phase 1 and 2) was the hypothesis that intensive agricultural production in a large part of the EU has resulted in pollution from, *inter alia,* plant protection products ("PPP"), with resulting threats to groundwater, surface water, soil and air quality.

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[1] Prepared by the Centre for Agriculture and Environment ('CLM'), and the Agricultural Economics Research Institute ('LEI - DLO') respectively.

Although different types of regulation have been introduced at EU level to combat these problems,[2] there remains a growing concern whether the current regulatory framework is sufficient to produce desired reductions in environmental pollution caused by the use of PPPs. The Terms of Reference for the sub-Reports forming the basis of Phase 2 of the project, and of this Synthesis Report, are therefore related to the issue whether there is a need for an additional plant protection policy, defined as 'additional to the current EU regulatory framework' and in particular Directive 91/414's admission policy for PPPs.

Phase 2 was designed to take into account at least the following aspects:

- That an improvement was required in both the PPPs used ('chemical innovation') and in actual pest control practised at farm level ('agricultural innovation').

- Current EU policy focuses on possible effects of PPPs themselves and less on use reduction or similar objectives. Present incentives directed towards stimulating farmers to re-evaluate use of PPPs are expected to have limited effect;

- There is at present little data available clarity as to how the three elements in a plant protection policy interact (use of PPPs, the presence of residues in the environment, and the environmental impact) in impacting either the environment or human health;

- The precautionary principle alone appears to be an insufficient device for a general reduction in use of PPPs. Although the principle of reduction in chemical inputs (to the point that none of the basic natural processes indispensable for a sustainable agricultural sector be affected), is identified in the Fifth Environmental Action Program ('FEAP') of 1992, no actual methods, goals or limits were defined. Nevertheless, the FEAP includes as one of its priority actions, the development of *'Proposals for progressive replacement of harmful pesticides and progressive use limitations'*;

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[2] See in particular Council Regulation 2078/92 of 30 June, 1992, on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside, OJ L 215/85; Council Directive 79/117 of 21 December 1978 prohibiting the placing on th market and use of plant protection products containing certain active substances (as amended) OJ L 33/36; Council Directive 91/414 of 15 July concerning the placing of plant protection products on the market, OJ 230/1 (as amended); Council Directive 76/895 of 23 November 1976 relating to the fixing of maximum levels for pesticide residues in and on fruit and vegetables, OJ L 340/26; Council Directive 86/362 of 24 July 1986 on the fixing of maximum levels for pesticide residues in and on cereals, OJ L 221/37; Council Directive 90/642 of 27 November 1990 on the fixing of maximum levels for pesticide residues in and on certain products of plant origin, including fruit and vegetables, OJ L 350/71; Council Directive 80/68 of 1 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances, OJ L 20/43; Council Directive 80/778 of 15 July 1980 relating to the quality of water intended for human consumption, OJ L 229/11; Council Directive 67/548 of 27 June 1967 on the approximation of laws, regulations, and administrative provisions relating to the classification, packaging and labelling of dangerous substances, OJ L 196/1 (as amended); Council Directive 77/93 of 21 December 1976 on protective measures against the introduction into the Member States of harmful organisms of plants on plant products (as amended by Decision 91/683, OJ L 376 (29), OJ L 26/20.

- Significant disagreement on the environmental impact of PPPs in the EU hampers a common understanding on possible objectives of an additional EU policy;

- Definition of the environmental problems associated with use of PPPs is difficult at present due to differing parameters used by different parties, and different Member States. There are a number of possible objectives which an additional EU PPP policy might seek to achieve, for example, reduction in environmental impact, in use, in concentration, in emission, in residue, in application frequency, in area treated;

- Notwithstanding the wide agreement at the 1994 workshop that environmental considerations should be factored in to any modification of EU agriculture policy, it is not clear what influence the Common Agricultural Policy ('CAP') exercises on PPP use in the EU.

In the light of the above observations, it was determined to divide Phase 2 into six sub-projects, as follows:

Sub-Report 1 (Summarised at Section 2 o this Synthesis report)

Possible Arguments and Objectives of an Additional EC Policy on Plant Protection Products - See Section 2 below for Report prepared by **Oppenheimer Wolff & Donnelly**. This sub-Report presents the strategic assessment of possible developments in EU PPP policy in the future. Unlike previous assessments of policy options, which had focused on a more *de facto* approach, this Report is intended to consider the underlying motivations for different policy options. Experiences to date in three Member States with PPP reduction strategies in place are compared to three Member States without such policies.

Sub-Report 2 (Summarised at Section 3 of this Synthesis Report)

Additional EU Policy Instruments for Plant Protection Products - Report prepared by **Wageningen Agricultural University (Mansholt Institute)**. This sub-Report takes as its starting point the conclusions from the Oppenheimer Wolff & Donnelly study on possible arguments and objectives of an additional PPP policy for the EU. This Report is particularly intended to take a comparative approach to measures with a local, national or European character, and assess the cost and enforcement implications of policy alternatives. Suggested starting points proposed during the workshop therefore included instruments directed at more effective training and education, registration of PPP trade and use, consideration of economic instruments, and an examination of the possible impact of the EU Eco-labelling scheme.

Sub-Report 3 (Summarised at Section 4 of this Synthesis Report)

Analysis of Agricultural Policy in Relation to the Use of Plant Protection products - Report prepared by **Produce Studies Limited**. It was concluded at the Workshop in 1994 that the relationship between current EU agricultural policy and PPP use was insufficiently developed to allow informed discussion on the possible role of the CAP in an additional EU PPP policy. This Report was therefore commissioned to conduct a medium and long term analysis of agricultural policy and its environmental impact of PPP use, to include an assessment of the effectiveness of EU measures such as price policy and use of structural funds, agri-

environmental measures and relevant EU PPP legislation (such as Directive 91/414). The Report examines the potential impact of additional measures such as the set asides established under Regulation 92/2078.

Sub-Report 4 (Summarised at Section 6 of this Synthesis Report)

Further analysis on use patterns of PPPs in EU farming - Report prepared by **Landell Mills Market Research Limited**, entitled 'Regional Analysis of Use Patterns of Plant Protection Products in Six EU Countries'. Phase 1 of the project had identified the need for greater examination of differing PPP use at farm-level and crop-level. This sub-Report examines in particular whether further reduction in PPP use is possible, and how such an objective might be achieved at farm level.

Sub-Report 5 (Summarised at Section 7 of this Synthesis Report)

Further analysis of presence of residues and environment impact of PPPs in the EU - Report prepared by **Soil Survey and Land Research Centre (SSLRC)** (and sub-contractors). It was concluded that Phase 1 results, which had addressed this issue from the perspective of monitoring on the one hand, and science and modeling on the other, were insufficient for the purposes of clarifying the relationship between use, presence and impact of PPPs necessary for an examination of the need for an additional EU policy.

Sub-Report 6 (Summarised at Section 5 of this Synthesis Report)

Assessment of the Benefits of Plant Protection Products - Report prepared by **Eyre Associates**. This sub-Report is intended primarily to address the economic benefits occurring from PPP use, most particularly by consideration of the theoretical impact of fully non-PPP using farming throughout the Member States.

1.2 STRUCTURE OF CONSOLIDATED REPORT

1.2.1 Introduction

The present Synthesis Report is intended to provide a starting point for discussions to take place in a Workshop on additional EU policy on Plant Protection Products to be held in mid 1998. Following a summary of the primary conclusions of the six sub-Reports, the Synthesis Report proceeds to examine the OWD Report into possible arguments and objectives of EU PPP policy, and the Wageningen Agricultural University Report into additional policy instruments first.

The study of the impact of current CAP on PPP use is examined third. In this way, it is hoped that a policy framework will be in place before the reader proceeds to an examination of the factual or information-based Reports concerning, respectively, benefits of PPPs, a regional analysis of use patterns of PPPs in Six EU Member States, and an analysis of the presence of residues and environmental impact of PPPs.

The six sub-Reports cover approximately 3,000 pages, as a result of which there are severe restrictions on the space available in a Synthesis Report of around 100 pages. Accordingly, as

a general remark, only the primary findings and conclusions of each individual sub-Report have been distilled into this Report. Readers must therefore refer to the full texts for wider discussion of the conclusions and recommendations produced by the authors of each sub-Report. Where appropriate, references are made in this Synthesis Report to the section(s) of individual sub-Reports where further consultation is recommended. Any developments which have occurred since the preparation of the industrial sub-reports are not examined in this synthesis report, but will be addressed in the Workshop to be held in 1998.

1.2.2 Methodology

As an initial task, sub-Reports were read through individually. As a subsequent task, corresponding sections of each Report (but notably the policy driven Reports of OWD, WAU and Produce Studies) were compared.

Each sub-Report was summarised in two stages. Firstly, information not required for an understanding of the conclusions and/or recommendations made in the sub-Report were omitted.[3] As a second step, the text remaining was synthesised, leaving only those elements which (a) space allowed; and (b) lead the reader to a better understanding of the policy strategies and policy instruments elaborated by the sub-Reports.

In this Synthesis Report it will be seen that greater attention is paid to the policy-driven sub-Reports of OWD, WAU and Produce Studies, for a number of reasons:

- the areas and/or regions compared in the last two more technical sub-Reports do not completely correspond. As a result, the findings of one sub-Report are not fully supported by the other, as might have been desirable;

- the scope of each of these more technical sub-Reports is stated to have been affected by considerations of time and space, although ultimately budgetary considerations appear to have reduced the intended scope of these sub-Reports;

As a result of the above, the more technical or 'factual' sub-Reports prepared by Eyre Associates, Landell Mills Market Research, and by the Soil Survey and Land Research Centre are not considered to provide strong numerical or statistical support for the policy conclusions and recommendations produced by the other sub-Reports. It is for the readership of the

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[3] This task is of course subjective in nature. It is accepted that the authors of the individual sub-Reports may disagree with the selection of information included or omitted. As a result, this Interim Synthesis Report will be distributed also to authors of all other sub-Reports for their remarks.

Synthesis Report and/or the full text of the sub-Report on Benefits of PPPs to assess whether sufficient data and statistical support exists for findings of the sixth sub-Report (summarised at Section 5 of the present Report).

The need for further study of PPP use is largely unchallenged, and the, by necessity partial, coverage in the relevant sub-Reports in Phase 2 of this Project reflects this fact. However, their findings nevertheless remain relevant at this stage of the Project. As indicated above, the intention of this Synthesis Report is not to provide definitive answers either regarding current PPP use levels or practices, any more than its conclusions reflect the only policy choices, or instrument mixes available to policy makers.

The Synthesis Report is rather intended to provide the policy drivers for future discussion. It provides the background, and the starting point for the Workshop. Where conclusions in the OWD or WAU sub-Reports can be supported by the results of the other Phase 2 studies, this appears in the text. Where they can not, this may be due to a number of factors, not necessarily the result of the limited scope of the Landell Mills and SSLRC sub-Reports.

By way of example, only some of the six Member States examined in the OWD sub-Report have data available for analysis. Even where data is available, it often exists in an uncoordinated and haphazard fashion. While improving the flow of information does not directly affect the level of PPP use in the EU, but rather assists in recording it, it is apparent from the outset that great strides need to be taken in the near term to resolve the different approaches taken by Member States to the tasks involved.

1.3 PRIMARY CONCLUSIONS OF SUB-REPORTS

1.3.1 Oppenheimer Wolff & Donnelly

Oppenheimer Wolff & Donnelly studied motives, objectives and parameters from 6 Member States' policies (Denmark, France, Germany, Italy, the Netherlands, Sweden and Finland) selecting States both with, and without a PPP-Use reduction programme in operation, in addition to authorisation policy. A study on the impact of Directive 91/414 on PPP use is also included in the sub-Report.

The sub-Report concludes with the proposal of six options for an additional EU PPP policy. These six options are not, however, pure alternatives, but to be considered along a continuum of unrestricted use at one end, to prohibition of PPP use at the other. It is accepted that neither end of the spectrum is viable.

The sub-Report notes that almost all Member States have some form of 'additional' policy in place, intended to reduce risk from PPPs. Measurable objectives were identified, largely to assist farmers and the general public. It is felt that Directive 91/414 alone is insufficient to meet the goals of an EU PPP policy, and that there is further scope for risk reduction.

Of the six options set out in the sub-Report (found at Section 2 of this Synthesis Report) four may be considered shorter term measures, while two are directed at reduction of agricultural dependency, and therefore represent a more long term view of PPP policy. One option (Option 2 - controls over risks in distribution/use of PPPs) is presented as a minimum requirement for EU policy.

1.3.2 Wageningen Agricultural University

The WAU sub-Report concentrated primarily on the risks arising to the environment, although it is accepted that because of the large range of active substances and the variety of conditions in applying PPPs it is difficult to define even one broadly accepted measure of degree of risk posed by PPP-use.

The sub-Report proposes a re-animation of the examination procedure under Directive 91/414, and recommends a significant increase in the resources allocated to the task. The insufficiency of current data is highlighted also in this sub-Report. A number of policy instruments receive an overall negative assessment. These include both green labelling as well as recording of trade and abolition of short-term set aside.

Other instruments achieve mixed conclusions following their examination in terms of their (a) acceptability, (b) efficiency, (c) effectiveness, (d) enforceability, (e) homogeneity and (f) in relation to the degree of disturbance to income or property rights which occurs.

EU stimulation of Member States' use reduction plans is considered, although favoured at a regional level, and requiring significant changes in current infrastructure and adequate monitoring. Integrated environmental programmes at farm level also achieve a positive assessment, although dependent on high management skills of farmers. Integrated farming will also require important adjustments by farmers to be effective. Similarly, a programme on resistant cultivars is also considered to make a significant contribution to use/risk reduction.

The following mix of policy instruments is proposed:

- Stimulation of research and policy of generating resistant cultivars / removal of sensitive cultivars
- High uniform VAT
- Encouragement to Member States to develop PPP use/risk reduction programmes
- Speeding review programme under Directive 91/414

Three layers of cumulative policy instruments are further summarised at Section 3 of this Synthesis Report.

1.3.3 Produce Studies

This sub-Report examined the agricultural policy of the EU in so far as it impacts PPP use and risks, and includes a statistical analysis for a limited selection of Member States (Denmark, France, Germany, Italy, the Netherlands, Spain and the United Kingdom) on aggregate PPP use. It should be noted, however, that the Landell Mills, SSLRC and Produce Studies sub-Reports examined different farmers and/or regions. The data collected are not, therefore, fully comparable.

Produce Studies were also invited to conduct a desk study on the relationship between structural policy in relation to environment issues. Research also relied on a series of farmer interviews in which the effect of price on PPP-use was examined. The sub-Report provides the primary conclusions that (a) the impact of Regulation 2078/92 on total PPP-use is minimal, and (b) that CAP has only a limited effect on PPP-use.

1.3.4 Eyre Associates

This sub-Report is intended to address the benefits from PPP-use. The methodology adopted involves examination of the consequences on full non-use of PPPs across European Farming. Environmental and social benefits of PPP use are considered in lesser detail. Four case studies were produced involving apples (Trentino-Adige, Italy), ware potatoes (Flevoland, The Netherlands), wheat (Schleswig-Holstein, Germany) and wine (Bordeaux, France). The main findings are that PPP use allows significant economic savings over farming using reduced PPPs. The additional benefits of land conservation, improved food security, employment savings are also measured favourably against deficits in PPP use identified in this and other sub-Reports.

1.3.5 Landell Mills

This sub-Report made a study of selected regions (some different from those in other sub-Reports, however) where above-average PPP doses are found. Use data (including seed treatment, fungicides, herbicides, insecticides, and so on) were analysed for four crops (wheat, potato, vines and apples).

The sub-Report found that chemical loads differ widely from farm to farm, and from region to region, although explanation for these differences is not always currently known. Wheat herbicides provided the highest chemical load in all regions, although fungicides were also found to be substantial contributors in the Northern regions studied. In potatoes, vines and apples fungicides were found to dominate the chemical load.

1.3.6 Soil Survey and Land Research Centre/Cranfield University

This sub-Report studies the relationship between use and concentrations of PPPs in groundwater and surface water. Insufficient data was frequently a problem in drawing reliable or widely applicable conclusions. Information was gathered on usage and cropping as well as PPP presence in the environment. Twelve broadly representative pesticides were studied in detail (two herbicides, five fungicides and five insecticides/acaricides). The impact on non-target organisms was assessed with available ecotoxicological data.

Some regions did not monitor PPPs, while in others data was classified as confidential. Current administrative structures in a number of Member States makes full achievement of the terms of reference for this study (and therefore proper examination of PPP use/concentrations) impossible at the present time.

Improvements which are minimum requirements for this type of study are identified as: examination of usage over a period of years and information gathering on non-agricultural usage. As Member States continue to study older, more persistent AS, a transfer of resources is considered likely to achieve more efficient goals. A database of health and environmental water quality standards was compiled. Lastly, the sub-Report did find that significant incidences of contamination do occur.

INDIVIDUAL PHASE 2 SUB-REPORTS

SECTION 2

Elaboration on Possible Arguments and Objectives of an Additional EU Policy on Plant Protection Products

(Report prepared by Oppenheimer Wolff & Donnelly)

This Report analyzes the experiences of six Member States with regard to PPP risk reduction and PPP use reduction programs. It assesses the likely impact of Directive 91/414 on PPP use patterns and the risks stemming from those patterns, after the Directive has been fully implemented. Finally, it identifies a number of options for an additional EU policy, and discusses their appropriateness for achieving different risk-reduction objectives.

2.1 INTRODUCTION

The European Community's Fifth Environmental Action Programme sets as one of its targets the significant reduction of pesticide use per unit of land under production and conversion of farmers to methods of integrated pest-control, at least in all areas of importance for nature conservation. It lists three actions for meeting this target: (1) registration of sales and use of PPPs; (2) control on sale and use of PPPs; and (3) promotion of "Integrated Control" (in particular training activities) and promotion of bio-agriculture.

Four of the EU's Member States -- Denmark, France, The Netherlands, and Sweden -- have already set in place programs designed to achieve overall reductions in the volume of plant protection products used in agricultural activities within their borders. Advocates of PPP use reduction programs point to these countries as examples of the feasibility of reducing use of plant protection products without unduly lowering agricultural productivity.

In other Member States, such as Germany and Italy, reductions in PPP use are occurring without government intervention. Opponents of PPP use reduction programs point to this as evidence that EU-level action may not be necessary.

Plant protection product use reduction as an objective is therefore somewhat controversial. Although the Member States have approved the Fifth Environmental Action Programme and its call for a significant reduction in PPP use at least in all areas of importance for nature conservation, no clear consensus exists as to whether this should be the direction for future EU risk reduction efforts in this area.

2.2 OBJECTIVES OF THE SUB-REPORT

This Report envisages a more strategic study on possible directions of an additional EU policy on plant protection products. The problem posed for this study is the following:

> ***Given the differing concerns and objectives of the Member States with regard to PPP risk reduction policies, what are the most relevant options for an additional E.C. policy on plant protection products?***

2.3 BACKGROUNDS OF NATIONAL STRATEGIES

The national strategies and policies of the six Member States investigated for this study are very diverse, in terms of both content and ripeness for investigation. Existing national initiatives for all six countries are summarized in Table 1 below:

Table 1: PPP Risk Reduction - National Initiatives

National Initiatives	DK	SW	NL	D	F	I
Requirement to spray only if observed need	X	X		X	X	
Re-registration program[4]	X	X	X			
Regular review of registrations		X		X		
Obligatory education/certification of sprayers	X	X	X	X	X	
Mandatory farm-level record keeping of PPP use	X					
Approval of types of spray equipment	X		X	X		
Phase-out of harmful active substances	X	X	X	X		X
Permits for PPP use			X	X		X
Applied agriculture research program	X	X	X	X	X	X
Extension programs promoting need-based models		X	X	X	X	
Groundwater monitoring program	X		+/-	X	X	
Controls over PPP use in drinking water protection zones		X	X	X	X	
Strict limits on aerial spraying	X	X				
Tax on PPPs	X	X				
National reduction program	X	X	X			
Active research on integrated and biological farming	X	X	X	X		X
Economic support to convert to organic farming	X	X	X	X		X
Economic support for spray free zones	X			X		
Standards for max. allowable concentrations of PPPs in environment general			X			

[4] Note that since 1968, Germany has required all PPPs to be assessed against strict criteria at 10-year intervals.

Which concerns or motives[5] drive a country's choice of strategy and policies goes to the heart identifying feasible options for an additional EU policy. Where the underlying concerns or motives are similar in nature, it may be easier for the Member States to reach agreement on the need for an additional policy, and the content of that policy.

Box 1: Top Ten Concerns (all 6 Member States)
1. Contamination of water resources used for human consumption
2. Possible adverse effects on the ecology, e.g., non-target species
3. Risks to consumers of food with residues
4. Effects of exposure to residues in water, soil and air
5. (tie) Contamination of surface water or marine environments
(tie) Risks to users of agricultural chemicals
7. Misuse of PPPs due to lack of knowledge of users
8. Specific concern about adverse effects on an ecosystem element (D - agriculturally beneficial arthropods, SW -herbicide use in forests)
9. Dependency of agriculture on chemicals for pest control (NL)
10. Frequent and large-scale use of PPPs (NL)

Other patterns become clear when the concerns of countries with PPP use reduction strategies are analyzed separate from the three Member States in the study which do not pursue PPP use reduction.

Box 2: Top Concerns of 3 Member States with PPP Use Reduction Strategies
1. Contamination of water resources used for human consumption
2. Possible adverse effects on the ecology, e.g., non-target species
3. Contamination of surface water or marine environments
4. (tie) Effects of exposure to residues in water, soil and air
(tie) Risks to consumers of food with residues
(tie) Frequent and large-scale use of PPPs (NL)

Box 3: Top Concerns of 3 Member States without PPP Use Reduction Strategies
1. (tie) Contamination of water resources used for human consumption
1. (tie) Risks to consumers of food with residues
1. (tie) Risks to users of agricultural chemicals
4. (tie) Possible adverse effects on the ecology, e.g., non-target species
(tie) Effects of exposure to residues in water, soil and air

[5] This study uses the term "concern" to denote a worry or anxiety about a matter. A concern is, in effect, a perceived problem. An individual concern may not, by itself, be sufficient to bring about a response. However, a cluster of concerns may tip the balance and become motivation.

The term "motive" is used in this Report to mean an impelling force, i.e., the circumstance, desire or fear that has induced an action. A motive can be a positive response to a concern. It can consist of a desire to go forward by seeking a solution to a concern, or by seizing a particular opportunity. The concerns and motives underlying Member Sates Strategies were obtained by questionnaire and contact with key officials in competent authorities.

Box 4 below provides the top five motives for all six countries when evaluated together. Once again, differences emerge when the countries with use reduction strategies are analyzed separately from those without such strategies.

Box 4: Top Motives (all 6 Member States)
1. General public demand for PPP use reduction
2. Increase agricultural productivity by *inter alia,* development of IPM
3. Export market requirements, *e.g.:* maximum residue levels for foodstuffs
4. (tie) Strengthen admissions policies by reducing dependency on PPPs (NL)
(tie) Incorporate more integrated approach towards pest control

Box 5: Top Motives of 3 Member States with PPP Use Reduction Programs
1. General public demand for PPP use reduction
2. Strengthen admissions policies by reducing dependency on PPPs (NL)
3. International commitment to reduce chemical emissions (DK, NL)
4. Prolongation of product efficacy by retarding development of resistance (NL)
5. Make admissions policy more flexible by ensuring responsible pest control practices (NL)

Box 6: Top Motives of Member States without PPP Use Reduction Programs
1. Increase agricultural productivity by *inter alia*, development of IPM
2. Export market requirements, *e.g.*, maximum residue levels for foodstuffs
3. (tie) General public demand for PPP use reduction (I)
(tie) Opportunity to incorporate more integrated approach towards pest control (D)

Most officials interviewed felt that the original motives and concerns underlying their country's additional strategy were still relevant today. Nonetheless, most countries' additional policies have developed considerably over the years, and new concerns have emerged. For example, there is growing concern about dependency of agriculture on chemical pest control.

2.4 OBJECTIVES WITH RESPECT TO AN ADDITIONAL POLICY

The term "objective" is used in this analysis to refer to the endpoint which a strategy or policy aims to achieve, *i.e.*, the purpose or intention of a country's additional policies with respect to PPPs.

Interestingly, though concerns varied greatly, policy makers have responded by choosing remarkably similar objectives.

Box 7: Top Objectives for Additional PPP Strategies (all 6 Member States)
1. Reduction of risk to consumers' health through protection of water resources used for human consumption
2. Reduction in emissions to the environment
3. Reduction of load to surface waters and/or the marine environment
4. Reduction of risk to consumers' health from residues on food
5. (tie) Promotion of alternative methods of pest control, *e.g.*, via support of research, subsidies for low-input agriculture
(tie) Improvement of technological base for, *inter alia*, application of PPPs
7. Reduction of dependency on PPPs in agriculture (NL)
8. (tie) Reduction of risk to chemical workers or users of PPPs
(tie) Achieve a balanced approach towards reduction of risks associated with PPP use (D)

Box 8: Top Objectives for Member States with PPP Use Reduction Strategies
1. Reduction of risk to consumers' health through protection of water resources used for human consumption
2. Reduction in emissions to the environment
3. Reduction of load to surface waters and/or the marine environment
4. Reduction of risk to consumers' health from residues on food
5. Reduction of dependency on PPPs in agriculture

Box 9: Top Objectives for Member States without PPP Use Reduction Strategies
1. Reduction of risk to consumers' health through protection of water resources used for human consumption
2. (tie) Reduction in emissions to the environment
(tie) Reduction of load to surface waters and/or the marine environment
(tie) Promotion of alternative methods of pest control, *e.g.*, via support of research, subsidies for low-input agriculture
(tie) Improvement of technological base for, *inter alia*, application of PPPs
6. (tie) Reduction of risk to consumers' health from residues on food
(tie) Reduction of risk to chemical workers or users of PPPs
(tie) Achieve a balanced approach towards reduction of risks associated with PPP use (D)

2.4.1 Use-Reduction Versus Risk-Reduction

The objective "reduce use of PPPs" was not one of the options provided in the questionnaire. Although interviewees could have volunteered it, they did not. In all three countries with PPP use reduction strategies, PPP use reduction was regarded as only one of the means to achieve the objective of risk reduction, although considered useful in particular because (1) risk reduction is difficult to quantify; (2) use reduction can be quantified in ways that can be communicated to the public, including the farming community; and (3) "it gets the ball rolling".

Other Member States (*e.g.*: Germany) oppose a PPP use reduction strategy on several grounds: (1) the current framework conditions already minimize PPP use at necessary amounts; (2) further use reduction would result in both high economic costs and negative impacts for the environment; (3) PPP use reduction is not considered an efficient way to reduce risk; (4) improvements in application conditions and strengthening research and extension of IPP would be more effective risk reduction measures than reducing quantity used.

It should be noted that there are limits to PPP use reduction. For example, Sweden considers that further use reductions beyond its current goal of 75% will be increasingly difficult to achieve without incurring excessive costs for farmers, given the competition experienced upon accession by Sweden to the EU.

2.5 PARAMETERS FOR MEASURING PROGRESS IN MEETING OBJECTIVES

A parameter is defined as a measurable or quantifiable characteristic or feature, and the choice of parameters for measuring progress may be fundamental to the success of any additional strategy. There is no consensus among the six countries surveyed concerning the relevance, usefulness and/or feasibility of an agreed range of parameters.

Box 10: Primary Parameters Used to Measure Progress in Countries with Additional Programs

Denmark - Reduction in total amount of active ingredients sold nationally (but not differentiating AIs from toxicity) *combined with* reduced frequency of treatments as indicator of 'environmental load'[6]

Germany - Reduction in number of products registered; monitoring of negative impacts (applicators, consumers, environment)

Netherlands - Reduction in total amount of active ingredients sold nationally

Sweden - Reduction in total amount of active ingredients sold nationally *combined with* phase-outs of specific products and area of land treated[7]

[6] One difficulty identifiable with a parameter based on frequency of application is that a farmer's decision to apply a PPP in separate treatments may be based on actual need and would therefore be in line with IPP principles.

[7] Any parameter based on set-aside areas should however be used with caution, since other areas could be more intensely cultivated. For example, in Italy most set-aside areas one in fact the less productive areas, e.g. hillsides, that had never experienced high rates of PPPs in any event.

2.5.1 Total Amount of Active Ingredient Sold

The parameter of total amount of active ingredient sold is viewed (notably in France and Germany[8]) as inappropriate, on the grounds that (i) it is derived from the principle of restriction of industrial emissions and does not reflect the fact that plant protection products are applied to solve a problem; (ii) it neglects the need for a practicable alternative; (iii) it does not account for the different biological activities of active substances and therefore does not correlate with the actual danger potential; (iv) no use of PPPs is not always the best alternative*e.g.*, soil erosion following mechanical weed control. Despite its flaws, the parameter of total amount of active ingredients sold is nevertheless monitored even in countries without PPP use reduction strategies, including Germany and France.

2.5.2 Environmental Indicators

Environmental indicators used by Member States include surface and groundwater contamination; effects on water organisms or birds. By way of example, the 'environmental yardstick' developed by the Dutch Center for Agriculture and Environment (CLM) is used on a voluntary basis by 5-10 % of Dutch farmers.

One of the problems with environmental indicators is that the perception of what constitutes a negative side-effect from PPP use can vary widely among government, industry and the agricultural sector, on the one hand, and among environmental groups on the other hand. Some scientists have argued that the indicator should be actual occurrence of damage. But even the scientific community is divided on what should be considered "actual damage".

2.5.3 "Pesticide Load Index" or "Risk Index"

In Denmark, considerable discussion has taken place concerning the development of some type of "pesticide load index" or "risk index" which could express the joint effect from PPPs, based on each PPP's toxicity to plants and animals, combined with treatment frequency and quantity used for each PPP, and intended to provide a quantitative measure of the risk or load each PPP comprises for plants and/or animals. These modeling systems are extremely complex, however.

A "risk index" would indicate the total weighted effect of the hazardous characteristics of a PPP,*e.g.*, toxicity, mobility and biodegradability, together with the degree of exposure in the environment, and would summarize the risk to the environment associated with the use of a PPP. It may, however, be impossible to create a risk index that can summarize all risks to the environment from PPPs in a meaningful way, since most risks cannot be compared. An index for a specific PPP would not be able to indicate there was a great risk for a single group of plants or animals, or a lower risk for several groups.

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[8] Although in Germany the amount of active ingredient sold is considered both before and subsequent to authorisation (the latter for purposes of considering re-authorisation).

A "joint load index" would aim to provide an indicator of the total environmental load posed by the use of several PPPs. This would, however, encounter similar difficulties as with the proposed "risk index". A "joint load index" would need to summarize the environmental effects of chemicals used for completely different purposes, e.g., insecticides, herbicides, and growth regulators. Since these groups of chemicals have completely different effects on the environment, a joint load index would appear to have no scientific basis.

2.5.4 "Environmental impact quotient" (EIQ)

The environmental impact quotient ("EIQ") although sometimes criticized, is a proposed system of comparing PPPs on the basis of their known toxicological properties, characteristics, and behavior in the environment, determined for each PPP on the basis of farm worker, consumer and environmental exposure components. The averaged relative toxicities are added together to arrive at a single numerical value for each PPP, multiplied by (a) its use rate and (b) its frequency of application, to arrive at a final EIQ value for each PPP in a specific cropping system, reportedly enabling different PPPs to be compared, with those having low values being safer than those having high values. Some concerns have been expressed, however, that such a method would be far too complicated to operate in practice.

