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A Field Practitioner's Guide to Economic Evaluation of IPM

G. Fleischer, F. Jungbluth, H. Waibel, J.C. Zadoks

In cooperation with FAO

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A Field Practitioner's Guide to Economic Evaluation of IPM

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List of Abbreviations

ADB	Asian Development Bank
BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
FAO	Food and Agricultural Organization of the United Nations
FFS	Farmer Field School
ICP	Inter Country Program
IPM	Integrated Pest Management
IRR	Internal Rate of Return
MCA	Multi Criteria Analysis
MU	Monetary Unit
NGO	Non-governmental Organization
NPV	Net Present Value
OECD	Organization for Economic Cooperation and Development
TOT	Training of Trainers
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WHO	World Health Organization

Preface

Many books have been written on the Economic Analysis of Agricultural Projects. These books provide the theoretical and sometimes the practical background to carry out economic evaluation of proposed, on-going or completed projects. From this point of view there would be no need to add another one on IPM.

What, therefore, determines the need for a "Field Guide on Economic Evaluation of IPM"? There are at least three good reasons why this "project" may be justified. Firstly, Integrated Pest Management (IPM) has become a real catchword in international development. There would be hardly any stakeholder in the area of crop protection who would oppose the IPM. However, the actual content of the various IPM approaches differs widely and people are keen on operating their crop protection approach under the banner of IPM even to the extent that pesticide companies use IPM in order to boost pesticide sales. Hence, it is no longer sufficient to judge initiatives in crop protection on whether or not they can be attributed IPM but to ask for what results they have really achieved. Very often IPM projects draw upon public resources or affect public goods. Therefore, the demand for economic evaluation of IPM projects increases.

Secondly, among the many IPM approaches there is one which has become particularly popular with development agencies. It is the Farmer Field School approach (FFS – IPM), which has become widely known due to its reported success in the Indonesia national IPM program. FFS – IPM is said to be farmer–driven, it follows the principles of participation and tries to generate a better understanding of the important interactions in the agro-ecosystem. This is believed to make a difference from other training approaches who aim at transferring technologies to farmers by teaching them what they should do. The FFS approach has been embraced by the many non-governmental organizations that now are engaged in IPM. However, increasingly also governments and even pesticide companies (with their own intentions) become interested in this approach. As more resources are being put into this type of FFS – IPM, hence causing opportunity costs by foregoing alternative approaches, economic evaluation becomes relevant.

Thirdly, and perhaps most importantly, FFS – IPM is very often performed by people who show some considerable distrust of economics. They often think that what matters is not the rate of return on investment but whether farmers are more happy and more confident after having gone through a Field School cropping season. Furthermore, as crop protection specialists and ecologists they are not comfortable with the economic language. Hence, they sometimes create their own economics: We may call it crop protection economics. On the other hand, they also realize that there is no escape from the economist's world if public support and funds for FFS – IPM shall be sustained. So there is a need for economics of IPM which is understandable to people working in the field and to those who are confronted with evaluation. For these reasons three agricultural economists have argued with a distinguished expert in crop protection for over two years to produce this little book. It is our hope that the result of this "interdisciplinary discourse" will strengthen the integrating forces between economists and crop production specialists for the benefit of true IPM.

Hannover, Wageningen and Washington, September 1999

The Authors

1 Introduction

Integrated Pest Management (IPM) has become one of the most widely used catchwords in agricultural development and environmental conservation programs. Everybody claims to like and even to do IPM, but the actual content of this term differs widely. Hence, the question of measuring the success of IPM programs becomes crucial. Successful IPM programs are of central importance for the world's food security in order to induce a change from pesticide dominated to information based cropping systems management on a global scale.

It is increasingly agreed that we need better common understanding of the impacts of implementing IPM. Economic evaluation tools have been used only to a little extent. Moreover, there is uncertainty about the value of economic analysis for project monitoring and evaluation although it actually could be used as a powerful tool for improving the quality of project work.

This book provides a guidance to the economic evaluation of projects that deal with implementing IPM and fall under the type 'farmer-driven'. This project concept has become known as *Farmer Field School* (FFS). It is being promoted by the Global IPM Facility[1] on a worldwide scale as well as by donor and development agencies and increasingly adopted by national extension services. Furthermore many NGO initiatives on IPM follow a participatory approach which is at the core of FFS. Therefore these guidelines may serve as background information for all those interested in assessing the economic impact of IPM projects that fall under this category.

