Guidelines for Pesticide Policy Studies

A Framework for Analyzing Economic and Political Factors of Pesticide Use in Developing Countries

S. Agne
G. Fleischer
F. Jungbluth
H. Waibel

A Publication of the Pesticide Policy Project

Hannover, January 1995

Publication Series No.1

Pesticide Policy Project Publication Series
No. 1, January 1995

Institut für Gartenbauökonomie,
Universität Hannover

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

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Editors:

Prof. Dr. H. Waibel
Institut für Gartenbauökonomie
Universität Hannover
Herrenhäuser Str. 2

30419 Hannover
Germany

Dr. T. Engelhardt
Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ)
GmbH, Abt. 423-4
Postfach 5180

65726 Eschborn
Germany

Publication of the Institute of Horticultural Economics, Herrenhäuser Str. 2, 30419 Hannover
Printing: Uni Druck Hannover, 30419 Hannover

The Pesticide Policy Project

The Pesticide Policy Project started in April 1994 as a project of the GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit), sponsored by the BMZ (Ministry of Economic Cooperation and Development) and carried out under supervision of Prof. Waibel, Institute of Horticultural Economics, University of Hannover. Within the project four country studies in Latin America, Africa and Asia are conducted which principally follow the proposed guidelines.

The overall hypothesis of the project states that the current use of pesticides goes beyond a level which is acceptable from the society's point of view. This seems largely a result of ignoring economic considerations in pest management. The objective of this project therefore is to augment the use of economic instruments in pesticide policy. This is expected to lead to increased agricultural productivity and ecologically benign pest management.

Within the five year duration of the project a series of publications will be published ti inform about the latest findings of the project as well as related topics. The series is titled "Pesticide Policy Publication Series" and is available on request through:

Prof. Dr. H. Waibel
Institut für Gartenbauökonomie
Universität Hannover
Herrenhäuser Str. 2

30419 Hannover
Germany

Tel.: (0)511 - 762 - 2666
Fax: (0)511 - 762 - 2667
E-Mail Waibel@ifgb.uni-hannover.de

Dr. T. Engelhardt
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Abt. 423-4
Postfach 5180
65726 Eschborn
Germany

Tel.: (0)6196 - 791430
Fax: (0)6196 - 791115

Acknowledgements

The authors are grateful to the participants of the Göttingen Workshop on Pesticide Policies in February 1994, which was organized by the Institute of Agricultural Economics of the University of Göttingen and sponsored by the Food and Agriculture Organization (FAO). During this workshop a first concept of the framework on pesticide policy studies was developed through the intensive discussions and the presentation of papers by participants.

The workshop output has been taken as a baseline for a first version of the guidelines which has been published in the workshop proceedings. Special thanks go to Sebastiao Barbosa who was instrumental in providing funds through the FAO. Also, Bob Frans and Jan Zadoks from the FAO/UNEP panel of experts on IPM who made valuable suggestions to an earlier draft of the guidelines.

Matthias Kern and Rolf Link of the GTZ made helpful comments for this final version of the guidelines which are highly appreciated.

The Authors

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1 Introduction

Pesticide use in developing countries has spread dramatically since the onset of the Green Revolution in agriculture and horticulture. Market forecasts of the agrochemical industry show a further increase in the near future. Since chemical pesticides were seen as a quick and efficient solution for occuring pest problems, their use at the farm level was promoted by national governments in order to accomplish food self-sufficiency and raise cash crop production.

The trends in pesticide use increasingly become a matter of concern among policy makers, researchers and extension specialists. In many areas, over- and misuse of pesticides has been observed. Its usage is frequently accompanied by negative side-effects such as poisoning of users, chronic health effects, pesticide residues in food and drinking water and damage to the natural environment. Since incentives for non-chemical methods of pest control are lacking, a growing dependency on pesticides can be observed.

The concept of Integrated Pest Management (IPM) is seen as a valuable alternative to the indiscriminate spread of pesticide use. However, several factors contribute to a sluggish adoption of this technology. The lack of knowledge of the factors which influence the use of chemical pesticide has been frequently identified as a key problem.

The present paper draws substantially on the results and joint formulation of a framework elaborated during a workshop among researchers, donor representatives and members of the FAO/UNEP Panel of Experts on Integrated Pest Control which was held in February 1994 in Göttingen[1]. It was concluded that a general methodological framework was needed to facilitate inter-country comparisons and to raise the level of transparency of pesticide policy studies.

As a major step towards achieving empirical results from several regions of the world, GTZ commissioned the Institute of Horticultural Economics of the University Hanover, Germany, to conduct country studies in four countries of Latin America, Africa and Asia.

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1 A Conceptual Framework for Pesticide Policy Studies, in: Proceedings of the Göttingen Workshop on Pesticide Policies, ed. by S. Agne, G. Fleischer and H. Waibel, Göttinger Schriften zur Agrarökonomie, Vol. 66. Institute of Agricultural Economics, University of Göttingen,1994.

The preparation of these country studies yielded additional ideas and testable hypotheses, which are summarized in these guidelines. It is understood, however, that this framework is subject to changes as empirical results are obtained through the country studies and experience is gained in conducting such studies.

Chapter 2 outlines the objectives of pesticide policy studies and explains the difference between private and socially optimal levels of pesticide use, while chapter 3 specifies the audience for which an analysis of pesticide policies is believed to be of major interest.

The methodology of the guidelines is presented in chapter 4. Focus is given to critical issues to be considered while conducting the studies. The summary outline of the individual research topics forms the main part of chapter 5 which is divided in three sections. The first section proposes that pesticide policy studies should start with an analysis of the existing situation of the agricultural sector. An analysis of existing crop protection and pesticide policies is the main focus of the second section. Finally, details about farm and crop characteristics affecting pest management should be provided.

A selection of annotated literature on pesticide policies and the economics of pest management is presented in the last chapter. Latest studies which contributed major results and methodological improvements in pesticide-related research are reviewed in short abstracts. These references are believed to be a kind of minimum requirement for anyone doing pesticide policy studies.

2 Objectives of Pesticide Policy Studies

The present guidelines adress experts commissioned to conduct pesticide policy studies. They provide a general approach, but are not meant to limit the scope of the inquiry.

The guidelines may be used both as an outline for short-term exploratory studies, as well as framework for in-depth research, focusing on specific issues. Short term studies should concentrate on sections 5.1, 5.2 and those parts of 5.3 that are marked as priority issues. These exploratory studies will identify issues particular to individual countries requiring more intensive research in the future. It is expected that, as actual studies are carried out, the guidelines themselves will be improved and adapted to the needs of individual countries.