2.5.5 Other

A number of other parameters were mentioned as interesting possibilities by interviewees, including the percentage of PPP users trained in integrated pest control techniques; the number of sellers and users of PPPs having specialist qualifications; calls to its occupational safety board's "hot line" reporting PPP-related incidents; substitution of modern technology for old spraying equipment; monitoring of the number of PPP sprayers inspected; amount of investment in low-input versus higher-input agriculture; allocation of money for technical training of farmers; number of farmers advised to follow *agriculture raisonnée* and extent of agriculture area where IPM applied. Finally, Italian environmental organizations expressed a wish for a mandatory limit on total amount of PPP residues on food, similar to the overall limit for PPP residues stipulated in the EU Drinking Water Directive.

2.6 EVALUATION OF NATIONAL EXPERIENCES

One theme throughout interviews conducted with officials was the difficulty in measuring progress in risk reduction because of a lack of reliable parameters in this areas, and lack of agreement on principles of monitoring. Determining the effectiveness of specific policy elements and activities was also difficult because of the existence of other factors which could have affected the outcome.

As a general remark, achievement of set goals has had mixed success when measured against stated parameters. For example, although the parameter of a 50% reduction in PPP use and treatment frequency has been identified in Denmark, in practice reduction figures for treatment frequency have not taken place, reducing only by between 6-22%.

By way of contrast, in most of the Member States re-registration has resulted in refusals of applications and withdrawal of substances from the market. Stricter conditions are

also frequently placed on older active substances. The elements to which success in reducing PPP use are attributed differ widely from Member State to Member State, however. The most important elements, are summarized in Table 2 below.

Table 2:Factors contributing to the effectiveness and the lack of effectiveness of additional strategies

Factors contributing to the success of additional strategies	**DK**	**NL**	**SW**	**F**	**D**	**I**
High level of environmental awareness generally	X	X	X		X	
Strong national consensus on need for the additional strategy on PPPs			X			
Good cooperation between agricultural and environment ministries	X	X	X			
Strong commitment and participation on the part of farmers			X			
Extensive agricultural research and extension network to reach local farmers		X	X			
Good information about ways to reduce dependency on PPPs			X			
Setting of quantifiable targets		X	X			
Mandatory activities, such as certification of users	X	X	X	?	X	
Strict registration criteria					X	
Consumer demand for quality food						X
Factors contributing to lack of success	**DK**	**NL**	**SW**	**F**	**D**	**I**
Lack of support among farming community	X	X		X	X	X
Difficulties in defining objectives and parameters for measuring progress			X		X	
Lack of resources for agricultural research and extension		X	X	X	X	X parti
Adverse economic results associated with restricted use of PPPs		X	X			
Conflicts with other environmental initiatives, *e.g.*, "green cover" program	X		X			
Lack of penetration of information to farming community		X		X	X	X
Lack of alternatives for certain "high risk" PPPs			X			
Lack of cooperation among ministries and interest groups in general				X	X	X
Lack of legal basis for additional programs		X				
Difficulties linking agricultural innovation with product phase-out needs		X				

2.7 THE IMPACT OF DIRECTIVE 91/414 ON RISKS FROM FUTURE PPP USE

Directive 91/414 concerning the placing of plant protection products on the market[9] ("the Directive") is intended to harmonize the PPP registration systems now in existence in the various Member States. It establishes common rules which are to be applied in approving -- or rejecting -- active ingredients and plant protection products. These rules include health and environment-related criteria set forth in 'Uniform Principles'.

After the Directive has been fully implemented, active ingredients ("AI") and PPPs have to meet the criteria established within the framework of the Directive in order to be placed on the market within the European Union. Full implementation is expected to take 10 to 15 years -- the estimated amount of time required for the review of some 800 active substances currently on the EU market mandated by the Directive.

Some important stakeholders in the debate concerning possible additional EU measures concerning PPPs -- including the PPP industry -- contend that the Directive by itself will be adequate to control risks to humans and the environment from plant protection products.

If the Directive is not expected to sufficiently reduce such risks, the EU may need to take further risk reduction measures now, rather than waiting to see the results of Directive 91/414's implementation.[10]

The legal analysis conducted as part of this sub-Report was concluded prior to adoption of definitive Uniform Principles. The comments set out below should therefore be read in the light of the recently revised Uniform Principles. Several potential problem areas were identified.

- Exceptions for many environment-related criteria, *i.e.*, if scientific demonstration of no unacceptable impact under field conditions
- The need for better definition of "proper use" and "good plant protection practice"
- No provision for reduction of dependency on PPPs for plant protection

The UP's provision of exceptions for many environment-related criteria could be a potential area of concern. However, applicants wishing to avail of a particular exception will be under a considerable burden to demonstrate via field trials that a PPP not meeting the criteria will have no unacceptable impacts under field conditions. The cost of such field trials will limit the number of PPPs exceeding those criteria to those with a strong market potential and a strong likelihood of passing the field tests. It will be difficult to assess whether such exceptions will diminish the effectiveness of Directive 91/414 as a risk reduction measure until after such field trials have taken place.

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[9] Council Directive 91/414/EEC of 15 July 1991 concerning the placing of plant protection products on the market, O.J. L 230/1.

[10] Due to considerations or space, readers unfamiliar with the provisions or operation of Directive 91/414 are invited to read the following section following consideration of the Directive itself or the summary of Directive 91/414 provided at pages 39-45 of the Oppenheimer Wolff & Donnelly sub-Report.

Implementation of the Principle of Mutual Recognition ('MR') may also pose problems. Though MR will have positive environmental aspects*e.g.*, PPPs that meet modern environmental criteria, less testing on animals, and so on, these gains have come at some cost. Individual Member States wishing to establish special controls over a PPP deemed to pose a national or local risk will face the burden of having to establish non-comparability of conditions. Counterbalancing that burden is, of course, the burden on the applicant to establish comparability of conditions. Nonetheless, the loss of national flexibility in this area may increase PPP-related risks in those countries that had previously pursued aggressive re-registration programs to eliminate high-risk products.

Directive 91/414's inadequate definition of "proper use" and "good plant protection practice" is also a concern. A legal definition of "proper use" and "good plant protection practice" is particularly important, given that the risk reduction rules set forth in Directive 91/414 and the Uniform Principles assume that a PPP will be subject to "proper use". Since this is not necessarily the case, better definition would help not only enforcement efforts but would also provide a basis for educating users about how to keep risks in using PPPs at a minimum.

A final concern is that Directive 91/414's risk reduction measures are aimed only at controlling products. As such, it perpetuates the status quo of dependency on PPPs for pest control. Given the wide range of other risk reduction measures available to policy makers in this area, including measures to reduce dependency on PPPs in agriculture, it would appear prudent to consider other, more preventive risk reduction actions at EU-level.

In general, the impact of Directive 91/414 on PPP use patterns in the different Member States will depend on the number of AIs and PPPs currently authorized within each country. The general expectation among countries without use reduction programs is that the number of AIs currently on the market within the EU will significantly decrease, as will the number of PPPs and the average number of uses for an individual PPP. This phasing out of higher-risk PPPs should lead to an overall reduction of risk, but at some cost to those countries with strong PPP risk reduction programs involving use reduction goals.

Notwithstanding the issue of Directive 91/414's adequacy as a risk reduction measure, the length of time for full implementation is of serious concern. The projected period of 10-15 years may in fact be somewhat optimistic, given that the process of reviewing "old" active ingredients is still at an early stage. Assessment of the some 700 active substances on the EU market could well take longer than the allotted 10-15 years at current levels of human and technological resources. Subsequent monitoring to determine its impact on PPP-related risks could add on an additional 5 years if the decision to set in place an additional EU policy is postponed until monitoring results are available. Thus it may well be 15-20 years before the full impact of Directive 91/414's controls over active substances and PPPs can be assessed. The issue of implementation of Directive 91/414 is considered further in the sub-Report prepared by WAU, summarised below.

2.8 SELECTING OPTIONS FOR AN ADDITIONAL EU POLICY

This section draws on the findings of individual country studies to consider whether any of the common concerns and motives identified therein could provide a platform for further work to develop an additional EU policy. It also considers whether any objectives derived from national programs could be relevant at EU-level, and reviews the various parameters identified to assess their viability at EU-level.

2.8.1 Common Concerns or Motives

Six concerns were highlighted as priorities for most of the countries surveyed and therefore most likely to form a common basis for further discussion as summarised in Table 8, overleaf.

Table 3: Common concerns

Common concerns	Combined Rank	Countries with Use Reduction	Countries w/o Use Reduction
Contamination of water resources used for human consumption	1	1	1
Possible adverse effects on the ecology, e.g., non-target species	2	2	4
Risks to consumers of food with residues	3	4	1
Effects of exposure to residues in water, soil and air	4	4	5
Contamination of surface water or marine environments	5	3	7
Risks to users of agricultural chemicals	5	10	1

A similar process was used to derive rankings for possible motives, though it should be noted that the information on which these rankings are based is much less robust than that for possible concerns. Table 3 nonetheless provides an overview of the responses received.

Table 4: Possible motives

Possible motives	Combined Rank	Rank for Countries with Use Reduction	Rank for Countries w/o Use Reduction
General public demand for PPP use reduction	1	1	3
Increase agricultural productivity by, *inter alia*, development of IPM	2	6	1
Export market requirements,*e.g.*, maximum residue levels for foodstuffs	3	6	2
Opportunity to strengthen admissions policies by reducing PPP dependency	4	2	5
International commitment to reduce chemical emissions	4	2	5
Opportunity for more integrated approach towards pest control	4	6	3

Overall, because of the general lack of agreement about motives as a factor underlying a country's choice of risk reduction policies, the rankings overleaf provide only limited information about motives shared across EU Member States. On the other hand, the top five concerns listed above do appear to tap into a strong common vein.

2.8.2 Relevant Objectives

Table 10 below lists the top six objectives identified in the course of this study. A comparison of the rankings of the risk reduction objectives identified via the country studies reveals a remarkable homogeneity, at least towards the top of the rankings. This held true whether rankings were made on the basis of groupings of countries with pesticide use reduction strategies, countries without such strategies, or all six countries together.

A comparison of Tables 8 and 10 also reveals considerable correspondence between the top-ranked objectives and the top-ranked concerns. For example, the top-ranked objective of "reduction of risk to consumers through protection of drinking water resources" corresponds to the top-ranked concern -- "contamination of water resources used for human consumption", while the second-place objective of "reduction in emissions to environment" compares to the second-ranking concern of "possible adverse effects on the ecology".

Table 5: Possible objectives

Possible objectives	Combined Rank	Rank for Countries with Use Reduction	Rank for Countries w/o Use Reduction
Reduction of risk to consumers through protection of drinking water resources	1	1	1
Reduction in emissions to environment	2	2	2 (tie)
Reduction of load to surface waters and/or marine environment	3	3	2 (tie)
Reduction of risk to consumers from residues on food	4	4	6
Promotion of alternative methods of pest control, *e.g.*, research support	5 (tie)	7 (tie)	2 (tie)
Improvement of technological base for, *inter alia*, application of PPPs	5 (tie)	7 (tie)	2 (tie)

2.8.3 Relevant Parameters

Since respondents to the survey of PPP policies in the six countries were not invited to weigh various parameters against each other, a ranking as such cannot be produced from this study. Nonetheless, some basic themes relevant for an EU-level discussion can be drawn.

Each of the three countries with use reduction goals have relied on the parameter reduction in total amount of active ingredient by weight. To reflect differences among PPPs on the basis of biological potential, however, these countries have used this parameter in combination with other parameters.

Variances on this parameter that were targeted to address specific problems, *e.g.*, amount of AIs used by sector or for specific crops, had broader support. All of the countries in the study (except Germany) have used or are discussing the value of such a parameter. The parameter of reduced number of registered products -- a parameter which could well be used to measure progress in implementation of Directive 91/414 -- was considered relevant by most of the countries surveyed.

The notion of a pesticide load index or other type of environmental indicator was regarded by officials from all six countries in the study as potentially one of the most valid parameters and appears to be the parameter potentially most closely linked to the objectives of 'protection of drinking water resources' and 'reduction of load to surface waters', and it is noteworthy that the concentration limits for pesticides found in both the Drinking Water Directive and the Surface Waters Directive already serve as "trigger values" to activate policy responses.

The limit of this kind of index, however, is that response occurs only after a certain impact on the environment has already occurred. A 'trigger value' would therefore have to be set well below the point of significant impact, so as to avert the possibility of a damage.

The most relevant parameters among those identified in the study with regard to the objective "reduction in emissions to the environment" would appear to be those related to reductions in quantity of PPPs used. However, given the variances among the Member States in uses of PPPs and quantities used, common quantifiable goals may not be feasible -- or indeed even scientific. A more viable approach may be to consider a range of quantified targets. The Packaging Directive which sets minimum and maximum targets for recovery and recycling of packaging waste could serve as an example.[11] Alternatively, Member States could be required to identify possibilities for risk reduction within their own goals, similar to the scheme in the proposed Directive on ecological quality of water, whereby Member States would be required to set their own "operational targets for maintaining and/or achieving good ecological quality".[12] Both of these approaches would also be in accordance with principles of subsidiarity.

Progress towards the objective "promotion of alternative methods of pest control" could be measured by such parameters as percentage of pesticide users trained in IPM or amount of investment in low-input v. higher-input agriculture. These parameters are under discussion in several countries in the study. These issues are examined further in the sub-Report prepared by Produce Studies, summarised at Section 4 below.

2.9 OPTIONS FOR AN ADDITIONAL EU POLICY

As the national reports in this study reveal, a range of policy options and policy instruments aimed at reducing risks from PPP use are currently in place among the Member States. Some of these were identified and discussed in the first phase of the "Possibilities for future E.C. environmental policy on plant protection products" project.[13] To provide a focus for the Phase 2 discussions, various policy options and instruments are set out below in six "packages":

Each of these packages is focused on one or more risk reduction objectives, as indicated, and discussed on the basis of the information gathered during the comparative studies of six Member States. The key elements guiding discussions[14] include the extent to which

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[11] Directive 94/62/EC of 20 December 1994 on packaging and packaging waste, O.J. L 365 of 31 December 1994, at 10.

[12] Proposal for a Council Directive on the ecological quality of water, COM (93) 680 final - 94/0152 (SYN).

[13] E.g., Centre for Agriculture and Environment (CLM), Towards a Future EU Pesticide Policy (1994).

[14] The criteria above are certainly not the only criteria which may be relevant. Rather, they are derived from the information which has been gathered for this study during the research phase. Indeed, it will be seen from the Questionnaire annexed to this synthesis Report that in the light of the conclusions of the other sub-Reports to this Project, resulting options have been modified to produce seven possible strategies for an additional EU PPP policy.

underlying concerns are shared by the various Member States; whether an option is perceived as "effective" in terms of achieving the identified objective; the existence of a relevant parameter for measuring progress in risk reduction; whether the option will be politically acceptable to Member States.
The options, and the measures listed under each, should be viewed as stages along a risk reduction continuum. Unrestricted use of PPPs would be at one end of the continuum and PPP-free agriculture - the ultimate measure to reduce risk from PPPs - would represent the other end. Both far ends of the continuum are unrealistic, and Options are not mutually exclusive, therefore suggesting that indeed a 'package' of measures will be required.

2.9.1 Option 1: Speed Up Directive 91/414 Implementation

Relevant measures: - Additional resources for implementation *e.g.*, financing, within the European Commission and Member States

Relevant priority objective(s): - Reduction of risk to consumers through drinking water resources and residues on food, and improvement of technological base for *inter alia*, application of PPPs

Though technically increasing resources would not be a policy measure "additional" to the current system of authorization of PPPs, it would nevertheless represent a cost-effective way to ensure that PPPs posing unacceptably high levels of risk are taken off the EU market, or their use restricted. Since Directive 91/414 has already been agreed by the Member States, this option would likely have a high level of acceptance.

Relevant parameters for measuring progress could be numbers of active substances and PPPs reviewed under Directive 91/414's guidelines and criteria, and reduction in numbers of authorized active ingredients and plant protection products. Environmental indicators such as concentration levels of PPPs in groundwater could also be useful for monitoring progress.

2.9.2 Option 2: Controls Over Risks in Distribution and Use of Plant Protection Products

Relevant policy instruments: - Training and certification requirements: - accreditation of dealers and distributors; certification of farmers and professional users of PPPs; access to high-risk PPPs restricted to certified users; essential requirements/inspection for equipment. Record keeping requirements: - registration of PPP sales; mandatory farm-level logs of PPP usage.

Relevant objective(s): - Reduction in emissions to the environment; improvement of technological base for, *inter alia*, application of PPPs; reduction of risk to chemical workers or users of PPPs; reduction of risks to consumers of food with residues.

The Fifth Environmental Action Program proposed measures to control the sale and use of pesticides by 1995. Option 2 focuses on training and certification of all those involved in the chain of marketing and use of PPPs, from distributors to users, and includes

components to upgrade equipment for application of PPPs, and for keeping records both of sales and of PPP usage at farm-level.

EU-wide measures to require minimum training and certification of PPP users, and to upgrade equipment standards, are also among the recommendations made by the Farming Methods Working Group at the October 1995 OECD/FAO Workshop on Pesticide Risk Reduction in Uppsala, Sweden.[15]

Relevant parameters for measuring progress would include: number of distributors certified; number of PPP users trained and certified; number of PPP-related occupational poisonings reported; number of sprayers meeting essential requirements and/or inspected.

Most of these measures, with the possible exception of farm-level record keeping, bear a high probability of being acceptable to most Member States. In some ways Option 2's package of risk reduction measures could be viewed as the minimum step for an additional EU policy.

2.9.3 Option 3: Water Protection Programs/Measures Reducing Specific Ecosystem Risks

Relevant policy instruments: Watershed monitoring programs; area-based bans or restrictions on use of PPPs in ecologically vulnerable zones, *e.g.*, well heads or streamside areas; nature protection reserves, *etc.*; restrictions and/or bans on pesticides with high mobility; setting of limits for PPP residues in surface and ground water.

Relevant priority objective(s): - Reduction of risk to consumers' health through protection of water resources used for human consumption; reduction of load to surface waters and/or the marine environment.

The policy measures grouped together in Option 3 address various water-related (contamination) concerns, ranked high in the survey of all six Member States.[16]

Area-based bans or use restrictions are in place in Denmark, Germany and the Netherlands. Use of designated water protection zones is also viewed as an effective measure in, *e.g.*, Germany, where water companies consider it more cost-effective to pay farmers to change their practices with respect to PPPs than to allow the water to be polluted and then clean it afterwards. Note that Community nature protection legislation, *e.g.*, the Birds Directive and the Habitats Directive, already require Member States to take requisite measures to prevent pollution of certain protected areas.

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[15] It is worth noting in this context that the so-called Nitrates Directive provides for the possibility of Member States including record keeping requirements in the Code(s) of Good Agricultural Practice for reducing pollution by nitrates.

[16] Given the EU's water quality requirements such as those in the Drinking Water Directive, these concerns are no doubt important in other Member States as well. It should be noted also that the Fifth Environmental Action Program called for the progressive replacement of harmful pesticides and progressive use limitations, as examples of measures needed to protect groundwater.

Moreover, the forthcoming EU Groundwater Action Plan and the proposed Ecological Quality of Water Directive also propose watershed monitoring.

Standards for surface waters are also prefigured in the Ecological Quality of Water Directive, which would have Member States set standards at levels of 'no-effect', leaving Member States the burden of proof. It should be noted that quality standards already exist under the Directive on quality of surface water intended for drinking water. Relevant parameters for this option would include pesticide load in surface and groundwaters. Indeed, the measures in this option may be regarded as the direction of future EU-level water quality protection legislation.

2.9.4 Option 4: Voluntary/Mandatory Programs on Pesticide Emission Use/Reduction

Relevant policy instruments: - Codes of Good Plant Protection Practice; Codes of Best Environmental Practice; promotion of Integrated Pest Management or Integrated Crop Management; restricted access to certain high-risk PPPs; charges or taxes on active ingredients; increased financial support for research and extension on integrated pesticide management; voluntary agreements with farmers' organizations to reduce dependency on PPPs, with specific targets by sector or crop; overall pesticide use reduction targets.

Relevant priority objective(s): - Reduction in emissions to the environment; reduction of risk to consumer's health from residues on food; improvement of technological base for, *inter alia*, application of PPPs.

The long list of measures under Option 4 represent a variety of approaches aimed at, *inter alia*, reducing unnecessary use of plant protection products. Together, they address virtually all of the priority concerns identified in this study. Several of the measures are voluntary, *e.g.*, Codes of Good Plant Protection Practice, implementation of which would require strong Member State commitment, as well as commitment at farm-level. The effectiveness of such measures is therefore open to some doubt. For example, the EU's Nitrates Directive calls for a Code of good agricultural practice, but implementation in a number of Member States is far behind schedule.

One of the strongest arguments for a Code of Good Plant Protection Practice is that it addresses Directive 91/414's failure to define "proper use" and thus would be complementary to the EU's current admissions legislation. A Code of Best Environmental Practice is more controversial, in that some critics see it as a single-issue measure which does not take into account other aspects of plant protection practices, such as farmer profitability. Nonetheless, it is under discussion in a number of countries.

Charges and taxes are considered effective elements in Sweden. Both Denmark and Sweden mentioned charges and taxes as important not only as measures which can reduce pesticide use because of their price effect, but as potential sources of funding for the research and extension programs needed to promote Good Plant Protection Practice, IPM, and so forth. The possibility that such charges and taxes could have a negative impact on the competitiveness of agriculture and the income of farmers would need to be considered. It seems likely that such measures would, however, incur significant opposition from the pesticides industry.

Relevant parameters under this option would include the various volume-based reduction targets, but in particular the sub-measures, such as amount of active ingredient used per hectare, by sector or for specific crops. A number of these elements would seem to have high political acceptance among the Member States and industry participants, especially Codes of Good Plant Protection Practice, promotion of IPM, and increased financial support for research and extension on IPM.

2.9.5 Option 5: Further Promotion of Low-Input or PPP-Free Agriculture

Relevant measures: - EU eco-label for PPP-free agricultural products; increased financial support for research and extension on low-input or PPP-free agriculture; subsidies or tax break for switching to organic farming or for set-asides and extensification.

Relevant priority objective(s): - Reduction of emissions to the environment; promotion of alternative methods of pest control.

Option 5 would build on EU Regulation 92/2078 by providing further support for environmentally conscious agriculture and for the development of an EU-wide market for organically produced foodstuffs, by *inter alia*, the development of an EU "green label" (although it is accepted that the sub-Report prepared by WAU, summarised at Section 3 below arrives at a different conclusion in relation to the efficacy of a green labeling scheme). It supports the Fifth Environmental Action Programme's proposal for promotion of "Integrated control" (in particular training activities) and promotion of bio-agriculture. Measures to increase the use of biologically based farming methods are among the recommendations made by the Farming Methods Working Group at the October 1995 OECD/FAO Workshop on Pesticide Risk Reduction in Uppsala.

The primary concern(s) underwriting this option are risks to consumers of foods with residues, dependency of agriculture on chemicals for pest control, and possible adverse effects on the ecology.

Relevant parameters for measuring progress under this option would be number of acres in biological farming or in other agri-environmental programs. Whether the EU market for organic food will become substantial enough to support a significant switch from conventional to biological practices is, however, a major uncertainty with regard to this option.

2.9.6 Option 6: Integration of Environmental Concerns into the Common Agricultural Policy

Relevant measures: - Removal of support for crop prices and other subsidies based on productivity; compensation for sustainable agriculture measures; support for research & extension focusing on sustainable agricultural measures.

Relevant priority objective(s): - Reduction of emissions to the environment; promotion of alternative methods of pest control; improvement of technological base for *inter alia*, application of PPPs.

Option 6 would aim to achieve a flexible and environmentally friendly agriculture by supporting sustainable farming measures. It would aim to complete the reform of CAP initiated in the early 1990s by extending and intensifying the EU's existing agri-environmental schemes. This would include further reduction of price supports for those input-intensive crops subject to CAP supports, such as cereals and oilseeds -- unless farmers shifted to other crops not subject to CAP supports, but still requiring intensive use of PPPs and other inputs. To counter this latter possibility, Option 6 would aim to shift farmers to more sustainable agricultural practices, through compensation for taking certain environmentally sound measures.

One important outstanding issue is whether current levels of food production could be maintained under this option without bringing more land under the plough. If the level of food production dropped considerably, there could be a need for support for farmers' incomes and for importing foods no longer produced within the EU. Similarly, it has been questioned whether the land remaining available would be cultivated more intensively, resulting in an increase in PPP application. This issue is discussed further in the sub-Reports prepared by both WAU and Produce Studies.

2.10 CONCLUSIONS

Re-registration programs using strict environmental criteria have been important measures for taking overly risky pesticides off the market. In that regard, Directive 91/414 is a significant step forward for the EU in that it requires all Member States to apply up-to-date criteria, including environmental criteria, when taking decisions concerning PPPs. In many Member States, the numbers of active ingredients and PPPs are expected to be significantly lower at the end of Directive 91/414's implementation. Speedy implementation of Directive 91/414, as per Option 1 above, would eliminate higher-risk PPPs from the EU market and thereby reduce current levels of risk from PPP use.

However, as the discussion of Directive 91/414 indicated, there remain a number of areas where Directive 91/414's coverage may be incomplete, *e.g.*, with regard to groundwater protection. Thus, even if Directive 91/414 is implemented speedily, additional risk reduction measures may still be needed to address underlying concerns about risks from PPP use within the EU.

In this regard it is important to note that every country surveyed for the OWD sub-Report has undertaken some type of program aimed at reducing risks from use of plant protection products that was *in addition* to its program of authorization for such products. This is especially true for the countries with the most intensive review and re-registration programs.

Legislation providing for controls over risks in distribution and use of plant protection products is in place in some form or other in most countries. Such controls are especially important, given the length of time expected before Directive 91/414 will be fully implemented.

Targeted measures to protect groundwater and surface waters from PPP-related risks, as in Option 3, would be compatible with current discussions on the direction for future EU-level water quality protection legislation.

The lack of guidance provided by Directive 91/414 concerning "proper use" of PPPs has also been flagged in this study. Some of Option 4's measures -- in particular, a Code of Good Plant Protection Practices -- would help provide the guidance and definition needed to bridge this gap. Voluntary and mandatory programs on Best Environmental Practice, Integrated Crop Protection and other measures to minimize pesticide emissions would be important complementary measures.

Options 1-4 may in many ways be seen as minimum steps towards reducing risk to humans and environment from PPP use. They are already in place in some form in the three countries with pesticide use reduction programs. They are in place or under consideration in the three larger countries without use reduction programs but with large areas in agricultural production. They would provide a framework of risk reduction measures designed to minimize remaining risks accompanying the use of PPPs in agriculture. An EU-level additional program based on these options would have high acceptability among the Member States.

Options 5 and 6 are aimed at reducing agricultural dependency on the use of PPPs -- Option 5 through further promotion of low-input agriculture, and Option 6 through integration of environmental concerns into the Common Agricultural Policy. Insofar as these measures would promote sustainable agricultural production practices, they may represent the best long-term direction for EU action.

As this study has noted, those countries with pesticide use reduction programs have defended such programs as necessary for distilling risk reduction goals into measurable objectives, and for increasing the effectiveness of their overall programs. Because of the usefulness of such goals for mobilizing the support of farmers and the general public for environmentally sound agriculture, an EU-level pesticide use reduction program should continue to be given careful consideration. Given the variances among the Member States with regard to PPP practices, such a program would of course need to be tailored by country, by agricultural sectors and perhaps by crops.

An observable trend in EU lawmaking is to set criteria and targets for Member State action, but to then leave it to each country to determine the optimal means for achieving the common goal at national level, *e.g.*, the Packaging Directive and the proposed Ecological Water Quality Directive. Such an approach would be in line with the principle of subsidiarity and could help to address the concerns of individual Member States regarding their own agricultural and environmental situation.

SECTION 3

Additional EU Policy Instruments for Plant Protection Products

(Sub-Report prepared by Wageningen Agricultural University)

The main focus of this sub-Report was to identify, describe and analyse a set of additional policy instruments with the objective of a reduction in use and, where possible, risk of PPPs.

Each additional policy has several variants, which led to an overview of 52 partly overlapping instruments. In total the 22 instruments elaborated in detail were those which most adequately met the criteria of effectiveness, efficiency, acceptability, enforceability, homogeneity and which avoided large disturbances of property rights and income, and as defined in the author's Terms of Reference.

3.1 INTRODUCTION

3.1.1 Plant Protection Product-use in EU Agriculture

It is extremely difficult to characterise the situation of PPP-use in the European Union and the Member States by means of a single overview table. It is accepted, for example, that regional and crop differences may largely cancel each other out in the larger EU Member States. Moreover, data for one year will depend also on random aspects such as the weather, disease patterns and PPP and crop prices. It has nevertheless been assumed that use of the summary Table 3.1 overleaf, will at least allow the current situation to be placed in some kind of general perspective.

Two different parameters should be noted: (1) the intensity of PPP-use (measured by means of kilogram active ingredient per hectare), and (2) the efficiency of PPP-use (mostly measured by means of kilogram of active ingredient per unit of crop production). The two characteristics are shown in the Table below. There is a large difference between the two measures between Member States of the EU. By way of example, the Netherlands has the highest PPP-use per hectare, but is found at the lower end per unit of crop production. Similarly, Portugal has the highest use per unit of crop production, but roughly 'average' sales per hectare.

Several disturbing elements influence the 'overall picture' provided in Table,1 identified in the sub-Report as:

- the share of PPPs used at grassland (which pushes up the data *e.g.* Ireland and Luxembourg);
- the high price level of agricultural products in Finland, and to a lesser extent in Austria (which leads to a high efficiency level). In addition, most attention is

paid to emissions of PPPs to the environment and health risk elements (sometimes in comparison with the benefits of PPP-use).

Table 1 Overview of PPP-use characteristics in the Member States of the European Union in 1993

Country	Arable and hort. area incl. set-aside (1000 ha)	Crop value (million ECU)	Sales of PPPs (tons AI)	Sales of PPPs (kg AI) per ha	Sales of PPPs (kg AI) per 1000 ECU crop production
Austria	918	1481	3669	4.0	2.48
Belgium	747	2600	10282	13.8	3.95
Denmark	2460	1921	4277	1.7	2.23
Finland	999	1516	1150	1.2	0.78
France	15865	22061	88492	5.6	4.01
Germany	11359	12283	29350	2.6	2.39
Greece	2111	5914	9260	4.4	1.57
Ireland	155	532	2523	16.3	4.74
Italy	8464	20969	78394	9.3	3.74
Luxembourg	58	38	253	4.4	6.72
Netherlands	839	7224	11284	13.5	1.56
Portugal	1578	1362	9426	6.0	6.92
Spain	12888	13099	29501	2.3	2.25
Sweden	1394	739	1621	1.2	2.19
United Kingdom	5186	6722	33240	6.4	4.95

3.1.2 Categorisation of Instruments

Instruments are grouped in the sub-Report according to policy characteristics:

1. mandatory regulation (currently the most important set of instruments used by Member States in the area of PPP use reduction);

2. information, persuasion and awareness objectives (achieved on a voluntary basis, acting directly on agents in the PPP chain);

3. covenants/arrangements between industry/government;

4. technological and institutional change (working in a more indirect way with the intention that a behavioural change will result);

5. economic instruments (where government is the main initiator);
6. private law instruments (are rather general and can be applied in nearly every situation. Only a single private law instrument was felt to contribute significantly to the debate on potential additional PPP policy instruments).

3.2 SELECTION OF RISK MANAGEMENT ACTIVITIES

Once policy instruments have been categorised, an examination of the probable effects of selected instruments is performed, by means of an analysis of the objectives of instruments, in comparison with opportunities for risk management within the production chain. An evaluation of instruments was therefore prepared, using the criteria described at Section 3.4 below.