There are other IPM initiatives which take a different approach, be it through more traditional training concepts, crop protection policy interventions or modern mass media approaches. The evaluation of these programs follows the same economic principles which are applied in these guidelines but may require to take into account other criteria and indicators not being dealt with here.

The book is mainly designed as a working aid for field practitioners carrying out actual project implementation, monitoring and evaluation. It does not intend to replace standard textbooks of project planning and evaluation. However, it deals with the specifics and peculiarities of IPM, to be applied in the context of

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1 The Global IPM Facility is based in Rome as a joint project of the Food and Agriculture Organization of the United Nations (FAO), the World Bank, the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP).

pilot IPM projects or IPM components in agricultural projects. The objective is to assist crop protection specialists and others without a thorough training in economics to perform a professionally acceptable economic evaluation of IPM projects, within a reasonable time and cost frame.

Chapter 2 outlines the specific objectives and features of IPM programs, with a special focus on the Farmer Field School (FFS) type. **Chapter 3** sketches the project planning and evaluation cycle. It stresses the interaction between planning and evaluation and points to the communicative and education dimension of project evaluation in addition to its control function. The difference in focus of ex-post, intermediate and ex-ante evaluation is explained.

Chapter 4 presents the basic features of the methodology of economic assessment in crop protection. Benefits and costs at the farm level, the project level and the level of the society as a whole, differ in nature, size, time frame and way of assessment. The quality of the economic evaluation depends on the quality of the data used (**Chapter 5**). The reality of project evaluation tells us that good data to be used in economic evaluation are scarce; one has almost always to work with reasonable assumptions.

Chapter 6 gives an example of the economic evaluation of an IPM Project. Attention is given to the assumptions made for the assessment. The analysis of a five year IPM project is presented. **Chapter 7** provides some possible misinterpretations of the results of economic calculations. The salient points of impact evaluation in IPM are analyzed. **Chapter 8**, finally, provides a glossary of economic terms for better understanding.

2 The Challenge of the Farmer Field School Concept in IPM

2.1 The Diversity of IPM Approaches

The FFS type of IPM implementation has to be put into the context of the history of IPM approaches over the past three decades. This is supposed to help the user of these guidelines to more clearly analyze the policy context of the project to be evaluated. It is also supposed to help the analyst to assess to what the degree the project under consideration falls into the FFS category.

In view of increasing problems due to intensive production systems with high pesticide use, IPM was designed to escape the chemical spiral. IPM aims to combine various control tactics in such a way that interference with the agro-ecosystem by pesticides becomes minimal. It is expected to provide an optimal solution to handle pest problems and reduce negative side-effects of pesticide use. Optimal means here, from the society's point of view i.e., to achieve maximum economic efficiency while maintaining a defined level of environmental objectives. This will lead to a crop protection system which is based on rational and unbiased information leading to a balance of non-chemical and chemical components moving pesticide use away from their present political optimum to a social optimum defined in the context of welfare economics (WAIBEL and ZADOKS, 1996).

Early IPM was dominated by a mono-factorial control philosophy, often considering one pest after the other, and usually concentrating on insect pests. Present-day IPM focuses on the crop ecosystem as a whole and tries to integrate knowledge on insects, pathogens and weeds into one single approach. Modern IPM appeals to the farmer, who is crop and not pest oriented, and who has nearly always to deal with several and very different pest organisms. It also tends to consider the cropping system, including those agronomic aspects which affect pest severity, and the cropping environment.

One generation of IPM approaches was typically threshold-based. Researchers determined critical values for pest intensity. When a pest had passed a given threshold, chemical treatment was recommended. Threshold-based IPM systems are still very common. They may be effective in plantations and estate farms, but usually fail when it comes to changing crop protection practices in small-scale agricultural production in developing countries. IPM therefore appeared to be too complicated to be transferred by the regular extension approaches. Furthermore, it was widely perceived as financially not viable for application as a routine strategy. Acceptance and adoption in many cropping systems remained low.

