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EXTENDED POLICY BRIEF

THEORETICAL DEVELOPMENTS AND EMPIRICAL MEASUREMENT OF THE EXTERNAL COSTS OF PESTICIDES

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SEVENTH FRAMEWORK PROGRAMME

SUMMARY

The aim of this project is to provide a methodological framework that will serve as the foundation for the introduction of EU policies aimed at achieving ***sustainable use of pesticides in European agriculture***. This is accomplished through, first, a detailed assessment of the external costs of agricultural pesticide use on producers, consumers, and the environment, and second, the design of a socially optimal tax and levy scheme aimed at the reduction of pesticide use to its socially optimal level, and the study of probable effects.

The project has successfully fulfilled its aims, by combining traditional and well-established theoretical methodologies with the most recent advancements in economic theory, building also upon the biological and technical scientific work on pesticide use developed over the last years. The validity of the employed theoretical models and policy tools was extensively verified in case studies in several EU countries (Bulgaria, Cyprus, France, Greece, Netherlands, Portugal, Sweden, UK), to account for the diversity in pesticide use among producers in different geographical locations, different farming practices and varying farmer attitudes. At the same time, consideration was given to the effects of the accrued scheme and alternative policy tools on the optimal pesticide use, as well as on economic sustainability and social welfare. The project's results and policy recommendations provide validations for the tax and levy schemes proposed.

MAIN OBJECTIVES

The project's two main scientific objectives are *(i)* to develop a consolidated methodological framework comprised of detailed qualitative and quantitative analytical tools, in order to identify external costs of pesticide use, and *(ii)* to propose, test and validate a system of taxes and levies and studying the feasibility of such alternative regulatory systems.

By addressing these issues, the project fulfilled the following specific objectives in a measurable, scientific way:

- To assess the impacts of pesticide use on yield, efficiency and productivity.
- To cast the impact of pesticide use on farm operators and residents.
- To estimate the environmental effects (pollution and contamination) induced by pesticide use.
- To measure the impact of pesticide use on consumers. To estimate the socially optimal level of pesticide use at the farm level.
- To design and study an effective tax and levy scheme that reduces the use of pesticides to a socially optimal level from the point of view of a policy maker.
- To assess producers' willingness to adopt low pesticide use production methods.
- To assess the policy schemes for reducing the indirect cost of pesticide use.

PROJECT STRUCTURE

The project is based on the objectives mentioned above and includes ten work packages (WP) divided in three phases:

Phase I: Quantifying external pesticides costs: A theoretical descriptive analysis of pesticide use and productivity across EU incorporated with an empirical analysis of both direct and indirect effects of pesticide use (WP1-4)

Phase II: Designing and testing policy tools: Development of options for effective pesticide use control - Study of the substitution principle to pesticides - Development of policy tools (WP5-8)

Phase III: Dissemination: Integration, synthesis and dissemination – Conclusions and recommendations (WP9-10)

The first Phase provides an overall description of pesticides' effects on the agricultural production process, on the environment and on consumers. Special attention was given to sources that recognize the stochastic nature of agricultural production processes and the damage-control nature of most agricultural pesticides. Moreover, the effects of pesticides'

use on farmers' health, as well as productivity differences among farmers were assessed. In addition, the damage to aquatic environments from agricultural pesticide use was evaluated using a toxicology indicator that assigns weights to each substance based on their environmental risk. Finally, the impact of pesticides on consumers/residents health and preferences, using consumer behaviour theoretical frameworks based on their Willingness-to-Pay, was determined in experimental markets using choice experiments.

The second Phase assesses existing literature on modelling economic sustainability, evaluating biodiversity, and defining tax policy. Upon the recovery and development of the optimal regulator behaviour, the identification of the most efficient policy tools is explored by defining the first and second-best tax and levy policies. Emphasis was given at the *sectoral* level, designing a realistic and effective tax and levy scheme that reduces pesticide use to a socially optimal level, i.e. the level that also takes into consideration the negative effects of pesticide use on consumers, farmers, and the environment in addition to the positive effects of pesticide control inputs to agricultural production. Phase II also includes the development of an interdisciplinary framework in order to define the economic and social factors affecting the adoption of organic farming and other certified low pesticide input systems in horticulture, permanent crops and arable production. The analysis was carried out in three different countries with dissimilar market characteristics, namely the UK, Netherlands and Bulgaria. Finally, an empirical investigation of the profitability of organic and reduced pesticide system management compared to traditional practices, along with a string of different scenario models for varying levels of relative profitability was developed. Phase II was completed by testing the feasibility of the whole framework in one, common environment.