The overall objective of pesticide policy studies is to approximate the socially optimal level of pesticide use taking into account the possibility of non-pesticide alternatives.

Economic assessment of pesticide use has to be treated within a framework, that covers the farmer's point-of-view as well as the society's viewpoint (Figure 1)[2]. The criterion for the farmer is to maximize expected net returns. Gross returns from applying pesticides is equal to prevented crop loss in monetary terms. Costs of pesticide use are referred to as the amount of farm resources used for every unit of crop loss prevented. Farmer's level of pesticide use is therefore denoted with U_p^{Pc} in figure 1. This level depends on the farmer's subjective assessment of crop loss, the effectiveness of his control method and the costs which he perceives. This may well lead to an overestimation of the returns as explained above and to an underestimation of costs if, for example, actual health hazards are not fully recognized. If perfect information on the above mentioned variables were available, the optimal level of pesticide use would be reduced to U_a^{Pc} and increase his net returns.

The criterion for the society as a whole on deciding of how much pesticides to apply is to maximize net social benefit. This differs from the private optimum, because pesticides cause external effects, e.g. through the contamination of ground water or food, which are not taken into

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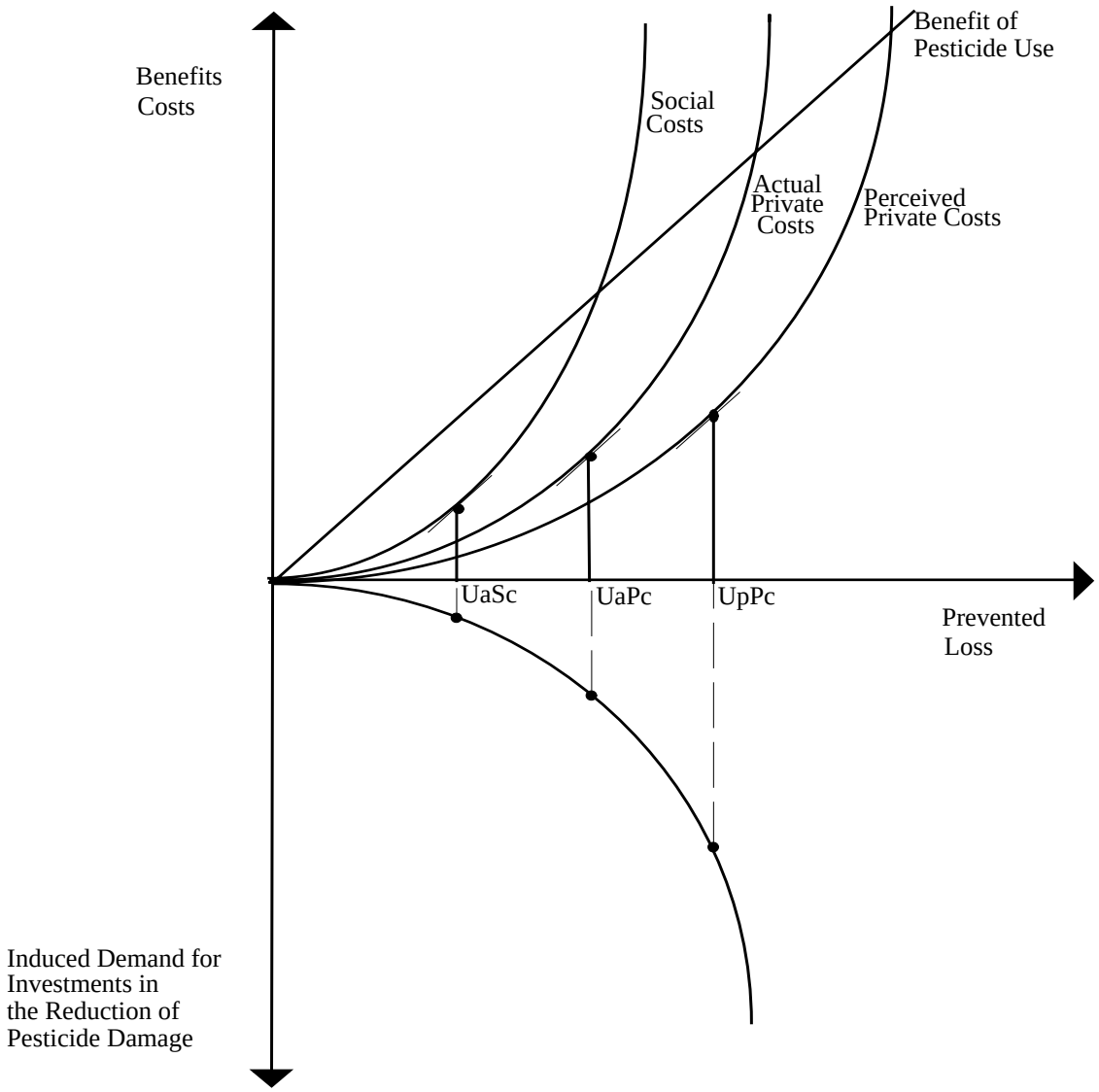
2 WAIBEL, H. (1994): Towards an Economic Framework of Pesticide Policy Studies. In: Proceedings of the Göttingen Workshop on Pesticide Policies, ed. by S. Agne, G. Fleischer and H. Waibel, Göttinger Schriften zur Agrarökonomie, Vol. 66. Institute of Agricultural Economics, University of Göttingen, 1994.

account by the farmer. To include these negative externalities shifts the cost curve upwards and further reduces the optimal level of pesticide use to U_a^{Sc}.

Figure 1: Optimal Level of Pesticide Use and Induced Investments



Source: Waibel, H, 1994

If governments do not interfere in the pesticide market, adequate information on crop loss will not be provided and externalities will not be internalized. As a concequence the level of pesticide use is likely to be above the social optimum.

The resulting overuse of pesticides causes additional costs, because potential and actual damage caused by pesticides leads to an increased need for government activities which aim at monitoring the implementation of rules and regulations as well as at reducing the

environmental and health damage caused by pesticides. Examples of such activities are the establishment of pesticide residue laboratories, residue monitoring programs and training programs on the safe use of pesticides. There is no doubt that such activities, which mostly require public funds are necessary in principal. However, the extent of these activities must be decided simultaneously with the level of pesticide use, or else over investment is likely to occur. If activities in pesticide damage mitigation measures come up to the current level of pesticide use, public funds are likely to be wasted. If pesticide use would be at the socially optimal level, the induced demand for such activities would be lower. This is shown by the lower panel of figure 1 (WAIBEL, 1994).