2.2 The Farmer Driven IPM Concept

Projects aiming at implementing IPM by the use of participatory or ‘farmer driven’ concepts, cross the borderline between the natural sciences and the social sciences. Economics and sociology, among which non-formal adult education methods, merge with agronomy and crop protection science to produce a fresh approach which aims to generate a new mentality among the involved stakeholders. The natural sciences contribute heavily by research results already available, by supporting research where needed and by explanatory research after the facts, where desirable. Similarly, the social sciences among which primarily sociology and non-formal education, contribute in changing the traditional roles of communication between extension staff and farmers from a top-down to a more balanced, group based joint learning process.

New is the respect for farmer knowledge, be it traditional knowledge, knowledge acquired by farmer experimentation, or intuitive knowledge made explicit by discussion. The self-respect gained by the farmer as the principal decision maker for the field, helps to more critically assess external information. Under the FFS approach, the delivery of thresholds by researchers to farmers is being replaced by training farmers to perform their own ecosystems analysis. Farmers become 'empowered' to make their own decisions accordingly. The next step is that farmers drive the demand for scientific information, instead of being pushed by research-created knowledge. Farmers make their decisions individually and as a group. Farmers may approach administrators and researchers for help, but they are no longer told ‘top-down' what to do or not to do.

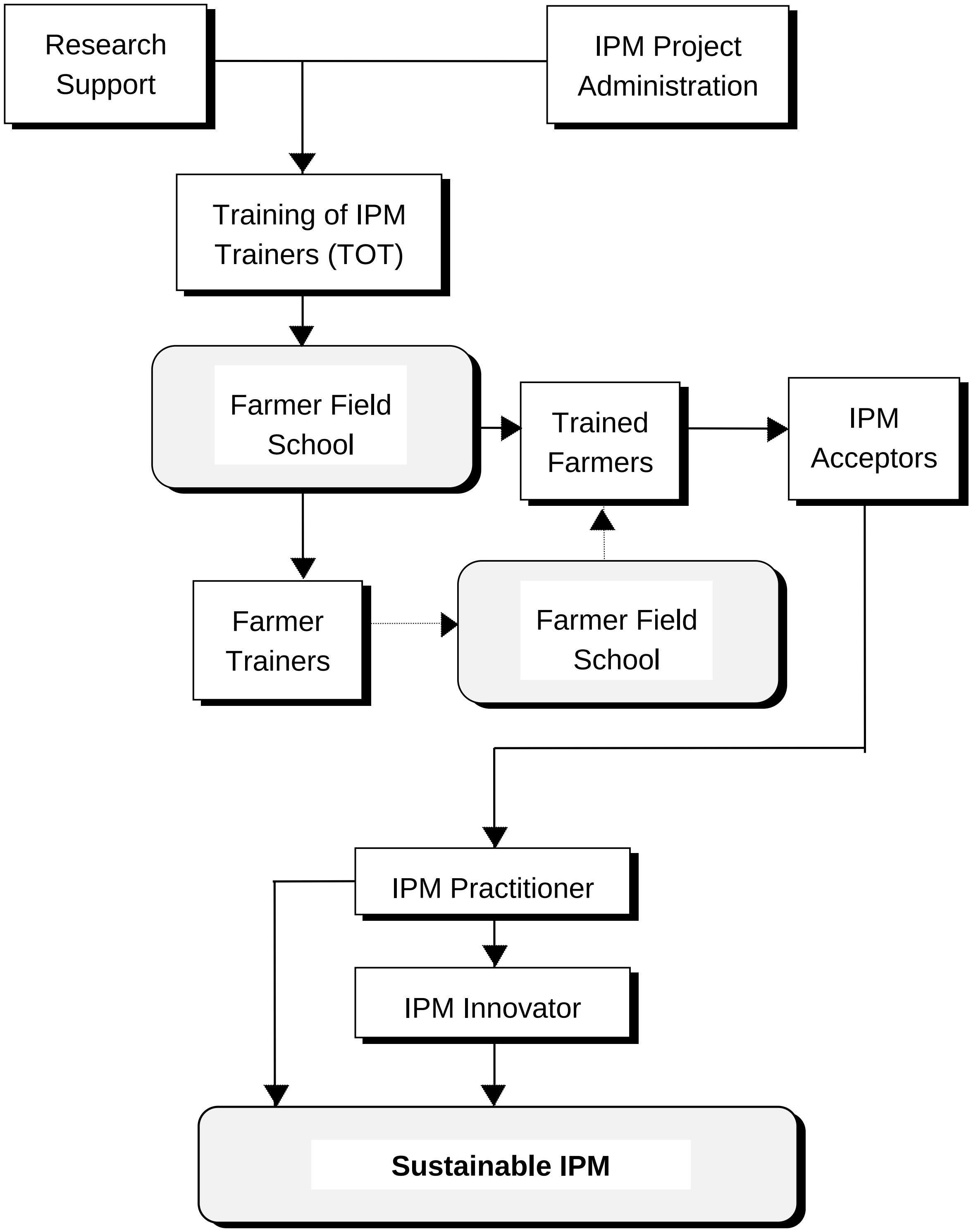
During a FFS on IPM, farmers meet weekly during an entire cropping season to conduct experiments and to monitor and discuss crop management interventions. They learn field observation methods. Groups depict the situation in their field in drawings and present their ‘Agro-Ecosystem Analysis’ for plenary discussion. The participating farmers then decide what crop management practices will be applied and closely monitor the impact. Conservation and utilization of local natural enemies and other beneficial organisms play an important role in the control of insect pests. Participants also look to other pests and at water and nutrient management. The four key principles of FFS training courses are: 1) Grow a healthy crop; 2) Observe field weekly; 3) Conserve natural enemies; 4) Farmers understand ecology as experts in their own field. (TER WEEL, VAN DER WULP, 1999).