The third Phase encompasses the demonstrative and the disseminative aspects of the project. The methodologies are integrated into a synthetic format and disseminated via various channels, along with the generated policy recommendation reports. More specifically, the demonstration and dissemination of the results include: *(i)* the design of a leaflet containing information on the results of the empirical research; *(ii)* the organization of the 120th EAAE Seminar on the "External Costs of Farming Activities", held in Chania, Greece; *(iii)* the organization of an intensive course on modeling tools, held in Wageningen University, the Netherlands; *(iv)* the creation of a CD-ROM containing the modeling tools; *(v)* the publication of the research results in scientific outlets; *(vi)* the development of synthesized reports; *(vii)* the organization of a Pre-Congress Symposium at the 2011 European Association of Agricultural Economists Congress in Zurich, Switzerland.

THE EXTERNAL ADVISORY AND REVIEWING COMMITTEE (EARC)

The project's consortium has made consistent efforts to comply with the European Commission's priorities, to maintain a high standard of scientific quality to all its tasks and actions and generate sound results and deliverables that will be useful for policy-makers and scientists. To further ensure the quality of the project's outcome, an External Advisory and Reviewing Committee was set up with the main role to oversee the progress of the project and provide counseling regarding possible improvements. The TEAMPEST Executive Advisory and Reviewing Committee is comprised of four members:

- **Gert van Dijk** (General Committee for Agricultural Cooperation in the European Union - COGECA),
- **Peter Midmore** (Aberystwyth University),
- **Dulce Ricardo** (Deco Proteste consumer group) and
- **Francesca Ydraiou** (Representative of the European Crop Protection Association).

These leading experts have been advising the TEAMPEST consortium in all matters ranging from the methodological framework, project improvements, insights and feedback from consumers and farmers, as well as have recommended actions for addressing new pesticide control policy measures. Furthermore, these committee members represent important links to relevant stakeholders across the EU.

WORK PACKAGE FINDINGS

EXTERNAL COSTS ON PRODUCERS | WP1-2

The results of the analysis regarding the evaluation of the effects of pesticides on farmers' productivity indicated that agriculture in the three member states (Greece, Bulgaria, and the Netherlands), has benefited by the overall use of pesticides over the past decade. Increases in pesticides use enhanced farmers' productivity and resulted in production growth. Nevertheless, production growth caused by pesticides was decelerated due to significant impairments in farmers' health. Inappropriate use of pesticides and farmers' aging were mainly responsible for that impairment. On the other hand, improvements in education diminished the extent of the negative health effects and were an important source of labor productivity growth. More specifically, in the Netherlands where farmers' educational level is higher and pesticides' application is conducted under higher safety standard in comparison with Greece and Bulgaria, the health effect of pesticides on productivity was approximately five times lower compared to the other two countries.

EXTERNAL COSTS ON THE ENVIRONMENT | WP3

The results of the analysis regarding the environmental impact of pesticides on the environment suggest that pesticide environmental toxicity differs significantly among pesticides and environmental toxicity does not necessarily correlate with human health toxicity of pesticides. Furthermore, the carrying capacity of the aquatic environment significantly determines the amount of traceable pesticide residues. The environmental impact of pesticides on the aquatic environment was assessed under two tax scenarios, a differentiated tax based on the toxicity level and a flat tax on all pesticides. Results indicate that flat taxes on inputs cause a weaker link between the tax and the environmental impact. Differentiated taxes proved capable of achieving the social optimum, but at an increased administrative cost. In addition, a flat tax can result in too high taxation of some pesticides and too low taxation of others. Furthermore, the impact of taxation on the economy is relatively small.

