Study on a European Union wide regulatory framework for levies on pesticides

Executive Summary

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1 Introduction

Background

Whereas it is generally acknowledged that the use of pesticides[1] has large benefits to farmers, the present use of pesticides in agriculture also causes negative environmental (and health-related) effects to society. For example, during and after application of pesticides a substantial amount of it end up in soil, ground- and surface water or air. These negative effects demands for an effective policy. Such policies have been initiated, both at the level of the individual Member States of the European Union and at the level of the European Union itself.

At the level of the European Union, at present, Council Directive 91/414/EEC concerning the placing of plant protection products on the internal market is probably the most prominent regulation. Whereas administrating this Council Directive will decrease the number of active ingredients on the internal market, full implementation is expected to take quite some time. Given this implementation problem, and the fact that administrating Council Directive 91/414/EEC will mainly ensure specified safety standards for pesticides without affecting the quantities used, there is a need to broaden current European Union policy activities on pesticides.

In this regard, DG-XI has initiated a long-term project in co-operation with the Dutch Ministry of Housing, Spatial Planning and Environment, aimed at developing and evaluating new instruments and strategies for an additional EU pesticides policy, defined as additional to the present EU legislation, in particular Council Directive 91/414/EEC. This long-term project consists of two phases. The first phase was concluded in 1994, while the second phase was concluded in 1998. A total of eight studies have been published during these two periods. In some of these studies, a levy on pesticides was regarded potentially effective in reducing the use of harmful pesticides in the European Union. However, a comprehensive evaluation of the possible economic and environmental effects of such an EU wide levy was not part of the key objectives of the long-term project.

In acknowledging the potential effectiveness of a levy to reduce the use of harmful pesticides in the European Union, DG XI initiated in 1997 a separate project to investigate the various pro's and contra's of such a levy, and to define the contours of an EU wide regulatory framework for the taxation of pesticides. This executive summary presents the key results of this project.

[1] This study deals with the plant protection products which are covered by Council Directive 91/414/EEC. These products are mainly used in agriculture and usually referred to as pesticides. Yet, in EU legislation pesticides are divided into plant protection products and biocides. Hence, when the word 'pesticides' is used in this executive summary, it should be recognized that the plant protection products are meant as covered by Council Directive 91/414/EEC.

Objective of the study

As there is little experience in the Member States of the European Union on the effects of a levy on pesticides [2], it seems justified to represent the evaluation of such a levy as a so-called 'grey box': both with respect to its economic and environmental consequences and with respect to defining a best working EU wide regulatory framework. As a result, the key objective of this study is *to enlighten this grey box.*

It should be recognised that such a process of enlightenment is warranted, given the implementation problems of Council Directive 91/414/EEC, the necessary environmental improvements in the European Union to reach the ambitious goals set out in FEAP, and the need to harmonise the internal market on this subject: i.e., in case a levy on pesticides would be defined by the Commission, the basic elements of this levy should hold for all Member States to avoid discrimination.

The following research questions are derived from the above-stated objective:

1. In what respect is the experience presently available in the Member States on the use of pesticides useful for developing an EU wide regulatory framework for levies on pesticides?
2. What would constitute the ideal EU wide levy on pesticides?
3. Are there potential bottlenecks, if any, which could hinder the introduction of such a levy on pesticides?
4. What are the main economic and environmental effects of an EU wide levy on pesticides?
5. What would constitute the ideal EU wide regulatory framework for levies on pesticides?

Approach of the study

The approach which has been followed by EIM/Haskoning to answer the above-stated research questions consists of four major elements.

1. Desk-research and expert interviews on the use of pesticides in the Member States of the European Union, on the effectiveness of a levy on pesticides, on ways to define a EU wide regulatory framework, etceteras.
2. Building an economic model to analyse the main economic effects of an EU wide levy on pesticides. These effects relate to the change in using the pesticides, the change in pesticide costs at the farm, the change in gross margin per farmer, and the expected revenues of the imposed levy.

[2] Nowadays, only Denmark and Sweden have a tax on pesticides with the aim to influence the farmers' behaviour on the use of pesticides.