Figure 1 describes the Farmer Field School (FFS) concept for IPM training. With the help of researchers and IPM master trainers, extension staff is trained in IPM, ecosystem analysis and non-formal adult education methods. These Training of Trainer (TOT) courses are usually full-time, season-long, and field-based exercises. As part of the TOT, trainers conduct first FFS under guidance of experienced master trainers.

In FFS, farmers are trained and additionally farmer trainers are identified to conduct farmer field schools in the future. A successful FFS encourages the practice of IPM. IPM practitioners may turn into IPM innovators by further refining existing IPM control methods and developing new tactics by combining indigenous and external information. Trained farmers may also convince other farmers of the value of IPM. Those farmers may then undergo a similar learning process, although with a lower degree of intensity. The entire FFS process may lead to sustainable IPM provided its quality standards can be maintained.

The lead to this version of IPM was given by the FAO Inter-Country Program for Integrated Pest Control in Rice in South East Asia (KENMORE, 1995). The FFS approach is now the standard procedure to implement IPM training programs in Asia, not only in rice but in other crops as well. Meanwhile, it has spread to other areas, including countries in Africa and Latin America.

Figure 1: The Farmer Field School Concept in IPM



2.3 IPM in the Context of Government Policy

The success of an IPM project - regardless whether implemented by FFS or other approaches - not only depends on good technology and farmers' skills and knowledge but to a large extent on the overall policy environment. Crop protection policy is part of the larger agricultural and environmental policy framework. Therefore, the policy environment has to be taken into consideration when planning, implementing and evaluating IPM projects. As a primary task in evaluation a judgment is necessary whether the general policy environment is conducive or hampering IPM implementation.

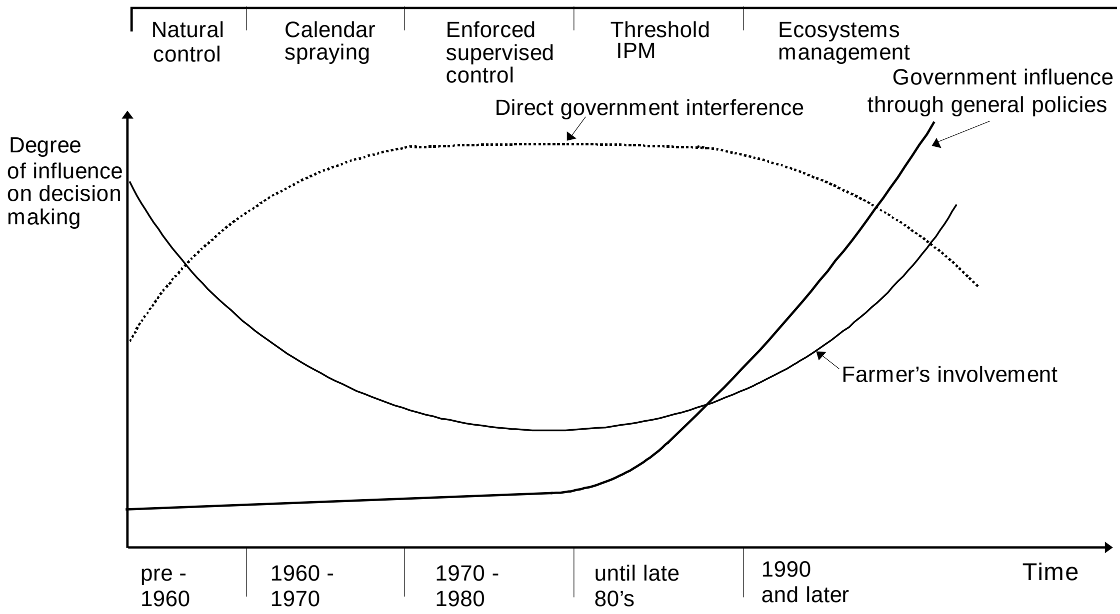
IPM is often mentioned in national agricultural policy documents and statements of politicians. In contradiction to these, chemical crop protection methods often still receive direct and indirect support and hinder the effective dissemination of IPM.