EXTERNAL COSTS ON CONSUMERS | WP4

The external cost of pesticides on consumers/residents was determined through choice experiments and assessment of their willingness-to-pay for products with various levels of pesticide residues. Consumers' willingness-to-pay for products without pesticides (organic) compared to regular and integrated pest management indicate that consumers' premium for pesticide reduction is not independent from the product's sensory attributes. In the context of the experimental auctions carried out for apple, results indicate a premium for organic of around 96% in Portugal, 72% in France, and 68% in Greece. Moreover, the results show that income is not significant in explaining the premium for organic products, which implies that the demand for organic products is likely to grow significantly within the EU in the coming years. This demand involves a priori all segments of the population and the willingness-to-pay for these products is relatively large.

TAX & LEVY SCHEMES | WP5

The aim of this work is to assess the effectiveness of different economic instruments such as taxes and levies in encouraging farmers to decrease their intensity of pesticide applications. The dilemma inherent in pesticide taxation is that the use of pesticides may be so essential for some crops or regions that tax rates would have to be very high to modulate pesticide use. This could result in a major reduction in farm income as depicted through the pesticide tax scenarios presented in this study.

Three different tax schemes were selected for evaluation: a flat tax on pesticides; a tax that differentiates according to toxicity and a price penalty for pesticide impacts on biodiversity. Levy schemes, where tax revenues are redistributed back to the agricultural sector, were also considered including: direct payments; subsidies on the use of low toxicity pesticides; and on research and development (R&D) of low toxicity alternatives and more environmental friendly chemicals. The results of the study indicate that high taxes or levies are required in order to achieve considerable pesticide reduction targets.

Taxes that differentiate according to toxicity do not lead to substitution of high with low toxicity pesticides. This can be attributed to the lack of low toxicity substitutes or the high effectiveness of high toxicity products in the damage abatement process. On the contrary, a substitution effect is observed when subsidizing R&D of low toxicity pesticides. No single tax or levy instrument outperformed the others, indicating that an optimal pesticide regulatory strategy should include a set of additional instruments such as direct controls or extension.

OPTIMAL TAX & LEVY POLICY | WP6

The work undertaken here focuses on the development of a dynamic model analyzing the optimal pesticide use, achieved through an effective tax and levy system. The findings of the work, have contributed to the creation of a formula, which allows for the estimation of the optimal tax rate, on the price of pesticides, while taking into consideration all the externalities associated with their use. Specifically, pesticides aid agricultural production by protecting them from pests but, on the other hand, produce negative side effects on the health of consumers, farmers and the quality of the environment.

Simulation results, on the estimation of pesticide taxes for three country case studies (Cyprus, the United Kingdom and the Netherlands) are based on different specifications of the model parameters for each case study. Results indicate that the socially optimal tax rates vary widely among countries and that high tax rates on pesticides are required (up to 32 percent for Cyprus, 25 percent for the UK and 76 for the Netherlands) to achieve the socially optimal pesticide use level.

INCENTIVES FOR PESTICIDE SUBSTITUTION | WP7

The aim of this work is to study the effectiveness of introducing incentives to implement the substitution principle regarding pesticide use and therefore to reduce its use. More specifically, it develops an interdisciplinary framework in order to define the economic and social factors affecting the adoption of organic farming and other certified low pesticide input systems. A combination of focus groups and qualitative data analysis were used to illicit farmers' thoughts and feelings on a range of issues associated with pesticide use in their farming systems. In the focus groups, high crop-protection use farmers were presented with financial information about farms similar to their own compared and contrasted with low input and organic farms, and farms that had a tax imposed on their crop protection costs. Three focus groups per country were carried out (UK, Bulgaria and the Netherlands). The cropping farm type with the greatest pesticide use was identified for each country and this farm type used as the basis for analysis. For Bulgaria this was grapes, in UK and Netherlands this was arable cropping systems, predominantly cereals but including some pulses and oilseeds.