3.3 OBJECTIVES OF AN ADDITIONAL EU POLICY

The EU has committed itself to reducing the impacts of PPPs to the point where natural resources are maintained and agriculture is sustainable. Authorised PPPs should therefore possess good efficacy and acceptable impact, when used properly.

The main objective of current PPP policies is summarised as that of striking a balance between the benefit (the prevention of crop losses) and three risks: to persons applying PPPs, from residuals in water and food products; and from PPPs emitted into the environment. Accordingly, in cases of high risk, use should be adjusted, and need of use proven. Both PPPs residuals and pests and crops should be monitored adequately. The measurement of progress (as the indicator of progress of any given objective or strategy) in reducing risk requires several indicators, the most widely used, but not sole, indicator has been chemical load (kg active substance per ha).

3.3.1 Risk Management

From an economic perspective, application of PPPs should continue only up to the level where marginal net benefits for the farmers applying them are equal to the marginal value of all risks for food, workers and the environment plus their resources costs. Presently, such optimal application levels cannot be calculated in the highly intricate area of PPPs. Risk aspects of PPPs are mainly managed by authorisation: *i.e.* an *ex-ante* performance check for active substances and PPPs, thereby influencing costs of the PPP industry. (Hazard assessment in the EU will be performed according to the Uniform (authorisation) Principles of Directive 91/414).

Other PPP-related problems, such as water contamination, come to light *post-facto*. The sub-Report uses the concept of a ' PPP chain' to identify the distinct stages at which additional EU policies may influence PPP development, distribution and application, and focuses on those stages at which the use of PPPs by way of volume and application may be influenced (therefore concentrating upon potential technological changes in agriculture, rather than in the production of PPPs).

Apart from the governmental role evident in current PPP policy, also at farm level much can be achieved to reduce the chemical load of PPPs. In this context, use was made of the findings of the sub-Report prepared by Landell Mills (on PPP use for four different crops, studied in relation to 13 regions, and on 850 farms) summarised at Section 6 below.

Because many variables play a role, reasons for differences between farms were difficult to identify. Questionnaires forming part of this sub-Report[17] were oriented towards observing factors specifically mentioned by farmers. As a result, it is concluded that this variation will depend to a large extent on the level of control of the target pests required by the farmer.[18] Other factors influencing PPP use include the choice of PPPs, variation in pest and disease pressure, climatic conditions/weather conditions (partly in interaction with disease pressure, party independent), crop rotation and prevailing cropping systems.

It was found that variation in PPP use will depend to a large extent on the level of control required for the target pests. A number of opportunities for reducing chemical loads are therefore suggested along these lines, such as 'reducing the dominance of varieties susceptible to diseases'; 'continued development of disease warning systems'; and 'extension of IPM/ICM techniques.'[19]

3.4 SELECTION OF INSTRUMENTS

Some of the instruments examined in the sub-Report prepared by WAU receive, when their effect is analysed on an individual basis, a negative judgement (see the full text of the sub-Report in particular in relation to recording of trade, green labelling for consumers, abolition of short-term set-aside, marketable permits, and insurance against yield risk. Due to limited space, these instruments are not considered further in this summary of the sub-Report, although it should be noted that a number of these instruments given a 'negative' assessment were examined positively by authors of other sub-Reports.

A number of the instruments examined received a clear, positive judgement. These include speeding up the Directive 91/414 review-programme, PPP-reduction programmes, monitoring residues in water, integrated environmental programmes at farm level, programmes on resistant cultivars, recognition of integrated farming, improvement of application technology, use of covenants

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[17] Authors of this sub-Report built on results of Questionnaires distributed by the OECD.

[18] Other variables of importance mentioned appeared to be: crop type, crop(type) varieties, timing of treatments, dose rates, application volumes, part-crop praying and mechanical weed control.

[19] In addition, reference should be made in this context to the sub-Report of Landell Mills, summarised at Section 5 below, which identified the following opportunities for reducing chemical loads: seed treatment and cold storage technique of potato; selective targeting of fields and treatments along the row; greater use of post emergence herbicides and contact herbicides; increased use of mechanical weed control where soils permit; reducing the dominance of varieties susceptible to pests; increased use and continued development of disease warning systems; extension of IPM/ICM techniques (including crop and soil monitoring).

between EU and the PPP-industry on packaging or on monitoring, and introduction of a high uniform VAT on PPPs. Each of these measures has been selected according to criteria intended to produce an objective analysis of what additional policies are realistically available to the EU. These criteria include:

- the *effectiveness* of the instrument - as related to the degree to which predetermined objectives are achieved through the use of a certain instrument. The efficiency of an instrument also affects the cost of reaching predetermined objectives;

- the *efficiency* of the instrument - achieving objects in the least costly way;

- the *acceptability* of an instrument - referring to the way instruments are judged by those playing an important role in targeting policies (the farming community, the general public and professional experts and so on);

- a policy instrument which is effective, efficient and acceptable does not necessarily have a high level of *enforceability* - which is related in principle to whether individuals who do not behave according to the policy objectives may be forced to do so. Enforcement, therefore, refers to the legal basis for using policy instruments and also to the cost of the monitoring necessary to detect non-compliance;

- the *institutional homogeneity* of an instrument - refers to the instrument's compatibility with the basic policy principles embedded in other government programmes and accepted by society, such as the polluter pays, and precautionary principles, and the existing EU regulatory framework;

- the requirement that there be *no large disturbances of property rights and income levels* is intended to avoid the difficulties which may result from such disturbances.

3.5 ASSESSMENT OF POLICY INSTRUMENTS

3.5.1 Regulation

Three potentially useful instruments categorised as regulation were identified: speeding up the review programme; use-reduction programmes; and monitoring of PPP residues present in water.

(a) Speeding up the review

Presently, Council Directive 91/414 is an important instrument for managing PPP risks. Given current progress in the reviewing programme, it must be considered extremely unlikely that the 2003 target will be reached. An ambitious working plan is therefore proposed to evaluate most of the remaining 815 active substances within the next seven years.

The effectiveness of speeding up the review is as high as the harmonisation was first planned to be. To reach the 2003 target, it is estimated that the efficiency of

the authorisation procedures has to increase six-fold (if the EU capacity stays constant at the level of about 500 man years). Such a rise in efficiency might be possible *via* the 'learning by doing' approach and the diminishing importance of national authorisation policy. The general public is considered to be sceptical. From Directive 91/414, it can be assumed that some Member States (those which evaluate PPPs on other, more or less detailed data than in the harmonised procedure) could be expected to oppose an acceleration of the review programme. Professional experts have variable opinions on speeding up the review as harmonisation is not yet complete, and some problems with enforceability remain. The homogeneity of the working plan is good, however, as it builds on the same framework as Commission Regulation 3600/92 and makes use of accumulated experience. The operation of Directive 91/414 is examined in greater detail in the sub-Report prepared by OWD, summarised at Section 2 above.

(b) Approval of a PPP-reduction plan

Examples of PPP-reduction plans can be found in the northern European countries: Sweden, Denmark, the Netherlands and Finland. In most cases, established targets are reached. A good infrastructure (experts, legal basis) and adequate monitoring of use are identified as necessary conditions for preparing and evaluating these plans

The position of the EU with respect to PPP-reduction plans is necessarily different from the position of Member States. Because most benefits of PPP-reduction plans will be realised by and within Member States, it is proposed that the EU compensates 25% of the costs of developing, communicating, effectuating and monitoring a plan.

The expected effectiveness of a PPP-reduction plan is estimated by means of a statistical analysis of existing use-reduction plans by comparing total use in countries with and without a use-reduction plan, for fungicides, herbicides and insecticides (including nematicides). The estimated results indicate an annual 4% reduction of the volume of PPP-use per year due to a PPP-reduction plan[20].

In PPP-reduction plans, use is considered as crucial (as the efficiency of risk reduction is perceived to be less than use reduction) and if monitored at active substance level, use reduction can be translated into effects reduction with chemical and toxicological knowledge. The sub-Report prepared by OWD however has recorded significant opposition in some Member States to use reduction plans. Acceptability of a voluntary PPP-reduction plan among experts is 'variable', although some opposition from PPP-industry to a mandatory system can be expected. The instrument is, however, good according to the other criteria.

(c) Monitoring residues in water

The sub-Report found that herbicides are most frequently monitored, without, however, co-ordination. Central co-ordination and guidance from the EU should

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[20] This effect is additional to an annual 2% reduction which holds for all EU countries included in the analysis.

therefore define clear roles and responsibilities to comply with a specific monitoring strategy alongside improvement of analytical techniques. Existing directives, to monitor active substances that are no longer authorised, should be reconsidered. Monitoring data of concentrations in water, soil and sediment should be centrally collated in an EU database.

Monitoring in itself does not influence the risks from PPPs, but merely records them. However, society becomes aware of risks from PPPs, and adjustments to PPP use can subsequently be proposed when considered necessary. Collection of samples and associated analyses are time-consuming and costly, although centrally collated data will enhance efficiency. There are some doubts about the acceptability of this instrument by experts.

3.5.2 Information, Persuasion and Awareness

Four instruments were categorised under this heading: training and education of farmers and retailers; promotion of Integrated Crop Management and Decision Support Systems; integrated environmental programmes at farm level: introduction of green labelling for reduced PPPs produce. For various reasons, the first two instruments are incorporated into the third, while green labeling is not considered further for reasons explained above.[21]

(a) Integrated Environmental Programmes at Farm level

The Integrated Environmental Programme at Farm Level ('IEPF') is an instrument of self-regulation, involving voluntary participation and combined individual and collective responsibilities. Participants enter into a (voluntary) sustainability contract with regional authorities, concerning environment aspects of agricultural practices. IEPFs are best organised within the framework of negotiations between regional farmers' groups and regional authorities. Participating farmers are as a result relieved from (most of) the existing environmental regulations and permits.

IEPFs demand extensive record-keeping. Premiums for achieving good results would, however, provide for an additional incentive to participation. EU financing is of great importance to the development and dissemination of integrated environmental programmes.

Effectiveness can be considerable. A strategy of small steps is considered to be successful. Financial costs are relatively low, but installation of IEPFs requires co-ordination between the administrative levels concerned and therefore asks for creative human efforts. If policy objectives are clear and farmers' craftsmanship is recognised, voluntary action will follow. Acceptability of this instrument (at this stage) is good. The instrument is also good in the other criteria.[22]

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[21] Differing opinions on the efficiency of a green labeling scheme for PPPs suggests the need for further consideration of this instrument before a definitive judgment is arrived at.

[22] Given the somewhat experimental status of IEPFs however this is only provisional judgement, although support from industry associations must be considered as encouraging.

3.5.3 Technological and Institutional Change

Six instruments were identified under the heading of technological and institutional change: a programme regarding resistant and sensitive cultivars; use of integrated farming; improvements in application technology/inspection programmes, and measures to remove PPPs from drinking water resources are considered below. Abolition of short-term set-aside and of price support for cereals are not considered as driving instruments by the full sub-Report. Further consideration of these instruments is reproduced in the sub-Report prepared Produce Studies, at Section 4 below.

(a) Programme on resistant and sensitive cultivars

Crop cultivars differ in their sensitivity to pests, and therefore affect the yield losses associated with lower PPP input. Epidemics can be slowed down by improving resistance of cultivars by reducing the frequency of sensitive cultivars in a crop rotation, (including by means of a ban) and by improving the regional diversity in the growing of crop cultivars.

All three instruments are considered effective and efficient on this short term. In the long term however the sub-Report questions whether resistance can be maintained, especially in the case of air-borne pests, when temporal or spatial arrangements are not accepted. The acceptability of this instrument is not always good, however.

(b) Programme on Integrated Farming

Introducing integrated farming (which is a knowledge-intensive technology) will require a change in attitude and sufficient recognition of the efforts of farmers to restrict the use of PPPs. The main instruments to stimulate integrated farming described in full in the sub-Report are: (1) increased recognition of agricultural practices which reduce use of PPPs; (2) the stimulation of balance cropping patterns and cropping systems, requiring less PPP input; and (3) the stimulation of the development of monitoring and sampling systems to learn when to apply which product, and the minimal but effective amounts of PPPs.

The potential of integrated farming systems is large, as has already been proven in many countries, both in experimental farming systems and in on-farm practice. The instrument requires public awareness, and sensitivity to and knowledge of ecological interactions among different organisms in the agro-ecosystem, although the public may resist the instrument if prices of agricultural produce increase as a result. One problem which was identified in the sub-Report is that integrated farming is very site-specific and therefore not easy to generalise or implement.

The reduction of PPPs can, however, be enhanced by proper monitoring and warning systems of pests. These are especially valuable for predictable epidemics of air-borne diseases. For soil-borne pests with very low tolerance levels for presence in the marketable plant parts by the consumers, the instrument is less

effective or efficient. The acceptability of this instrument is, however, considered as good.

(c) Improvements in application technology

The EU could stimulate voluntary test programmes of equipment in use in all Member States of the EU to eliminate spillage from faulty equipment. Member States could also (as in Germany) issue listings of equipment meeting required legal standards. The size of the EU funding to be provided for implementation of this instrument could be linked with the area of arable and horticultural crops. Eventually, the EU could opt for a mandatory system for the testing of equipment all over the EU.

Several Member States have reported that the test programmes made clear that existing equipment was more defective than expected. Testing would prevent contamination of the environment to a certain extent and avoid having to remove contamination from water at a later stage. The expectation is, however, that funding is only an efficient means if achieving improvements in the first years of the test system. After a certain period, testing should become self-supporting. Testing programmes appear to be quite acceptable to specialists, and will certainly be acceptable when voluntary (and may even be considered acceptable in a mandatory system). At present both voluntary (*e.g.*: Sweden) and mandatory (*e.g.*: Germany) systems are in place.

(d) Removal of PPPs from Drinking Water

The widespread treatment/regulation of drinking water in the EU occurs through operation of Directive 80/778, establishing a limit for plant protection products of 0.1 µg/l for single active substances (and 0.5 µg in total). In a number of Member States operation of this Directive has resulted in alterations to treatment processes and higher water charges. The sub-Report therefore proposes that information on alternative systems of water treatment be disseminated in other Member States. By way of example, the addition of chlorine into water may be replaced by alternative techniques less hazardous to human health and the environment.

Removal of PPPs from drinking water is not expected to have any effect on PPP use levels, but would rather impact only the potential risk to the consumer of residues. This instrument is also unable to give effect to any benefits of PPPs, does not impact PPP users and has negligible effect on food residue and environmental PPP emission levels. The sub-Report also identified potential risks present in cleaning processes themselves. This instrument does not represent a preventive approach, and is not in accordance with the polluter pays, source or precautionary principles of EU environmental policy.

3.5.4 Covenants/Arrangements

One instrument is categorised in the sub-Report as a viable 'arrangement': a covenant on specific aspects of PPPs. One possible covenant would concern the prevention of PPP-packaging waste. In addition to Directive 94/62/EC, concerning the management of packing and packaging of waste, a covenant at EU

level is therefore proposed, to introduce the use of returnable/refillable containers or other systems of reuse or prevention.

Generally speaking, re-use of packaging is an efficient *ante* manner to reduce disposal of packaging waste. Acceptability of farmers is good, because PPP-packaging is redesigned to enhance workers' safety. Acceptance of the general public will only be good, however, if this covenant has clear results in terms of reduced waste.

A second covenant addresses the investigation of indications of damaging consequences of PPP use. In addition to Directive 91/414, concerning the placing of PPPs on the market, it is therefore suggested that the PPP industry assist in enhancing the availability of relevant monitoring data. The effectiveness of this second covenant is mainly indirect, as avoiding double research costs will enhance the efficiency of the authorisation process. For the acceptance of this covenant the public accessibility of the monitoring results is crucial.

If a covenant has been accepted by both participants, then (1) the threat of introducing other instruments and (2) the reputation of the PPP industry each suggest that such an agreement can in practice be enforced.

3.5.5 Economic Instruments

Of the five 'economic' instruments examined in the full sub-Report, the possible instrument of a uniform value added tax on PPPs was considered to provide the most a viable additional PPP policy.[23]

(a) A Uniform Value Added Tax on PPPs

This instrument is examined in this Synthesis Report, as the sub-Report considers it to be preferable to imposition of a financial or regulatory levy[24] (described in detail in the sub-Report itself). Presently there are large differences in value added tax (VAT) on PPPs. Categorising PPPs uniformly within the high VAT rate is administratively simple, and conforms to the basic principles of the single European market. The effectiveness of the instrument is acknowledged to be limited, but the limited reduction in PPP use (about 3%) is nevertheless thought to be achieved efficiently. The evaluation on the other criteria (acceptability, enforceability and homogeneity) is also quite good.

A differentiated VAT rate (where all PPPs are included at the high rate, but where certain, high risk PPPs are included in an exceptional rate, and low risk

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[23] The other economic instruments examined in greater detail in the full sub-Report were: deposit-system of old stocks, a financial or regulatory levy on PPPs; premiums to prevent water contamination; adjusting the agri-environmental measures of the CAP-reform and cross-compliance restriction on CAP-income support.

[24] The main focus of a levy is to generate money for particular targets, for example to finance programmes to reduce environmental effects. Levies in the present context would also be intended to influence behaviour of farmers in such a way that we and/or risk of PPPs is reduced.

PPPs are included in a lower VAT rate) is more targeted towards a reduction in use of high risk PPPs. Its effectiveness is therefore much higher, although not easily quantifiable. Acceptability of the measure on the part of those subject to the tax is questionable, and a general aversion against high taxes is identified.

(b) Financial Levies

The main objective of a regulatory levy is to influence the behaviour of farmers to reduce use and risk of PPPs. A levy can be used to finance programmes which reduce negative external effects of PPP-use and to reduce demand. For example, a financial levy of *e.g.* 10% of EU sales would raise approximately 580 million ECU. Because of the price elasticity of demand for PPPs a 4% reduction of PPP-use is implied with a resource cost of about 12 million ECU.

A larger financial levy might be used if: (1) a larger share of the costs are compensated, (2) larger reductions in use/risk of PPPs are required, and (3) EU or national governments must finance programmes to realize these reductions. It is estimated that the results of a 2.2 ECU per kg A.I. levy would generate a revenue of 580 million ECU. In this example, a 4.5% PPP-use reduction can be expected with a 14 million ECU efficiency loss (resource costs). Before deciding on levies, a preceding investigation of implementation and expected administration costs is advisable.

3.5.6 Private law Instruments

One instrument is categorised in the sub-Report as a viable private law instrument:

(a) PPP-Reduction Clauses in Land Lease Contracts

The incentive for the landowner in agreeing to such clauses could be that he wants to safeguard environmental concerns in general. An alternative motivation would be concerns relating to the specific land leased to the farmer. Incentives for the tenant could include the lower rent available for the lease.

Land lease varies throughout the Member States (and while high in Belgium is low in Ireland). EU Member States have special laws prescribing the lease of land, although other national legislation may also impact the possibilities for the landowner and the tenant to agree on a reduction in the use of PPPs. This policy instrument therefore presupposes some degree of civil or administrative law harmonisation, which itself brings attendant political considerations to the debate.

It is evident that not all landowners would be prepared to act in this manner. From land lease statistics it can be concluded that effectiveness will vary per member state, but is in general moderate. Efficiency is considered to be high, and enforceability good (because such an instrument would form part of the existing enforcement of land lease law in general[25]).

[25] It should be pointed out, however, that the authors of the present synthesis Report remain somewhat sceptical that such a legal instrument at EU level is possible as a matter of EU law. Even in the event that a sufficient EU legal basis exists for such harmonising legislation, the present

3.6 FURTHER ANALYSIS OF PROMISING INSTRUMENTS

The situation with respect to PPPs in the EU is very intricate. Several hundreds of crops are grown commercially in the EU and these crops are threatened by thousands of diseases and pests, viruses, bacteria, fungi, weeds, nematodes, insects, mites, *etc* The large number of specific crop-disease/pest combinations initially suggests that an extensive package of preventive methods and also PPPs is required. This conclusion is mitigated, however. Firstly, only the pests and diseases that cause economic damage have to be controlled and, secondly, broad spectrum PPPs are used which work on more crops and are effective, against many organisms (Oskam,*et al.*, 1992).

The large variations in conditions within the European Union, in, for example, cropping systems, form important determinants of use and risk of PPPs. In addition, climate and weather contribute to the extent of PPP-use in total and per category. The position of a country, or region as exporter or importer also plays an important role. Exporting countries have to fulfill international phytosanitary regulations, which often lead to rather high levels of PPP-use, unless products are marketed with different specifications. In addition, if crop yields are relatively high (in kilogram or in value) then crop damage results in large losses. This variety of factors therefore results in the conclusion that only a package of future measures will satisfy the objectives of an additional EU policy, a conclusion shared by the OWD sub-Report summarised above.

3.6.1 Achieving an Efficient Instrument Mix

Given this conclusion, the sections above, which emphasised the operation of selected individual instruments, must be developed to examine how a combination of instruments may be selected to achieve the objectives set for an additional EU PPP policy.

Instruments should at least qualify as the 'economically efficient and environmentally effective' (measured in terms of costs per equivalent unit[26] of PPP-reduction). It has also been assumed in the sub-Report that estimated reductions are of 'average risk level'. For several instruments, however, reasonable indications of costs related to the reduced use of PPPs could not be produced. It should also be noted that both estimated benefits (related for example to the environment, food safety, and workers protection) and perceived negative aspects (for example related to farm labour due to a reduction in PPP use) do not form part of this economic assessment.[27]

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authors consider that such an instrument would encounter serious acceptability problems. It would be an imbalanced instrument where as in some Member States a large percentage of land is leased, while in others only very little land is leased. Similarly, while it would constrain the behaviour of tenants of leased land, owners of their own land (and therefore a majority of land use in some Member States) would not be subject to such restrictions.

[26] An average kilogram of PPP (measured in active substance) is the 'equivalent unit'.

[27] It should be noted that in identifying 'economically efficient and environmentally effective instruments' qualitative indications were available for only some instruments, while for others no figures were available. This has made it difficult, therefore, to provide a straightforward

The sub-Report sets out the minimum criteria to be satisfied if an instrument mix is to satisfy the objectives of an additional EU PPP policy. In particular, it is concluded that instruments must be complementary (and certainly not antagonistic); mixed at federal, regional and national level; flexible (to receive a higher priority); varied, in implementation period and in the period required to reach full effectiveness.
An efficient instrument mix depends very much on the size of the PPP risk and use reduction which is desired. The sub-Report adopts a different approach from that used in the OWD sub-Report which had grouped similar instruments to define different categories of policy options.

In this sub-Report, another approach was used, whereby three target levels were defined in a qualitative sense: a small, medium and higher risk and use reduction of PPPs at EU level.[28] These target levels are termed *'layers'*. Instruments of the first layer will be included in the next one, and so on, so that the last layer will contain all instruments. It is accepted that some arbitrary decisions have been made to come up with the results summarized in the Table overleaf.

The first layer contains four instruments which are either demonstrably very efficient (uniform VAT rates or programmes on resistant cultivars) or which are assumed to be efficient, and which also form an important precondition for other policy instruments (such as speeding the review programme). None of the instruments included at Layer I pose significant problems with other policy criteria. Layer I is also considered to form a mix with respect to different policy characteristics.

Layer II instruments require more time to be introduced (such as IEPF or an PPP-industry covenant), depend on the review programme of PPPs (possibly differentiated VAT rates) or are judged at a lower effectiveness than a programme on sensitive and resistant cultivars (such as programmes concerning application technology). The difference between the second and third layer is less distinct than that between Layers I and II, largely due to lack of available information. Instruments in the Layer II, however, did receive a better 'general judgement'. Some instruments in Layer III, however, are typical regional, and could therefore be preferred from a regional perspective above those instruments appearing in Layer II.

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comparison of all instruments.

[28] It should be noted that the Terms of Reference specified no target level.

Layer	Description	Typical regional ?[29]	Term (S/M/L)	Direct / Indirect	Preventive/curative
I	Speeding up review	No	Medium	Direct	Preventive
	Use/Risk Reduction Plans[30]	Yes	Medium	Direct	Preventive
	Resistant Cultivars	No	Long	Indirect	Preventive
	Uniform VAT	No	Short	Direct	Preventive
II	Individual Environ-mental Programme at farm-level ('IEPF')	Yes	Medium/long	Indirect	Preventive
	Recognition IF/IPM	Yes	Medium	Indirect	Preventive
	Application technology	No	Medium	Direct	Preventive
	Covenant with PPP industry	No	Medium/long	Direct	Preventive
	Financial levy (small)[31]	No	Short	Direct	Preventive/curative
III	Within Channel labeling	Yes	Medium/long	Indirect	Preventive
	Frequency sensitive cultivars in rotation	No	Long	Indirect	Preventive
	Differentiated VAT	No	Short	Direct	Preventive
	Financial levy (large)	No	Short	Direct	Preventive/curative
	Premiums in water catchment areas	Yes	Short/medium	Indirect	Preventive
	More focus on PPPs in 2078/92[32]	No	Medium	Indirect	Preventive
	Conditions in land leases	Yes	Medium/long	Direct	Preventive

[29] For the regional instruments within the second layer it is suggested that the European Commission should develop a directive to define the conditions and the related compensations at national and/or regional levels, giving special attention to Integrated Environmental Programmes at Farm level.

[30] Here we assume that the EU provides a 25% compensation of the costs of an approved PPP-reduction plan.

[31] To be replaced by larger financial levy in Layer III.

[32] See the sub-Report of Produce Studies, summarised at section 4 below for a fuller summary of the operation of Regulation 2078/92, also described in the full text of the present sub-Report.

3.7 CONCLUSIONS AND RECOMMENDATIONS

At least four different aspects have been identified as being of relevance in analysing risk of PPP use.[33] All risk aspects play a role, but most attention in this Section has been given to risk in relation to the environment. It is, however, accepted that, because of the large number of active substances and the large variety of conditions for applying PPPs, it is difficult to define even one broadly accepted measure by which to assess the environmental risks attached to PPP use.

3.7.1 Directive 91/414

EU PPP-policy has a firm basis in Directive 91/414, and it is recommended that Uniform Principles should be applied to the authorization of PPPs. This intensive programme, to be followed both by the PPP industry (in providing information) and by national and EU organisations (in applying Directive and assessing active substances) has allowed the PPP industry to transfer its costs (in testing PPPs and providing the information) to be included in the price of PPPs. This implies that a part of the costs in preventing negative external effects has already been incorporated in the price of PPPs. It is not known, however, how industry distributes these costs among different PPPs.

It is likely that Directive 91/414, once implemented, will indeed result in PPP risk reduction, although implementation by 2003 requires an estimated six-fold increase in effort on the current review-programme. A redistribution of the workload among EU Member States is both helpful and efficient, as without additional measures the reliability of the EU and national Member States will be much lower. A working plan would demonstrate whether such an increased effort is realistic.

A classification of PPPs on substance intrinsic properties should be stimulated by the European Commission by broadening the classification of Council Directive 78/631.

3.7.2 Data Collection

There are at least two independent datasets on PPP sales: the data provided by the European Crop Protection Association ('ECPA') and the data of the farm account data network (FADN). Moreover, several specialized organisations gather data on the sales and use of PPPs at farm level or even crop level. According to the SSLRC sub-Report, summarised at Section 6 below, co-ordinated monitoring data of incidences of PPPs with respect to the environment are absent and should be centrally collected in an EU database.

The available information with respect to PPP use and risk should be brought into an accessible database, which can be used for research purposes. Except for the area observed environmental effects of PPPs, there is plenty of information

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[33] *i.e.:* Risk for the farmer of crop loss, risk of workers applying PPPs; risk in relation to residues of PPPs in food; and risk of emission of PPPs to the environment.

available, but the research in this area is weak and this is also caused by inaccessible data, which should be combined for more integrated research.

If the first recommendation is followed, several pieces of information gathering might be stopped or should be integrated with this database. Most relevant information in this respect are regional or local information on pest pressure in different crops, weather conditions and the broader set of agronomic and economic data.

3.7.3 Failed Instruments

The research for this sub-Report has, as requested, addressed several policy instruments, a number of which were found, however, not to function adequately, namely (a) recording of trade, (b) labeling of PPP-use, (c) abolition of short-term set aside, (d) use of marketable permits and (e) insurance on yield risk. In addition, restricting access to high risk PPPs has serious disadvantages with respect to acceptability, homogeneity and efficiency, although it appears to function in situations where good recording of PPP-sales and good infrastructure for monitor results are present.

The sub-Report concludes that a PPP-reduction plan will be effective (with an expected reduction of circa 4% per year over a period of years). In addition, from the available literature, it is concluded that abolishing short-term set-aside would, rather than improve the PPP use situation, result in increased PPP-use.

3.7.4 Use Reduction

On the assumption that use-reduction is an acceptable objective, the development, communication, effectuation and monitoring of PPP-use reduction plans by Member States may be stimulated by the EU, by compensating a part (25 % is suggested) of costs arising. This instrument may very well be more appropriate for implementation on the regional level. Risk reduction must, however, be accompanied by adequate and relevant risk measurement. Monitoring data of concentrations of PPPs in the environment are quite limited, but necessary to measure progress. In particular, the sub-Report concludes that benefits of monitoring of water can be enhanced in an EU coordinated programme.

Member States can be challenged by the European Commission to go further than use reduction, by monitoring use on a substance level and by targeting additional risk indicators. The European Commission is encouraged to open the discussion with the PPP-industry on a number of targeted items in use/risk reduction of PPPs.

An overview of national/regional experiences in reduction of use and risk of PPPs, provided within a rather uniform framework and in an accessible language for potential users in other parts of the EU is very useful. It belongs to the tasks of the European Commission to provide useful knowledge for local/regional and

national participants in the PPP chain, and as such forms a first step in the form of a Concerted Action.

3.7.5 Integrated Environmental Programmes at Farm Level

Integrated environmental programmes at farm level (IEPFs) appear to be very promising instruments in a number of Member States, and are best organized within the framework of negotiations between regional farmers' groups and regional authorities. For reasons of both social organization and ecological homogeneity, these regions relate to relatively small rural areas, comprising only a few municipalities. IEPFs depend, however, on a good administrative infrastructure and high management skills of farmers.

Development of further integrated farming will require adjustments on the part of farmers, which should be supported by proper recognition of their efforts to reduce the use of PPPs. It is a complex innovation, however, which can be realised only by a long term plan of prototyping, supervision and guidance, as supported by relevant research. A quicker reduction of PPPs can be achieved, however, by the stimulation of monitoring and warning systems for air-borne posts.
Incorporating experiments with Individual Environmental Programmes at Farm level within the framework of 2078/92 would stimulate a promising policy instrument that deserves serious support.

3.7.6 Consumer-Driven Change

Provision of information to consumers (thereby stimulating demand for produce with reduced PPPs) by means of labelling is expected to be ineffective, although labeling may prove effective within the production and marketing channel. Acceptability of a 'reduced-PPPs' label, additional to existing labels, might also raise difficulties, although these may be compensated for by introducing reduced PPPs labelling as a transitory precursor to environmental labelling. The European Commission can stimulate the process of within channel labelling by subsidising R&D in this area. The main developments, however, should come from participants in the particular channels.

3.7.7 Resistant Cultivars

As indicated above, a programme to develop resistant varieties to pests and to replace sensitive cultivars is considered an important contribution to the risk and use reduction of PPPs. Regulation of the use of sensitive crops and crop cultivars and of their regional distribution is considered in the sub-Report as potentially problematic, however, due to changes to the present system of property rights.

The breeding for durable pest resistance and the use of partially resistant cultivars should be stimulated, both by R&D and by researching and supporting regulation mechanisms to restrict the use of sensitive cultivars. The European Commission should also take the lead in stimulating the development of monitoring and warning systems for air-borne pests.

3.7.8 Equipment-Related Instruments

Equipment based initiatives, such as inspection programmes for application equipment contribute to a more effective use of PPPs and meet no serious disadvantages. The European Commission should make the inspection programmes for application equipment mandatory. Research on the implementation of improvements in application technology should be stimulated.