It is important to identify the role of government in the different crop protection systems. As illustrated for the Asian scenario (see Figure 2) the role of government is changing. Before the green revolution period, i.e. in the late fifties and early sixties, farmers by necessity had to rely on natural methods of control using endogenous knowledge and materials. With the green revolution, farmers were made to believe that pesticides are a panacea and a simple, effective and cheap way of controlling pests. Through credit programs and government and private sector promotion of pesticides, farmers' practices and attitudes were changed towards considering pesticides as an 'insurance' against the risk of crop loss caused by pests.

The disadvantage of this strategy quickly became apparent. The result of misguided pesticide interventions in the ecosystem was a disruption of the natural balance of pests and predators leading to pest resurgence. Thus governments were faced with a situation where, despite the widespread use of chemical treatments, pest outbreaks occurred. A good example for secondary pest outbreak problems which were created by indiscriminate use of broad spectrum insecticides in rice is the case of the Brown Plant Hopper (*Nilaparvata lugens*) in Indonesia, Thailand and other countries (IRRI 1994).

The role of farmers in decision making has been emphasized after a period of strong direct government interference. Farmer knowledge and farmer involvement in decision making is considered to be more important than the transfer of "pre-packaged" extension messages.

Figure 2: Role of Farmers and Governments in Pest Management Decisions in Asia



Source: WAIBEL (1993)

In reality there are still many inconsistencies in plant protection policy. For example, governments may support the implementation of FFS and nevertheless continue to run a centrally-managed pest surveillance system. The reason lies in outdated information channels and inappropriate decision making procedures among administrators and politicians. Therefore it is important that economic evaluation in IPM must take institutional factors into account. These factors may not only be decisive for the validity of some of the quantitative assumptions but change in these conditions may in fact demonstrate the success of IPM.

2.4 Purpose of Economic Evaluation

Project evaluation serves the purpose of raising awareness about the potential implications of the project among the different interest groups. Formerly, project evaluation was mainly undertaken to prove the project's success and to avoid economic loss to society (RUTHENBERG, 1976). Recently, the communication and education dimension of project evaluation has become more relevant and raised new interest in the tools and methodologies.

Successful IPM projects require to be economically viable, both from the viewpoint of the participating farmers and the society. This means that the benefits gained from the project investment should be higher than those achieved with an alternative investment, e.g. projects dealing with any other public intervention, be it in crop protection, extension, agricultural mechanization, irrigation, small-scale agro-industry etc.. In order to assess the economic viability of an IPM project, evaluation should follow a protocol that gives consideration to the farmer community, the partner country institutions and - if applicable - the donor agency.

Proper evaluation is necessary in order to avoid misallocation of funds and increase the likelihood of success. In that way, economic assessment criteria play also an important role for quality assurance. This is especially relevant in cases when positive results of pilot schemes have to be validated in the process of up-scaling the program to provincial or national level.

In the case of FFS-IPM, economic principles shall be applied to a process-oriented and participatory training approach in IPM. This requires the description of indicators that go beyond the 'static economic efficiency thinking' which underpins the standard textbook of economic project evaluation.