In order to draw valid conclusions for the design and implementation of international and national plant protection studies and in order to approximate the socially optimal level of pesticide use, a conceptual framework is needed which can serve as a guide for conducting pesticide policy studies. The present guidelines will be applied in the studies carried out by the GTZ Pesticide Policy Project, but may be used by other institutions and evaluators as well.

Applying this framework is expected to achieve the following:

- provision of an overview of pesticide use within the context of the nation's crop protection strategy
- create increased awareness of pesticide policy in the context of agricultural, environmental and health policies
- stimulate demand for in-depth studies addressing specific issues raised by the exploratory studies

The framework is intended for general purpose and may be used not only in the agricultural and horticultural sector, but may be relevant for the forestry and veterinary sector also.

3 Target Groups of Pesticide Policy Studies

Pesticide policy studies are expected to serve as an avenue to move pesticide use from its current level towards its social optimum. Also, such studies are anticipated to increase the appreciation given to non-chemical pest management options as the external costs of pesticides become more explicit. To achieve the above targets a broad spectrum of organizations and individuals concerned with political and economic conditions of pesticide use shall be reached.

The intended audience includes:

- policy makers and other relevant groups at the national level
- donor organizations
- aid agencies
- other international non-governmental and technical service organizations
- the chemical industry
- public administrators

4 Methodology

The studies should be carried out, whenever possible, by local institutions and experts. The studies are of an interdisciplinary nature and in order to accomplish the methodological requirements presented below, an agricultural economist should be included in the research team.

Several critical methodological issues should be considered:

1. The studies should preferably begin with a local workshop in the country of interest setting out the objectives of the study and soliciting the participation of relevant individuals and institutions.
2. The representatives should be selected from the policy areas of agriculture, environment and health and should include individuals from both government and non-governmental organizations, particularly farmers and consumers.
3. The researchers should place a high priority on direct contact with farmers and farm workers. Every effort should be made to avoid gender bias in obtaining information from the field.
4. Before submitting the final report, the draft report should be discussed with all concerned parties within the countries and their input should be

sought. Whenever possible the study project should end with a workshop.

5. Special attention should be given to the following methodological problems:

   a) Benefit of pesticide use often appears difficult to measure in economic terms. Several methods may be considered. A pragmatic approach is to use partial budgeting methods in comparing alternative crop protection strategies and tactics. The shortcoming of this approach is that no causual relationship between pesticide use and reduced crop loss can be established. This can only be achieved by applying econometric methods. As a result the marginal value product of pesticide i.e. value of crop loss prevented for every $ spend on pesticides is calculated. The most sophisticated method is to use simulation models which include crop loss estimations via damage functions and control functions which represent effectiveness and costs of alternative strategies. The limitation of this approach is the lack of crop loss data. Furthermore, existing crop loss estimates are limited to the ”spray-no spray paradigm” and thus ignore possible adjustment strategies.

   b) The relative importance of price and non-price factors determines the demand for pesticides. In spite of the problems with cross-sectional and time series data, efforts should be made to estimate the demand elasticities for pesticides. Having information on the impacts of the different factors which determine the pesticide use contributes to formulating economic and political instruments which also consider the social costs of pesticide usage.

   c) The valuation of externalities should be expressed in monetary terms whenever the available data and methodological considerations allow. Only by expressing external effects in monetary terms can a comparison with other cost factors be feasible. For example, a recent field study in the Philippines has shown that the costs of damages to farmers health by insecticide use in rice production are about equal to the amount farmers spend for pesticides (ROLA AND PINGALI, 1993)[3].

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[3] Rola, A.C. and P.L. Pingali (1993): Pesticides, Rice Productivity and Farmers’ Health - An Economic Assessment. International Rice Research Institute, Los Baños, Philippines.

d) Whenever time is not sufficient for conducting surveys using representative sampling, the researchers should use rapid rural appraisal methods to facilitate the collection of information in the time available. The researchers should seek ways of approaching a range of farmers in order to obtain a realistic picture of conditions in the field.

e) Among the alternatives to pesticides to be considered are biological control, cultural control and resistance breeding as measures that lead to changes in pesticide use and dependence.

f) The studies should pay attention to measuring the existing degree of pesticide dependence and ways to diminish such dependence in the future. The increase in pesticide expenditures in real terms relative to other inputs may serve as an indicator of this dependency.

5 Concept of Studies on Pesticide Policy

In order to provide detailed information about the issues of general concern in pesticide policy studies, three main sections are necessary. The first section contains a review of existing literature and an interpretation of relevant statistics which enables an assessment of the current situation. Section 5.2 contains an in-depth analysis of the current crop protection policy and section 5.3 provides a detailed analysis of microeconomic issues, if necessary with supplementary data collection and case studies.

If constraints do not allow a complete survey of all issues mentioned in this concept, priorities should be set in view of follow up in-depth studies.

5.1 Analysis of the Existing Situation

The objective of this chapter is to present an overview of the agricultural sector, agricultural pricing policies, pest problems and management practices, externalities of pesticide use and the extent of social pressure for reforms as far as the use of pesticides is concerned in each case-study country.

The chapter should be based on a review of existing information and on discussions with government agencies, etc. It must be pointed out that the consistency of the available statistics and data should be examined thoroughly.

5.1.1 Characteristics of the Agricultural Sector

The aim of this section is to provide a detailed review of the role of the agricultural sector in the economy. This seems to be of great importance considering the enormous influences overall development has on the agricultural sector. The increasing trend of diversification towards more intensive crops also raises the amount of pesticides used. Therefore, the characteristics of the agricultural sector has to be considered. Some of the types of data to be collected include the following:

- relative share of the agricultural sector in GDP (gross domestic product)
- relative share of the agricultural sector in employment
- structure of the agricultural sector, i.e. farm size structure
- level of technology
- major crops: trends in production and productivity
- trade patterns
- nature of the market, information and information gaps and extension infrastructure
- dependence of the agricultural sector on external economies.