3. Developing a classification scheme of pesticides on the basis of their negative effects to the aquatic environment. In fact, seven classes have been distinguished. The most hazardous pesticides are those pesticides which are very toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment (class I), whereas the 'least' hazardous pesticides are those pesticides which are harmful to aquatic organisms (class VII).
4. Using so-called *pesticide chains* to come up with qualified estimates of the economic and environmental effects of an EU wide levy on pesticides. A pesticide chain consists of a certain type of pesticide, a certain crop in which the pesticide is used and a certain region in the European Union. An example of a pesticide chain is *fungicides in cucumbers in England and Wales.* By using this concept it is expected that, on the one hand, enough detailed information on the types of pesticide used, their environmental hazards, prices, and alternatives can be collected in order to gain reliable outcomes, while, on the other hand, it is expected that the outcomes are broad enough to design an EU wide regulatory framework for levies on pesticides (see Annex I for an elaboration of the concept of pesticide chains).

2 An EU wide levy on pesticides: the ideal case

Given the potential advantages of a levy on pesticides, it is interesting to define the ideal case. In other words, how would the ideal European Union wide levy on pesticides looks like? Below, five conditions have been set on which such a levy should score '+++' in order to be ideal.

1. The ideal levy discriminates effectively among the various pesticides
Firstly, the ideal levy should discriminate effectively among the various pesticides used at the farm. In other words, the levy should be proportional to the damages pesticides cause to the environment. Pesticides which are most harmful to the environment should be levied the most.

2. The ideal levy is set at the correct rate
Secondly, the ideal levy should be set at the correct rate. From a theoretical point of view, this means that the amount charged to the farmers is equivalent to the marginal external costs of the pesticides. If set at this rate the marginal social costs of using pesticides will match the corresponding social marginal benefits. Since it is very difficult, if not impossible, to determine the exact marginal external costs of pesticides, usually the 'correct' rate of the levy is determined by taking into account the efficiency of using the charged products (the efficiency of pesticide use) and the number and quality of environmental-friendly alternatives.

3. The ideal levy has an efficient collection and effective reimbursement system
Thirdly, the ideal levy should have an efficient collection and effective reimbursement system. With respect to the former, the way the levies are collected is important. The ideal levy is collected with a minimum of administration costs. With respect to the latter, the way the revenues are returned to the ones involved is important.

The revenues of the ideal levy should be reimbursed in such a way that a maximum acceptability is achieved, both at the political level and at the level of the farmers, and that the use of the most harmful pesticides is further reduced at the farm.

4. The ideal levy is fraud-proof
Fourth, the ideal levy should be collected with a minimum of fraud practices. Therefore, the levy should be set at the level of the European Union to counteract possible fraud at the inter-borders. Moreover, it should be feasible and maintainable from an administrative point of view with little possibilities for fraud.

5. The levy implies a permanent incentive to farmers

Finally, the levy should imply a permanent incentive to the farmers: either to use pesticides more efficiently at the farm or to change to less-harmful pesticides. This means that a market-based oriented pesticide policy of the European Union has a long-term environmental perspective rather than a short-term political perspective.

Unfortunately, the above-sketched ideal EU wide levy on pesticides cannot be established yet. Two main obstacles are:

- the exact environmental effects of many pesticides are not known, and, when they are known, the various types of environmental damages are difficult to summate into one single target. Hence, it is not possible to discriminate perfectly among the various pesticides.
- the optimal rate of the levy cannot be determined. On the one hand, this is because the environmental effects of pesticides cannot be monetarised, on the other hand, this is because relevant information on the efficiency of pesticide use at the farms and the number and quality of environmental-friendly alternatives is still limited.

3 A review of price elasticity's of demand of pesticides

The price elasticity of demand of pesticides used in agriculture is an important variable in designing a best working EU wide regulatory framework for levies on pesticides. For example, if pesticide use at the farm is almost indifferent to price increases of pesticides, perhaps due to a high efficiency of pesticide use, the introduced levy will generate substantial revenues whereas the *direct* beneficial environmental effects of the levy will be small. As part of the study, several European studies have been reviewed which have estimated price elasticity's of demand of pesticides. Table 1 presents an overview of the results.

Table 1. Overview of studies on the price elasticity's of demand of pesticides.