The main finding from the focus groups is that a tax on crop protection costs is unlikely to result in a decrease in the use of crop protection products or a significant change in the way high input farmers farm. It is very unlikely, given these results that farmers would move from high input crop protection systems to low input or organic systems for the reasons outlined. Bulgarian farmers were willing to pay a tax or levy if the funds raised were directly reinvested back into their sector to develop practices and technology for reducing pesticide use in the future. This was not acceptable to the UK farmers, who wanted investment in technology but were not willing to pay for its development directly. In both UK and Bulgaria focus groups, the more wide-ranging implications of a tax on crop protection costs were raised. In Bulgaria, the farmers felt that a tax on pesticides would result in higher prices for grapes and consequently wine products, which in turn would result in reduced demand and significant impacts on the GDP of Bulgaria. In UK, it was felt that the introduction of a tax on crop protection inputs would increase the financial burden on farmers to such an extent that smaller, family farms would no longer be viable and that the speed with which farms in UK are becoming larger and larger would be increased.

POLICY RELATED RESULTS

A short list of consolidated policy related results derived from the project, is cited here:

- ☐ No single tax or levy instrument can lead to a substantial reduction of pesticide use
- ☐ Pesticide taxes as a single instrument have not been proven very effective, as they yield small changes in pesticide use
- ☐ The most cost efficient taxation involves a differentiation of taxes according to toxicity levels. A toxicity indicator, such as the Pesticide Toxicity Index, could be used to develop a system of differentiated taxes
- ☐ Pesticide tax schemes, which put higher penalties on high toxicity (HT) than low toxicity (LT) pesticides, do not result in a substitution to LT pesticides. This could imply the absence of effective LT alternatives and farmers stick to HT pesticides
- ☐ Pesticides taxes have negative effects on farmers' income, which can be counterbalanced by levies (returning the revenues to farmers as lump sum payments). Moreover, investing part of the tax revenues in the development of more environmental friendly products or pesticides that are more efficient can reduce the negative effect on income
- ☐ The demand for pesticides was found generally inelastic. Thus, high tax rates need to be applied in order to achieve major reductions in pesticide use
- ☐ Incentive schemes, such as taxation, education, public and private research and investment on alternatives to pesticides, have been indicated as effective alternatives
- ☐ Decisions on the financing of private and/or public research in damage-control technologies should be based on accurate measures of productivity growth that account for the negative externalities of pesticides
- ☐ Accurate information on pest populations and other stochastic factors is key to measuring the true productive impact of pesticides. Thus, efforts should be made to enhance collection of such data for leading crops across the EU
- ☐ Consumers across the EU show high willingness-to-pay for organic products, across all income groups. Thus, expanding organic farming is a viable solution to reduce pesticide use
- ☐ Consumers are generally uninformed about pesticide use and pesticide residues in agricultural products. Therefore, more information regarding pesticides in agricultural products should be provided to consumers, to assist them in making knowledgeable decisions
- ☐ Lack of relative data or homogeneous data throughout Europe hamper accurate estimates on pesticides' effects

POLICY RECOMMENDATIONS

A few policy recommendations based on the projects' results:

- ☐ Enhancing farmers' education on the impact of pesticides on health, on the appropriate application of pesticides and on alternative application techniques could be very conducive to optimal pesticide use
- ☐ Promotion of less toxic pesticides through demonstration and dissemination activities involving public and private extension services with respect to the appropriate and safe use of pesticides, and through prevention activities for the most hazardous pesticides
- ☐ Development of policy schemes that promote the safe application of pesticides and the promotion of less toxic chemical elements. Incentives for the adoption of those technologies, such as through reduced loan interest rates for investments on such technologies, can conduce to this direction
- ☐ Investment in novel plant protection products, variety development, GM technologies, new technologies for pest, disease and weed problems
- ☐ Development of support payments for specific beneficial activities on farm (e.g. agri-environmental schemes)
- ☐ Development of a political framework that encourages companies to enhance products in terms of effectiveness, specificity, environment and human health
- ☐ Financing of private and public research for the development of less toxic pesticides and for the improvement of the damage control technology, targeted through an incentive scheme to small producers
- ☐ Undertaking of lifecycle analysis of various farming systems to identify the most sustainable systems for the future
- ☐ Encouragement of precision agriculture usage for more targeted pesticide application that can reduce overall pesticide use
- ☐ Establishment of tax deductions on the purchase of machinery for cultural weed control or application tools and technologies aligned to safe application (e.g. specific nozzles)

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