5.1.2 Agricultural Policy Setting

Because agricultural policy plays a major role in influencing pesticide use patterns, a review of existing policies is needed. This section will provide an overview of agricultural policies in the case-study countries and can therefore help to quantify the existing market deteriorations. The main elements to be covered are the following:

- general agricultural policy of the country, e.g. heavy versus light government interference
- impact of macroeconomic policy changes (e.g. structural adjustment programs) on the agricultural sector
- sub-sectoral analysis with detailed overview of product and factor markets
- structural agrarian policies

- indicators for the degree of protection of the agricultural sector (outputs and inputs) over time (tariffs, non-tarrif barriers, differences between domestic and world market price)

5.1.3 Pest Problems and Pest Management Practices

The objective of this chapter is to provide an overview of the state of the art vis-a-vis the pest problems and management practices and the degree of importance given to pest problems and pest management practices on the national level. The quantification of pest problems is for the most part difficult. For example, the actual crop loss due to pests can only be estimated and it is not known to what extend the real damage of the pests would have been without pesticide use or with an alternative method of control. Besides this, most available data comes from research stations which do not represent normal growing conditions in the farmers field.
The issues to be covered are as follows:

- definition of crop loss
- current and historical status of losses from pests
- history of pesticide use over time (classified by types of pesticides, quantities and expenditures)
- degree of importance given to pest problems and pest management practices at the national level
- summary of existing literature regarding evidence for pesticide productivity, e.g. production functions including pesticide as a variable, experiments, on-farm trials of alternative pest control strategies with yield measurements

5.1.4 Externalities of Pesticide Use

Over- and misuse of pesticides has been shown to have effects beyond the fields on which they are applied. It is, therefore, important to identify negative externalities, especially as they affect human health, water quality and other natural resources. Such externalities should be internalized in the pricing of pesticides so as to provide incentives for shifts to other pest management technologies.

This chapter has the objective of documenting the extent of these negative externalities with appropriate literature citations. If information on these externalities are not available in the country, the researcher will

have to review available information elsewhere and make appropriate recommendations for areas to be covered in the case-study countries. Some of the issues to be covered are:

- pesticide resistance (for example see the study on the costs of resistance in Californian cotton production)[4]
- destruction of beneficial insects
- reduction of biodiversity (reduction of animal and plant species found under "non-pesticide conditions")
- health impacts of pesticides on farmers and farm workers
- pesticide residues in food
- pollution of ground and surface water resources
- damage to productive resources (fish, honey bees, ducks, etc.)
- non-agricultural consequences (e.g. emissions from pesticide industries, etc.)

5.1.5 Social Response to Pesticide Issues

The perception of pesticide use by various groups concerned influences policies regarding pesticides. The objective of this section is to review the current situation with respect to the views of these interest groups. Some of the issues to be examined are:

- perception of crop losses by the different groups
- perception of the appropriateness of pesticide use by NGOs, consumer groups, farmer groups, industry (food processing and retail industry, chemical industry), government, researchers and donors
- considerations given to chemical and non-chemical pest control measures
- perception of environmental and health risks by the different groups
- perception of appropriateness of political instruments in the plant protection sector
- considerations given to the potential reduction of pesticide use

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4 ARCHIBALD, S.O. (1988): Incorporating Externalities into Agriculture Productivity Analysis. In: S.M. Capalbo and J.A. Antle (ed.): Agriculture Productivity - Measurment and Explanation, Washington D.C.

5.2 Analysis of Existing Crop Protection and Pesticide Policies

The purpose of this section is to identify the extent to which existing policies and institutional factors induce a non-optimal use of pesticides, and in particular to identify whether chemical control is favored relative to other methods. The analysis should lead to recommendations for removing distorting policies and introducing measures which take into account the externalities caused by pesticides.

There are different types of policies in place that significantly affect pesticide usage in the major crops. It is assumed that such may include pricing, trade and input, regulation, and research, education and extension policies. It is also assumed that there is a need for assessing the possibility of modifying or even eliminating the policies that distort pesticide pricing and utilization to levels that are substantially different from the socially optimal levels.

In addition, it is hypothesized that the current legal environment and regulatory enforcement capabilities may be inadequate and disfunctional, thus having a significant impact on the current levels of pesticide use.

Finally, it must be considered that an inbalance may exist within the research, education and extension apparatus, such that the curricula and work programs emphasize chemical control relative to non-chemical options.

The overall framework of the analysis of existing policies is based on the principles of welfare economics. Quantitative indicators are to be developed in support of the narrative comments concerning the issues described in the following sections.

5.2.1 Policy Formulation and Transparency

This section should provide a listing and description of the entities involved in setting pesticide policies and their relative political or bureaucratic leverage (ministries, NGOs, donors, media, private growers associations, food processors and retailers, pesticide industry, etc.).

Public awareness

- role of autonomous farmer organizations in pesticide policy and awareness
- role of consumer organizations in pesticide policy and awareness
- extent of NGO activities in pesticide matters

- media coverage of pesticide related problems

Political economy of the pesticide market

- analysis of collaborative links between institutions and personnel (composition of the board for pesticide admission and registration, etc.)
- interaction between social groups and institutions (e.g. in the legislative process)
- conduct of the industry regarding pesticide use

5.2.2 Analysis of Pricing, Trade and Input Policies

The analysis of this section refers to subsidies or taxes, to trade and exchange rate policies and to other interventions in plant protection which directly or indirectly promote pesticide use. The likely existence of preferential treatment for the pesticide sector should be examined for each of the following issues. Policy impacts will have to be estimated for the case that subsidies are partially or totally removed. Quantitative information should be provided to the extent possible.

Direct subsidies or taxes

- role of subsidies (or taxes) to producers and distributers in the formation of the sales price
- distribution of low-priced pesticides and materials (spraying equipment etc.) through donor or government contributions

Trade and exchange rate policies

- exchange rates for imports of pesticides and other agricultural inputs (in favor of pesticides?)
- tariff rates for imports of pesticides and other agricultural inputs
- allocation of foreign exchange for pesticides (special budget?)
- quantitative import restrictions for pesticides
- import restrictions on certain types of pesticides

Indirect subsidies

- subsidies to local producers of pesticides (e. g. through capital grants or cheap credits)
- sales tax of pesticides and of agricultural inputs in general
- government control of marketing margins

- subsidies to complementary inputs (e. g. gasoline for airplanes, spraying equipment)
- any other form of subsidy through which government makes pesticides cheaper

Interventions in input and commodity markets

- effect of commodity price support policies in major pesticide-consuming crops
- obligations to use pesticides in order to be eligible for insurance or credits
- limitation in credit supply for activities related to non-chemical pest management
- rules of pest control actions, i. e., outbreak control measures by government (e.g. in forestry)
- government determination of the types, the quantity and the timing of pesticides applied (e.g. cotton in Egypt)
- political economy of pest outbreak budget (allocation of funds and disbursement)

5.2.3 Regulatory Policy

In this section a detailed description of the legal apparatus affecting pesticide use should be given (pesticide law, rules and regulations, etc.). The following issues should be included:

- elements of the regulatory system (existence and functioning of pesticide registration system, process of registration, e. g. who provides the information, criteria of risk/benefit assessment)
- degree of enforcement of different laws and rules (complexity of the legal system, enforcement mechanisms, budgetary provisions for enforcement mechanisms)
- status and impact of the FAO "Code of Conduct" including the "Prior Informed Consent"
- procedure for pesticide quality control
- residue analysis facilities (residue information released to the public?)
- formal standards for spraying equipment
- procedures restricting introduction of biological control agents
- limitations in the government regulatory personnel or budget

- health control rules and procedures affecting pesticide use (records on pesticide intoxication cases)
- status of health and safety legislation
- emission and immission/contamination standards (e.g. maximum residue levels)

5.2.4 Analysis of the Research, Education and Extension System

In addition to the factors having a direct influence on the price of pesticides, other conditions affect the use of pesticides. These factors should also be included:

- public support for pesticide versus non-chemical pest management research (magnitude and proportion)
- donor support for pesticide versus non-chemical pest management research (magnitude and proportion)
- actual capabilities and research agendas of public/private institutions to implement IPM research
- relative importance of pesticide versus non-chemical pest management in the school and university curricula
- actual knowledge of technical school graduates, extensionists, researchers on pesticide versus non-chemical pest management alternatives
- actual extension agenda
- percentage of extensionists concurrently working as pesticide distributing agents or salespersons
- main providers of pest management advice to farmers (public or NGO extensionists, pesticide salespersons, etc.)
- extent and quality of pesticide safety and efficient use training available to farmers
- existence and effectiveness of pesticide information systems

5.3 Farm and Crop Characteristics Affecting Pest Management

Farm and crop characteristics directly influence the farmer’s decisions on control measures to manage pests in agriculture. The aim of the farm level research is to analyze the reasons for pesticide usage and to identify

indicators for farmers' perceptions of the risks and potential damages of pesticides. Furthermore, it should be pointed out how these factors influence the adoption and diffusion of alternatives to current pest management practices.

The researcher should take care regarding the source of basic information, the quality and the reliability of data. Direct contact with representatives of the farming communities, including women, children and landless laborers is essential. Surveys should be done in a rapid rural appraisal mode by analyzing different issues on the local level. Furthermore, special attention must be paid to the use of secondary data and their suitability for comparisons.

As mentioned in the introduction, the farm level analysis may require long-term studies. However, if budgetary constraints exist, short-term studies may be conducted which include only a few elements of this chapter. These issues are marked with an asterisk (*).

5.3.1 Farm Characteristics Affecting Pest Management

The state of a farming system, i. e. its degree of crop diversification, often preconditions the level of pesticide use. This is reflected in the share of expenses for crop protection inputs in the total farm budget. Other variables like farm size, land tenure situation or labor availability are to be taken into account.

The farmer's access to resources is another important issue. The product's destination, (basic food or cash/industrial crop, for local consumption or for export), the structure of product markets, as well as infrastructure conditions should be considered. For this purpose the interdependencies among researchers, extension workers and farmers and among farmers, sales agents and extension workers should be analyzed.

The data to be collected are comprised of the biophysical and socioeconomic characteristics of farming and its environment. In addition, information regarding farmers' awareness of health and environmental hazards should be gathered, as this can be assumed to affect farmers' attitude and behavior of pesticide use.

Biophysical characteristics of farming and its environment

- climate
- soil
- habitat
- on-farm water supply

Socio-economic characteristics of farming system and its environment

- farm size
- tenure status
- availability of non-farm income
- state of farm systems (diversification versus specialization):
  - share of crop protection inputs in farm budgets (including labor)*
  - high versus low external input
- access to resources:
  - output markets (market institutions, farmer-trader linkage, storage facilities, future markets)*
  - input markets
  - credit facilities
  - availability of information (e.g. through extension agents, sales representatives); research-extension-farmer linkages.

Farmers' awareness of health and environmental hazards

- disease symptoms as recognized and described by medical services
- farmers' perception of disease symptoms
- kind of protective measures (e.g. use of protective clothing)
- discrepancies in pest management practices between crops grown for home consumption and marketable crops
- indicators for the availability of open access resources

5.3.2 Crop Characteristics Affecting Pest Management

Different crop profiles need to be well characterized and understood in order to permit the assessment of many kinds of pest management strategies. They are also related to variables that show the farmer's sensitivity to pesticides: the spraying frequency, the dosages, and practices such as the use of mixtures of different pesticides ("pesticide cocktails").

*Crop profile**

- type of crop (annual/perennial, low versus high input requirements)
- type of product (subsistence, home markets, export crop, quality standard)

*Description of the chemical pest control measures**

- types of pesticides in use
- dosages
- spraying frequencies
- pesticide cocktails

These data also serve as first indicators for the existing susceptibility and/or emerging resistance of pests towards pesticides.

Description of non-chemical pest control measures

- resistant varieties
- cultural control
- natural enemies

5.3.3 Expected Benefit/Cost Ratio of Available Control Methods

In this section, the economic performance of different plant control measures should be assessed taking into consideration the farmer's perception as compared to the actual situation. The marginal benefit/cost ratio may be generated based on either farm surveys, on-farm trials or on simulations using the following variables: damage functions, pest counts/assessment, effectiveness of various control methods, input and output prices and assumptions as regards to farmer behavior.

The analysis should also include health costs associated to pesticide use. If no appropriate data are available, data from literature shall be taken. Whenever possible, attempts should be made to quantify off-site external effects.

Marginal cost/benefit ratio of different control measures

- economic analysis of on-farm trials
- inclusion of pest management variables in estimations of the production function
- simulation studies based on damage functions

Quantification of external effects at the farm level

- health
- soil fertility
- farm animals including aquatic organisms (fish, crabs, etc.)
- beneficial organisms

Quantification of off-site external effects

- pesticide resistance
- environmental effects
- residues in crops, food, water, soil and air
- losses in productive activities (fish, honey bees, ducks etc.)
- nature conservation/tourism

6 Annotated Literature on Pesticide Policies and the Economics of Pest Management

ANTLE, J.M. (1988): Pesticide Policy, Production Risk, and Producer Welfare - An Econometric Approach to Applied Welfare Economics, Resources for the Future, Washington, D.C.