Study	*country*	*elasticity*	*demand of*	*remarks*
1. Oskam (1997)	EU	-0.2 to -0.5	pesticides	general overview of other studies
2. Elhorst (1990)	Netherlands	-0.3	non-factor inputs	short term; arable farming, based on data 1980-1986
3. DHV and LUW (1991)	Netherlands	-0.2 to -0.3	pesticides	short term: -0.2 for arable farming; -0.3 for horticulture
4. Oskam (1992)	Netherlands	-0.1 to -0.5	pesticides	medium term: -0.1 for mixed farms (potatoes, unions); -0.5 for specialised farms
5. Oude Lansink and Peerlings (1995)	Netherlands	-0.5 to -0.7	pesticides	based on data 1970-1992; -0.7 is inclusive the CAP reform
6. Russell (1995)	UK	-1.1	pesticides in cereals	based on 26 cereals producers; period 1989-1993
7. Falconer (1997)	UK	-0.3	pesticides	using a linear programming model
8. Ecotec (1997)	UK	-0.5 to -0.7	herbicides	long term; only for herbicides used for cereal grass weed
9. Dubgaard (1987)	Denmark	-0.3	pesticides	using a threshold model
10. Dubgaard (1991)	Denmark	-0.7	herbicides	long term; period 1971-1985
11. Dubgaard (1991)	Denmark	-0.8	fungicides and insecticides	long term; period 1971-1985
12. Schulze (1983)	Germany	-0.5	fungicides	using a linear programming model
13. Johnsson (1991)	Sweden	-0.3 to -0.4	pesticides	based on filed experiments; -0.3 for insecticides, -0.4 for fungicides
14. Gren (1994)	Sweden	-0.4 to -0.9	pesticides	econometric model; -0.4 fungicides, -0.5 insecticides and -0.9 herbicides
15. SEPA (1997)	Sweden	-0.2 to -0.4	pesticides	general overview

Source: EIM

Table 1 shows an 'overall' price elasticity of demand for pesticides between -0.2 and -0.5 (based on study no. 2, 3, 4, 5, 7, 9 and confirmed by study no.1 and 15). Compared to this price elasticity, the 'overall' price elasticity of demand for herbicides, fungicides and insecticides is higher. With respect to herbicides the price elasticity lies between -0.7 and -0.9 (based on study no. 10 and 14), for fungicides the price elasticity lies between -0.4 and -0.8 (based on study no. 11, 12, 13, 14), for insecticides the price elasticity lies between -0.3 to -0.8 (based on study no. 11, 13 and 14). Finally, from Table 1 it is shown that the price elasticity of demand for pesticides used for a special crop, such as pesticides in cereals, is the highest: i.e., the price elasticity for such specialised pesticides lies between -0.5 and -1.1 (based on study no. 6 and 8).

4 Results of the pesticide chains

Table 2 presents the pesticide chains which have been evaluated in this study. Taken together, these chains comprise three different types of pesticides (herbicides, fungicides and insecticides), seven different crops (both arable and horticulture)[3] and four different regions. To some extent, the selected pesticide chains are biased towards the Netherlands. This is due to the fact that relevant data were relatively easy to get there and quite comprehensive.

Table 2 Overview of the selected pesticide chains

Type of pesticide used	*Disease*	*Cultivated crop*	*Region or country*
Fungicides	mildew	lettuce	England/Wales
Fungicides	mildew	green peppers	Almeria (Spain)
Insecticides	insects	cucumbers	the Netherlands
Insecticides	insects	cucumbers	England/Wales
Fungicides	phytopthora	potatoes	Sweden
Fungicides	phytopthora	potatoes	the Netherlands
Herbicides	weeds	corn	the Netherlands
Herbicides	weeds	winter barley	England/Wales
Fungicides	rust, mildew	winter wheat	Sweden
Herbicides	weeds	public pavements, roads	the Netherlands

Source: EIM

Due to the available information, the majority of the crops involved in the pesticide chains analysed, are cultivated in continental and maritime climate conditions: i.e., potatoes, cucumbers, corn, winter barley and winter wheat. Unfortunately, other interesting crops, such as grapes, citrus fruits and olives had to be excluded from the analysis. With respect to the types of pesticides, the chains encompass most of the pesticide used in agriculture.