3.7.9 PPP Content in Drinking Water

Measures to remove PPPs from raw water used for drinking water belong to 'end-of-pipe' solutions which, although not very costly and potentially useful if sources go above limits, have limited curative effects. Burdening the consumer with associated costs is further not consistent with the Polluter Pays Principle. The EU should therefore participate in the further development of environmental quality limits and indicators, in particular in relation to water contamination. Premiums to prevent water contamination can best be organised at a local level.

3.7.10 CAP-Related Measures

Abolishing the price support of cereals and replacing it by additional income support is estimated to reduce PPP-use in the EU by 2 to 3% (albeit with large regional differences), although it was felt that the income, budgetary and efficiency effects make it difficult analyse this policy instrument as part a PPP-reduction policy. CAP related measures studied in the Produce Studies sub-Report are summarised in greater detail at Section 4 below.

Adjusting agri-environmental measures of the CAP-reform to a stronger focus on PPP use/risk reduction is considered to be of limited importance, as subsidies fit better with providing landscape and nature preservation elements than with a reduced chemical load. In particular the reference quantity was felt difficult to observe. More attention, however, for PPP-use in agri-environmental measures may be useful in specific regions/circumstances.

Reduced use of PPPs as a condition for direct income support under the CAP is, however, considered potentially effective, although acceptability of this instrument among farmers is evidently low. It is suggested that a combination of other instruments (unrestricted income support and a financial levy on PPPs) would prove more efficient.

The analysis of the Landell Mills sub-Report, together with work of LEI-DLO makes clear that application levels of PPPs are farm specific and very dependent on crops and cropping systems, which are also related to soil and climate.

3.7.11 Covenants

A covenant between the EU and the PPP-industry provides an opportunity to allow the PPP-industry to use available expert knowledge in relevant policy areas. Both examples studied demonstrate efficient opportunities for covenants and their high acceptability, and, as voluntary instruments, the relatively low cost of implementation.

3.7.12 Economic Instruments

A high VAT-percentage for all PPPs in the EU is estimated to reduce PPP-use by about 3%. A differentiated VAT-percentage, according to the risk aspects of PPPs, is expected to be more effective and efficient, but will require a broadly accepted classification system for PPPs.

A levy can be used to finance programmes which reduce negative external effects of PPP-use and to reduce demand. For example, a financial levy of *e.g.* 10% of EU sales would raise approximately 580 million ECU. Because of the price elasticity of demand for PPPs a 4% reduction of PPP-use is implied with a resource cost of about 12 million ECU. A larger financial levy might be used if: (1) a larger share of the costs are compensated, (2) larger reductions in use/risk of PPPs are required, and (3) EU or national governments must finance programmes to realize these reductions.

It is estimated that the results of a 2.2 ECU per kg A.I. levy would generate a revenue of 580 million ECU. In this example, a 4.5% PPP-use reduction can be expected with a 14 million ECU efficiency loss (resource costs).

3.7.13 Private Law Instruments

An EU Regulation is recommended to harmonize national land lease law by ruling out obstacles for reduced PPP-use in land lease contracts, with the aim of stimulating negotiations between landowner and land user, although acceptance of this instrument is likely to be reduced were this instrument to be mandatory. Effectiveness and efficiency, of reduced PPP-use land-lease contracts should be tested in areas where those contracts are in operation or will be in operation.

3.8 THE RECOMMENDED POLICY 'MIX'

The most attractive mix of instruments was found to consist of the following elements:

- 'effectuating a uniform high value added tax for plant protection products';
- 'encouraging Member States to develop a PPP-use/risk reduction plan';
- 'stimulating research and policy of generating resistant cultivars and removing sensitive ones'; and

- 'speeding up the review programme of Directive 91/414'.

One omission from this, and indeed the other Phase 2 sub-Reports, is the absence of information for making effective statements on the costs per unit of reduction of several policy instruments. It is hoped that the use of more indicators would provide much betterinformation in this regard. In addition, the sub-Report has not taken an 'EU, national, regional, local' approach to the various proposed policy instruments. A focus on particular regional problems is always possible, but requires specific information at regional level. Specific regional problems of PPP-use can be tackled by several instruments. The most preferable set depends on the particular situation. The European Commission may foster such developments by taking a share (say 25%) of the costs, where comparisons are made to the costs and targets of a 'standard' PPP-use/risk reduction plan.

If programmes require financial support, a financial levy as operated by Denmark would raise sufficient funds, although clear targeting of funds is important to circumvent acceptability problems.

Various Reports and studies, but also more general overviews make clear that there is a large variation in PPP-policies pursued at national or regional level (CLM. 1994; Michalek and Hanf, 1994. Agne, et al., 1995; Oskam. 1995: OWD, 1996: Pettersson, 1996; Waibel and Fleisher, 1996). Without pretending to characterise the situation in the EU, one could say that countries like Sweden, Finland and Denmark are concentrating on reducing volume of PPP-use, the number of treatments, the number of authorized PPPs, the emission of PPPs by increasing coherent policies. Germany works more along the line of the authorization process and the Netherlands concentrates on volume, impact (to the environment) and dependency reduction of PPPs. Countries like Greece, Portugal and Spain are just starting to realize the consequences of PPP-use for the environment. Within individual countries, there are also large differences: see *e.g.* Baden-Württemberg in Germany and some areas in Northern Italy, where organic farming, and IPM receive much more attention than in other parts of the country. This situation implies that Member States and regions are in quite different phases of PPP-policies, a factor which is central to identifying an additional EU PPP policy.

SECTION 4

Analysis of EU Agricultural Policy in Relation to The Use of Plant Protection Products

(Sub-Report prepared by Produce Studies Limited)

As part of the overall objective to achieve "sustainable use of plant protection products" (as opposed to an unconditional reduction of use) the task of the sub-Report prepared by Produce Studies was defined as follows:

> *To determine what effects the current Common Agricultural Policy has had and may have in the future, on the use of plant protection products in the EU in order to assist the determination of the most appropriate adjustment and modification of policy instruments to minimise the risk from PPP-use.*[34]

Research for the sub-Report consisted of (i) an initial economic analysis (comparing the historic relationship between changes in the CAP to changes in crop areas, and PPP-use); (ii) a series of farmer group meetings (to discuss recent changes in CAP (since 1992 CAP reform) and their impact on sustainable PPP-use); and (iii) an evaluation of the impact (actual and potential) of the accompanying measures to CAP Reform, structural funds and other specific measures. This work was carried out through a combination of desk studies and discussions with local scheme administrators in selected case study areas.

4.1 INTRODUCTION

The CAP impacts directly on land use and crop management through its Common Market Organisations ('CMOs') for each commodity. The CAP also influences management through incentive measures such as those specifically for environmental protection (*e.g.*: Council regulation 2078/92)[35]. Measures in the CMOs can be divided between market support (through intervention, import duties and so on with the objective of maintaining producer prices); production control measures such as quotas or set-aside; and direct aid (most notably the arable compensation payments that are direct payments to farmers for each hectare grown).

These CAP instruments influence changes in PPP-use both by provoking changes in what crops are grown (as land use changes may lead to shifts towards either more or less intensive PPP using crops) as well as by influencing the way crops are managed.

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[34] The study was conducted for Denmark, France, Germany, Italy, Spain, the Netherlands and the United Kingdom. Fuller details of the methodology utilised by the Produce Studies may be found in the full Sub-Report.

[35] Only small parts, however, of the 2078/92 programme have a reduction-impact on PPP-use since many of the programmes do not specifically address sustainable PPP-use.

The effect of CAP on crop management in terms of use levels of PPP has largely been through the CAP's effect on crop prices and thus the profit optimising level of PPP-use. It should be noted at the outset, however, that this Sub-Report makes clear that although the CAP has an effect, other factors are much more important in determining how much PPP farmers use, such as the weather, new technology (in terms of new agrochemicals and new varieties) and changes in the cost of PPP.

Sustainable use of PPP is subject to factors which are, as a rule, more significant than changes which might be wrought from CAP and related policies. Nevertheless the CAP has had some influence in levels of PPP-use, which have been greatest *via* the workings of the Common Market Organisations for individual crops. While in the past this was through the mechanism of supporting farmer prices for crops, today measures such as compensation payments and set-aside also have an effect.

In contrast to some of the programmes of 2078/92 which have a very direct impact on PPP-use (*eg:* conversion to organic), the CMOs address simultaneously multiple objectives on the CAP, of which environmental sustainability is only one. The challenge for policy makers interested in influencing the sustainable level of PPP-use in relation to the CAP is therefore to consider the various options and scope for change within the available instruments.

Although PPPs consist of different types including the main categories of herbicides, fungicides and insecticides, often the data on spend on PPP is not desegregated into these different categories. The simplification of aggregating different PPP types belies the differential response that may often exist between various economic stimuli and types of PPP.

The sub-Report has examined the last twenty years. The CAP has not, however remained a constant instrument over this time. Because there is only one season of crop production per year, there can be only one observation of use level of PPP for each year. With so many factors other than CAP influencing PPP-use, it is considered extremely difficult to assign a quantitative and statistically valid measure to the CAP impact. In addition, the regional heterogeneity within countries (both climatic and pedological) affects PPP-use. Such diversity confounds the extent to which clear relationships could be identified.

Operation of CAP also altered quite significantly in 1992/93 for many crops (through the CAP reform). Given the limited number of observations following CAP reform, research for the Sub-Report for this period was based on interviews with individual farmers[36].

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[36] Budget constraints for the project as a whole are mentioned as a reason for the limited extent of this survey. In examining the various specific measures of the CAP the project was accordingly limited to an evaluation by desk study.

SUB-REPORT CONCLUSIONS

4.2 MEASUREMENT OF PPP-USE

For the purpose of this Sub-Report, an economic analysis using financial information about spend on PPP per hectare was deflated by the index of agrochemical prices to obtain a volumetric equivalent. From private survey sources, data is available in the UK on the number of treatments on crops. This is called the superdeveloped area treated: area of crop receiving at least one treatment times the number of passes with the tractor times the number of formulations in the tank. The gross total for arable crops over recent years suggests, however, that the volumetric equivalent acts as a good proxy for superdeveloped area (expanded number of treatments).

The deflated spend (volumetric equivalent) is also considered a good measure of use which relates to farm practice as farmers' judgments about use can be expected to be closely related to the number of treatments made for each crop, and for each type of product. It is also a measure that is much easier to integrate with discussions about farmer behaviour and policy than measures of dose rates, as those rates and active material have been declining for reasons of technical advance in PPPs.

4.3 CAP AND PRICES

Historically, the most dominant impact of CAP has been to effect producer prices for crop output, and thereby the economic optimum for the use of PPP. In reality the CAP market support mechanisms have often tried to both diminish the variation in prices from season to season, while increasing the overall level of prices to support farm incomes. As the second objective increases in importance, the extent to which the CAP has been the dominant factor in determining producer prices increases.

By way of illustration,[37] from the beginning of the CAP up until its reform in May 1992, the principle objective of the CMOs was supporting producer returns through maintenance of the market prices. Up to 1992, analysis suggests that as much as 90-95% of variation in price in these years can be explained by changes in CAP support measures.

Shifts in producer prices (which may have been caused by changes in CAP) have also led to shifts in which crops are grown, as the more attractive the returns from a crop, the more of the crop is likely to be grown. However, for annual crops, there are rotational links for reasons of crop husbandry that mean the economic attractiveness of one crop can cause increases in another crop. For example increases in winter oilseed rape have sometimes encouraged increases in winter barley since this crop is a good entrée for planting oilseed rape[38].

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[37] Compared to arable crops the CMOs for permanent crops have much less effect on producer prices.

[38] In permanent crops the output price has a less immediate impact on land use since it takes a number of years to establish a fruit bearing crop. Furthermore there are schemes for encouragement of grubbing up as well as limitations on new planting.

The work examined cropping up to the 1995 harvest (*ie:* beyond the CAP reform). In more recent years a new CAP instrument has become important: set-aside. This measure clearly has a much more immediate and direct bearing on cropping patterns, and has certainly impacted crop rotations.

4.4 LAND USE AND CAP

4.4.1 Arable versus Grassland

Over ten years up to CAP reform the proportion of land devoted to arable (which includes set-aside) has risen from 56% to 58% as a proportion of total arable plus grass. However the proportion of EU budget put to arable is not a variable that explains much of this variation. There is a relationship but it is very weak, as the CAP explains only 8% of the shift between arable and grassland.[39]

CAP does constrain, however, expansion of milk through its quota system. From 1984 the introduction of milk quotas limited expansion of dairy production. Nevertheless the genetic improvement in EU daily cows increased yields per cow, thereby reducing dairy cow numbers, as a result of which land was released for arable production.

More recently the CAP has imposed limits on headage numbers for beef and sheep payments. The COP (cereals, oilseeds and protein crops) area has also been impacted by the 1992 CAP reforms, as headage payments for beef and sheep are now limited, and no new arable land may be brought into production. In this way, the land use balance between crops and grassland has essentially become fixed by the rules. Nevertheless, variation in land use between crops remains under the influence of the CAP.

4.4.2 Arable crops

CAP has influenced producer prices and, along with other policy instruments of the CMOs (of quotas and set-aside) is estimated to have influenced 49% of the variation in use.

Since up to the time of CAP reform of 1992 set-aside was not a major policy instrument and producer prices were more dependent on the management of the CMOs, it is possible to say that changes in the CAP provoked 45% of the shifts in area between one crop and another.

From the farmer research[40] the impression was gained that the shifts in area between one crop and another since the reform of the CAP are equally the result of the CAP. Of these variations an estimated 70-80% has been caused by the introduction and

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[39] Grassland is a very light user of PPP products (limited use of herbicide and little else). Thus within the realms of past experience, the CAP change in balance of support between ruminant livestock and arable crops has had a little measurable impact on PPP-use change *via* the stimulus of more or less arable area.

[40] Note that the work was qualitative and consisted only of a very small sample, so the results must be considered as indicative only and treated with some degree of caution.

variation of the set-aside instrument and 20-30% by variations in price and compensation payments.

Since CAP reform, set-aside has become a more important policy instrument, and has had a significant impact on crop rotations and choice of crop (for example a drop of 5% points in the set-aside rule has related to a fall in sunflower area of 26 % while in the wheat area of just 2%). The impact of the CAP on price has, however, become less important. Direct payments to farmers have been introduced for cereals, protein crops, oilcrops and durum. Such differences arise in part from the price per tonne set at an EU level and in part through translation to per hectare payments via the average yields of the region. Thus although the CAP reform has less impact on producer prices and choice of crop, it is still influences the relative economic attractiveness of each crop.

From the analysis of the last twenty years it has been possible to examine the extent to which the variation in crop areas can be explained by the variation on producer prices. Thus through this instrument and the set-aside, the CMOs have an impact on producer prices with consequent effects on crop areas. The order of magnitude is broadly similar across the different arable crops. Of course in some ways it does not make much sense to examine the last twenty years since policy has changed very much over this time, as have technical methods of crop husbandry. On the other hand, reducing the time period examined also reduces the number of observations available for analysis, rendering the results less significant.[41]

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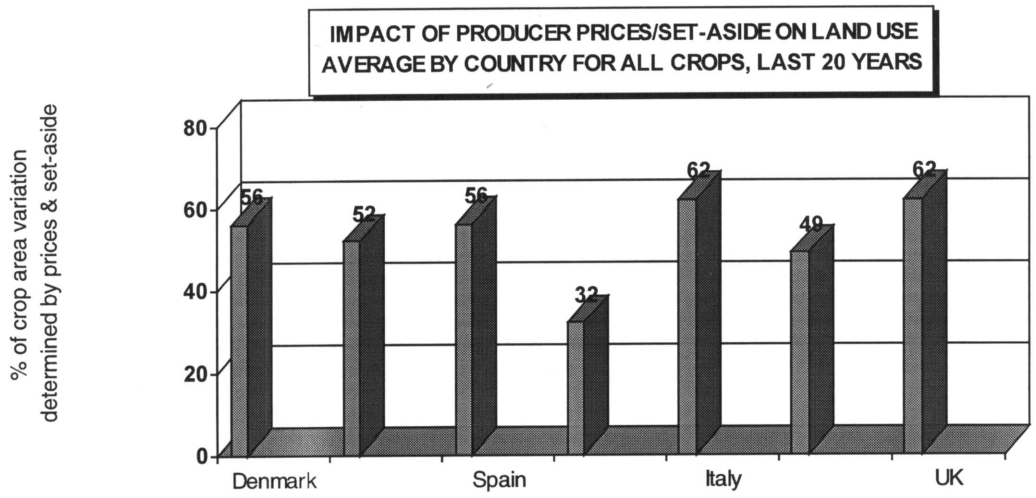
[41] This is considered in the sub-Report as the dilemma of econometrics applicable to agriculture: taking a sufficiently long period for there to be enough observations and yet not so long to address completely different characteristics of external variables. Most convention examines periods of around twenty years. Data availability for longer periods is also often a problem. In this case th principle variable is producer price which has been influenced by CAP in a reasonably consistent way during this period. The main and more recent change has been the introduction of set-aside. But this too seems reasonable to examine over this period, first when it has not been an influential factor and more recently when it has.

Figure 1 Impact of producer prices and set-aside on land use, by country



Source: Produce Studies research

Other than crop price and set-aside, important factors such as climate and soil conditions also influence farmers' land use decisions. For example the balance between winter sown cereals and spring sown cereals may well change as a result of weather conditions, as poor weather in the autumn can hold up planting to such an extent that they switch to spring planting instead.[42]

4.4.3 Permanent Crops

The impact of producer prices on the change in area of permanent crops is very limited. For countries examined the weighted average of the impact of producer prices on crop area was found to be: 8% of the variation in apple area; and 14% of the variation in citrus area.

The CAP has a very low impact on producer prices in these crops estimated as 0.5-3% of the variation in crop area. In contrast the area of vines is 100% affected by the CAP since all new planting is prohibited under CMO for wine and there are grants for permanent abandonment of the crop area.

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[42] Breakdowns of the relationship between particular crops and producer prices/set-aside are provided in the full Sub-Report. See in particular in this context pages 17-18.

4.5 PPP-USE AND CAP, DIRECT EFFECT

CAP also has an impact on the management of crops and thus PPP-use change. Data for economic analysis has been for the ten years up to and including the harvest year 1993. To obtain an understanding of relationships since CAP reform farmer interviews have been used.

4.5.1 Arable Crops

(a) Up to CAP-Reform (1992)

The measure of PPP-use has been the expenditure per hectare on all PPP deflated by the index of PPP prices. This effectively measures the aggregate number of treatments per hectare. The amount of PPP-used should relate to their cost and the unit value of the crop output. The ratio of the PPP input cost to crop output value has therefore been used to explain the variation in PPP-use change.

Summarising all crops examined in the countries studied then during the last 10 years around 28% of PPP-use change may be liked to changes in the ratio of producer prices to PPP prices.

During this period CAP caused 90-95% of the variation in producer price. 72% of the variation in the producer price/PPP price ratio was caused by producer price changes. It is estimated therefore, that rather than changes in PPP price 19% of PPP-use change can be attributed to the CAP.

This suggests that the majority of the reasons for the change in use are factors other than those influenced by CAP changes: weather, new technology, PPP price.

(b) Since CAP-Reform 1992/3

Information on the relationship between PPP-use change and CAP, since the 1992 CAP reform is based on the farmer survey work. Summarising all crops examined in the countries studied, then during the last 3 years around 20% of PPP-use change may be linked to changes in the ratio of producer prices to PPP prices.

This is a decrease compared to the previous period and reflects an increase in the effect of crop rotations stimulated by the implementation of CAP reform and most notably set-aside.

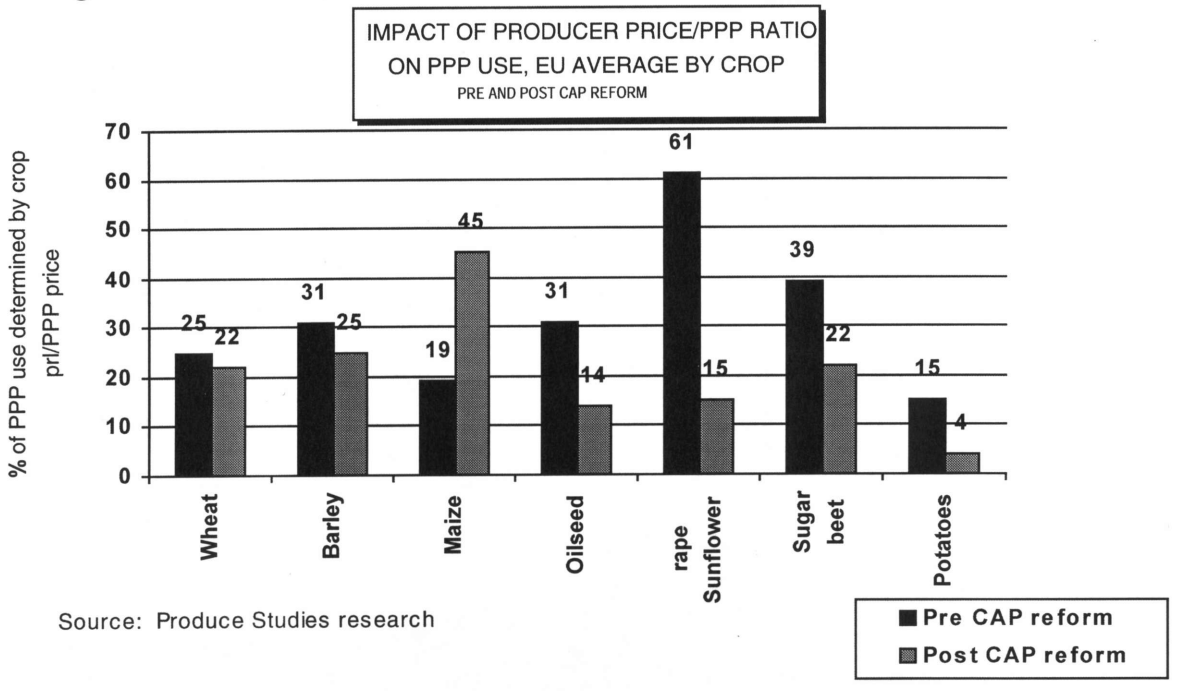
The proportion of changes in the ratio of PPP price to producer price attributable to producer price has remained similar at an estimated 65% (compared to 35% of the variation coming from changes in PPP price).

Since reform the influence of the CAP on producer prices has therefore declined (fallen for cereals and removed altogether for oilseeds).[43] On the other hand farmers

[43] For oilseeds the CAP regime no longer supports farmer returns through aids to processors and thence supported farmers prices. The support takes the form of compensation payments which are adjusted in relation to the difference between internal farmer price and world market price. Thus

claim that the direct payments have some small influence on PPP-use change. Bringing all these factors together then around 21% of PPP-use change can be attributed to the CAP. As indicated above, the majority of the changes in PPP-use must therefore be attributable to factors such as weather, new technology, PPP price and quality of production target.

Figure 2



Source: Produce Studies research

(c) Sensitivity of PPP-use to producer price change

Changes over the last ten years may be summarised as follows: a +/- 20% change in producer prices has caused a +/- 5% change in the use of PPP on arable crops.

4.6 OTHER CROPS

A full economic analysis was possible only for Italy (where sufficient time series of data existed). This suggests that PPP-use change over the last ten years has been influenced by both producer prices and PPP prices. The variation of PPP-use change that can be explained by price changes are: 13% for apples; 46% for melons; 5% for peaches.

The farmer survey work for vines and apples further suggest that 19% of PPP-use change may be linked to changes in the ratio of producer prices to PPP prices.

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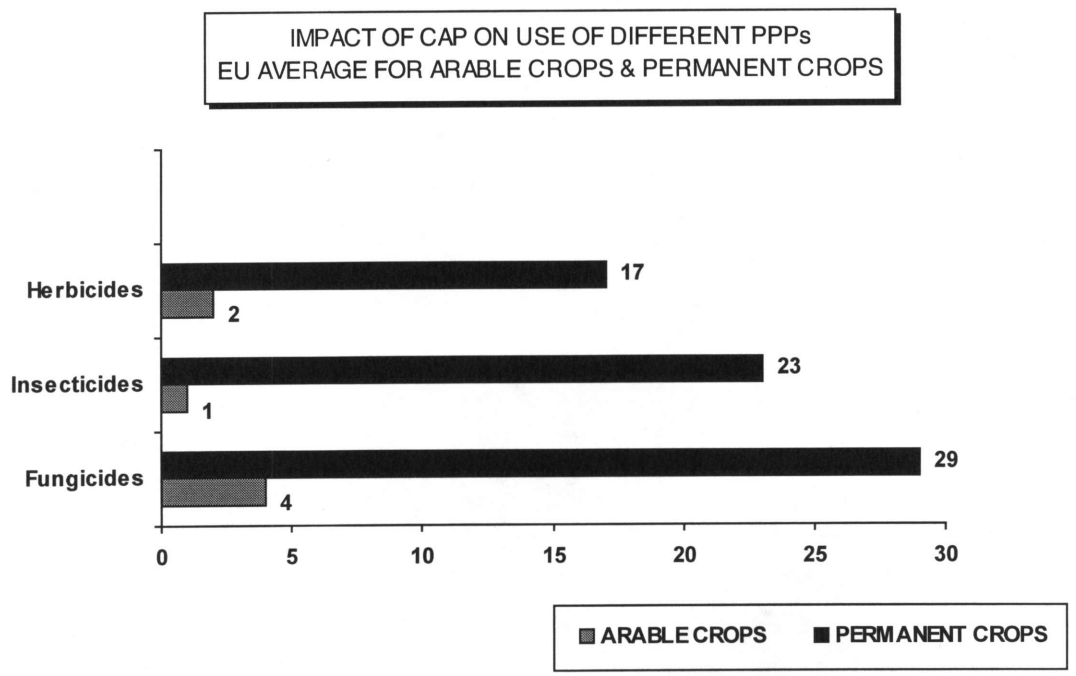
the CAP still influences returns per hectare, but the level of the returns are decoupled from individual farmer yields. For example in the UK in 1995 32% of crop returns came from compensation payments, not affected by the individual yield.

Since CAP during that period caused 2 - 42% of the variation in producer price and 58% of the variation in the producer price/PPP price ratio (the balance caused by PPP price changes) it is therefore estimated that just 0.2-5% of PPP-use change can be attributed to the CAP.

4.7 DIFFERENT TYPES OF PPP-USE AND CAP

The farmer research suggests that fungicide use is more influenced by the economic ratio of producer price to PPP price than insecticides or herbicides. This translates into a similar relative importance for the measures of the CAP.

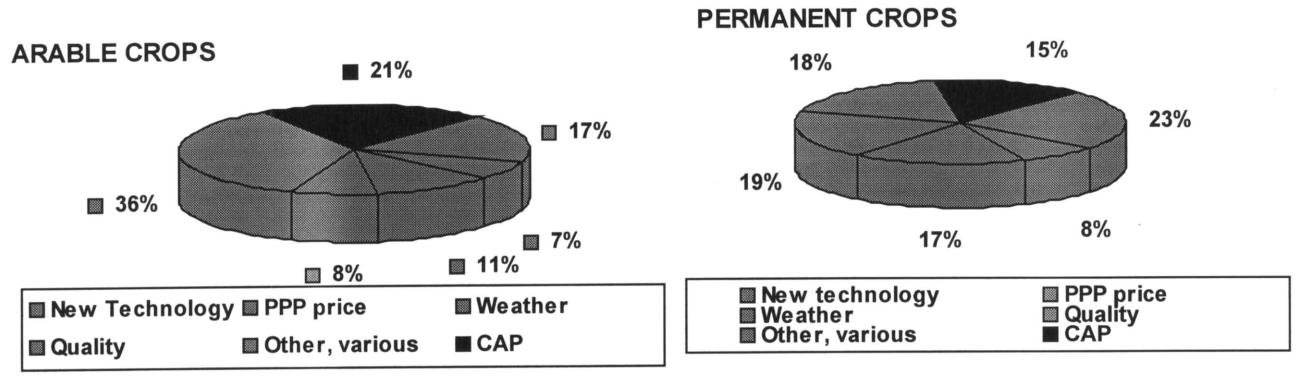
Figure 3 - Estimate of the variation in different types of PPP-use effected by the CAP.



Source: Produce Studies research

4.8 PPP-USE AND NON-CAP FACTORS

According to farmer research a number of other factors impact the use of PPP. Weather is an important criteria. In the case of permanent crops (vines and apples) then pursuit of a quality product is an important factor.



4.9 CAP AND PPP-USE, INDIRECT EFFECT, ARABLE CROPS

While above sections considered how the CAP, (most notably through its effect on prices of crop output) has had some influence on the level of use of PPP, (*ie*: modification of the management of individual crops) this sub-Report also examined the effect of CAP on land use and choice of crop. These two factors are not, however, distinct. The choice of land use and how the crop is managed are intimately bound together. For example, planting wheat after another wheat crop will likely result in that crop being managed differently than had it been planted after ploughed out grassland.

The impact of CAP on PPP-use change is accordingly considered as a consequence of shifts in land use, as CAP influences areas of crop grown. Since the crops have different levels of PPP-use there is an effect on overall PPP-use. CAP nevertheless remains only one of the factors to cause change in land use.

4.9.1 Producer Price Changes

A shift in one of the crop output prices relative to others will affect overall PPP-use change to only a relatively a modest degree and depends on which crop price is altered as to the direction of the effect. Overall the average response to a 10% price change is +/-0.7-0.8% change in overall PPP-use change. The increase in price of most crops causes shifts in land use change that result in only a small increase in PPP-use change.[44] This effect is far more significant than the indirect effect on land use.

4.9.2 Set-aside

As set-aside has been introduced crop rotations appear to have been changed. Even though set-aside takes land out of arable production altogether, in the arable area that remains there are changes in cropping mix. If to those changed areas a standard amount of PPP-use per hectare is applied then an increase in set-aside has therefore increased PPP-use. In practice set-aside became very important at the same time as the price support for arable crops took place.

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[44] Such conclusions only apply in so far as the level of PPP-use on each individual crop does not change, *i.e.*: ignoring the crop management change within a crop caused by price changes.

The set-aside instrument appears to have provoked cropping changes towards more intensive PPP-using crops. If other factors associated with CAP are not changed and PPP price does not change, then at constant intensity on PPP-use change per crop a 5 % increase in set-aside has tended to increase change in PPP-use by 7-8%.[45]

In practice, however, CAP reform has been associated with changes in both crop prices and PPP prices, both factors that have compensated this tendency for increase.

4.10 SPECIFIC CAP MEASURES

A number of specific policy instruments of EU agricultural policy have an effect on sustainable PPP-use. The diversity of the measures are such that investigation in the full Sub-Report was conducted by desk study. The type of impact of these measures are summarised in the following Tables,[46] in which four graded classifications are made about the nature of the impact of measures on sustainable PPP-use:

- *Insignificant:* the aspects of the programme that have very little at all to do with issues that affect PPP-use;
- *Marginal:* measures where there may be some aspect of the programme that could conceivably influence PPP-use but then in a marginal way only;
- *Indirect:* parts of programmes or programmes which can be expected to have some impact on PPP-use but the nature of the impact is indirect;
- *Direct:* measures that directly target use of PPP or the intensity of the methods of crop production.

The scale of the impact is necessarily a qualitative and judgmental view, the only way possible to summarise the findings.

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[45] The model is, however, subject to statistical error, so the precise number should not be used without reserve. However the potential direction in the relationship is valid that set-aside has on the one hand the tendency to increase PPP-use change because of crop rotation changes (notwithstanding that PPP-use on set-aside land is minimal).

[46] It has not been possible to quantify in numeric terms the impact of this part of the CAP although some case studies are provided in the full Sub-Report.