The purpose of the study is to provide an econometric framework for the measurement and analysis of the direct economic benefits that agricultural producers derive from the use of pesticides, and other pest management practices such as IPM. It is illustrated how the framework can be used by examining its application in a case study of a California processing tomato production.
For the first time the determination of social costs and benefits of pesticide use is considered. The need to design policies for cases where unregulated pesticide use fails to yield net social benefits is highlighted.

ARCHIBALD, S.O. (1988): Incorporating Externalities into Agricultural Productivity Analysis. In: S.M. Capalbo and J.A. Antle (eds.): Agricultural Productivity - Measurements and Explanation. Washington, D.C.

A dynamic model of agricultural production that incorporates intertemporal and externality effects is developed and linked to the analysis of long-run productivity. Furthermore, existing regulatory policies to mitigate externalities are discussed. The dynamic production model is developed for the cotton sector in California which faces severe problems with pesticide resistance.

BAUMOL, W.C. and W.E. OATES (1988): The Theory of Environmental Policy. Second Edition, Cambridge University Press, Cambridge, New York, Melbourne.

This book can be taken as a good introduction into the economics of natural resources and to environmental policy.The first part discusses the theory of externalities, while the second part designs policy instruments making use of economic incentives for natural resource management.

BOCKSTAEL, J. and R.E. JUST (1991): Commodity and Resource Policies in Agricultural Systems. Springer Verlag, Berlin, Heidelberg, New York.

Agriculture, natural resources and environmental quality are heavily regulated in the U.S., but this is done by a vast array of agencies. The book makes an assessment of which aspects of the interface of agricultural and resource policy hold the most potential for increased benefits from policy coordination. A variety of U.S. policy interactions are examined either from a conceptual viewpoint or from an empirical one.

BOSSO, C.J. (1987): Pesticides and Policies - The Life Cycle of a Public Issue. Pittsburgh, Pa., University of Pittsburgh Press.

The evolution of U.S. pesticide policy is analyzed focussing on the competition among interest groups and their influence on legislation and the political process. The absence of public awareness in the 1950s and 1960s led to a pesticide policy firmly controlled by an "iron triangle" composed of the pesticide industry, US Department of Agriculture and Congress agricultural committees.

Political disturbance followed by the publication of R. Carsons book "Silent Spring" in 1962 accelerated the development of active environmental pressure groups and directed their efforts towards agriculture. Pesticide policy became a more dynamic process in which numerous interests are considered.

BROUWER, F.M., I.J. TERLUIN and F.E. GODESCHALK (1994): Pesticides in the EC. Agricultural Economics Research Institute (LEI-DLO), The Hague, The Netherlands.

The report provides an overview on the amount and costs of pesticides used in the EC on a regional level. The results of the study show that a conclusive environmental policy depends on a sound monitoring system of pesticide use which is presently not in place. Pesticide use patterns remain presently unknown.

CARRASCO-TAUBER, C., L.J. MOFFITT (1992): Damage Control Econometrics - Functional Specification and Pesticide Productivity. In: American Journal of Agricultural Economics, Vol. 75, p. 158-162.

Most of the empirical studies on the productivity of chemical pesticides in agriculture concluded that the value of the marginal product of pesticides exceeds marginal factor costs. The purpose of this paper is to provide an empirical utilization of the Lichtenberg and Zilberman damage control specification. Results show the exponential specification of the damage control model yields strikingly different conclusions than the use of a Cobb Douglas model. The exponential model estimates a marginal product of pesticides of 0.11 compared to 5.94 resulting from the Cobb Douglas estimation. But neither a strong theoretical nor an empirical reason for choosing the exponential function is apparent.

CHADWICKS, G.D., J. MARSH (eds.) (1993): Crop Protection and Sustainable Agriculture. CIBA Foundation Symposium 177, John Wiley & Son, Chichester, United Kingdom.

This volume summarizes the papers presented and the discussion held of a small group of plant protection experts. The meeting addressed the problem of how to integrate crop protection into the requirements of sustainable agricultural systems. The book is a good source for deriving conceptual frameworks as well as case studies on the ecology, economics and politics of pest management and pesticide use in various parts of the world.

CRAMER, H.H. (1967): Pflanzenschutz und Welternte. Bayer Pflanzenschutz-Nachrichten 20, Vol. 1, 1967, Bayer AG Leverkusen, Germany.

For the first time a worldwide assessment of crop loss has been conducted. Care should be taken in using the crop loss data because the methodology is based on the questionable conversion from area infested to crop loss.

CRISSMAN, C., D. COLE and F. CARPIO (1994): Pesticide Use and Farm Workers Health in Ecuadorian Potato Production. In: American Journal of Agricultural Economics, Vol. 76, p. 591-597.

The report presents research results from a case study to assess the impacts of pesticide use in potato production. It follows methodological guidelines laid out

by Antle and Capalbo to quantify the interaction between production technology, environmental quality, and human health. Information on crop production comes from data on individual fields, while pesticide practices are derived from interviews and the monitoring of worker exposure from a sub-sample. Additionally, farm family members and non-pesticide exposed control subjects were included for a set of clinical examinations. This report can serve as an example how to conduct health studies.

CROPPER, M.L., W.N. EVANS, S.J. BERARDI, M.M. DUCLA-SOARES, P.R. PORTNEY (1992): The Determinants of Pesticide Regulation: A Statistical Analysis of EPA Decision Making. In: Journal of Political Economy, Vol.100, No.11, p. 175-197.

U.S. EPA's decision to cancel or continue the registrations of cancer causing pesticides that went through the special review process between 1975 and 1989 is examined. The interest lies in the examination of whether or not economic benefits of pesticide use are balanced by the risks the substances may pose to human health and the environment. Risks to human health or the environment increased the likelihood that a particular pesticide use was cancelled by the EPA; but at the same time larger benefits related to a particular use lowered the likelihood of cancellation. Results show that the EPA is capable of making this kind of balanced decisions, but there are also some methodological problems. First, the procedures normally used to assess risks are almost sure to lead to upwardly biased estimates. Second, the EPA should be given the resources to conduct more acurate estimates of the benefits of pesticide usage.

FARAH, J. (1993): Pesticide Policies in Developing Countries - Do They Encourage Excessive Pesticide Use? World Bank Technical Paper Series 238, Washington D.C.

For the first time research has been conducted to quantify the factors which lead to an increased use of pesticides. A major reason why IPM methods are not widely used in developing countries is that economic environment and government policies related to pesticides encourage excessive pesticide use. The paper analyzes the pesticide policies of a large number of developing countries using a conceptual framework which distinguishes between price and non-price factors. One of the main findings of the report is the fact that most developing countries provide financial incentives either directlly or indirectly which subsidize the use of pesticides. Relatively little focus is given to research and extension on alternatives and on IPM training from the governmental side.