Table 3 presents an overview of the key outcomes of the analyses. In order to interpret these outcomes correctly two aspects need to be explained. On the one hand, it should be noted that in the analyses of the pesticide chains two levy scenarios have been distinguished. In the first *scenario* all active ingredients of the pesticides are treated the same way. This means that the levy rate for the various active ingredients are equal, irrespective of possible different environmental hazards. As a first step, for all pesticide chains a 20% levy on active ingredients is assumed. In the second *scenario* the levy on the active ingredients of the pesticides depends on the environmental hazards of these

[3] Although using herbicides to counteract weeds at public pavements and roads does not fit within the scope of this study (i.e., pesticides used in agriculture) this pesticide chain has been included and evaluated on request of DG XI.

pesticides. As described in chapter 1, the pesticides used in agriculture have been classified into seven classes. The rate of the levy is based on the following, somewhat arbitrary procedure: the levy on pesticides belonging to the 'middle' classes III, IV and V is 20%, the levy on pesticides belonging in the 'hazardous' classes I or II is 40%, twice as high as the average levy, finally, the levy on pesticides belonging to the 'harmless' classes VI or VII is 10%, twice as low as the average levy.

It should also be noted that in analysing the effects of an EU wide levy on pesticides, for each pesticide chain a price elasticity of demand had to be chosen. The following procedure was followed: if there are none or only few alternative plant protection devices available in the pesticide chain a low price elasticity was chosen, if there are many different alternatives available a high elasticity was chosen.

Table 3 Overview of the key outcomes of the pesticide chains

Pesticide chains	*change in use of pesticides*		*change in total costs*		*change in gross margin per farmer (in Euro)*	
	scenario 1	*scenario 2*	*scenario 1*	*scenario 2*	*scenario 1*	*scenario 2*
1. fungicides in lettuce in England and Wales	- 8%	- 7%	+ 0.2%	+ 0.2%	- 148	- 124
2. fungicides in green pep-pers in Almeria	- 8%	- 10%	+ 0.2%	+ 0.2%	- 51	- 63
3. insecticides in cucumbers in England and Wales	- 16%	- 24%	+ 0.02%	- 0.05%	- 7	- 9
4. insecticides in cucumbers in the Netherlands	- 16%	- 19%	+ 0.02%	- 0.01%	- 299	- 343
5. fungicides in potatoes in Sweden	- 16%	- 11%	+ 0.02%	+ 0.02%	- 51	- 44
6. fungicides in potatoes in the Netherlands	- 16%	- 18%	+ 0.05%	- 0.01%	- 365	- 396
7. herbicides in corn in the Netherlands	- 18%	- 18%	- 0.1%	- 0.1%	- 267	- 267
8. herbicides in winter barley in England and Wales	- 14%	- 25%	+ 0.2%	+ 0.1%	- 23	- 36
9. fungicides in winter wheat in Sweden	- 16%	- 32%	+ 0.03%	- 0.2%	- 72	- 117
10. herbicides in public pavements in the Netherlands	- 18%	- 28%	- 0.1%	- 0.2%	- 28	- 32
General mean[(a)]	- 14%	- 18%	+ 0.1%	+ 0.02%	- 143	- 155

(a) The general means have been calculated on the basis of the first nine pesticide chains.

Source: EIM

From Table 3 it can be seen that the decrease in the use of the pesticides lies between 8% and 18% for the first levy scenario, and between 7% and 32% for the second levy scenario. The increase in total costs at the farms due to the levy lies between + 0.2% and - 0.1% for the first levy scenario and between + 0.2% and - 0.2% for the differentiated levy scenario. Finally, the decrease in gross margin per farmer lies between € 7 and € 365 for the first scenario and between € 9 and € 396 for the differentiated levy scenario. On average, the latter scenario has a greater impact on the income of the farmers: € 155 Euro versus € 143 Euro in the first scenario.

Annex II presents an overview of the more detailed results in one of the pesticide chains.

5 A charcoal sketch of an EU wide regulatory framework

This chapter presents a *charcoal sketch* of a European Union wide regulatory framework for levies on pesticides. That is, for several consequential elements of the regulatory framework, such as the charge base and the allocation of revenues, explicit propositions will be put forward. Yet, as the contemporary information on the regulation of pesticides by means of market-based instruments is too fragmented and brittle, it is not possible to draw the many details of the regulatory framework. In other words, a *blueprint* for a European Union wide regulatory framework on the taxation of pesticides, alike the one on energy products, cannot be designed yet.

In choosing the major consequential elements of a European Union wide regulatory framework for levies on pesticides, the existing Directive on the taxation of energy (Directives 91/12/EEC and 92/81/EEC) was used as a guideline. On the basis of *Article 1* to *Article 26* of this European environmental legislation, the following important elements have been selected: the products involved, the charge base, the charge rate, the imposition points, the allocation of revenues.