Table 1 - Impact of Structural Funds on PPP-use

Policy	Budget (mn ECU)	Potential Area (% of Community area)	Nature of impact on PPP-use				Scale of impact
STRUCTURAL FUND			Insignificant	Marginal	Indirect	Direct	
Objective 1							
1989-93 1994-99	36,2 93,810	38 45	* agricultural related projects only a small part of Obj. 1 budget (approx. 15% 1989-93 programme).	* agricultural measures such as: rural tourism; rural infrastructure	* measures which may lead to increase/decrease in PPP usage - Reforestation; Increasing value of quality products; Improving production conditions * crop conversion measures possible +/-ve impact on PPP reduction. * environmental protection measures only limited application, but +ve direct impact on PPP usage.		Very limited, since both tl budget assigned to measu relating to agriculture are small (in comparison with CAP market support measures) and the objecti are not specifically targete PPP reduction. - limited impact not due to poor efficacy of instrument
Objective 5a							
1989-93 1994-99	3,415 5,371	horizontal measure		* measures designed to improve the efficiency of agricultural structures: compensatory allowances; aid to individual investment; aid to young farmers.	* measures to improve processing and marketing conditions for agricultural and forest products: rationalise and modernise processing and marketing without increasing capacities; improve product quality and the efficiency of distribution networks	* prior the 1992 reform Objective 5a included set-aside, extensification and environmental measures in sensitive areas, these were withdrawn as they are covered in the Accompanying Measures.	Very limited. Both the bu assigned to measures relat to agriculture are small (ir comparison with CAP ma support measures) and the objectives are not specific targeted at PPP reduction. limited impact not due to efficacy

Table 1 - Impact of Structural Funds on PPP-use (continuation)

Policy	Budget (mn ECU)	Potential Area (% of Community area)	Nature of impact on PPP-use				Scale of impact
STRUCTURAL FUND			Insignificant	Marginal	Indirect	Direct	
Objective 5b							
Policy	Budget (mn ECU)	Potential Area (% of Community area)	Nature of impact on PPP-use				Scale of impact
STRUCTURAL FUND			Insignificant	Marginal	Indirect	Direct	
1989-93 1994-99	2,607 6,134	17 26.6	* two priority axis of no significance - development of human resources and development of non-agricultural sector. * under environment axis - installation of sewage purification; air pollution reduction; processing of bio	* under agricultural priority - farm tourism; village renewal; agri-infrastructure; adjustment to market developments	* forestry, qualify production and irrigation measures	* under environment axis - environment preserving agriculture & protection of flora and fauna (application/uptake reported to be limited). * cultivation of hill areas (Cantabria) direct/-ve impact on reduction of PPP usage	* limited impact due to - endeavours not to duplicat the PPP usage measures addressed in the agri-environmental programme and limited uptake of thos measures which may impa on PPP usage - limited im not due to poor efficacy of implementation

Table 2 Impact of Accompanying Measures (2078/92) on PPP-use

Policy	Nature of impact on PPP-use				Scale of impact
	Insignificant	Marginal	Indirect	Direct	
					See Part 3 for justification of comments Limited impact due to limited budget assigned to the measures and not notably low efficacy in implementation.
Reg 2078/92, ~5 Becu over five years, but 1995 underspend of 40% on 1.4 Becu					
Art 2.1 a				* reduction of fertilisers and PPP	* without total ban difficult to assess actual decrease in active ingredients
Art 2.1 a				* organic farming - implemented according to 2092/91 (Art 6.1)	* low premium levels so predominant uptake on existing organic farms
Art 2.1 b			extensification - less intensified production measures may specifically refer to reduction livestock density (possible +/-ve impact on PPP reduction)	* extensification - less intensified production measures often specifically refer to reduction of fertilisers & PPP	* Included in most programmes but uptake focuses on low level environmental commitment measures * low premium levels so concentration on maintaining existing extensive practices not converting practices (income support rather than environment benefits) * uptake concentrated on least useful farm types
Art 2.1 b				* convert arable into grassland - reduced inputs	* premium levels in general too low to make up for loss of earning
Art 2.1 c			* reduction in livestock density		
Art 2.1 d		*environmental practices - may include drilling or mowing requirements	* environmental practices - may include crop growing or land improvement requirements	* environmental practices - may include reduction/banning of PPP	* concentration on maintenance not introduction of environmental practices.
Art 2.1 d				* maintenance of countryside - may require a reduction/banning of PPP	
Art 2.1 d	* to rear animals of local breeds in danger of extinction				

Table 2 Impact of Accompanying Measures (2078/92) on PPP-use (continuation)

Policy	Nature of impact on PPP-use				Scale of impact
	Insignificant	Marginal	Indirect	Direct	
					See Part 3 for justification of comments Limited impact due to limited budget assigned to the measures and not notably low efficacy in implementation.
Art 2.1 e				* upkeep of abandoned farmland and woodland - may include PPP usage specifications (limited inclusion in aid programmes)	* minimal adoption/uptake
Art 2.1 f				* 20 year set aside	* minimal adoption/uptake
Art 2.1 g	* manage land for public access and leisure activities - limited inclusion in aid programmes				

4.10.1 Specific Measures for PPP[47]

Registration of agrochemicals is now harmonised at an EU level with the implementation of Directive 91/414, and existing PPPs are being reviewed under Regulation 3600/93, although at the time this sub-Report was prepared, no national product authorisations had yet been made under this Regulation, and as yet the current impact is therefore considered to be minimal.

Although in Member States such as Denmark, Netherlands and Sweden the quantity of PPP-use has fallen the advent of more active PPP with lower dose rates (particularly herbicides) suggests that reduction in quantity of PPP-use may have occurred irrespective of reduction programmes. Different additional measures are, however, being introduced in the more recent five year programmes which may bring more direct effects.

4.10.2 Overall Extent of Impact

The most direct effect on sustainable PPP-use arises from Regulation 2078/92, although complete data is not easily accumulated for all the programmes and measures. From information on six countries the proportion of farmed area that may be covered by 2078/92 is around 38%. Actual take up is however running below the target in the majority of situations.

The measures of direct impact, conversion to organic production and various programmes for reduction of PPP-use account for 2-26% of the total 2078/92 package in regions. In many ways it is too early to judge the efficacy of the accompanying measures' programmes. There are much more extensive surveys in progress contracted by the Commission that will provide greater depth of analysis about the efficacy of the measures. A critical issue for these studies is considered to be the question of additionality: the extent to which the premiums paid to farmers incite them to additional behaviour and actions more favourable to the environment.

(c) Organic Production

Council Regulation 2092/91 on organic production of agricultural products sets out uniform and harmonised rules for this type of production, although it does not set out an organic farming conversion or support programme. Measures under Regulation 2078/92 include aid to farmers who undertake to introduce or continue with organic farming[48].

The area under organic cultivation has increased fourfold in recent years. However, it remains a limited share (about 0.3%) of total utilised agricultural area. It is suggested that the higher prices for organic crops do not necessarily offset lower yields that are achieved and that support payments are at present too low to overcome loss of income from traditional farm practices.

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[47] In assessing the impact of 2078/92 and related measures and comparing these with the impact of the market support measures of the CAP it is important to keep in mind the difference in scale of the EU budget associated with each: 2 billion ECUs 1996 for accompanying measures compared to 17.2 billion ECUs for arable crops, market measures. Such budget limitations mean that the area targeted by 2078 is limited but also the premiums for inciting farmer participation in schemes are often on the low side.

[48] Programmes adopted under this Regulation are implemented in accordance with Regulation 2092/91.

In summary, if the findings of the limited case studies proved representative of the whole programme the PPP reduction measures of 2078/92 may provoke 0.25-3% decline in PPP-use.

Another comment from local administrations was that the grants do not encourage farmers to enter organic production, but are rather mainly received by farms who have already converted (or who would have converted anyway). These two factors together lead to a tentative conclusion that 2078/92 measures for organic farming are effecting overall PPP-use by less than 0.5%[49].

The assessment in this paragraph is not a judgement on the efficacy of the 2078/92 instrument, (that must be subject to more rigorous examination through direct research) as the objectives of the research have been only to measure the impact of the CAP on PPP-use.

(b) PPP-Reduction Measures, 2078/92

Other specific measures that have a direct effect on PPP-use under 2078/92 include specific reduction of pesticide use (*eg:* Lombardy); restriction on use of herbicides/plant growth regulators (MEKA Germany); and support for integrated pest management (*eg*: Spain, Veneto, Piemonte).

(c) Arable to Pasture Land Conversion

Schemes to stimulate such conversion from arable to pasture also exist under 2078/92. Although such will reduce PPP-use significantly (since there is little PPP-use on pasture) the areas subject to these programmes is even less than that for organic farming or PPP reduction. Initial reports derived from discussions with local administrators in the case studies further suggest that uptake is low (estimated to be because the premiums provided are considered insufficient).

4.10.3 Comparison of different measures

It is somewhat difficult at this early stage of the 2078/92 programme, with the limited research of this project to evaluate the efficiency of the different types of measure for reducing PPP-use. Conversion to organic production has the advantage of removing all PPP-use (provided the premiums stimulate an action of conversion that really is additional to that which may have taken place anyway). This same issue of additionality applies to the various pesticide reduction programmes. These programmes also face the challenge of monitoring and measuring that reduction actually takes place.

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[49] In part this results from the fact that 2078/92 measures are only applicable to a limited part of the territory uptake has not been high so far.

4.10.4 Structural Funds

The overall impact is anticipated to be minimal. Again this is not a judgment on the quality or efficacy of the instruments, as the objectives are not specifically to reduce PPP-use. It appears that the positive and negative effect on PPP-use in some programmes across the whole of the EU are likely to balance each other out.

The observation does not imply that the Structural Funds might have greater impact on PPP-use with modification, but simply that the current formulation of the instrument does not have reduction of PPP-use as an objective, so it is not surprising to note that its impact is limited.

4.11 SUMMARY OF IMPACT

4.11.1 CAP Changes

The figures below summarise the overall findings of the research in terms of the extent to which CAP has affected producer prices, the extent to which CAP has affected land use, and how CAP has affected the management of crops in terms of changes in PPP-use. (NB: Only the CMO measures of CAP are treated here, not 2078/92). As has been explained in the introduction, the models and farmer research from which such results are drawn are statistically weak. Thus, the absolute numbers must be treated with caution. Necessarily, the charts have to contain some numbers, but their purpose has been to illustrate the order of magnitude of impact and the relative influence.

Figure 4 - Impact on Producer Returns and Arable Returns

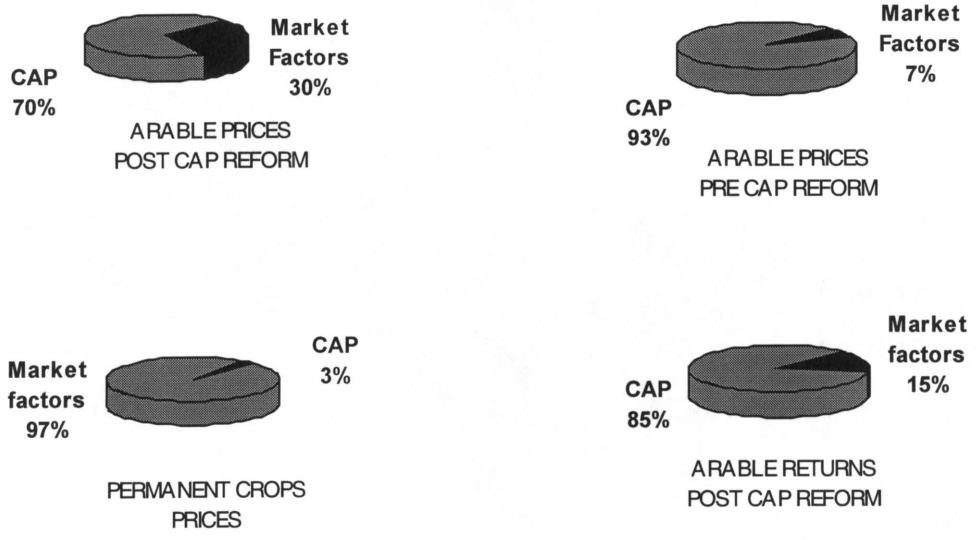
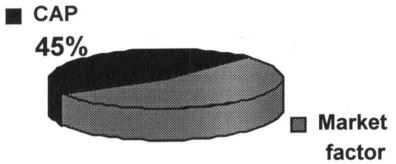
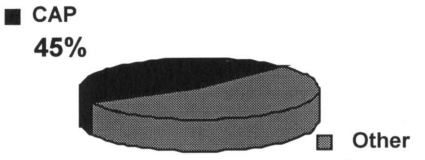


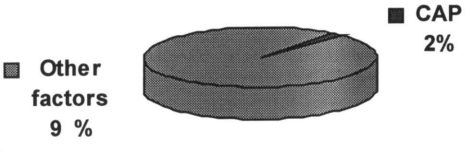
Figure 5 - Impact of CAP on Land Use



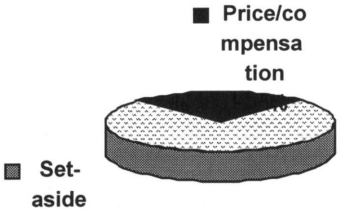
ARABLE CROPS: AREAS
PRE CAP REFORM



ARABLE CROPS: AREAS
POST CAP REFORM

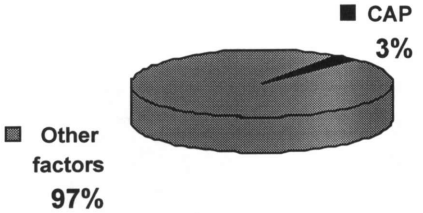


PERMANENT CROPS
AREA, APPLES & CITRUS
BUT VINES 100% CAP

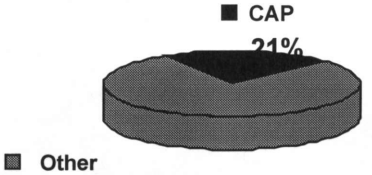


SET-ASIDE V. PRICE
POST CAP REFORM

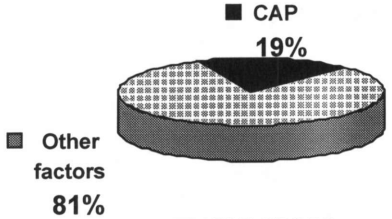
Figure 6 - Impact of CAP on PPP-Use in Crops



PERMANENT CROPS AREA



ARABLE CROPS
POST CAP REFORM

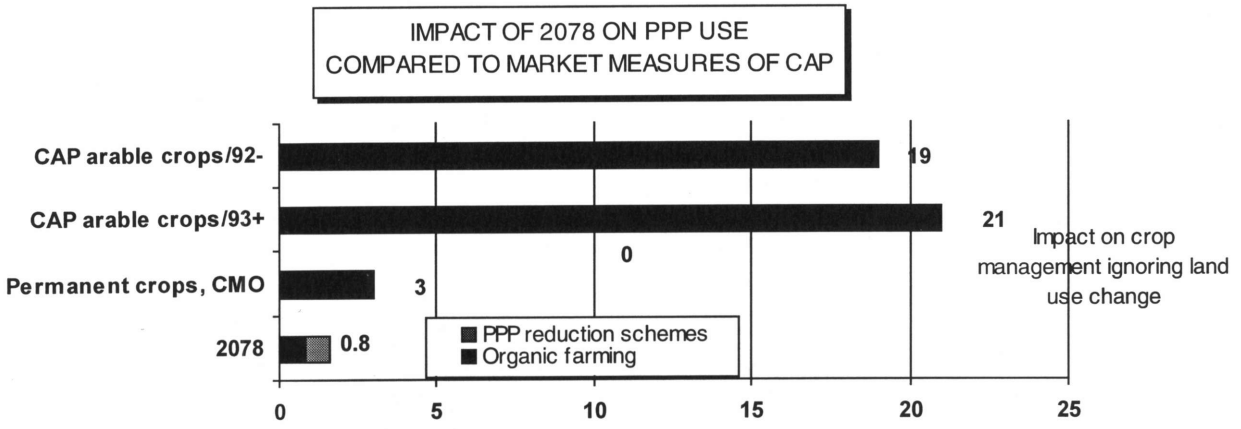


ARABLE CROPS
PRE CAP REFORM

4.11.2 Specific measures

The most direct influence of measures (between structural funds and accompanying measures) are programmes identified under 2078/92. The broad order of magnitude of influence roughly estimated from the study is compared to the impact of the rest of the CAP.

Table 3 - Comparison of possible scale of effect of 2078/92 on PPP-use to CAP market measures.



Source: Produce Studies research

The scale of the impact of specific measures therefore seems to be much less than the overall impact direct of CAP market instruments. This is explained by the fact that the budget for implementing 2078/92 is extremely low (at 2-3%) relative to the total annual expenditure under the CAP budget. Even within 2078/92, a majority of measures is orientated towards livestock and reduction of fertiliser. In addition, measures which have a direct PPP effect (conversion to organic and PPP reduction programmes) have only a limited target area under 2078/92. Early tentative reports (not however, quantitatively substantiated) also suggest that uptake is lower than anticipated and that, within programmes targeting PPP reduction, the level of reduction may be less than could otherwise be expected.

4.11.3 Sensitivity

Sensitivity of changes in producer prices and set-aside on PPP-use are summarised in greater detail in the full text of the sub-Report. The CAP influence through prices on the level of PPP-use is an important factor. In contrast the impact of CAP through prices on land use (which may increase or decrease PPP-use depending on crop) is much smaller.

4.12 DISCUSSION OF RESULTS/CONCLUSIONS

At the 'highest' level of policy making the CAP can affect the balance between grassland (very low use of PPP) and arable crops (the more intensive user of PPP). Up to CAP reform the economic relationship was weak, but tending to increase arable at the expense of grass. Since CAP reform, the measures of CAP on both arable and livestock side have tended to more or less 'fix' the areas associated with each. In discussion of policy change it would be theoretically possible to consider changes in the relative balance of livestock, as determined

by milk quota plus headage payment limits on beef and sheep compared to permitted arable area.

The sub-Report illustrates that there is a relationship between how CAP is managed and the level of PPP-use. In the past the main influence of CAP was through price support for crop output, as higher prices can shift the economic optimum for PPP-use. Of course, over time, there are many other factors that also effect PPP-use such as changes in the weather, technical developments in the genetic make up of the crop, and in improvement in the efficacy of the PPP. These other factors are dominant.

Since CAP reform, the price support instrument has become less important. Thus the relationship between CAP and PPP-use through this price signal has become less significant. However, at least for arable crops, the introduction of the set-aside instrument has had a limited indirect effect on overall PPP-use through influencing the mix of crops grown. Thus since CAP reform, the relationship between CAP and PPP-use has become more complex. With the current rules of set-aside (small farmer exception and so on) and within the experience of a nominal set-aside in the range 0-15%, then increasing the set-aside instrument has a tendency to increase PPP-use in so far as it has encouraged a switch to more intensive PPP-using crops. This is, however, slightly mitigated by the tendency of the CAP reform to reduce PPP-use per hectare.

Whilst the economic analysis has suggested this relationship is in both directions, it may be doubtful that a removal of set-aside now will reverse the crop shift of recent years. Introduction of set-aside encouraged a shift towards wheat away from oats, rye and spring barley (depending on country). Technical developments both in crop production (varieties, PPP) and in animal feed use (permitting higher proportions of wheat) have supported this shift.

It is likely that increasing the set-aside instrument to >15% (nominal level, not actual) will begin to reduce overall PPP-use as crop is taken out of production and the switch in land use does not provoke an increase. Of course if set-aside was applied on a crop specific basis rather than as an aggregate measure for COP (cereals, oilseeds and protein crops) the conclusion would be different. In these circumstances the CAP would clearly have a direct effect on each crop area.

In contrast to the rise in importance of set-aside, the price instrument of CAP has become less important in influencing market prices and thus the optimum use of PPP. The change that has taken place is that a much higher proportion of arable crop returns comes from direct payments. It would therefore be possible for policy makers to adjust the relative return between different crops taking into consideration the relative intensity of PPP-use between crops. No doubt, up to now in policy decisions of this sort, the PPP-use impact has not been a factor in assisting relative returns to different crops.

It should be noted that there are crops where land area is very much controlled by CAP. Sugar beet is a profitable crop in comparison with other arable crops. However the area devoted to the crop is limited by quotas. In contrast, potatoes (except industrial starch potatoes) have no policy instrument affecting the land area (though they have been influenced by the policies on other crops that have affected the relative attractiveness of potatoes), while the area put to vines is very strictly limited by the implementation of CAP.

Generally speaking the impact of CAP on areas of fruit and vegetables (not vines[50]) is minimal, as too, the impact on levels of PPP-use through the producer price affects all crops, including vines. These are significant users of PPP (around 26% by value in the EU), thus there is a large element of PPP-use in which the CAP has limited impact.

Other measures such as 2078/92 and Structural Funds have a much lower, and, in some situations, negligible impact on PPP-use. As far as this sub-Report was able to assess, the Structural Funds have had as many positive impacts on use as negative, and both are extremely small. It might be considered as policy neutral as far as PPP-use is concerned. Only small parts of the 2078/92 programme are noted as having a reduction impact on PPP-use.

It would be wrong to conclude from this study that 2078/92 is an effective or ineffective instrument. Funds put to the programme are relatively modest, especially compared to the major part of CAP expenditure on CMOs. It is also too early to know with any confidence what the impact of 2078/92 will be in those zones where highly specific PPP reducing measures have been introduced.

In the past the major expenditure of CAP in CMOs was in price support. This has an impact on PPP-use. The objectives of the CAP are many and the explicit objective of PPP reduction does not feature directly. It appears only indirectly as part of the objective of environmental sustainability. In the policy decision making of the past it is difficult to imagine a PPP reduction objective featuring very heavily in CMO adjustment decisions. The more recent CAP for COP crops has a more direct link with land use, but the nature of the relationship between changes in the measures and land use is quite complex. Development of a PPP risk reduction philosophy within the context of these new CAP instruments so as to move towards a more sustainable use of PPP will not be easy.

Some programmes of 2078/92 have a very direct impact on PPP-use (*e.g.*: conversion to organic). However, such programmes may have highly specific objectives. In contrast the CMOs have to address simultaneously the multiple objectives of the CAP, of which environmental sustainability is but one. The challenge for policy makers interested in influencing the sustainable level of PPP-use is therefore whether to develop and expand the highly specific programmes and policy instruments (such as 2078/92) or whether to focus attention on modification of how the CMOs work, building more criteria of PPP sustainability in the decisions on compensation levels for the different crops.

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[50] The area of vines determined directly by the CAP in that all new planting (as opposed to replanting) has been prohibited since 1996.

SECTION 5

An Assessment of the Benefits of Plant Protection Products

(Sub-report prepared by Eyre Associates)

5.1 INTRODUCTION

This sub-Report contains a full description of its origins, Terms of Reference, study approach and methodology. In summary, the research for the sub-Report was limited to four case studies: Apples in Trentino-Adige (Italy) Potatoes in Flevoland (Netherlands); Wheat in Schleswig-Holstein (Germany) and Wine in Bordeaux (France). Priority has been given to the **economic** dimension of PPP use, although social and environmental benefits are also considered.

5.2 STARTING PREMISE

The basic assumption on which this sub-Report has been based is that the benefits of PPPs can only be assessed by comparison between the present day "standard" system with alternatives which use less pesticides, namely integrated and organic systems. The organic system has therefore been used as a baseline in terms of yields and costs from which the benefits of PPP are measured. Thus this sub-Report provides an assessment of the benefits of systems in which PPPs are used, rather than the gains of PPPs use for which data mostly do not exist.

5.3 BACKGROUND AND KEY ISSUES

5.3.1 Present extent of PPP use

No reliable and comprehensive data on the size and breakdown of the world and EU agrochem markets are publicly available. Accordingly, the data supplied in the sub-Report have been taken from the authors' own world agrochemical database. In summary, the world market for chemical PPPs was worth approximately 23.1 billion ECU in 1995 at end user prices, while the market in Western Europe (including Switzerland) is estimated to account for approximately 25 percent of the total, fractionally more than the North American share. The number of hectares treated and the value of the agrochemical market in the four countries in which the case studies were carried out are shown in Table 1 below.

Table 1: Agrochemical market in four EU Member States, 1995

	Crop area 51 grown 000's ha	Product area treated[52] 000's ha	Product value (end user) ECU m
France	14,371.0	82,338.1	1,806.7
Germany	9402.0	44,876.0	977.1
Italy	7739.0	38,609.1	721.9
Netherlands	6468.0	36,936.0	79.6
Total	337,980.0	202,809.2	4,288.1

Source : Landell Mills

Table 2 below summarises the data on "product area" in the four countries for the four crops covered in the case studies (the area sprayed multiplied by the number of applications given). It can be seen that wheat dominates the area treated, except in Italy where relatively little of the cereals area is treated with fungicides.

Table 2: Agrochemical use on case study crops (ha treated), 1995

	France 000's ha	Germany 000's ha	Italy 000's ha	Netherlands 000's ha
Wheat	30,847	16,094	3,772	1,012
Pome/stone fruit	2,517	834	5,068	440
Potatoes	2,091	2,448	511	1,883
Vines/grapes	14,012	1,367	13,483	0

Source : Landell Mills

Expenditure by farmers on PPPs in the four crop/country case studies is shown below.

Table 3: Agrochemical market value for case study crops, 1995

	France ECUm	Germany ECUm	Italy ECUm	Netherlands ECUm
Wheat	735	280	59	20
Pome/stone fruit	56	24	115	14
Potatoes	39	58	10	46
Vine/grapes	294	39	190	0
Total	1,124	401	374	80

Source : Landell Mills

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51 Includes set-aside

52 The "product area treated" is the total number of hectares which were sprayed, multiplied by the average number of treatments. The average number of spray treatments per hectare varies greatly from crop to crop and is "high" in particular for some perennial crops including apples and vines.

5.3.2 Reasons for use

Essentially, PPPs are used by farmers for two main reasons, (a) to improve yields by eliminating or reducing the competition from weeds and attacks by disease and pest organisms; and (b) to improve or protect product quality. PPPs are used both **prophylactically** and **therapeutically** or curatively when a problem has arisen. The focus of much present research and development effort is to improve diagnostic and "threshold" analysis systems.

5.4 ECONOMIC ISSUES

5.4.1 Summary

The economic performance of the three different systems in each case study is summarised in Table 4 below. This shows the yields and gross margins at current prices, and also estimates what they would be if the organic price premium fell (a) to 20 percent, and (b) to zero.

Table 4

	Apples	Potatoes	Wheat	Wine
Standard	100	100	100	100
Integrated	89	100	90	100
Organic	70	59	48	73

The standard and integrated systems were found to have performed similarly; where the integrated yields are a little lower, this reflects a reduction or elimination of prophylactic treatments against diseases and pests, as well as of reduced fertiliser applications, nitrogen in particular. In contrast, yields under the organic systems are dramatically lower, especially with arable crops grown in a rotation. With wine the yields in Bordeaux under all systems are restricted to well below the technically feasible level, for quality and market management reasons.[53]

The profitability of the various systems was compared chiefly at the gross margin level, for each crop studied and at the rotation level for the two arable crops. The gross margin indices at the case study price levels (data came mostly from the 1995 crop year) gave a rather variable picture.

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[53] One important proviso is needed. Data on the performance of the integrated systems come generally from research projects and from farmers pioneering the alternative approach. The intensity and quality of the management involved may fall away as an integrated approach is more widely adopted, with a consequent greater yield penalty.

Table 5

	Apples	Potatoes*	Wheat*	Wine
Standard	100	100	100	100
Integrated	140	100	93	100
Organic	190	200	133	56

* rotation level

The economic performance of the integrated systems were fairly close to the standard; the better performance of integrated apples reflects the price premium that apples from Trentino obtain. More significant is the worse performance of the Schleswig-Holstein integrated wheat rotation. First, the data are probably more reliable; second, the interpretation of "integrated" is strict; third, this case study is the most important by far in the context of EU agriculture as a whole.[54]

The organic systems appear at present to be very much more profitable (except with wine) than the standard and integrated systems; owing largely not to reduced input costs but to higher end product prices. As the farmgate price indices below demonstrate, the prices for standard and integrated products were found to be generally similar (except for apples, a special case), whereas the premia for organic products were high, apart from wine.[55]

Table 6

	Apples	Potatoes*	Wheat*	Wine
Standard	100	100	100	100
Integrated	113	100	100	100
Organic	200	204	298	107

* rotation level

What would happen to the prices of organic products if production expanded greatly is considered to be an 'unknown' at present, by the authors. The available evidence from consumer studies suggests that, broadly speaking, only 20-25 percent of consumers are willing to pay any premium at all for organic produce. The study estimated the gross margins for the organic systems on two different assumption (a) that the organic premium remained at 20 percent over standard, and (b) that it fell to zero. If the present high prices for organic products decline, profitability would fall below that for standard and integrated production,[56] and gross margin indices for organic production at different levels of premium are set out below.

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[54] The results presented are drawn from the relatively few farms following an integrated approach however.

[55] The small premium for organic wine produced in Bordeaux (which varies considerably from one product to the next) is part of a price structure which reflects perceptions of quality and long-established reputation, and where the production system used influences very few buyers.

[56] The economic cost of a large-scale switch to organic is quite probably underestimated as it does not allow for the likely fall in livestock product prices that would follow as a result of the increased production of these under most organic rotations (assuming that organic stockless

Table 7

	Apples	Potatoes*	Wheat*	Wine
Present level	190	200	133	56
20% premium	80	(loss)	40	63
Zero premium	40	(loss)	(loss)	31

* rotation level

The overall economic benefits provided by PPPs (in conjunction with fertilisers) at national level for each case study crop were estimated by calculating the differences in output under organic and standard systems, and valuing these differences at the case study farmgate prices for standard production, summarised below:

Table 8

	Apples (Italy)	Potatoes (Netherlands)	Wheat (Germany)	Wine (France)
Output gain ('000 tonnes)	589	1,474	9,204	15,015
Value (ECU million)	62.4	154	1,243	1,747

It is accepted, however, that theoretical estimates of this sort must have a large measure of uncertainty.

5.4.2 Explanation

While economic comparisons between organic and standard systems have been made, there have been few if any which have also considered the economics of integrated crop production. The situation is complicated by a tendency towards convergence between systems, as is indicated by the Trentino case study described in the full sub-Report, here the "integrated" system has largely become the "standard".

Comparing the farm-level economic performance of alternative production systems - Comparisons of the economic performance of different systems have relied on comparisons of yields achieved, costs, and enterprise gross margins. The findings of some relevant studies are reviewed in the full sub-Report, albeit that the evidence of such studies is considered incomplete. Two limitations of an approach based on systems comparisons if these are used as a basis for policy-making are identified - (a) there may be significant off-farm costs with the standard and integrated systems *i(e.* for pesticide monitoring

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rotations prove unsustainable). In addition, the economics of organics at present benefit from set-aside, which allows the set-aside area to be used for part of the fertility-building phase of the organic rotation. Given the likely disappearance of set-aside if there was any large scale switch to organic (because of the production shortfall that would result), it is felt that this would have a further negative effect on the economics of organic systems.

and water clean-up) which are real though not at present carried by farmers, and (b) the fact that historic data alone may be an inadequate guide to future performance or technical and economic changes.

Yields in standard, integrated and organic systems - Comparisons of yields under the three systems point to a ranking of standard, closely followed by integrated followed quite a way behind by organic across all products. Unfortunately, there are few comparative data covering integrated systems, and the data relate primarily to standard-organic comparisons.

Costs and margins - Evidence on costs and margins relates primarily to organic and standard systems. The available evidence suggests, however, that lower yields also provide lower variable costs in organic and integrated systems. Fixed costs for labour and machinery may also be higher. Lower variable costs alone, however, have been found to be insufficient to offset the effects of lower yields on enterprise gross margins for organic systems. The Landell Mills (1992) study covering seven European countries found that in general higher prices for organic products compensate for lower yields.