FEDER, G. (1979): Pesticides, Information and Pest Management under Uncertainty. In: American Journal of Agricultural Economics, Vol. 61, p. 97-103.

The study presents the basic methodological starting point for the influence of risk on pesticide use. The impact of uncertainty on the decision making process made by risk-averse farmers regarding pesticide use and the way uncertainty affects reaction to various changes is discussed. An analysis of random elements in several components of the pesticide crop system is introduced while making two main assumptions for risk behavior: maximization of expected utility and risk aversion.

GEORGHIOU, G.P. (1990): Overview of Insecticide Resistance. In: M.B. Green et al. (eds.): Managing Resistance to Agrochemicals - from Fundamental Research to Practical Strategies. American Chemical Society Symposium Series No. 421, Washington, D.C.

Pest resistance to insecticides has been recorded in at least 504 species of insects and mites. Chronologically, resistance has hit all major types of insecticides. In some cases, multiple resistance has created a crisis situation due to a lack of alternatives in high intensity cropping systems and in vector control of human diseases.

KENMORE, P.E. (1991): How Rice Farmers Clean up the Environment, Conserve Biodiversity, Raise More Food, Make Higher Profits - Indonesia's IPM - A Model for Asia. FAO Inter-Country Programme for Integrated Pest Control in Rice in South and Southeast Asia. Manila, Philippines.

This paper presents a case study about the environmental consequences of governmental policy decisions in Indonesia. It summarizes the relations between increased pesticide use and increased environmental pressure. The IPM program is presented as a solution to deal with growing environmental concerns. It includes a lot of useful information and data for people working on pesticide policy in Asia and may be used as an example for which kind of data should be considered to assess the impacts of pesticide use.

LICHTENBERG, E. and D. ZILBERMAN (1986): The Econometrics of Damage Control: Why Specification Matters. In: American Journal of Agricultural Economics, Vol. 68, p. 261-273.

It is demonstrated that standard production function specifications based on the Cobb Douglas model overestimate the damage control agent productivity and therefore have implications for the use in response to changing environments. An exponential damage control model is introduced which considers the kill function of pesticide use.

LICHTENBERG, E., D.D. PARKER and D. ZILBERMAN (1988): Marginal Analysis of Welfare Costs of Environmental Policies - The Case of Pesticide Regulation. In: American Journal of Agricultural Economics, Vol. 70, p. 867-874.

Marginal analysis to data on supply and demand elasticities and the estimated costs and yield effects is used to predict the net social welfare costs of the ban of parathion on tree crops in the U.S. Distributional effects are shown to be of major importance. Because of the ban former parathion users face substantial income losses. Revenue of farmers who do not depend on parathion use rises caused by the induced crop market price increase. At least in the short run for crops with significant export markets, foreign consumers may bear much of the cost of restrictive policies.

OERKE, E.C., H.W. DEHNE, F. SCHÖNBECK, A. WEBER (1994): Crop Production and Crop Protection - Estimated Losses in Major Food and Cash Crops. Elselvier, Amsterdam, Netherlands.

Crop loss estimates are derived from research data which stem primarily from industry sources. The assessment of loss is based on the questionable spray-no spray paradigm. Therefore care should be taken in interpreting the data.

OSKAM, A.J., H. VAN ZEIJTS, G.J. THIJSSEN, G.A.A. WOSSINK, R. VIJFTIGSCHILD (1992): Pesticide Use and Pesticide Policy in the Netherlands - An Economic Analysis of Regulatory Levies in Agriculture. Wageningse Economische Studies 26, Wageningen Agricultural University, The Netherlands.

The study gives a broad overview of the use and application of pesticides in the Dutch agricultural sector. Pesticide use and policy in Sweden and Denmark are analyzed and information and research results for some other European countries are given. Two different models have been used to derive the level of regulatory levy needed to reach the targeted reductions in pesticide use. The first model is an econometric estimation model based on historical data of prices and quantities. The second is a linear programming model to study the effects of new technologies. The models lead to quite different estimations about the regulatory levy. This raises the question if an estimation of levy through models is possible at all. However, both models indicate income effects smaller than those mentioned in the Long Term Plant Protection Program, which makes a levy more efficient than any other type of policy.

PANNELL, D.J. (1991): Pests and Pesticides, Risk and Risk Aversion. In: Agricultural Economics, 5 (1991), p. 361-383.

Literature about risk in the decision making process is reviewed and discussed. Uncertainty about some variables, such as pest density and pest mortality, does lead to higher pesticide use under risk aversion. But on the other hand uncertainty about other important variables, such as output prices and yield, leads to lower levels of pesticide use. There seems to be no reason to assume always risk aversion behavior of farmers in relation to pesticides. Other results show that uncertainty about various variables reduces the profit maximising dosage and increases the treshold density for herbicide treatment. It is concluded that risk does not necessarily lead to increased pesticide use by individual farmers. Analyzing risk and risk aversion when input level is treated as a continuous variable could be a useful approach.

PIMENTEL, D., H. ACNAY, M. BILTONEEN, P.RICE , M. SILVA, J. NELSON, V. LIPNER, S. GIORDANO, A. HOROWITZ, M. D'AMORE (1993): Assessment of Environmental and Economic Impacts of Pesticide Use. In: D. Pimentel and H. Lehman (eds.): The Pesticide Question - Environment, Economics, and Ethics, p. 47-84, Chapman & Hall, New York, London.

For the first time an overall assessment of the external effects of pesticide use in the United States is presented. Public health Impacts, losses to domestic animals, birds, fisheries, natural enemies, and honeybees, contamination of groundwater as well as the costs of crop damage, pesticide resistance, and government regulations are summed up to 8,123 Millions US$ per year. This accounts for 195% of the costs of pesticides used.

PIMENTEL, D., L. MCLAUGHLIN, A. ZEPP, B. LAKITAN, T. KRAUS, P. KLEINMAN, F. VANCINI, W.J. ROACH, E. GRAAP, W.S.KEETON, G. SELIG (1993): Environmental and Economic Impacts of Reducing U.S. Agricultural Pesticide Use. In: D. Pimentel and H. Lehman (eds.): The Pesticide Question - Environment, Economics, and Ethics, Chapman & Hall, New York, London, p. 233-278.

The potential for a fifty percent reduction of pesticide use in U.S. agriculture is reviewed. Additional pest control costs would increase food prices by 1.5%, but would be more than offset by the reduction of environmental and public health risks.