Below, in Table 4, four of these consequential elements have been put together. As for each element several alternatives are available, many variations exist in sketching a *charcoal* of a European Union wide regulatory framework for levies on pesticides. For example, from Table 4 it can be seen that the charge base of a levy on pesticides can be put on the hazards the pesticides cause to the environment, on the value of the pesticides (retail or wholesale price) or on the active ingredients of the pesticides. Moreover, the charge base selected could hold for all kinds of pesticides or could be differentiated to the different types of pesticides.

Table 4. Variations in four consequential elements of an EU-wide regulatory framework on pesticides

Charge		**Imposition**	**Refunding of revenues**	
base	**rate**	**points**	**organisation**	**target**
environmental hazards	fixed	industry	EU	CAP
wholesale price	minimum	wholesalers	Member States	deficit reduction
retail price	differentiated	retailers	agricultural sector	direct payments per hectare;
active ingredients		farmers		crop premiums, innovation
				programs for industry
general, specific	high, medium, low		farmers involved	supporting environmental plant
				protection measures

Source: EIM

Table 4 exhibits that many European Union wide regulatory frameworks can be designed in combining the different charge bases, the different charge rates, the different imposition point systems and different allocations of revenues. The many options for designing

an EU wide regulatory framework for levies on pesticides need to be ranked in order to select a best working system. On behalf of this, four criteria have been defined on which the possible alternatives will be evaluated. The criteria were established by noting that the *ideal* EU wide regulatory framework on pesticides, at least, *should* be:

- environmentally effective;
- economic efficient;
- acceptable for those concerned;
- easy to accomplish.

In summarising the various analyses on the five consequential elements, the charcoal sketch of an EU wide regulatory framework for levies on pesticides includes the following proposals:

1. First, it is proposed to define the framework to all (registered) pesticides used in the agricultural sector of the European Union. Potentially, this definition will produce the most beneficial effects to the environment.
2. Second, it is proposed to put the EU wide levy on the value of the pesticides, alike the current system in Denmark. Yet, in the regulatory framework each Member State should be free to choose the retail price or the wholesale price as the exact charge basis of the levy.
3. Third, the charge rate system of the EU wide regulatory framework consists of minimum rates that are, preferably, differentiated towards the environmental hazards of the pesticides. If such a differentiation is not feasible, it is proposed to differentiate the levy towards the various types of pesticides.
4. Fourth, industry should be used to collect and pass on the revenues of the EU wide levy. At this level the number of collection points is very limited, thereby simplifying the implementation and enforcement of the levy.
5. Finally, it is proposed to reimburse the revenues of the EU wide levy to the farmers involved and to use the revenues for (fiscal) regulations in the agricultural sector which further stimulate farmers to change their behaviour in a more environmental-friendly way.

Table 5 provides an overview of the proposed decisions on the five consequential elements of a European Union wide regulatory framework for environmental levies on pesticides, together with the scores on the criteria defined above.

Table 5. An overview of the decisions on the consequential elements of an EU wide framework on pesticides

	Env. effect.	Ec. efficient	Easy to acc.	Acceptable
products involved				
• all pesticides used in the agricultural sector	✓ (*most)*	✓	✓	✓
charge base				
• value of the pesticides	✓	✓ (*more)*	✓	✓
charge rate system				
• minimum rates (differentiated)	✓ *(more)*	✓ *(more)*	✓	✓ *(more)*
imposition points				
• industry	-	✓ (*most)*	✓ (*most)*	✓
allocation of revenues				
• farmers involved (rewarding base)	✓	✓	✓ *(less)*	✓

Source: EIM

6 Conclusions

Conclusions from the various chapters

Below, the most important conclusions that originate from the various chapters of this study are reported.

1. At present, there is little experience available in the Member States of the European Union which is useful for evaluating the economic and environmental effects of an EU wide levy on pesticides and for designing a best working EU wide regulatory framework.

2. Although a levy on pesticides is judged effective and useful, compared to other policy instruments, such as arrangements and regulations to reduce the use of harmful pesticides in the European Union, many scientists and policy makers involved believes that speeding up the review of Council Directive 91/414/EEC is the most effective policy instrument at the moment.

3. The ideal EU wide levy on pesticides consists of five essential features: it discriminates effectively among the various pesticides, it is set at the correct rate, it has an efficient collection and effective reimbursement system, it is fraud-proof and it provides a permanent incentive to the farmers.