Rewards to management and investment are identified as negative. In the case of wholly organic farms, financial performance was generally worse as general cropping farms achieved an output per hectare only about half that of standard farms. A recent study (Leake, 1996) over a seven year period found that the average net margins for each system (stocked organic, stockless organic, integrated, standard with integrated rotation, and standard with standard rotation) were more or less comparable. Existing data suggest that, in the absence of premia, organic production would need to be subsidised in some way to overcome its financial weaknesses.

Prices and markets - Other than the (occasional) use of special labels, marketing of integrated products appears to follow similar procedures as standard products. Organic products however, tend to be marketed in rather different ways (according to product type), although the trend is towards more mainstream channels and methods, such as the recent development in "quality assurance" schemes operated by larger retailers. In general, premium prices are not offered to producers for sticking to these improved standards. Rather, they tend to be a condition of getting the business.

Volumes of organic food traded are typically small, and economies of scale are limited. Quantity and quality of products are variable. Supermarket penetration is therefore considered necessary for the more widespread availability of organic products. Price premia for organic products have been significant - up to 150 percent for organic milling wheat in the UK, and up to 300 percent in Germany, for example. For livestock products in Northern Europe, the organic premium is significantly less at 10-25 percent. Research reported in a Landell Mills (1992) study found that in Denmark and Germany 20 percent of consumers were willing to pay a premium of 15-20 percent, but no more than 5 percent willing to pay a premium of 35-40 percent.

In spite of the limited demand for organic products domestic production is still far too little to meet market requirements, and imports account for a significant market share. The UK, for example, imports 70 percent of its fresh organic produce.

The outlook for organic and integrated production - Recent years have seen an apparent expansion in the extent of organic and integrated farming systems, although they remain small in absolute terms. Further expansion is expected, and it appears that the open-ended prophecy that organic production will ultimately capture 5-10 percent of retail markets for agricultural products is still current. The extent of any price change will depend upon the elasticity of demand for organic and integrated products. Unfortunately, these basic parameters are unknown. For the generality of standard consumers price is a major issue and presumably elasticity of demand for organic and integrated products will be higher than for standard products.

In general, complete conversion to organic production is expected to lead to a 40-50 percent reduction in cereals output with an accompanying shift away from wheat and barley and towards rye and oats; large increase in output of forage crops, especially grain legumes; a reduction in oilseeds production; a reduction in sugar beet production; an expansion in production of potatoes and field vegetables; reduction in numbers of grazing livestock; a substantial reduction in pig and poultry production.

5.5 ENVIRONMENTAL ISSUES

The sub-Report does not detail the arguments and evidence on the negative environmental effects of PPPs against which net benefits may be calculated, as this has been done exhaustively in many recent publications (e.g. Beaumont, 1993). In brief, these negatives are considered to include pesticide residues in food, pesticides in ground and surface water, accidental poisoning of those exposed to pesticides, (both the users and the general public), and damage to fauna and flora of every type. These problems divide between those arising where the stringent regulations on pesticides are broken, and those which occur despite observance of the regulations. The following observations are made:

Biodiversity - Agriculture, since its beginning, has contributed to a loss of biodiversity. A return to farming systems which exclude use of PPPs would involve an enormous increase in the crop area to produce the same quantity of food with a consequent loss of wildlife habitats.

Soil Erosion - Soil erosion is generally due to bad farming practices. PPPs can contribute to this by making possible no-tillage systems and by reducing the soil damage done by frequent cultivations to control weeds mechanically.

The high level of farmgate prices brought about by the CAP is thought to have encouraged intensification and persuaded farmers throughout the EU to bring marginal land into cultivation. Lower prices might therefore achieve a movement in the opposite direction. Conclusions about the net benefits (or losses) in environmental terms of PPPs must balance the pluses and the minuses, and can mostly only be put in

qualitative terms. Attempts to put monetary values on these are considered inherently flawed.

5.6 SOCIAL ISSUES

The social consequences of a return to a farming system which did not use chemical PPPs would be some increase in farm employment. The loss of output which would follow from a wholesale switch to organic would have negative employment consequences. The lack of raw material would reduce the extent of food processing, and would reduce (generally better paid) employment in the ancillary industries such as pesticide manufacture. It is accepted that present day organic food consumers do not necessarily spend much more on food, because their pattern of consumption changes. Whether this is socially a good thing or not introduces value judgments beyond the scope of this study.

5.7 ALTERNATIVE SYSTEMS

Overview

Rising concern at the consequences of modern, mainstream intensive systems of agriculture (and horticulture) have resulted in two main alternative approaches. These are broadly categorised as "organic" and "integrated". The sub-Report dedicates some considerable space to the background and definitions of the two systems. Only very broad definitions are distilled in this Synthesis Report.

The organic approach -At its simplest, organic farming is crop production without using synthetic chemicals and pesticides and livestock production without using pharmaceuticals and intensive methods, although to define the ideas of the organic movement merely in such limited and negative terms would be neither accurate nor fair. The explicit aim is to develop a sustainable system of farming which gives priority to ecology.

The integrated approach - This incorporates the integrated pest management (IPM) approach - defined by the FAO as "the use of all suitable techniques in a compatible manner to reduce pest populations and maintain them at levels below those causing economic injury" - but goes further by involving all aspects of farm operations and management.

5.8 DISCUSSION OF SUB-REPORT FINDINGS

5.8.1 Limitations of the study

The method used in preparation of the sub-Report was to compare the performance of the three systems - "standard" (the current conventional and mainstream system used by the majority of farmers), "integrated" (a system which puts greater emphasis on ecological/environmental considerations, and generally involves a substantial reduction in PPP use), and "organic" (which in general avoids the use of chemical PPPs, and follows stringent rules which have legal force for farmers who wish to market their products as organic). The authors of the sub-Report conclude that the

differences between the performance of farms using an organic system on one hand, and integrated and standard systems on the other, appropriately extrapolated to regional and national level, properly reflects the benefits provided by PPPs.

In order to assess the benefits of PPPs an examination was undertaken of the performance and problems of a system which does not use them, *i.e.*: theorising about the implications of a complete switch to organic in order to provide a baseline from which the benefits of PPP-using systems can be assessed. Many commentators find this exercise unrealistic, but nobody has been able to suggest an alternative and better way of making the estimates needed.[57]

While it would have been possible to have arbitrarily allocated a percentage of the benefits accruing from use of fertilisers and the rest to PPPs, this is considered to have little scientific justification. Therefore the authors have allocated the whole benefit to PPPs (as in many instances it would have been lost without their use) while making it plain that this includes the benefits of fertiliser use. In other words what has been demonstrated are the benefits of agrochemical use, rather than solely PPPs use.

The second important limitation of the analysis is considered to relate to farmgate prices of organic products. In each of the case studies the organic market share is minuscule - under one percent for all crops (except wheat in Schleswig-Holstein - around 3%). Despite recent increases in production organic products serve a small niche market, at very high prices. There is only limited evidence of what would happen to organic product prices if and when production expands substantially (distinguishing between changes in the overall price level and the premium for organic (and in some cases for integrated products) over those from standard systems). Indications suggest that the present organic premium will rapidly diminish, and that only a minority of consumers are prepared to pay one at all. The provisional assumption made is that in a theoretical situation where organic production reached 20 percent of the total supply, the organic premium would be no more than 20 percent.

In practice, if organic farming was to become the mainstream system, the impact on food supply and demand is expected to be so dramatic that one can only guess at what would happen to prices overall. But it is also not unreasonable for the advocates of organic production to argue that, with suitable organisation and promotion, demand for organic products may grow in line with expanding output, thus maintaining present prices. That certainly might happen as the market expands from its present level to say, 15 or 20 percent of the total. But the authors' conclusion, on the basis of the limited consumer research done so far, is that it will not; in the author's view the organic premium will decline sharply as production increases.

As most organic systems are based on a combination of crop and livestock enterprise, in considering any large expansion of organic production one comes up against two major barriers: (a) at farm level, the practicalities of introducing livestock enterprises

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[57] It is accepted that this exaggerates the benefits of PPPs in one important respect in that it ignores the contribution of fertilisers. However, crop yields will generally only be at their economic optimum when both fertilisers and PPPs are used appropriately.

where they do not exist at present are immense, and there are also, under current CAP rules, quota limits to an expansion of dairy production; (b) a large increase in milk and meat production would have a drastic effect on product prices, as both are already in "structural surplus" (*i.e.* the farmgate prices assured under the CAP mean that production is substantially in excess of demand at these prices). Though organically-produced meat and milk might substitute for non-organic, the overall dilemma would remain.

This issue has led to a considerable effort by the organic sector to develop "sustainable stockless rotations". But it is felt unclear where the market for a massive increase in supplies of grain legumes arises, and it is considered that an attempt to substitute relatively high-cost domestically produced pulses for cheaper imported oilseeds would cause immense problems at WTO level, quite apart from the effect on EU food prices. As for green manures, these are either catch crops or grown on the set-aside area. The latter is an artificial situation, and if organic production expanded to 20 percent of the EU total, virtually the whole present set aside area would be needed for crop production. In effect, a sustainable stockless arable organic rotation needs 25 - 30 percent of the farm area to be diverted to fertility building.

In comparing organic and non-organic systems these matters ideally ought to be taken into account. The difficulty is that the effects on product supply, on product prices and on land use of a major switch to a system without agrochemicals can only be estimated within rather wide ranges.

The other serious limitation of the sub-Report is felt to be the difficulty of attempting to extrapolate the findings of four limited studies to provide regional and national estimates of PPP benefits. The authors have given broad brush estimates in numerical terms of these benefits, as that is one purpose of this exercise. It would be easy to retreat behind the barricades of scientific caution and to claim (with some justification) that the data are too weak to permit any general conclusions to be drawn. It was preferred, however, to put forward some inevitably rough-and-ready calculations, while making clear the assumptions on which they are based.

5.8.2. Economic benefits for the selected crops/regions

The overall findings of the four case studies are summarised in Table 9 below (expressing the area grown of each crop, the yields, the crop gross margin, the rotation gross margin (for the two annual crops), farmgate prices and reduction in PPP use as percentages of "standard". The figures are, inevitably, averages and the range within each category is wide. The main qualifications that need to be made about each score can be found by reading the case studies.

Table 9 : Summary of the economic performance indices from the four case studies[58]

	Apples	Potatoes	Wheat	Wine
CROP AREA :				
· Total	100	100	100	100
· Standard	6	82	96	94
· Integrated	83	15	2	5
· Organic	1	3	2	1
YIELDS :				
· Standard	100	100	100	100
· Integrated	112	100	90	100
· Organic	70	59	48	73
GROSS MARGINS :				
A. Crop				
· Standard	100	100	100	100
· Integrated	140	124	93	100
· Organic [1]	190	110	133	56
· Organic [2]	80	60	100	63
· Organic [3]	40	40	70	31
B. Rotation				
· Standard	n/a	100	100	n/a
· Integrated	n/a	100	93	n/a
· Organic [1]	n/a	200	133	n/a
· Organic [2]	n/a	(loss)	40	n/a
· Organic [3]	n/a	(loss)	(loss)	n/a
FARMGATE PRICES :				
· Standard	100	100	100	100
· Integrated	113	100	100	100
· Organic	200	204	298	107

Three main conclusions are drawn from the above data. Firstly, overall there appears to be very limited or zero economic benefits in using PPPs beyond the level needed for integrated production. In reality, however, this is a tautology. The rules for integrated production are flexible, and in practice tend to mean an effort to reduce the use of PPPs (alongside other environmentally-desirable modifications to the farming system) while avoiding any loss of profit. In other words, it is felt feasible to reduce PPP use (typically by the 25-40 percent), but to a varying extent from crop-to-crop depending on circumstances, while maintaining profitability. However, if the integrated protocols are strictly defined and include a (say 50 percent plus) reduction in overall pesticide use, then there will often be an economic cost; the German case study on wheat production - the one with the widest implications - suggest that gross

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[58] The organic gross margins are estimated at three levels : [1]The case study price premium (generally 1995 prices); [2]Organic products at a 20 percent price premium to standard; [3]Organic prices the same as standard.

margins would be reduced by around 10 percent if integrated products obtain the same prices as standard.

In practical terms, even if integrated production was as profitable as standard, many farmers would be reluctant to changeover comprehensively. There would be no economic benefit, there would often be some risk and the integrated system is likely to be significantly more management-intensive. So while some elements of an integrated approach, including agrochemical input reductions may well be adopted, a full-blown commitment to IFS is unlikely to appeal to a majority of farmers unless incentive is provided.

The second main conclusion is that, at the present time, assuming there have been no big changes over the past two years, organic production is on balance more profitable than standard or integrated. This is despite the much lower yields achieved by organic producers. The key to this is felt to be the extremely high farmgate prices currently obtained by organic producers. The subsidies for organic production are secondary.

The one exception to this is organic wine (which is also the exception in that organic wine production involves the permitted use of chemical PPPs, albeit old-fashioned ones). There is a smaller premium for organic wine and the price is insufficient to compensate for reduced yields. The important proviso needs to be made, however, that the price structure in Bordeaux is untypical, and organic wine producers may get a larger premium elsewhere.

5.8.3 Economic benefits at national level

Any attempt to extrapolate the case study results in order to estimate the economic benefits of PPPs at national level is fraught with hazards, because the relative performance of the different systems in other regions may well be different. What follows assumes these differences are zero, and therefore can best be regarded only as providing rough estimates.

Table 10 below estimates the benefits at national level in each country for the crop covered in the country case study. This calculation simply calculates what the production loss would be in total resulting from a 100 percent switch to an organic system. This loss is then valued at current market prices in order to give an estimate of the value of PPPs (in reality the benefits of using a standard system) with the crop in question in the case study country. Some economists argue that market prices should be used in this calculation as many EU prices are artificially inflated under the CAP system. If this approach was followed, the benefits would be reduced substantially but by variable amounts - least for potatoes, most for wheat.

Table 10 : Estimated benefits at national level of PPP use: *Standard to Organic Switch*

	Apples	Potatoes[59]	Wheat	Wine [60]
Current production (mn tonnes)	1.96	2.76	17.51	55.60
Estimated production (mn tonnes)	1.37	1.63	8.41	40.60
Production gain from PPPs (mn tonnes)	0.59	1.13	9.11	15.00
Total output ('000 tonnes)	1,964	3,595	17,700	55,610
Organic index	70	59	48	73
Gain from PPP ('000 tonnes)	589	1,474	9,204	15,015
Value per tonne (local currency)	210,000[61]	222	257[62]	761[63]
Value gain (local currency)	123.7[64]	327[65]	2,366[66]	11.4[67]
Value gain	48.75[68]	121	197[69]	1.36[70]
Value gain ECU	62.4[71]	154[72]	1,243[73]	1,747

What is felt to be evident are the enormous economic benefits which the use of agrochemicals, including PPPs, provide as the key components of the standard system.

The authors of the sub-Report also gross-up the benefits across the rotation to give an (inevitably crude) estimate of the benefits of PPP use on all arable crops in the

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59 In D/t

60 In '000 hl

61 Lira/tonne

62 DM/tonne

63 FF/hl

64 Bn lira

65 Fl mn

66 M DM

67 Bn

68 T=2538

69 M £

70 £ Bn

71 Mn

72 Mn

73 M

country concerned. In this calculation it has been assumed that if an organic system entirely replaced the standard system, then the organic price would fall to 20 percent above the standard price. The actual benefits of the standard system are probably seriously underestimated in this calculation, however, as it does not allow for the reduced area of the arable crops that would result from a switch to 100 percent organic, and the very low prices that would be obtained for livestock products if their supply was substantially increased above present levels. This further assumes that the supply shortages (of cereals) and surpluses (of livestock products) could not be covered by trade.

Table 11 : Estimated benefits at national level of PPP use on all arable crops

	Netherlands[74]	Germany[75]
1. Rotation margin : standard (ECU/ha)	259	805
2. Rotation margin : organic (ECU/ha)	0[76]	322[77]
3. Difference in margin (ECU/ha)	259	483
4. National arable area ('000 ha)	1,965	11,834
5. Value of difference (ECU/ha)	0.51	5.72
6. Total monetary difference (calculated by multiplying 3 x 4) in millions of ECU (rounded down)	508	5,715

Clearly, different assumptions will give different results, but the authors submit that its assumptions are not unreasonable, and do demonstrate how enormous would be the economic cost of a ban on PPPs.

5.8.4 Environmental benefits of PPPs

In each case study described in full in the sub-Report, the conclusion is reached that the main environmental benefit of PPP use arises from the much greater area of farmland that would be required to produce the same amount of the crop in question if a PPP-based system is substituted by an organic one. In other words, this is the area of farmland that is saved by the use of PPPs under a standard system.

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74 Netherlands data are net margins

75 Germany data are gross margins

76 This assumes the organic price premium is 20% over standard prices

77 At this level of prices organic production would make a loss, so the GM is shown as zer

The assumption in this context is that the quantity of each product currently reaching the market is needed to meet consumer demand. Therefore, if yields fall then the crop area will need to be increased. If an organic system is adopted in the case study country, the assumption made is that it will be adopted in other countries, so shortfalls in production in the case study country cannot be made good by extra imports. The argument has been made that within the EU there is considerable overproduction, and hence such land-saving is not a significant benefit. The counter-argument is that this is a consequence of CAP-influenced price levels. If prices were allowed to fall to world free market levels, "structural" overproduction would disappear. One consequence would almost certainly be some reduction in PPP use, though estimates of this are beyond the scope of this study. Thus with reduced farmgate prices there would be both some extensification of production due to reduced use of inputs combined with some reduction in the area cultivated as marginal producers ceased production.

However, the effect with the crops covered in the case study would not be uniform. Effectively, there is no EU price support for ware potato production, so CAP reform would have little impact on this crop. Over production in some years is the consequence of the largely unavoidable weather-induced fluctuations in yields from one season to the next. In contrast, wheat CAP-based support measures have a large impact on prices. With both apples and wine the situation is more complex, as reforms introduced to the fruit and vegetable regime will reduce market distortions, and will make product quality and marketing effectiveness of even greater importance than in the past. In this respect the Trentino producers are well-placed. For wine, the Bordeaux region depends hardly at all on the CAP mechanisms and the effect of CAP reform would presumably be to remove the present market distortions that still encourage over-production of low quality wine. The area of vineyards in Bordeaux, and the use of PPPs within the region, is unlikely to be effected by CAP reform unless it strengthens the direct incentives to adopt IPM methods. Table 12 below estimates the extra areas that would be needed at national level to make good the output reduction that would follow from a switch to organic.

Table 12 : Extra farm area needed for organic production

	Apples	Potatoes	Wheat	Wine
Present production area ('000 ha)	67.0	80.1	2,530.0	926.0
Organic yield (% of standard)	70.0	59.0	48.0	73.0
Extra area needed to maintain output ('000 ha)	28.7	55.7	2,741.0	343.0

While it is conceivable that the extra land needed to maintain apple and wine production could be found, this is felt to be impossible for potatoes in the Netherlands (for rotational reasons) and for wheat in Germany, as that much extra land suitable for the crop does not exist. These figures are considered in the authors' main point that a substantial increase in organic production will put immense pressures on current land availability and use.

From an environmental point of view, the demand for extra land to meet food supply needs under a reconversion to organic can only mean that land at present left as woods, wetlands, heaths and other uncultivated areas would need to be brought into cultivation.

Benefits to soil, flora, and fauna from organically farmed land are acknowledged by the sub-Report authors. For example, German research (Isselstein J. *et al.*, 1991) has highlighted the favourable impact of organic methods on soil microorganisms as well as on the populations of invertebrates, beetles and other genera. To the extent that weeds are poorly controlled, an increase in insect population occurs, and this in turn is beneficial for the populations of insect-feeding birds (and of the species which predate these).

The authors of the sub-Report suggest, however, that it is less clear what the comparative level of these gains would be on cultivated organic farmland and the biodiversity gains of areas used exclusively for conservation. The authors of the sub-Report found no research documentation that would allow this comparison directly to be made but what is felt to be clear is that such research needs to be done over a sufficient number of years to allow the full impact of system changes to become evident.

While the relative benefits of the two model scenarios as ways of sustaining and, where possible, strengthening biodiversity under different scenarios for the use of existing farmland can be disputed, the case is different once one considers a larger scale conversion to organic. It is felt that, should complete or near complete conversion take place, the need for extra land to maintain food supplies would require the bringing to cultivation of land not currently used for farming and this loss of existing uncultivated wildlife habitats would be beyond dispute, and an effect on biodiversity comparable to what was experienced in Europe in the periods of farming expansion in the 16-19th centuries, before pesticides were invented is suggested.

The sub-Report also identifies benefits from use of PPPs in the following areas:

Food quality - This has two main aspects (Johnen & Urech 1997) - (i) avoidance of fungal and bacterial contamination and damage (with many cash crops from organic systems a substantial proportion of the harvest cannot be marketed because of contamination and damage); (ii) storeability. For example, apples or potatoes with various rots and insect damage cannot be kept in store. In general, organic wheat losses in store are estimated at 15 - 20 percent higher than for non-organic. Around 2 - 3 percent of foodstuffs have detectable residues, and these may have long term negative health effects, a matter which the authors accept cannot be totally disproven. It is difficult to quantify the benefits of efforts to satisfy consumers, but the costs of monitoring are clearly a negative to be put against the benefits of PPP use.

However, the authors point out that provided PPPs are used correctly, any detectable residues should be well below the legal limits which in turn are designed to provide a wide margin of safety. It can and is argued that only in healthy, disease and pest-free

crops, can their genetic potential be fully expressed, for example in relation to the protein content and other aspects of nutritional quality of the crop.

There are many naturally occurring toxins that can contaminate foodstuffs. There are about 400 known toxins of fungal origin alone (Obst *et al.*, 1990; Anon., 1994). Crop protection products help considerably in preventing such contamination of food by these mycotoxins which are products of fungal metabolism. These toxins can be directly acutely toxic, but also exert chronic or long-term effects including causing cancer. Mycotoxins can develop both during the actual growing period of the crops as well as in storage. Processing does not destroy or remove these toxins, thus crop protection measures must be directed towards prevention.

The negatives of PPP use are discussed in other sub-Reports in the current study programme. What this study seeks to show, however, is that an integrated approach has relatively minor economic costs, and can further reduce PPP use by big amounts, both in terms of the quantity of active ingredient use per ha and of the environmental impact of the products used. Technical developments - safer PPPs, innovative biological alternatives, and better application methods, are thought to offer further gains in safety in future.

Social benefits of PPPs - It is accepted that any assessment of social benefits is value-laden, and the question is posed, for example, whether, maintenance of small farms is a good thing, regardless of other considerations. The social benefits are considered to be primarily the consequences of the economic and environmental benefits discussed above. Four are identified in particular, namely, in relation to:

- food prices - declined in real terms in recent years and absorb a declining proportion of EU consumers' incomes, despite price-raising effect of the CAP. Currently organic food prices are much higher (20-150 percent higher in general) than those for standard and integrated products;

- food security and quality - PPPs play an important role in ensuring reliable crops each year, as yields generally fluctuate less under a standard or integrated system than under an organic system (but note the contrary data on this from the German case study);

- land use for non-farming purposes - for housing, industry, roads, recreation, wildlife conservation and landscape protection is contingent on it not being required for food production (see above);

- rural employment and incomes - reconversion to organic farming would mean some increase in farm labour requirements, though the authors accept that it is difficult to quantify the impact.

5.8.5 GENERAL CONSIDERATIONS

The use of PPPs in modern agriculture has its costs and benefits. This study has attempted to evaluate, and where possible quantify the key benefits. In economic terms the sub-Report authors feel that they are enormous, but they are also real in

environmental and social terms. The authors draw the conclusion that an integrated approach would further reduce what limited hazards the correct current use of PPPs under standard systems still pose, as economic costs are felt to be small, particularly if CAP reform reduced the economic threshold for PPP use.

The overall picture which is concluded from the sub-Report is that farmers' expenditure on PPPs provides very large economic benefits, as well as significant and real environmental and social benefits which need to be balanced against any costs or losses which they may cause.

SECTION 6

Regional Analysis of Use Patterns of Plant Protection Products in Six EU Member States: PES - A/Phase 2

(Sub-Report prepared by Landell Mills Market Research Limited)

This Sub-Report runs to some 1500 pages. Given the space considerations in this synthesis Report, and the substantial body of data reproduced in the sub-Report, reference is made only to the principle findings of the five-volume study conducted by Landell Mills.

The Executive Summary to the full Sub-Report has proved valuable in this context in identifying the primary policy indicators which can be drawn from the extensive findings reproduced in the full sub-Report.[78]

6.1 SUMMARY

This sub-Report followed a review conducted by LEI-DLO in Phase 1 of the project on possibilities for future EU environmental policy on plant protection products, which had proposed that further investigation be conducted of:

(a) the areas of more than moderate use of plant protection products, and
(b) the intensity of use of plant protection products which vary substantially between countries.

Through a basis of agronomic analysis at farm level, the objective of the sub-Report was to study both differences in PPP use at farm level within regions (and identifiable explanations for such differences) and the potential scope for economically acceptable reduction in PPP use. Possible future developments/trends were also to be identified.

It should be noted that the authors of this Sub-Report consider that budgetary constraints have not permitted as wide a geographical review as suggested by the LEI-DLO study and that, as a consequence, the crops studies were modified (largely on the basis of the Landell Mills in-house agrochemical database, indicating the crops of importance in total agrochemical load across the EU).

For example, vegetables were regarded as too fragmented a crop for satisfactory review at farm level so the four crops selected were:

- vines;
- winter wheat (the major agrochemical user in cereals);
- potatoes;
- apples (the major agrochemical user in pome and stone fruit).

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[78] Further reference should be made to the full Sub-Report for development of what can by necessity be considered only as a distillation of primary conclusions. The full text of the Landell Mills Sub-Report is comprised of: Volume I - Executive Summary and Cross-Regional Revues for Wheat, Potatoes, Apples and Vines; Volume II - Winter Wheat: Volume III - Potatoes; Volume IV - Apples; Volume V - Vines. Full explanation of the crops selected and regions studied may also be found in the full Sub-Report.

Regions were selected across Europe where it was believed that there was above-average use of plant protection products for the crop and country concerned. In general, the regions selected proved satisfactory, although in hindsight a better choice for wheat in Italy would have been Emilia Romagna, where the crop is grown more intensively than in Piemonte.

Table 1 - Selection of Regions for Analysis

Crop	Country	Target	Actual
Cereals (winter soft wheat)	Germany	S Niedersachsen	Hannover
	UK	East Anglia	Cambridgeshire, Norfolk,
	France	Centre	Suffolk Eure, Eure-et-Loire, Oise, Loiret, Loir-et-Cher,
	Italy	Piemonte	Yonne Piemonte
Potatoes	Germany	N Niedersachsen	Lüneberg
	Netherlands	Flevoland	Flevoland
	UK	East Anglia	Cambridgeshire, Norfolk,
	France	Nord/Pas de Calais	Suffolk Nord, Pas de Calais, Somme
Pome/ stone Fruit	France	Languedoc-Rouissillon	Bouche du Rhône, Vaucluse, Gard, Heralt, Drome
	Italy	Trentino	Trentino
	Spain	Cataluna	Lerida
Vines	France	Bordeaux	Gironde, Charente and Charente Maritime
	Spain	Rioja	Rioja
	Italy	Veneto	Verona

6.2 METHODOLOGY

The method used in this study was face-to-face farmer interviews in each of the 14 regions. Preceded by a restricted number of farmer group discussions, a questionnaire of approximately one hour in length was developed (presented in the crop review volumes). Fieldwork was conducted in mid-1995 and details were asked regarding product use in the previous season (1994) as well as qualitative and attitudinal aspects. Approximately 60 farmers were interviewed in each region.

Once initial results had been provisionally analysed, a series of interviews were held with key extension personnel and local specialists in order to deepen the discussion and obtain models of growing costs and returns where possible.

6.3 CROSS CROP SUMMARY

6.3.1 Chemical Loads

Taking a by necessity somewhat simplistic approach for broad comparative purposes, the chemical loads in the regional sample of farms surveyed are summarised in the Table below:

Crop	Region	Chemical load per hectare of crop grown per farm kg ai/ha		
		Average	Range	
Wheat	Hannover (D)	4.5	0.08	8.5
	E Anglia (UK)	4.6	0	10.1
	N Central France	3.8	0.7	13.7
	Piemonte (I)	2.1	0.02	7.3
Potatoes	Lüneburg (D)	9.8	2.7	22.3
	Flevoland (NL)	12.6	1.6	34.6
	E Anglia (UK)	13.1*	2.0	26.7
	N E France	32.0	9.0	73.7
Apples	S E France	41.4	1.7	146.7
	Trentino (1)	33.7	0.6	83.4
	Lerida (E)	27.4	1.4	109.6
Vines	Bordeaux (F)	46.0	7.9	87.3
	Rioja (E)	16.8 (42)**	2.9	146.9
	Verona (I)	33.6 (43) **	0.8	142.4

* Excludes the use of sulphuric acid as a desiccant.

** There was suggestion by local specialists that farmers' use of sulphur was understated. Figures in brackets are computed as if all farms used sulphur.

** There was suggestion by local specialists that farmers' use of sulphur was understated. Figures in brackets are computed as if all farms used sulphur.

It can be seen that chemical loads[79] per crop varied widely between farms and regions. Comparative differences between regions were identified, although individual reasons for variability between farms were more difficult to identify, in particular due to the fact that there were so many variables in play, not the least of which was the difference in inherent activity between individual chemicals. This feature can result in dose rate differences, often varying by a factor of between 100 and 6,000 (sulphur compared to pyrethroids).

As a result of this difference in inherent activity of different chemicals, a broad comparison by weight of active ingredient is of limited value. However, in the absence any other parameter, and consistent with other pan-European studies, this measure has been used for the purposes of the present sub-Report.

Applying this method demonstrated that fungicides dominated that chemical load in all crops except wheat. In potatoes, apples and vines, season-long disease protection is required. Given the chemicals available, this necessitates a series of prophylactic treatments throughout the season. In wheat on the other hand, which shows relatively modest total chemical loads, herbicides were the major contributor, and fewer applications are required compared to the other three crops.

6.3.2 Provisos

The great range of chemical loads presented in the Table above are explained by differences in inherent activity together with the agronomical factors elaborated in Section 6.2.3 below. In addition, however, the following general factors governing variability were also found to be of significance:

(a) Managerial Expertise

Specialists emphasised the effect that good management can have on pesticide use. This covers particularly the choice of chemicals and the timing of applications. A mistimed application can lead to spiralling pest infestations later in the season and result in a requirement for excessive remedial use of chemicals as a consequence.

(b) Pest-Incidence and Infestation Levels

The sub-Report examined the incidence of major pests at farm and regional level. It was not felt possible, however, to determine the differences in intensity of infestations between farms.

(c) Control Achieved

It was not felt possible to measure the level of control achieved by different pesticide application regimes. For example, farms using lower levels of pesticides may have achieved lower levels of control of the pests.

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[79] Chemical load is the cumulative weight of active ingredient applied per hectare of crop per farm.

(d) Agronomic Variables

The following agronomic variables were found to have a substantial influence on pesticide use at both a farm and regional level:

- Crop types

  This is primarily of significance in potatoes. In contrast to ware (which has a long growing season, requires blemish-free produce, and therefore results in high fungicide use) seed has a shorter growing season, and hence requires less disease protection. High levels of insecticide applications are necessary, however, to control the aphid virus vectors. Starch is a lower priced and lower input crop.

All crop types may be grown on the same farm and the most sensitive crop type may dictate the regime for the whole farm in order to reduce reservoirs of infection. This attitude may be taken at times for all the crops studied.