RAVENSWAAY, E. van, P.T. SKELDING (1985): The Political Economics of Risk/Benefit Assessment: The Case of Pesticides. In: American Journal of Agricultural Economics, Vol. 67, p. 971-977.

Regulation of pesticides is influenced by the relative position of different groups affected by the outcome of possible cancellations. Manufactors' and growers' interest are likely to be more represented than the benefit to consumers and environmental pressure groups. Smaller, more concentrated groups are more effectively represented in regulatory decision making. Generally, the benefit of pesticide use is assessed only by measuring increase in control cost and yield impacts. Possible producer price changes and impacts on consumers' welfare are ignored.

REUS, J.A.W.A., H.J. WECKSLER and G.A. PAK (1994): Towards a Future EC Pesticide Policy - An Inventory of Risks of Pesticide Use, Possible Solutions and Policy Instruments, Centre for Agriculture and Environment, Utrecht, The Netherlands.

The report discusses the environmental and health risks of intensive pesticide use in EC countries. Possible solutions at farm and crop level to reduce the environmental impacts of pesticides as well as policy instruments to reduce overall pesticide use are presented.

REPETTO, R. (1985): Paying the Price - Pesticide Subsidies in Developing Countries. World Resources Institute, Washington, D.C.

For the first time the question is raised if subsidies given on pesticides result in adequate benefits. The paper shows that Third World governments subsidize pesticide production through various mechanisms. Subsidies, while making pesticides cheaper, increase the use of pesticides and undermine efforts for other pest control methods. Subsidies are costly for governments either through lost revenues or through direct budgetary outlays. Part two of the paper examines costs of subsidies in detail for nine countries. It is shown that in large countries the total costs of pesticide subsidies amount to hundreds of millions US dollars. There have not been studies conducted from governments or from international donors, with respect to which economical and ecological consequences occur through pesticide subsidies.

ROLA, A., P. PINGALI (1993): Pesticides, Rice Productivity, and Farmers' Health - An Economic Assessment. International Rice Research Instiute (IRRI), Manila, Philippines.

This is the first detailed farm level survey considering productivity, benefits of insecticide use and effects on farmers health in rice production. The marginal benefit of four different crop protection alternatives (complete protection, economic threshold level, present farmers practice and natural control) is estimated considering the risk behavior of the farmer. Additionally, health costs of insecticide use were estimated in a regression function. Since health costs occur, natural control, i.e. renunciation of insecticide use, is the most profitable alternative in rice production.

TENG, T.S. (ed.) (1990): Crop Loss Assessment in Rice. Papers Given at the International Workshop on Crop Loss Assessment to Improve Pest Management in Rice and Rice based Cropping Systems. Copies can be obtained from the International Rice Research Institute (IRRI), P.O. Box 933, 1099 Manila, Philippines.

The book contains a state-of-the-art on the methodology of crop loss assessment in Asian rice production. At the same time it contains actual crop loss estimates derived from several methodological approaches. The book is helpful in interpreting crop loss data from national statistics or other sources.

WAIBEL, H. (1990): Pesticide Subsidies and the Diffusion of IPM in Rice in Southeast Asia: The Case of Thailand. In: FAO Plant Protection Bulletin, Vol. 38, No. 2, p.105-111.

This paper introduces a framework for pesticide policy analysis which distinguishes between price and non price factors influencing pesticide use. Case studies on Integrated Pest Management in rice in Southeast Asia indicate that the present extensive use of insecticides can be reduced. Whether the potential benefit of pesticide reduction can be realized, depends on the development of agricultural policies with special regard on subsidies. An evaluation of these policies is done for the situation in Thailand as an example.

WAIBEL, H. (1994): Towards an Economic Framework of Pesticide Policy Studies. In: Proceedings of the Göttingen Workshop on Pesticide Policies, ed. by S. Agne, G. Fleischer and H. Waibel, Göttinger Schriften zur Agrarökonomie, Vol. 66. Institute of Agricultural Economics, University of Göttingen, 1994.

The paper discusses a preliminary analytical framework for conducting policy studies with regard to pesticides. Economic and policy factors are included which are believed to have a strong influence on pesticide use. The socially optimal level of pesticides is discussed and factors which cause excessive use of pesticides are reviewed. There is a perceived need in analyzing demand for pesticides. Five concepts are introduced to estimate possible development of pesticide use.

WISE, S., S. JOHNSON (1991): A Comparative Analysis of State Regulations for the Use of Agricultural Chemicals, In: Just, R.E. and N. Bockstael (eds.): Commodity and Resource Policies in Agricultural Systems. Springer Verlag, New York, Berlin, Heidelberg.

The current policy debate in the U.S. includes a diversity of interest groups interacting at various government levels. This report presents an evaluation of a survey of state pesticide/groundwater legislations during 1987 and 1988. The purpose is to give information on how state policy is formed. The survey was conducted in some federal states asking legislators about their impression of the legislative process. A regression analysis was conducted for defining the dependent variables. Results show that the states followed highly systematic tendencies.

WHO/UNEP (1990): Public Health Impact of Pesticides Used in Agriculture. World Health Organization, Geneva.

Current knowledge on the acute and long-term health effects of pesticides as well as on the level of exposure of various population groups is reviewed. Future epidemiological research and the control and reduction of acute pesticide poisoning is proposed.

ZADOKS, J.C (1992): The Costs of Change in Plant Protection. In: Journal of Plant Protection in the Tropics, Malaysian Plant Protection Society, Vol. 9, p. 151-159.

Objections against chemical plant protection are growing. There is a increasing need to consider externalities of crop protection technologies in economic analysis. Pressure to governments to initiate change in pesticide policy arises as well. A shift towards the use of IPM methods is obvious in some countries. Two major issues are raised: what are the costs of a policy change and who has to pay the price. The answers depend on the individual country's situation. Change can be costly to growers in some cases or profitable in other cases. At least in countries where output prices are fixed above the equilibrum price, there will be no financially change on the consumer side, only tax payers will gain.

ZILBERMAN, D., SCHMITZ, A., CASTERLINE, G., LICHTENBERG, E., SIEBERT, J.B. (1991): The Economics of Pesticide Use and Regulation. In: Science, Vol 253, p. 518-522.

The effects of potential pesticide bans on production and overall welfare are analyzed in Californian fruit and vegetable production. Yield and cost effects of the regulation are incorporated into a system of supply and demand equations in order to obtain the aggregated losses for consumers and producers revenue. Taxation and partial bans may have much lower economic costs than total bans.