4. The first two conditions of the ideal EU wide levy are confronted with major obstacles: on the one hand, because there is inadequate information on the (long-term) negative environmental effects of the pesticides, on the other hand, because it is difficult to set the EU wide levy at the correct rate. The other three conditions of the ideal EU wide levy, however, pose no major obstacles.

5. The review of fifteen European studies shows that the demand of pesticides at the farms is so-called *relatively inelastic*: i.e., an overall price elasticity of demand for pesticides was computed ranging from -0.2 to -0.5. The price elasticity of demand for herbicides, fungicides and insecticides are, however, more elastic. For herbicides it lies between -0.7 to -0.9, for fungicides between -0.4 to -0.8, and for insecticides between -0.3 to -0.8.

6. On the basis of the pesticide chains evaluated it was concluded that an EU wide levy on pesticides of 20% will have a substantial impact on the use of pesticides at the farms. An average decrease was computed of 14% for scenario 1 (one levy of 20% for all pesticides) and 18% of scenario 2 (a low levy of 10% for the least hazardous pesticides, a high levy of 40% for the most hazardous pesticides and a levy of 20% for all other pesticides).

7. The evaluations of the pesticide chains showed that the economic effects of a levy on pesticides of 20% are limited. An average increase of the total costs at the farms was computed of 0.1% for scenario 1 and 0.02% of scenario 2. Also the reductions in

gross margin per farmer are also relatively small: € -143 versus € -155. (It should be noted that these income reductions were calculated without a reimbursement of the revenues. By using an effective re-allocation of the revenues the reported decreases in gross margin should be reduced.)

8. An explanation of the large differences between the environmental and economic effects of a levy on pesticides of 20% relates to the relatively high efficiency in using pesticides in agriculture. Due to this high efficiency - i.e., the estimated cost-shares in the pesticides used in the nine pesticide chains lie between 2% and 6% - the economic effects of a EU wide levy will be largely neutralised.

9. As the contemporary information on the effects of a levy on pesticides is inadequate, it was not possible to present a blueprint for a best working EU wide regulatory framework for levies on pesticides. Instead a charcoal sketch of such a framework, including propositions for five major consequential elements, has been put forward.

10. With respect to the charge base system of the EU wide regulatory framework it is proposed to base the levy on the value of the pesticides (alike the system now in operation in Denmark).

11. With respect to the charge rate system of the EU wide regulatory framework it is proposed to set minimum rates that are, preferably, differentiated towards the environmental hazards of the pesticides. (If such a differentiation is not feasible, it is proposed to differentiate the levy towards the various types of pesticides.)

12. With respect to the reimbursement system of the EU wide regulatory framework it is proposed to reimburse the revenues of the levy to the farmers involved and preferable use them for (fiscal) regulations in the agricultural sector which further stimulate farmers to change their behaviour in a more environmental-friendly way.

General conclusions

It is recalled here that the key objective of this study was *to enlighten the grey box of an EU wide levy on pesticides.* The first general conclusion of this study is that this objective has been achieved only partially. For example, during the course of the research it became clear that for important topics, such as establishing an undisputed classification of the pesticides on their negative effects to the environment and setting the levy at the correct rate, there is still work to be done. This also holds for the assumptions which had to be made on the extent of substitution and complementary between the various pesticides in a pesticide chain.

A second general conclusion of this study is that introducing an EU wide levy on pesticides will be both effective and useful. *It will be effective* insofar as all (registered) pesticides used in the agricultural sectors of the EU Member States fall under the levy.

Moreover, it will be effective as the levy is based on the value of the pesticides.[4] It will be effective as the EU wide levy aims to differentiate between the pesticides involved, preferably on the basis of their negative effects to the environment. Finally, the levy will be effective because it creates an automatic incentive for the farmers to use their pesticides more efficiently. *It will be useful* because an EU wide levy on pesticides forms an excellent addition to Council Directive 91/414/EEC. Moreover, it will be useful, because an EU wide levy on pesticides will further stimulate industry to innovate towards more environmental-friendly pesticides. Finally, it will be useful, because Member States' arguments on possible 'leakage's' at the borders and harming domestic farmers and industry will become trivial if the levy is set at the level of the European Union.

The third general conclusion relates to the EU wide regulatory framework for levies on pesticides. Despite the above positive characteristics of an EU wide levy on pesticides it should be noted that some important elements of the regulatory framework for levies on pesticides cannot be resolved within the scope of this study.