- Varieties

  Variety choice is determined by end-use market demand. Only as a second priority are disease and pest susceptibility considered. In all crops, varieties differ markedly in their susceptibility to disease, attacks from insects, nematodes, *etc.* the need for growth regulators and, in the case of potatoes, for desiccants. As with crop types, in certain circumstances for diseases and insecticides, the most susceptible variety on a farm can determine the spray regime.

In many instances, crops in a region are dominated by a single variety often susceptible to particular diseases. It is suggested that widening variety shares would lead to considerable easing of the pesticide load. However, this in turn is determined by market demand.

- Target pests and level of pest control required

  The target pests were clearly the determining factor in chemical use. The technical levels of control required varied in relation to both pest and crop types (aphids in seed potatoes or ware, *etc.*). In relation to the levels of control required by individual farmers, weed control resulted in the greatest variation, showing considerable differences from region to region in their willingness to accept less than complete weed control.[80]

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[80] This was particularly marked in relation to vines in Verona, whose farmers were least demanding in the levels of weed control sought.

- Treatment timing

  In all crops and in all the regions, an official warning system exists to help time the start of applications against major diseases and insects. Some of the systems are less than optimal or geographically restricted and more sophisticated techniques are being developed. Farmers make use of these systems to varying degrees, in many cases employing them alongside less targeted techniques, such as crop stage or date. It was felt that this area could be developed with advantage to assist improved targeting of fungicide and insecticide use and reduce any unnecessary treatments.

- Dose rates

  Dose rates generally followed recommended rates except in wheat, where considerable reductions were made in herbicides and fungicides, and in potatoes with herbicides. Specialists felt, however, that this practice had reached its maximum utility.

- Application volumes and dose rates

  For fungicide and insecticide applications in apples and vines, volumes of spray applied per hectare increase throughout the season as the leaf canopy develops. Differences in planting density, crop height and training architecture also influence spray volume per hectare, while seasonal average volumes of application were found to vary substantially.

Chemical dose rates are generally given in concentration of product per volume of spray mix, though for vines in France this is only partially practised. Given the variation in spray volume used, it is suspected that some unnecessary use of chemical is therefore occurring.

- Herbicide placement

  In the perennial crops, application of herbicides along the crop rows was widely practised, although variations occurred between farms and regions, suggesting that there remained some scope for increasing this practice and further reduce the herbicide load.

- Part-crop spraying

  In all crops and chemical sectors, targeted spraying of parts of the crop most prone to or infected by a pest were evidently undertaken. This practice varied widely and, it is suggested, offers opportunity together with closer crop monitoring to wider exploitation.

- Mechanical weed control

  While practised specifically only in relation to potatoes, this technique tentatively resulted in lower use of herbicides where used. It should be noted, however, that soils vary considerably in their ability to benefit from this technique. Most widely

practised in East Anglia, it is under further development there (and in Flevoland for potatoes).

6.3.3 Crop Economics and Pesticides

The majority of farmers felt that the profitability of their crops was satisfactory or above in most crops and regions in the study year (1994). However, for wheat in Hannover and apples in S.E. France and Trentino, the majority of farmers were dissatisfied with their profitability. Anticipated levels of profitability for a given crop had no influence, however, on product choice or use for the great majority of farmers.

The chemical sector considered by farmers to have the most significant contribution on profitability was fungicides in all crops and regions, with the sole exception of apples in the Lerida (E) where insecticides dominated. Farmers were divided as to which sector contributed least in wheat and potatoes, although in apples and vines herbicides were identified as of being of least influence of profitability.

The majority of farmers in all crops and regions felt that no reduction in chemical use would be possible without reducing profitability. The minority which did feel reduction without loss of profitability was possible tended to refer to fungicide use in apples. It is worth noting that consumer demand for blemish-free quality produce (particularly in relation to potatoes, apples and vines) makes growers of these crops particularly risk-averse.

6.3.4 Pesticides and the Environment

(a) Product Labeling

In all regions, a large majority of farmers believed that label restrictions on handling and the environment were important or very important with regard to their choice and use of products. It should be noted, however, that in some sectors local specialists felt unable to accept that that these responses were genuine.

(b) Environmental Factors Influencing Product Choice

Consideration for environmental factors when choosing pesticides was not high on the agenda of most farmers. Wheat farmers paid greatest attention to these factors in Hannover and Piemonte (largely for reasons related to ground water considerations). In relation to potato growing areas, environmental factors were accorded most importance by farmers in Lüneburg. In the apple regions, only farmers in Trentino demonstrated reasonable consideration for factors of soil protection, ground and surface water. For vines, farmers in the Verona area demonstrated the greatest attention to environmental factors, in particular for soil protection.

(c) Alternative crop protection systems

Aspects of Integrated Crop Protection Management (ICM'), Integrated Pest management ('IPM') and Organic Production ('OP') methods were discussed with farmers. Replies were unsatisfactory as terminology appeared to be interpreted in a variety of different manners or not understood at all (although definitions were provided during interviews). It appears nevertheless that ICM or IPM techniques are practised, or under development to one degree or another in all crops and regions (in particular in relation to apples and vines).

In relation to apples, Trentino is noted for its local IPM/ICM protocol, the effects of which are very positive when compared to other regions subject to this study. In relation to vines, local trials in Rioja have demonstrated that improved adherence to advisory/warning systems can halve the number of fungicide applications.

It is evident that there is undoubtedly scope for these systems to be more widely introduced. However, they require significant commitment and technical awareness on the part of farmers and growers as well as considerable support from the extension network, a conclusion supported by the other sub-Reports summarised above.

6.3.5 Opportunities to Reduce Chemical Loads

In the light of the foregoing summary across crops, the following opportunities for chemical load reduction are proposed for the main chemical sectors:

(a) Seed Treatment

This is a low dose, environmentally sound way of plant protection which, with recent technological innovations and chemicals, now offers enhanced protection. It can reduce the need for early field applications of fungicides and insecticides. Pre-storage treatment of potatoes can in addition be substantially reduced through use of cold storage techniques.

(b) Herbicides

Dose rates are reported to be at a minimum in all crops, although particular opportunities for reduction in chemical loads applied to wheat are suggested to arise through increased use of selective targeting of fields. This can be assisted through greater use of the newer post-emergence chemicals now available, increased use of mechanical weed control where soils permit in potatoes, and continuing the move away from residual soil acting herbicides in favour of contact acting chemicals in apples and vines. Increased use of treatments along the crop rows would also have benefits in some vineyards.

(c) Fungicides

Varieties differ considerably in their susceptibility to diseases. This factor, however, is of a secondary priority to suitability for the end-user and so choice is considered to be consumer driven. In relation to potatoes in particular, the most dominant varieties are especially susceptible to disease. In the short term, reducing this dominance would help reduce fungicide requirements. In the longer term, newer breeding techniques may be able to marry up end-user demands with disease resistance. Influencing the consumer to accept some skin blemish would also help.

In all crops, increased use and continued development of disease warning systems would help to better target treatments and reduce load, although certain of the systems under development are some way off practical application. In apples and vines the optimisation of spray volumes would appear to offer additional opportunities for reducing unnecessary load.

(d) Insecticides

As with fungicides, increased use of local warning systems could tighten up use in all crops. Extension of IPM/ICM techniques, particularly in apples and vines, could also reduce load as would the optimisation of spray volumes.

SECTION 7

Further analysis on presence of residues and impact of plant protection products in the E.U.

(Sub-Report prepared by Soil Survey and Land Research Centre ('SSLRC'))

7.1 INTRODUCTION/SUB-REPORT OBJECTIVES

Given that a synthesis Report of 100 pages does not allow for inclusion of a detailed breakdown of results for this sub-Report (which appear in the full text by region as well as by Member State) reference should be made to the full text for information addressing specific factors such as climate, geology, soil, relief, water use/quality and agricultural use generally. Monitoring strategy and sources of data must also be found in the full text. The following pages seek only to draw out the most salient findings, conclusions and recommendations to this sub-Report. It is accepted that the results presented for individual Member States differ in length. This is largely to differences in availability of data.

The objectives of the sub-Report were identified as follows:

- to provide a more detailed overview of monitoring data on pesticides in the environment related to use patterns;
- to describe qualitatively various routes of the emission of pesticides into the environment and their importance, as well as to provide quantitative information on these emissions;
- to generate as far as possible data on effects of pesticides in the environment. If such data were only limited, reasons and implications should be addressed;
- to make recommendations with priorities for future monitoring strategies designed to protect environment.

7.2 METHODOLOGY/INITIAL REMARKS

7.2.1 Use of Plant Protection Products

Each collaborating country confirmed the registration status of the 12 active substances, and usage data from the draft Landell Mills sub-Report summarised for each crop and country. No active substance chosen for this study was applied at similar rates in the different regions, nor was the area of land treated consistent between the regions. Interpretation of environmental monitoring data to derive specific fate pathways was further complicated by the fact that many plant protection products are not crop specific.

It was concluded by the authors of the sub-Report that the original objectives of the study could not be met, for several reasons:

- studies to determine presence and impact of PPPs at regional level are too large if the objective is to understand processes, quantify losses and determine potential impacts, but should rather be conducted at a field or catchment scale;
- some regions had no available residue monitoring in place, and therefore no data were available;
- monitoring data was on several occasions classified as confidential;
- time and budgetary conditions prevented a study of all regions studied in the sub-Report prepared by Landell Mills.

7.2.2 Monitoring Data[81]

The EU pesticide monitoring database is held at Silsoe, UK, and currently contains 73,000 records from five countries. Time and budgetary constraints within this sub-Report have precluded further analysis of data but the structure and information within the database will allow future users to benefit from the considerable effort required to develop this information set. The monitoring data presented in this document cannot therefore provide a true indication of real environmental concentrations for any given active substance and hence the amount of exposure to non-target organisms, but simply provide 'snapshots' in time which must be related to previous and prevailing agroclimatic conditions for interpretation.[82] Until sampling strategies are designed to assess environmental impact it is considered to be dangerous to make evaluations on only a restricted number of detections.

7.2.3 Field Monitoring

Impacts of plant protection products on non-target organisms were divided into different categories according to the dose and severity of damage (Sheehan et al (1984)): acute toxicity causing mortality; chronically accumulating damage causing death; sub-lethal impairment of various aspects of physiology and morphology; sub-lethal behavioural effects; measurable biochemical changes. These impacts can all be ecologically significant since they can all have cascading impacts on communities and ecosystems. To determine whether a plant protection product has an impact on the

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[81] Data were also provided by the agrochemical companies on fate and behaviour in the environment. Basic information like laboratory degradation, sorption and mobility were made available to the project. The authors of this sub-Report have not, however, presented any of this information as the project investigations demonstrated that there was in fact insufficient field monitoring data available. The review did, however, demonstrate that it is company dossiers which provide the most comprehensive source of information available.

[82] For the purposes of this project the *maximum* detected levels in any crop or region for each country for all surface water types and groundwater were assessed. It is accepted by the authors of the sub-Report that summaries of this kind may be biased in that little detail is available on the origin of the detection, dilution, duration or frequency. Data do however provide a worst/extreme case for assessing potential exposure to non-target organisms.

ecosystem it is necessary to know a great deal about the functioning of the ecosystem. Such knowledge is scarce and many ecotoxicological studies only provide rudimentary knowledge of basic structure and function.[83] It can be concluded from the sub-Report that the impact of a specific active substance or even plant protection products *per se*, could not be easily assessed because of the multitude of factors influencing the ecosystem.

7.2.4 Quality Standards

The health and environmental quality standards for a large number of active substances have been tabulated and are not reproduced here due to considerations of space. These may be therefore be found in the full sub-Report.

7.2.5 Impacts on Non-target Organisms

Potential impacts on non-target organisms are commonly assessed by calculating toxicity exposure ratios (TERs) or comparing toxicity with health or environmental quality standards or advisory limits *e.g.* EQSs or MTRs. This type of assessment often uses the lowest effect level for the most sensitive species. Maximum detected concentrations are reported in this sub-Report. A summary of this kind is biased in that the most sensitive species is quoted regardless of its potential exposure and some dossiers presented a wider range of non-target organism studies and a range of effect levels. Further breakdown of these results may be found in the full text of the sub-Report.

The Sections below set out in brief form the operation of pesticides policy and practice in selected Member States, and summarises the main conclusions and recommendations drawn from the sub-Report.

7.3 FRANCE - RÈGION CENTRE[84]

7.3.1 Summary Findings

The tonnage of active ingredients applied (95,000 tons in 1995) makes France the heaviest user (by quantity) of PPPs in the EU, although this may be partially explained by the importance in France of arable land use.

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[83] A literature search in preparation of the sub-Report showed that numerous studies have been carried out to determine impacts of specific pesticides on non-target organisms in restricted situations, although the number of studies which actually occurred in the regions investigated was limited, and not necessarily related to the normal use of the product in a defined usage area. The origin of the contamination, pathways, quantification and relationship to environmental concentrations could therefore not be derived within the scope of this study.

[84] For the Règion Nord-pas-de-Calais and the Règion de Bordeaux permission to publish confidential information was denied. For the Languedoc Règion as yet there is no information available on pesticide applications on apples. In addition, for both soil and water no research of residues was been executed in the Languedoc region.

Since the end of the 1980s France has engaged in monitoring of pesticides occurrences in water, and in creating the administrative, scientific and financial means required for this research. Regional organisations such as the GREPPES in the Règion centre have also been established to improve monitoring.[85]

From this study of the pollution of water and soils by wheat pesticides in the Région Centre, a region in which groundwater is the most important system, it was concluded that pesticide residues are indeed present in water, although their presence seems to be more important in surface water than in groundwater. It should be noted, however, that the monitoring in surface water took place after application periods, when the risk is particularly high. Interpretation of surface water residues therefore seems particularly complex.

The occurrence of pesticide residues in water appears to depend on several factors, including the geographical region and the intensity of wheat production. In addition, it became evident that results have to be viewed in their annual meteorological context, especially for surface water. Similarly, the results of groundwater sampling must be considered in their hydrogeological context, the depth of the water table, the direction and velocity of its flow and the location of the boreholes in the watertable.

It can be seen that groundwaters are particularly important resources for consumption in the region studied. The occurrences of pesticide residues in surface water seem more frequent than in groundwater, but rapid variations and the choice of particular sampling periods must be taken into account. The lack of information is one limit of the study. Although data are available about soil residues at present, ecotoxicological impact of plant protection products may only be taken into account in the future, when water quality monitoring is available.

From a methodological point of view, if the evaluation of the risk of pesticide occurrence in water mainly by using index is left aside, this sub-Report demonstrates the necessity of an analytical approach, integrating the different and interdependent layers of information in order to residues in water. A very precise and dynamic hydrogeology knowledge is, however, considered necessary to explain pesticide occurrences in groundwaters (variation of transfer between different stratigraphic layers).

In relation to other crops, cereals - especially wheat - chosen for the Région Centre study, it appears that neither the administrative region nor the wheat area can be considered a whole, while a small catchment areas risks being insufficiently representative, leading to the conclusion that one should distinguish in a region several subzones in which crop extension, climate, soil and subsoil can be considered as homogeneous.

The author of the sub-Report accordingly concludes (see below) from this a need to continue the study, and to adapt the soil and water monitoring for a more scientific knowledge of the pathways.

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[85] It should be noted that the majority of the results of detailed studies for the Règion centre had not yet been published when this sub-Report was prepared.

7.4 GERMANY

7.4.1 Background

The total inland sales of pesticides are notified to the 'BBA' and published annually. Although the overall amount of different categories can be obtained, data for single pesticides or active ingredients are confidential. Herbicides have for many years been the main portion of all plant protectants used in Germany, followed by fungicides. Because of the cool climate, insecticides play only a minor role.

About 50% of a total area of 35.7 million ha is under agricultural use. Cereals, maize, sugar beet and rape are treated to about 80 to 95% with herbicides, potatoes to about 50% (Hanf 1987 in Pestemer 1991). Fungicides are used mainly in potatoes (about 70% of the area), cereals and rape (about 40). About 95% of the rape area is treated with insecticides and about 50% of the sugar beet. In the other crops the percentage is about 20% or even less.

Authorisation is given in Germany not for an active ingredient, but for each formulation, as the permission to sell a PPP for use in agriculture. Residue behaviour is a very important aspect during the evaluation procedure and is covered in many parts of the procedure, such as behaviour in soil, water/sediment systems and air (BBA 1993). In relation to ground water, if average leachate concentrations > 0.1µg/l in lysimeter studies authorisation is not given. For active ingredients showing slow degradation in soil (10% active ingredients. or metabolites left in the field after 1 year) authorisation may only be given after comprehensive risk-benefit analysis. Insufficient degradation in air (DT_{50} in air > 2d) in combination with bioaccumulation potential or adverse use pattern and slow degradation in the other compartments leads to a negative assessment and a comprehensive risk-benefit analysis.

In Germany no nation-wide monitoring programme for drinking, ground or surface water has been established so far. Supervision of water quality is a responsibility of the 'Länder' (states), but not all have water monitoring programmes. Since 1985 several states have carried out investigations to determine water quality regarding pesticide contamination. Most of these however have been single investigation programmes, and in most cases samples were not taken on the basis of a fixed schedule which could give an overview of the situation in the whole area. Most programmes concentrate only on specific problem areas, such as surroundings of storage dams or regions of intensive agriculture. The results of the data should therefore be used only to provide an impression.

Recommendations and target values are published by several organisations, such as the International Commission for Protection of the River Rhine in 1993 (IKSR 1993, as cited in Irmer, 1994). For the risk assessment for aquatic life standard test results for four categories of organisms are included green algae, daphnia*etc.*, fish and degrading bacteria.

To protect fishery, bioconcentration factors are used to estimate the potential concentration of the chemical in fish, which should not exceed the limit for the pesticide as stated in the German regulation on maximum residue limits for nutritional

products. For the abstraction of drinking water, the EU-drinking water limit of 0.1 µg/l is used.

Although limits for pesticides in soil have been established by several communities, they are used mainly to assess contaminated former production sites within urban areas. Therefore the approach is usually to define limits for different use patterns, such as sensible uses (home gardens, children's playgrounds, ground water protection areas), or restricted use (industrial areas). These guidelines are not applicable for agricultural soils, since the limits go down to 0.25 mg/kg soil and no guidelines are given concerning the time between soil sampling and application of pesticides.

Since 1989, the results of all investigations on pesticides in drinking, ground and surface waters should be reported to the Umweltbundesamt ((Federal Environmental Office - 'UBA') by water companies and the states. The latest statistics available from the UBA however contain data only up to the end of 1994. During this time, about 331,000 analyses have been reported for about 250 actives and metabolites. Although not all states report their results every year, about 70,000 single values are collected every year (Wolter 1995). These data are in most cases separated into the categories drinking water, ground/well water and surface water including bank filtrates and groundwater enriched with surface water.

Of all reported analyses, 91.3% were not contaminated by pesticides although this figure is decreasing since the beginning of data collection (end of 1990: 87.1%). In 2.4% of the reported analyses single pesticide concentration exceeded 0.1 µg/l. This figure has decreased from 5.1% in 1990. 74% of all analyses alone contribute to about 23% of the analyses and to about 70% of all findings, although the use of atrazine was banned in Germany in 1991.

By the end of 1992, 38.6% of the reported findings were from ground and well water, 23.4% from surface water and 38.7% from drinking water. Since only the positive findings were classified according to their origin, it is not known how all analyses were distributed over the water sources. Atrazine, simazine and desethylatrazine were still the most frequently analysed compounds with about two thirds of all findings, in ground as well as in surface water.

It is very difficult to identify any pathways or explain the occurrence or non-occurrence of certain chemicals in water, because no information upon location of the findings and upon use in Germany overall is given. Monitoring programmes often seem not to be adapted to the frequency and amount of chemical use and therefore results and conclusions may be biased.

7.4.2 Conclusions

The collated data are based on an annual pesticide usage in Germany of about 30,000 t. The investigations revealed that monitoring programmes for pesticides in water exist, but that it is very difficult to obtain data for the analysis of pathways and problem areas. Many findings, especially in rivers, are not related to agricultural use, but to industrial production.

The most comprehensive data base existing in Germany, set up by the UBA contains data from the whole country, but exact locations or time of sampling are not supplied. It is not therefore possible to further define problem areas.

Several monitoring programmes were single projects, sometimes running over two years, sometimes samples were taken just once. For detailed investigations trends in water contamination would be valuable which cannot be found without continuous programmes.

Water quality is the responsibility of the states of Germany and therefore regional differences occur in data availability, although a need is identified for coordination of the monitoring programmes which are conducted.

Detailed information about cropping in the different areas is probably available but within the short duration of the project it was not possible to get data other than for a greater area than those selected. It is even more difficult to find data about pesticide use. All such data are collected by agricultural offices not related to water quality monitoring at all. Therefore a joint evaluation of statistical records upon cropping, agricultural use of pesticides, soil and climate is necessary on a regional basis.

The compounds monitored are not always those used most frequently. Often it seems as if water authorities set up monitoring programmes rather by the number of pesticides analysed than by their agricultural importance. Therefore findings may reflect a biased picture, and monitoring programmes should be oriented more towards pesticide use patterns.

7.5 ITALY

7.5.1 Background

The analysis of data relating to agricultural use of chemical products in agriculture over the last twenty years shows a large increase in the intensity of use, even though in the second half of the nineteen eighties a reduction began to appear. This overall trend towards rationalisation seems to follow different paths according to the predominant land use and the extent of technical innovation. On a regional basis the intensity of use both of pesticides and fertilisers are on average higher in the North compared with Central and Southern Italy (between 50 and 100% higher) because there are better weather and economic conditions.

Drinking water is the only environmental compartment to be monitored by law (Article 12 of D.P.R. 236/88) for pesticides contamination, with a frequency that depends on the population number that draw from wells. For a single pesticide the limit is 0,1 µg/l, and for a total of pesticides the limit is 0,5 µg/l.[86]

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[86] Greater detail concerning specific Italian legislation relating to water quality, pollution by dangerous substances, use of slurry agriculture *etc.* may be found in the full sub-Report (see, *inter alia*, pp. 5.3-6). It should be noted, however, that in a number of instances, parameters used in monitoring areas such as fresh water quality and slurry use, do not include pesticides.

At the time the sub-Report was prepared, there were no national laws or regulations concerning the control of residues of pesticides in soils, and the only normative regulations in force in Italy were those of the Toscana Region. This plan considers soil standards as well as water (ground and surface) standards. During 1993, however, there was no lack of initiatives for controlling the use of chemical products in agriculture. In application of the Directive 676/91 on the protection of waters from pollution due to nitrates of agricultural origin, the first 'Code of correct agricultural practice' was prepared.

An important initiative was also taken by the Ministry for Agriculture concerning control of the effects of the use of chemical products in agriculture through the establishment of a national network for monitoring residuals of chemical products for agriculture. The lack of a systematic national monitoring programme has been overcome by decree D. lgs. 17 March 1995, n. 194, applying the principles of pesticides registration of Directive 91/414. In particular, Article 17 provides for official controls on trade and use of pesticides and their impact on human health and on environmental compartments. Moreover, paragraph 21 of article 5 of the same law, provides for the identification of 'vulnerable areas'.

Italian pesticide policy concentrates exclusively on the quality of drinking water. The most contaminated area are those in the rice-crop areas in Piemonte and Lombardia regions (Vercelli, Novara and Lomellina), and some areas near the Po delta (in addition to some more localised areas).

7.5.2 Conclusions

In preparation of its sub-Report, Landell Mills selected three Italian Regions (Piemonte, Veneto and Trentino Alto Adige) on the basis of pesticides use and on the dominance of wheat, vine and apple growing respectively. Nevertheless, for Piemonte and Veneto regions smaller and more homogeneous areas (Provinces of Alessandria and Treviso) were studied as they cover more than 50% of the whole regional cultivated area with respective corps. On the basis of data on farm management, it is apparent that it is impossible to characterise a 'specific' apple crop area, as apple and vine crops are nearly equally widespread on all regional territory.

Statistical data from a draft version of the Landell Mills sub-Report were the starting point to provide the relation between the use and the presence of plant protection products. However, in the opinion of the authors of the present sub-Report, these did not suit those utilised in the study areas. Moreover, some active ingredients reported in Landell Mills list did not reflect real use. For these reasons the average AI gr per ha was calculated with reference to the whole crop area. These values are obtained from multiplying the base active area treated (ha) by the average number of treatments, and by the crop area grown. This rough estimate represents more efficaciously the real active ingredients distribution in the whole area.

A national authority for pesticides use in agriculture, horticulture and non-cropped land is lacking, as well as a national up-to-date database on monitoring results for the different environmental compartments. Statistics on the total sale of pesticides in Italy are available but they are not indicative for a toxicological and ecotoxicological

assessment because they relate to the entire Italian territory and they are not specific for single active ingredients. Statistics on farm pesticides use are completely absent. On a regional basis the intensity of use both of pesticides and fertilisers are on average higher in the North compared with Central and Southern Italy (between 50 and 100% higher) because there are better agronomic conditions.

Climate, soil, geology and agriculture conditions are very different within Italian regions. In general there are no specific studies on geological and hydrogeological characterisation of the selected areas and generic information only can be extrapolated from national or regional maps.

The collection of data is not centrally co-ordinated, and there are no national laws relating to the control of residues of pesticides in soil. Surface and groundwater are the only environmental compartments to be monitored for pesticides contamination for drinking purposes, although data on pesticide detection in water is scattered among the local health authorities. In Italy there is a lot of data available but they are very difficult to compare because they are not homogeneous. In particular, it is evident that herbicides are researched more than fungicides and insecticides, and monitoring programmes are mainly concerned with quality only of potable water. The number of pesticides researched also varies significantly from region to region.

In the apple region examined, insecticides are more often detected (20) than fungicides (13). Only three herbicides were detected (although given that 8 of these insecticides are not used for agricultural purposes, the impact of the insecticides and fungicides is the same). In vines and wheat regions only herbicides (mainly for maize and rice) are monitored and detected. It was noted that vines and wheat regions have few data on pesticides included in the list identified in the Landell Mills sub-Report (3 of 42 pesticides for vines; 3 of 39 for wheat; whilst in apple region 36 of 45.

Of those 3, one insecticide was never detected and just two herbicides are found: metolachlor (3.7% of samples over the detection limit) and terbuthylazine (5.3% of samples over the detection limit). In the wheat region studied none of the 3 pesticides were detected. Of the 36 pesticides for the apple region studied, 13 (31%) were detected.

The vines region had only 9 pesticides comprehensively researched but a notable 25% of samples over the detection limit. In other regions ground water samples are frequently without pesticide residues whilst in surface samples there are a maximum of 5% of samples higher than the detection limit. This limit value of contamination of surface samples is confirmed from Ferrari data, which also analyses Po river samples. In the apple region the Landell Mills-selected pesticides detected are 0.5% of total samples and 0.09% is more than 0.1 µg/l.

Of the 12 ecotox pesticides, 9 are researched in the apple region and one (isoproturon) in the wheat region (none in vine region). Of the 9 ecotox pesticides, 5 are detected in surface water and sediment and often with concentration more than 0.1 µg/l. Azinphos-methyl (3.8%), pirimicarb (5%), chlorothalonil and dimehoate (7.3%), methaloxyl (1.3%) are frequently detected in surface water. MCPA, aldicarb and propiconazole were never detected and mancozeb only in sediment samples (32.5% of

samples). In addition, azinphos methyl was on one occasion detected in sediment samples (8.4 µg/kg). None of these pesticides, however, were detected in ground water samples. In the wheat region, isoproturon appears not to be detected at all. These data were therefore felt not to demonstrate evidence of any systematic contamination of surface water or sediment samples.

The main pathway for the movement of residues to surface waters was identified as the rapid movement following rainfall (*via* runoff, drains and subsurface lateral flow through the soil). This occurs for the most part immediately after treatments between May and July. Ground waters are contaminated mainly in spring area and the main pathway could be leaching through sand or gravel zones, although probably contamination of ground waters is a slower process. It is also easier to find metabolites than parent compounds.

7.6 THE NETHERLANDS

7.6.1 Background

Until the period 1984 - 1988 (the reference period for the Dutch long term crop protection plan) there was an increase in the use of PPPs in the Netherlands. Since that period the amounts used are declining drastically (largely attributable to a reduction in use of soil disinfectants dichloropropene and metamsodium).

Figure 1 - Estimated overall use (kg * 1000) of plant protection products

Pesticide	1984 - 1988	1995
soil disinfectants	12,700	2,500
other pesticides	10,000	10,800
Total	**22,700**	**13,300**

Source: Anonymous, 1995

Figure 2 - Sales of pesticides for 1991 by product group

Product Group	Sales
herbicides	3,312
fungicides	4,281
insecticides and acaricides	594
nematicides	7,679
other	1,440
TOTAL	**17,306**

Source: ISBEST (Merkelbach, et al. 1993)

Figure 3 - Average use of active ingredients in the main crops for 1992 (excluding the soil disinfectants)[87]

crop	kg active ingredient
winter wheat	6.0
barley	2.7
seed potato	24.6
ware potato	23.5
starch potato	11.7
sugarbeet	7.0
fodder maize	3.3

Source: Poppe et al., 1994

Pesticide registration has been regulated in the Netherlands since 1962. Since 1993, an independent board (Board for the Registration of Pesticides (in Dutch: College voor Toelating van Bestrijdingsmiddelen)) is responsible for the registration of pesticides, subject to national policy by using evaluation procedures and decision criteria laid down by the Ministries. Environmental monitoring in the Netherlands is spread over a large number of institutions and (private) companies (including drinking water pumping stations).

Dutch national policy in relation to general Pesticide Policy is laid down in the so-called 'Multi-year Crop Protection Plan' (LNV, 1991), which established the targets[88] of: reduction of the structural dependency of agriculture on chemical agents for crop protection; substantial reduction of the use of chemical agents in crop protection; reduction of the emissions of chemical plant protection products to environmental compartments by more than 50% for air, more than 75% for soil and groundwater and more than 90% for surface water.

Environmental quality standards had not yet been set for all registered pesticides at the time this sub-Report was prepared. Crucial elements in setting the quality standards are the Maximum Tolerable Risk Levels[89] (MTR) for the soil and surface water environment, and the 0.1 mg m^{-3} concentration level for the groundwater. 110 indicative MTR values (iMTR-values) for surface water given by Teunissen-Ordelmann and Schrap (1996) are currently under review.

Pesticide registration procedures follow closely the principles laid down in Directive 91/414. Pesticides are widespread in the Netherlands. Tabular breakdowns of

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87 The use in some bulb and flower crops may be somewhat higher, however. If the soil is disinfected, an additional 30 - 40 kg per ha should be envisaged (while soil disinfestation takes place once each four years at a rate of approximately 150 kg per ha).

88 Target values mentioned are for the year 2000, while the reference period is 1984 - 1988.

89 MTR are concentration levels in the environment that supposedly have little effect on the integrity of the ecosystems. MTR values are calculated from (No Observed) Effect Concentration of plant protection products on environmental species (mostly fish, algae and daphnids).

measured concentrations of pesticides (active ingredients) found in soil, groundwater, drainwater, surface water and sediments may be found in the full sub-Report.

Apart from diffuse emissions to groundwater and surface water (which have repeatedly drawn the attention of the authorities) some illustrative examples of pollution problems which have occurred in the recent past, and which forced companies to take corrective action include:

- the occurrence of pesticides in the river Rhine (to some extent due to the production of the pesticides), which forced drinking water companies to install additional filtering capacity;
- the occurrence of successively atrazin, diuron and glyphosate in the river Meuse (to some extent due to the use of these compounds in public green areas and on pavements), which caused temporal cessation of the intake of surface water;
- the occurrence of 1,2-dichloropropane in raw water (groundwater) of a drinking water pumping station in the province of Drenthe, which caused the closing down of several wells of this pumping station;
- the occurrence of ETU in raw water of a pumping station near the Hague, which was one of the reasons for the prohibition of bis-dithio-carbamate-fungicides in the area around this pumping station.

Few studies exist which relate effects (impacts) to occurrences of pesticides in environmental compartments, and most such studies refer only to illegal use, spillage or improper cleansing of equipment. Chronic exposure cannot therefore be inferred from the monitoring measurement performed and more dedicated monitoring is therefore recommended.

7.6.2 Conclusions

Pesticides can be found regularly in all environmental compartments. Leeching, spray drift and drainage are the most dominant processes that are responsible for the contamination. Spraydrift is dependent on the crop and the application techniques and may be related to the use of pesticides. In sandy areas, presumably chromatographic transport to the groundwater occurs, and this may lead to leaching of, for instance altrazine, bentazone and dichloropropene. In clayey areas additionally transport may occur due to preferential flow. As artificial drainage is more frequent in the clayey areas as compared to the sandy areas, drain water in these areas might contribute to the load of the surface water. In general, however, concentrations will be lower that those resulting from spray drift. Run-off might also occur occasionally in the Netherlands. More research is necessary on the transport routes to groundwater and surface water.

A national up-to-date database on monitoring results for the different environmental compartments is lacking, and it is recommended to establish such a database.

Impacts of pesticides in environmental compartments might be inferred from the comparison of monitoring data with MTR values. MTR values may be calculated from data enclosed in the registration dossier. A national view combining monitoring data with associated impacts is also absent, although the conclusion is drawn that

current Dutch pesticide policy is in line with the European policy as laid down in Directive 91/414.

7.7 SPAIN

7.7.1 Background

The use of pesticides in Spain has increased since the 1950s, particularly since the 1980s. From the historical series of consumption per class of pesticide it can be seen that the increased use of insecticides matches the use of herbicides in recent years. Waste per unit of surface is very variable, there being a clear difference between the wet regions (the littoral and the river basins) and the dry lands (the Meseta, Aragon, and Extremadura). Valencia, La Rioja and Murcia, are the communities which use higher doses per unit of surface.

There are few studies on pollution by pesticides in groundwaters in Spain. This lack of systematic information has therefore hindered a complete characterisation of this type of pollution, although a breakdown of the total use of pesticides and herbicides in Spain (by millions of pesetas) is provided in the full sub-Report.

Problems appear in the zones of greater consumption of these products. When these zones coincide with vulnerable hydrologic areas - as happens in Valencia - the potential risk of pollution in the aquifers site is considerable. In spite of apparent discrepancies concerning the location of responsibilities for the environment, and with regards to the use of pesticides, there appears to be good co-ordination within the National Working Groups on Pesticides, which hold periodical meetings attended by specialists of the official agencies of each Autonomous (Regional) Government. The records of the pesticide products are regulated by the Ministry of Agriculture, Fisheries and Food, and as their staff attend all the meetings of the various Working Groups, they appear entirely conscious of the potential incidences about pesticides, as well as the advances in pest and weed control.

Working Groups are composed by public officials that advise on the integrated control of pests, and cast light on works on plant material residues; *i.e.*: in recent years, and due to the characteristics of exports of part of the Spanish agriculture, emphasis has been put on the analysis and control of pesticide products residues on fruit and vegetables, either for export or for domestic consumption. However, in these Groups, the impacts on soils and waters of the pesticides have not yet been studied in depth. Other research institutions as the CSIC (Upper Council for Scientific Research); I.N.I.A. (National Institute for Agricultural Research); and Universities are now also studying specific problems of environmental impact of pesticides.

The pesticide industry has a common organisation named Spanish Pesticide Association (AEPLA), while growers associations are of crucial importance in Spain, due to their control over the quality of their produce, and because they have technicians trained in various topics such as integrated pest control, in minimising the environmental impact and quantity of PPP use.

The waste per unit of surface is also very reliable. The highest inputs occur in Almeria (where use of green houses is widespread). Valencia, La Rioja and Murcia also use higher doses per unit of surface. The impacts on soils and waters of the pesticides have not yet been studied in depth.

By way of illustration, the Valencian Community (C.V.), in the East of Spain has an extension of 23,305 km² and an intensive agriculture with high commercial value. This region is formed by the provinces of Alicante, Castellón and Valencia. Valencian agriculture is notable for its important system of irrigation, mainly in citrus, winter vegetables, summer vegetables. Vineyards, almonds, olive trees and carob trees, prevail in the dry lands. Farm size is very small, and almost 50% of all farms are smaller than 1 ha. More than 80% are smaller than 5 ha. Sixty five percent of farms grow citrus or fruit trees. In citrus the use of residual and post-emergence-applied herbicides as well as insecticide treatment during spring and summers are very common. The irrigation period takes place from March to October and is done by using surface and groundwater. The frequency of irrigation is about 15 to 20 days during summer and doses employed range from 6,000 to 7,000m3/ha year.

An intensive agriculture is practised in the C.V., and the use of residual herbicides in citrus is a widespread practice due to their effectiveness and low cost. They are also used in the vegetable and rice fields. The CV is one of the first to actively research pesticide pollution. Herbicides above the maximum allowable concentration of the EU drinking water directive (EU 1980) are detected in shallow irrigation wells in citrus orchards with loam soils and old record of herbicide use. The samples of both soil and well water studies, have, however, been selected as worst situation. It is estimated that diffuse ground water contamination in Spain to date is not therefore considered a significant problem.

7.8 SWEDEN

7.8.1 Background

There are two different kinds of statistics concerning pesticide usage in Sweden. One is based on sales figures of active ingredients reported yearly by manufacturers to the Swedish National Chemicals Inspectorate. The other is based on interviews, carried out every second year, of about 4% of Swedish farmers and reflects the use of pesticides, the distribution between different crops, and the use of herbicides, fungicides and insecticides.

The total sale of pesticides to agriculture in Sweden during 1994 was 1, 961 tons of active ingredient, distributed between herbicides (1,551 tons), fungicides (280 tons), insecticides (41 tons) and seed dressings (90 tons). The total number of AIs registered in Sweden is ca 240, distributed among around 500 different products. About 35% of the AIs are registered for use within agriculture (35 herbicides, 16 fungicides and 13 insecticides, with an additional 10 pesticides used for seed dressing only). Some pesticides are also registered for use in other sectors of society (e.g. horticulture, forestry and/or industry), and this use is included in the sales figures.

The total use of pesticides within agriculture in Sweden during 1994 was about 1,150 tons of active ingredient, distributed between herbicides (880 tons), fungicides (225 tons), insecticides (25 tons), growth regulators (15 tons) and top killers (5 tons). The total crop area treated with herbicides was 45%, with fungicides 7% and with insecticides 14%. The average dose of active ingredient is 0.8 kg/ha for herbicides, 1.2 kg/ha for fungicides and 0.07 kg/ha for insecticides. Low-dose herbicides were used on nearly 50% of the total arable area, with a per hectare-dose of 0.004 kg/ha, whereas the average fungicide dose in potatoes was 7.5 kg/ha. About 50% of Swedish farmers use herbicides, fungicides or insecticides (as a mean for the whole country).

There are large differences between different regions, different crops and different sizes of farms. On farms with more than 100 ha of arable land, 85% of the farmers used pesticides. In the northern part of Sweden very little pesticides are used (less than 2% of the total use of pesticides), whereas 44% of the total use of pesticides can be found in the intensively cultivated two southernmost counties of Sweden.

There is no organised collection of data at a national level of detections of pesticide residues in water or sediment. The National Food Administration has the responsibility for food and drinking water in Sweden and there is an obligation for local authorities to report to them findings of pesticides in water intended for human consumption. However, reported findings are not accessible in a single database. The Swedish Environmental Protection Agency has overall responsibility for monitoring and surveying the environmental conditions of Sweden, but for the moment only persistent organic pollutants (*e.g.* PCB, DDT and HCH) are part of national monitoring programs. During 1988 - 1991 central Government money was allocated to enable the inclusion of pesticides into regional monitoring programmes, and was utilised in certain regions for monitoring surface waters. There were large discrepancies, though, between the different programmes. Since 1995 authorities responsible for monitoring at a regional level can apply for money to include pesticides into their programmes, but so far this has been done in just two cases.

The aims of the present pesticide policy in Sweden are to reduce the potential risks for the farmer/sprayer/operator, consumer and the environment and also to reduce the total quantity of pesticides used. During the five year period from 1986 to 1990 the overall tonnage of agricultural pesticides used in Sweden decreased by 47% compared to the 1980-1985 average. In June 1990, a governmental Bill was accepted by the Swedish Parliament with the aim of a further reduction of the risks and another 50% reduction of pesticides used in agriculture. This means that the overall result of the risk reduction programme in quantitative terms should be a maximum allowable use at 25% of the mean 1981-1985 quantity to be reached by 1996 (Bernson & Ekström, 1991). According to the latest information, the total use in 1995 was 29% compared to the 1980-1985 average, which means that the overall goal of a 75% reduction over a 10-year period may well be achieved (Bernson, pers. comm.)

Apart from a reduction of the quantities used, the implementation of the risk reduction policy also includes several other elements such as stricter routines for approval of new pesticides and reapproval of pesticides already used, improved spraying equipment and spraying techniques, improved and extended education and training of

sprayers and extended control of pesticides residues in food and drinking water (Bernson & Ekström, 1991).

Significantly, the reduction of quantities used achieved so far has not been shown to be critical in terms of crop production*e.g.* there has been no drop in cereal yields during the same period. The overall cost to the farmers has in addition been small, in some cases even economically beneficial when adopting reduced herbicide dose rates. Importantly, the ongoing governmental risk reduction program has also been adopted by the Federation of Swedish Farmers. Since Sweden is a small market there is only limited interest shown by the chemical industry to apply for approval of new pesticides as well as in maintaining old pesticides on the Swedish market in minor corps. (Bernson, pers. comm.)

The National Food Administration has adopted the view that pesticides should not be present at detectable levels in drinking water (National Food Administration Ordinance on Drinking Water SLV FS 1989:30, 1993:35), but no specific guidelines have been laid down. The term 'drinking water' refers to raw drinking water*i.e.* surface as well as groundwater intended for drinking water consumption. Assessment of health risks is carried out according to WHO guidelines as no Swedish guidelines exist for irrigation water or the protection of freshwater aquatic life.

Until the mid-1980s, little information within Sweden on exposure data for current-generation pesticides in surface waters was available. In addition, no specific water quality standards for either surface water, irrigation water or drinking water were established for commonly-used pesticides. During the late 1980's various programs, with somewhat varying objectives, were set up to improve knowledge of pesticide residues in surface waters. There are, however, large differences between the programs in the number of sampling sites selected, the number of samples collected and the number of pesticides included in the analyses of the water samples. A summary of the results of the different studies is provided in the full sub-Report.

7.8.2 Conclusions

There are large differences in pesticide usage between different regions in Sweden, different crops and different sizes of farms. In the northern part of Sweden very little pesticides are used, whereas almost 60% of the total use of pesticides can be found in the intensively cultivated two southernmost counties of Sweden. Apart from a reduction of the quantities used, the implementation of the risk reduction policy also includes several other elements such as stricter routines for approval of new and reapproval of pesticides already used, improved spraying equipment and spraying techniques, improved and extended education and training of sprayers and extended control of pesticide residues in food and drinking water.

The most frequently found pesticides in surface water are the commonly used phenoxy acid herbicides dichloroprop, MCPA and mecoprop, and the herbicide bentazone (with peak appearances at time of spraying). Findings are more obvious in areas of intensive agriculture, but were found to be dependent on rainfall events during and after application. Strong correlation was found between amounts used and frequency of detection and concentrations found (with the notable exception of

Atrazine, which is found even more frequently than might be expected, due to non-agricultural uses).

The sub-Report makes clear that good quality data on pesticide exposure patterns and characteristics are lacking. Continuous (as opposed to one off) testing is therefore recommended. In addition, the sub-Report identifies ceratin minimum background data for adequate evaluation of findings, namely: catchment size; land-use patter; soil type; precipitation; water-flow rate; amount and type of pesticides used and spraying season. A lack of knowledge in relation to other transport pathways is also identified, including in relation to spills, run-offs, leaching, wind drift *etc.*
In the future, efforts must be made by the authorities responsible for monitoring to improve procedures for the selection of pesticides to include in monitoring programmes and at adequate detection limits. To facilitate comparison between monitoring programmes within the EU intercalibration activities between pesticide laboratories at an international level are needed for water samples and for the more complicated soil and sediment analyses. Internationally co-ordinated efforts regarding quality assurance and quality control measurements are also required, both for laboratory and field activities, when collecting and analysing the monitoring data.

7.9 UNITED KINGDOM

7.9.1 Background

Approximately 450 active substances are approved for use.[90] Unpublished data from PUSG (Thomas pers comm.) for 1994/1995 indicate that a total of 33,705 tonnes of active substance was applied to all crops in Great Britain, the majority of which was applied to arable crops (29,201 tonnes). The amount of active substance applied has decreased over the last few years but area treated has increased (a total area of 48,099,330 hectares were treated of which 43,422,390 were arable crops). Under arable cropping, herbicides were applied in the greatest amounts (7,362 tonnes), followed by fungicides (5,594 tonnes), growth regulators (2,558 tonnes), insecticides (653 tonnes) and molluscicides (251 tonnes). Other applications total 12,883 tonnes but this refers primarily to sulphuric acid (used as a desiccant on potatoes). Fungicides were applied to 21,509,760 ha, herbicides to 13,929,960 ha, insecticides to 3,819,890 ha, growth regulators to 2,938,260 ha and molluscicides to 998,670 ha.

Cereals hectarage treated was 32,586,250 with a total of 11,508 tonnes applied. Potato hectarage treated was 2,760,360 with 1,642 tonnes applied (excluding sulphuric acid). Detailed surveys for a wide range of agricultural and horticultural commodities are carried out, and information on crop or active substance by month, region or county may be easily accessed *via* the databases.

Pesticides approvals are normally granted in relation to individual products and for specific uses. The competent authority for use in agriculture, horticulture, forestry and non-cropped land in the UK is the Pesticides Safety Directorate (PSD), an executive agency of MAFF. The Environment Agency (formerly the National Rivers Authority)

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[90] Tonnage data should not, however, be considered in isolation, as no indication of application rates/frequency or potential biological activity is included in these figures.

has statutory duties and powders under the Water Resources Act 1991 to protect the aquatic environment from pollution, and is required to monitor water quality, investigate pollution incidents, control discharges by consents and maintain and improve the quality of all inland, coastal and groundwaters.

A national (England and Wales only) centre for toxic and persistent substances (TAPS) is dedicated to collecting and collating monitoring data on pesticides whilst other departments are responsible for monitoring the quality of waters with regard to biological diversity and health. A large pesticide monitoring programme is in place and regional results are supplied to the TAPS Centre where the data (currently over 250,000 pesticide measurements per year) is collated and summarised nationally. A GIS (Geographical Information System) has been developed to improve targeting of pesticide monitoring by predicting potential for contamination of surface and groundwaters.

Water companies which supply drinking water also analyse source water, monitoring data from which are reported annually to the Drinking Water Inspectorate (*e.g.* DWI 1995). In addition, the TAPS Centre provides a national advisory service on the potential environmental impact of plant protection products. Environmental Quality Standards (EQSs) have been developed for selected active substances, which are used in addition to the statutory EQSs to assess potential impact on non-target aquatic organisms. EQS concentration must not be exceeded within the aquatic environment. The values are derived from ecotoxicological data obtained from a variety of sources and are based on effects on the most sensitive species. Two values are provided, an annual average figure (to assess chronic impacts) and a maximum absolute value (to assess acute impacts). No environmental standards have been established in the UK for soil or sediments.

A recently published report (NRA 1995) indicates that 120 different active substances have been monitored, and 450,000 results reported from about 3,500 sites (Eke 1996). In general compliance with the EQS standards was very high. In 1993, over 99% of List 1 pesticides and 96% of all pesticides passed for all EQSs. Lindane (HCH) was the most frequent failure for List 1 pesticides. Just over 1% failed for List II substances, with moth proofing agents PSCDs/eulan and permethrin most frequently detected and associated with the textile industry. Most EQS failures were associated with sheep dip insecticide. Other pesticides detected included substances used in non-cropped land situations, the triazine herbicides atrazine and simazine (used until 1993) and diuron. Contamination of water sources is generally considered to be at a low level, suggesting minimal impact but it is acknowledged that much of the monitoring is not targeted to determine potential impacts of plant protection products on non-target organisms.

A very large amount of routine monitoring data has been collated by the Environment Agency and private water utilities/companies for the wheat- and potato- growing regions of the UK. Almost all of these data were for surface waters, possibly reflecting that much of the underlying aquifers is concealed by overlying impermeable layers.

Wheat and potato cultivation in the Anglian region was subjected to particular study. Over 120 compounds have been monitored in the Anglian region, but many are not registered for use on wheat or potatoes. Of the 86 individual compounds identified by the sub-Report prepared by Landell-Mills as being applied to wheat or potatoes in the UK, only 36 (42%) have been monitored, with fungicides monitored least. Intensity of monitoring decreases in the order herbicides > insecticides > fungicides.

Of the 36 wheat or potato pesticides monitored, only one herbicide and five fungicides have never been detected in water bodies in the region. Between 1991 and 1994, herbicides were detected at concentrations >0. I @g/1 in 7.2% of samples with the equivalent value for insecticides and fungicides being 0. 2 and 0. I% of samples. It is, however, very difficult to attribute the appearance of a given residue in water bodies to applications to a single crop.

Of twelve pesticides chosen for further ecotoxicological assessments, the two herbicides were by far the most commonly detected in surface waters. This was attributed to their widespread use, high application rates, physico-chemical properties and timing of application. Clear peaks in the proportion of surface water samples containing residues of these herbicides occurred in the months immediately after application to cereals in the region. The four insecticides and four fungicides selected were detected only very rarely and at lower concentrations than the herbicides.

7.9.2 Conclusions

The main pathway for movement of pesticide residues to surface water sources is rapid transport in response to rainfall either in drainflow or in sub-lateral flow through the upper soil across a relatively impermeable subsoil horizon. This rapid movement means that much of the potential for absorption or degradation in the soil is bypassed.

There are very few data for presence of the twelve pesticides in groundwaters. There is no evidence for any systematic contamination of groundwaters in the region with four of the eight pesticides monitored detected only very infrequently and at low concentrations. These residues might be attributed to point source contamination or to local hydrogeological conditions where fissuring causes rapid movement of surface-applied pesticides to depth.

Seven pesticides failed environmental quality standards for water in Anglian region in 1993. Lindane was the only one with extensive diffuse agricultural uses (although its detection may also have derived from use in wood treatment). Residues of the other six compounds were likely to have resulted from non-agricultural applications or industrial usage or were historical residues from persistent compounds which are no longer in use.

7.10 OVERALL SUB-REPORT CONCLUSIONS

The uncoordinated monitoring and data collection for all environmental parameters at the EU level prevents systematic interpretation of information with respect to determining the presence and impact of plant protection products. Regulation of plant protection products is by necessity largely based on the results of laboratory data generated by the agrochemical companies. Impacts on non-target organisms are assessed by calculating toxicity exposure ratios and, if appropriate, risk reduction management strategies are required *e.g.* without spray/buffer zones. Few field monitoring data exist in the regions studied to determine whether exposure to real environmental concentrations was likely to have any chronic or acute impact. The specific objectives of this sub-Report were therefore only partially met.

7.10.1 Scale of Study

Studies to determine the presence and impact of plant protection products at the regional level are too large if the objective is to understand processes, quantify losses and determine potential impacts. Detailed studies at the field or catchment level are required to provide the necessary information. Upscaling from this detailed information, (using mathematical models for extrapolation of data, for example), to the regional or national level could possibly be achieved provided detailed information is available on pesticide usage, cropping, climate, soils, hydrogeology *etc.*

The process of collating the dispersed or confidential data was more time consuming and demanding of resources than originally envisaged. This precluded the investigation of all regions chosen for the sub-Report prepared by Landell Mills and prevented further analysis and investigation within the resources allocated. Consequently, further evaluation of the collated data will be necessary to derive maximum benefit from the investigations.

7.10.2 Usage Data

Plant protection products are rarely crop specific. In a given region they may be used on a variety of crops (or even used in non-cropped land situations) at different application rates and at different times of the year. Qualitative or quantitative assessments need to take into account the full usage spectrum across a number of years to incorporate crop rotations. This information was not available in preparation of this sub-Report.

Several countries reported detections of active substances arising from use in industrial applications, food processing and non-cropped land. These uses can potentially have more impact on non-target organisms as they originate from a point source and concentrations in discharges can be significantly higher than those originating from diffuse agricultural contamination. Spillages, washings and other misuses were also known to be responsible for contamination events. Information is therefore also required on usage in non-agricultural situations.

Comparison of the fate of specific active substances in different Member States was found to be difficult since availability of the active substance and product type can vary, method of application and treatment rates and timing may also differ. Consequently, their fate and behaviour is expected to differ.

7.10.3 Monitoring and Strategies

Some regions did not have any pesticide residue monitoring programmes in place and therefore no data were available. Some regions did not have good characterisation data (for example, in relation to hydrogeology) and as a result definition of pathways was impossible. All regions were able to provide meteorological data, but not all could provide specific detail like average storm intensity and duration.

Monitoring data from some regions was classified as confidential or was presented in a summary format inappropriate for this project. Some of the regions incorporated several administrative authorities. Since data was not centrally co-ordinated in these countries it was difficult to access and collate comparable information.

Much of the data collected related to statutory monitoring of older, more persistent, active substances, many of which are no longer registered but are required by EU Directives such as those for Groundwater and Drinking Water. It is argued that this requirement uses key resources which could be better used to identify and characterise current problems.

No regional or national soil quality monitoring programmes appear to exist for the seven countries contributing to this sub-Report. The data evaluated for the 12 active substances suggest that there are no long term effects on soil quality. Further evaluation of the literature and other active substances would be required to determine whether effects from other plant protection products may occur in the field situation. No regional or national data were obtained for the routine monitoring of sediments though some analyses were located which were confined to specialist surveys.

Water quality monitoring was not usually targeted for location, timing or for a specific active substance with respect to impacts on non-target organisms. Most monitoring appeared to be in relation to drinking water intakes and was not designed to determine the magnitude and frequency of contamination events and their potential impact. Drinking water intakes are usually large water bodies and any upstream contamination event will consequently become diluted by other uncontaminated waters. Impacts on non-target organisms are more likely to occur upstream (where monitoring has not taken place). Some monitoring schemes appeared to exist because of particular local interest in a specific contamination problem and not because of a strategic monitoring plan. Other monitoring schemes were found to base the selection of determinands on usage data or on evaluation of cropping and then assumed use. In some cases determinands were further selected by assessing basic physico-chemical properties which characterise leaching and persistence. Only England and Wales had a designated authority responsible for the co-ordination and collation of monitoring data.

Herbicides were the most frequently monitored group of pesticides. The tonnage applied was generally greater than for other groups and the timing of application and physicochemical properties suggest that some may be more prone to leaching. The drinking water limit of 0. 1 pg/1 was more frequently exceeded in the water resources monitored by herbicides (although proportionately fewer fungicides or insecticides were monitored for). Analytical techniques were not available for routine determination of many active substances.

7.10.4 Pathways and Processes

Since monitoring was not targeted to the relevant environmental compartments no comparative assessments were made in the sub-Report. It is generally assumed that agricultural spray drift is the main source of contamination of surface waters yet little monitoring data is available to determine the post application concentrations or their impact. Subsequent contamination can occur via drainflow, lateral seepage, leaching, overland flow and atmospheric deposition. Only in intensively instrumented catchment based studies could these begin to be identified and quantified and the processes responsible understood.

Large amounts of historical monitoring data (mainly statutory) were collated during preparation of the sub-Report. In order that this could be effectively evaluated an EU database on pesticides[91] water, soil and sediment was compiled. The database allows summaries to be retrieved for active substance, water source type, country *etc.* Supporting data on location, source type, sampling date and contact organisation are essential components of the database as comparison of concentrations detected in isolation are meaningless. Interpretation of the data and an initial assessment of pathways and processes can be made.

7.10.5 Health and Environmental Quality Standards

A database of health and environmental water quality standards was compiled. This showed that for some active substances there are several orders of magnitude difference between values of different countries. The development of different environmental quality limits/standards in different countries was considered confusing and could be seen a duplication of effort at the European level. The basis for calculation of each needs to be available, as theoretically they are all based on available data yet different values are apparent. The process requires EU co-ordination.

Incidences of pesticide contamination of water were found to occur and comparisons of concentrations were made with health and environmental standards or limits. However, the sampling strategies which provided the data reviewed were not usually designed to fully characterise a contamination incident. This project used maximum detected levels to make the comparisons (although it is accepted that this method is not necessarily considered a valid approach). However, the use of 'means' is also

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[91] The European Pesticide Database can be obtained by initially contacting Dr Carter at Soil Survey and Land Research Centre, Cranfield University, Shardlow Hall, Derby, DE72 2GN. England. Tel: 00 44 1332 799000, Fax: 00 44 1332 79916 1.

problematic. The database retrievals allow a better comparison since they provide information on the total number of analyses, those below the detection limit and those above 0.1 µ/1. Until comprehensive databases are available showing the origin, magnitude, duration and frequency of events, quality standards cannot be scientifically compared with field monitoring data. Only continuous, frequent or carefully targeted monitoring can supply this detail.

Environmental standards from the UK and the Netherlands (EQS's or MTR's respectively) are based on the lowest effect level regardless of species tested. This may trigger regulatory action whether it is fish or algae at risk. In the regulatory assessment of data for inclusion on Annex I testing of a specific range of non-target species is required, where this data is absent it will be required as a condition of approval. The species range is then always comparable.

It was also noted that there is concern over the status of environmental standards in relation to the toxicity exposure ratios (TER's) calculated for regulatory compliance with Directive 91/414. It was considered that the purpose and need for each value should be clearly defined and the information made widely available.

No soil or sediment standards were located which were relevant to the agricultural use of pesticides. The need for and feasibility of creating such standards and monitoring for their compliance should be carefully considered if resources were to be allocated for this task. For example problems of monitoring strategy, timing, soil type influences, water status and cropping would all need to be considered.

7.10.6 Impacts of Plant Protection Products

Summary data on environmental fate and ecotoxicology are essential for determination of the impact of residues of PPPs. Two databases, PETE and Pandora's Box, were accessed to provide this fundamental information. Following the review of the first draft of this sub-Report it was noted that in some cases the data was considered inappropriate, had been superseded by results from modern studies or did not reflect the range of values retained by the original dataholders. Data from agrochemical company dossiers are more comprehensive than those found in the published literature and thus provide an essential basis for determining potential impact on the environment. In order that the wider community can access modern, validated information it is recommended that a Pesticides Properties and Ecotoxicological database, similar to Pandora's Box is established and routinely updated as European reviews and registration take place. This database could then be made available, for example,*via* the Internet.

Guidelines for determining the impact of a plant protection product on sediment dwelling aquatic species are required. No data were presented by the data holders for this group of non-target organisms. A limited number of field monitoring studies exist in the selected regions, though more were known to exist in other regions.

Impacts (particularly sub-lethal ones) of plant protection products are difficult to isolate because of the complex nature of the ecological system. It was noted that

other agricultural activities or environmental processes can have greater detrimental effects on a system.

Data (obtained from the agrochemical industry itself) showed that acute and chronic exposures were monitored under controlled laboratory conditions. In the field situation the environmental conditions are dynamic with many processes controlling the dissipation of the active substance. Yet comparisons with standards or regulatory assessments are made which assume the same environmental conditions apply in the field. Assessment of impact is complex and as a result too many simplifications and worst/extreme case scenarios may be used which together combine to provide unrealistic and possibly unnecessarily large safety margins. Field studies are occasionally required by regulatory authorities but these data are not usually available in the public domain.

7.11 RECOMMENDATIONS

Central co-ordination and guidance from the EU is essential if monitoring data are to be subsequently evaluated at the EU level to determine the impact of environmental and agricultural policy. Many organisations are involved in the registration of plant protection products and their monitoring in the environment at the regional or national level. A co-ordinated national approach regarding monitoring in the environment and potential impact on non-target organisms is required. The EU should consider defining clear roles and responsibilities for Member States to comply with a specific monitoring strategy. The scientifically derived information should be made freely and easily accessible. This can then be collated as required at the EU level.

There needs to be an EU approach to regional and national environmental characterisation for soils, geology, land use, climate *etc*. Whilst EU systems do exist for some of these they do not provide the opportunity for interaction or easy access. In many cases the detail available for the EU is not sufficient and therefore a layered or nested approach should be considered whereby representative areas are identified and characterised at the scale required. Confidentiality, Intellectual Property Rights or cost of purchasing data may provide barriers to general access and will need to be overcome.

All future studies to determine residues and impacts should be catchment based (whether for groundwater or surface water sources) in order that quantitative assessments can be made. The EU should consider the development of a range of representative catchment based studies across Europe to provide the necessary data. These catchments would form the detailed level of a 'nested' or tiered approach to the evaluation of monitoring data at the EU level. Existing catchments with historical data could be considered if appropriate and representative of the required agroclimatic conditions.

Monitoring should be targeted for location, timing and use of active substance in accordance with a strategic monitoring plan designed to monitor potential impact on non-target organisms.

Clearer analytical techniques are required. Many methods are complex and often specific to the active substance. Techniques for fungicides and insecticides are especially required. Acceptable analytical methods are only available for approximately one quarter of all active substances. A list of priority active substances should be established. If comparisons are to be made at the European level a quality control and standard procedures should ideally be implemented for collection, storage, analyses and data reporting.

Consideration should be given to the purpose and value of statutory monitoring of older, more persistent, active substances, many of which are no longer registered but are required by EU Directives such as those for Groundwater and Drinking Water. It is argued that this requirement uses key resources which could be better used to identify and characterise current problems.

Collection of samples and associated analyses are time consuming and costly. Maximum benefit could be obtained if all data were centrally collated at the regional, national and European level. An EU database on pesticides in water, soil and sediment is recommended to evaluate the success of environmental protection policies within Europe. The database software and structure developed in preparation of this sub-Report should be adopted by all Member States to facilitate easy interpretation and exchange of full scientific data. Supporting data on location, source type, sampling date and contact organisation are essential components of the database as any comparison of concentrations detected in isolation will otherwise be meaningless.

The development of environmental quality limits/standards in different countries is confusing and is a duplication of effort. The basis for calculation of each needs to be available as theoretically they are all based on available data yet different values are apparent. The process requires EU co-ordination. There is also concern at the status of EQS's in relation to the toxicity exposure ratios (TER's) calculated for regulatory compliance with EU Directive 91/414. The purpose of each value needs to be clearly defined and an evaluation of the relationship between the two values carried out. Clarification is required concerning the ecological basis for selecting the most sensitive species for toxicity calculations. The importance of the species in the ecosystem needs to be evaluated and factors such as population recovery rates, species abundance or influences on other compartments of the system need to be taken into account.

No soil or sediment standards were located which were relevant to the agricultural use of pesticides. The need for and feasibility of creating such standards and monitoring for their compliance should be carefully considered if resources were to be allocated for this task.

Summary data on environmental fate and ecotoxicology are essential for determination of the impact of residues of plant protection products. In order that the wider community can access modern validated information it is recommended that a European database, similar to Pandora's Box is established and routinely updated.

The impact of agricultural management systems designed to reduce contamination of the environment or simply compliance with good agricultural practice should be evaluated to determine whether these measures are likely to minimise contamination events.

Further studies which build on this preliminary desk study are required to make use of the considerable amount of information which has been collated and for which relatively little interpretation has been carried out. This sub-Report has therefore only served to initiate the process of investigating the presence of plant protection product residues in the environment and their potential impact on non-target organisms.