For example, it is unclear at the moment what the exact rate of the EU wide levy on pesticides should be and how it could be differentiated adequately. Whereas the proposal for differentiated minimum rates at the EU level still holds, it is argued that the exact minimum rates (alike the regulatory framework on energy products) cannot be determined on the basis of current experiences in the European Union. In the study a levy of 20% was used for illustrative reasons. Such a rate has been justified on the basis of the relative low pesticides costs as percentage of the total yield. Yet, it is acknowledged that this argumentation is too brittle to actually base on specific minimum rates of the various levies.

Related to this topic is the extent of differentiation of the EU wide levy on pesticides. In the study a classification was introduced based on the negative effects of the pesticides to the aquatic environment. Albeit debatable, this classification was used in the evaluations of the pesticide chains to base a levy system on. In essence, it was found that a differentiated levy system performed better than a undifferentiated levy system. Consequently, the ideal EU wide regulatory framework for levies on pesticides should base their classification system on the environmental hazards of the pesticides. Yet, much more research on this topic is required before an undisputed classification system can be established.

Also the precise level of detail of the EU wide regulatory framework on pesticides warrants further investigation. For example, in the study it was concluded that an EU wide regulatory framework for levies on pesticides should take into account the countries' specific agronomic circumstances in order to be acceptable. Questions which should be answered in this regard are: 'To what extent should the Commission define the exact

[4] In this regard, it is assumed that administrating Council Directive 91/414/EEC guarantees the removal of the older, cheaper and more hazardous pesticides from the market.

charge base of the levy'?, 'To what extent should the Commission define the various differentiated levies on pesticides;?, or 'To what extent should the Commission define the way the revenues should be reimbursed to the agricultural sector'? Although these questions fall outside the scope of this study, the issue did come up in defining the charge rate system, the charge base system and the reimbursement system. More research on this topic is needed in order to provide conclusive answers.

ANNEX I. The concept of pesticide chains

Ideally, the potential effects of a levy on pesticides should be analysed at the level of the farms: i.e., which reactions can be expected from farmers when the price of some of the pesticides they use will be, say, doubled? Will, and can farmers use the pesticides levied more efficiently? Will, and can they turn to mechanical or biological alternatives? Will, and can they turn to less levied pesticides? Or, will they simply pay the levy? To get a good overview of the possible reactions, in-depth interviews with a reasonable number of farmers are needed, whereby the interviews preferably are divided by type of pesticides, intensity and efficiency of pesticide use and agronomic regions in the European Union. Whereas this kind of information would be the most informative for this study, it would also be quite laborious and expensive to collect. Therefore, a different route had to be taken to collect the relevant data.

Analysing the effects at the level of Member States

Another possibility, almost contrary to the one above, and followed by Oskam et al. (1997), is to analyse the potential effects of a levy on pesticides at the level of the Member States. Based on a review of the relevant literature, Oskam et al. (1997) assumed a price elasticity of - 0.4 for all pesticides in the Member States and analysed the overall effect of a price increase of 10%. By using a very simple calculation, a 4% reduction of pesticide use was established in the European Union. After deducing certain administration costs also the net revenues of a levy of 10% was calculated.

This route, followed by Oskam et al., has only illustrative significance. For example, it is unclear whether one overall price increase of 10% would be the most effective for reducing the most harmful pesticides.

Analysing the effects at the level of pesticide chains

In this study a middle course of aggregation is adopted for analysing the economic and environmental effects of a levy on pesticides: i.e., the analysis will be done at the level of pesticide chains. An example of such a pesticide chain is *fungicides in cucumbers in England and Wales.* Hence, a pesticide chain consists of a certain type of pesticide (e.g. fungicides, herbicides, insecticides), a certain crop in which the pesticide is used (e.g. cucumbers, potatoes, winter wheat) and a certain region (e.g. England and Wales, the Netherlands).

Basically, the concept of pesticide chains forms a nice alternative to the ideal case of interviewing a representative number of farmers. By using the concept of pesticide chains it is expected that enough detailed information on the types of pesticide used, their environmental hazards, their prices, and possible alternatives, can be collected in order to provide reliable estimates of the economic and environmental effects of a levy. Moreover, by using this concept it is expected that the outcomes of the pesticide chains

are informative enough to design a European Union wide regulatory framework for levies on pesticides on. Therefore, the outcomes of the pesticide chains should not be too specific, but in one way or another be generalised to a higher level of aggregation. For example, in the case of cucumbers in England and Wales, the outcomes should preferably be generalised to the horticultural sector in England and Wales.

Annex II. Fungicides in lettuce in England and Wales

Fungicides in the cultivation of lettuce in England and Wales are used to protect lettuce against mildew. The most important chemical means used by the farmers, are propamocarb-hydrocloride (killing of fungi), fosetyl-aluminium (stimulation of plants' natural resistance), tolclofos-methyl and thiram (blockade of metabolism in fungi). The total usage of these active ingredients in the cultivation of lettuce in England and Wales is 8, 4, 3 and 2 ton per year, respectively. The farmers involved have a relatively high efficiency of using the fungicides: i.e., the estimated costs are about 2% of the total yield.

For this pesticide chain a price elasticity of demand of - 0.4 is assumed. This elasticity is at the lower bound. It was chosen because the pesticide experts in the UK did not report any plant protection alternatives to the use of the above-mentioned active ingredients. Moreover, substitution was assumed between the four active ingredients. As thiram is regarded very hazardous to the aquatic environment, it was classified with a 'I'. Hence, the levy for this active ingredient was set at 40% instead of 20%. Fosetyl-aluminium and tolclofos-methyl are regarded less hazardous to the environment, consequently the levy for these active ingredients was set at 10%, thereby encouraging a substitution from thiram to fosetyl-aluminium and tolclofos-methyl.

Table 6 presents the economic and environmental effects of the two levy scenarios in the pesticide chain fungicides in lettuce in England and Wales.

From this Table one can see that in levy scenario 1 the levy of 20% results in a decrease in the use of pesticides of 8%. Compared to the other pesticide chains this reduction is relatively low. Due to the levy the costs of fungicides at the farms increase by 10%. Pesticide costs at the farm rise because the decrease in using the fungicides is not enough to offset the price increase induced by the levy. The change in total costs is relatively small due to a high efficiency of pesticide use (i.e., the low share of pesticides costs). The gross margin per farmer reduces by € 148.

The overall effect of the levy system in scenario 2 is less than in scenario 1. Compared to the first scenario, the change in pesticide use increases by 1%, whereas the costs of pesticides decrease by nearly 2%.The differences can be explained by the lower levy of 10% on two of the four active ingredients. Due to the low share of pesticide costs in total yields, there are no large differences between the scenarios with respect to the total costs, revenues and gross margin.

Whereas the economic effects of the levy in the two scenarios are more or less the same, this is not the case for the environmental effects. In the first scenario, the four active ingredients are reduced by 8% each. In the second scenario, however, the (risky) active ingredient thiram is reduced by 16%, whereas the active ingredients fosetyl-aluminium and tolclofos-methyl are reduced by 4%. Whereas these changes could be

beneficial to the local and regional environment, it is difficult to choose between the two scenarios as the overall impact of scenario 2 is less than scenario 1.

Table 6. Economic and environmental effects of a levy on fungicides in lettuce in England and /Wales

Active ingredients	category	use in tons	price / ton
A. Propamocarb-hydrochloride	**III**	8	€ 75,000
B. Fosetyl-aluminium	**VII**	4	€ 35,000
C. Tolclofos-methyl	**VI**	3	€ 70,000
D. Thiram	**I**	2	€ 10,000
Cost share (pesticides)		2% of total yield	
Assumptions			
Price elasticity of demand		- 0.4	
Levy scenario 1		A, B, C, D : 20%	
Levy scenario 2		A:20%; B:10%; C:10%; D:40%	
Economic effects		scenario 1	scenario 2
Change in use of pesticides		- 8.0%	- 7.1%
Change in costs of pesticides		+ 10.4%	+ 8.8%
Change in total costs		+ 0.2%	+ 0.2%
Change in revenues		- 0.2%	- 0.1%
Change in gross margin per farmer		€ - 148	€ - 124
Revenues of the levy		€ 175,000	€ 147,000
Ecological effects		scenario 1	scenario 2
A. Propamocarb-hydrochloride		- 8.0%	- 8.0%
B. Fosetyl-aluminium		- 8.0%	- 4.0%
C. Tolclofos-methyl		- 8.0%	- 4.0%
D. Thiram		- 8.0%	- 16.0%

Source: EIM