Economic evaluation of a project is a task by itself, which can and should be undertaken in parallel to project implementation in order to guide, monitor and – if necessary – change the project implementation. It should be performed:

1. before the field work begins as support to project design (= ex ante). Ex-ante evaluation deals with expected values. It can take place as a pre-feasibility which is explorative or as feasibility study. The feasibility study focuses on concrete alternative project strategies. It finally has to provide a judgment to funding agencies as to whether the project is likely to be technically feasible, economically viable and in line with sustainable development. In addition to that, ex-ante evaluation generates information that allows priorities to be made with regard to project activities. Furthermore, potential risks that may severely hamper project implementation can be identified. Also, a monitoring system that makes progress observable and preferably also measurable, usually has to be designed during ex-ante evaluation. For IPM projects ex-ante evaluation requires a multi-disciplinary team, comprising the disciplines of crop protection, economics, sociology and anthropology.

2. during project implementation (= interim) to monitor the progress of the field work. The communicative and education dimension of evaluation is most important during the course of the project. Intermediate evaluation can be done regularly or incidentally starting from the beginning of the project. It is a management instrument for steering ongoing project activities. Intermediate evaluation may also be necessary if significant technological progress occurs (e.g. the introduction of transgenic cultivars), for preparing a follow-up project,

or in response to important political changes (e.g. a new five-year plan with changing priorities for IPM). The education effect of intermediate evaluation results stems from the pressure which will be put on the project implementing agency to undertake preparations that improve the transparency and publicity of the project by appropriate documentation.

3. after project implementation (= ex post), to provide the necessary data for the assessment of the impact. Evaluation at the end of the project period is dealing with the degree of achievement of development and project objectives. It can, of course, not improve the performance of the project, but it allows lessons to be learned for incorporation in the planning process of future projects. It is therefore important that ex-post evaluation is carried out in a comparative manner. Ex post-evaluation also has an education effect since it stimulates the implementing agency to raise the level of efforts and sincerity in implementing the project. After all, results of final evaluation may have consequences for other projects in the sector. For example, the donor agency may refrain from already planned projects in other areas in the agricultural sector if an IPM project or an IPM component of another agricultural project has proven to be unsuccessful because of corruption, sloppy implementation or continuous infighting among interest groups.

Thus, economic evaluation fits in a sequence from project design over economic evaluation to impact assessment. The latter provides the rationale for stimulating policy reform which in turn improves the framework conditions for successful project implementation .

3 Project Planning and Evaluation Cycle

IPM projects of multi- and bilateral donor organizations or national and local government institutions are public interventions in the process of agricultural development. They are based on a perceived discrepancy between the actual situation or development path and the socially desired state or path in the field of pest management.

To achieve an effective, efficient, equitable and sustainable impact of such public interventions an intelligent planning and evaluation cycle is required. This cycle has three major components:

1) Problem analysis,
2) Specification of project objectives,
3) Identification and formulation of an IPM strategy.

An IPM project is implanted in a physical, socio-economic and institutional environment which to a large extent may pre-determine the project's impact. A **project** is meant to contribute to specifically defined development goals through a specific project purpose. The definition of development goals is the basis of the project's design and time frame. Obviously, a project is limited in time, space and funding. The evaluation has to acknowledge these limits.

An economic assessment - in its design depending on the specific objective of the evaluation - has the purpose to measure the success of the chosen project strategy. With respect to IPM two aspects are of major interest. Firstly, how successful, economically viable and adaptable is the IPM-system promoted by the project. Secondly, and most important for the project - how successful is the project design in terms of achieving its goals.

The planning and evaluation cycle is carried out on an ex-ante and an ex-post basis. In the ex-ante mode, the project design and strategic planning takes place. In the ex-post process, either in the course of the project or after termination of the external contribution, the lessons learnt are the basis for planning future activities.

This chapter deals with the major components of the planning and evaluation process and provides some recommendations as regards the salient points for ex-ante, ex-post and intermediate evaluation of IPM projects.

3.1 Problem Analysis

Any project planning should start with a thorough problem analysis. Although people involved in development work assume that they are well aware of the problem, perceptions may differ, e.g. according to the professional background. For example, crop protection extension workers might see the main problem that farmers are not aware of the health effects of spraying. However, taking a broader view on it the 'root' of the problem could be the lack of safer alternatives or misguided information about the need to spray. In reality, problems are often poorly structured and intervention is guided by biased information. Analysts should seek interdisciplinary exchange and develop a logical problem structure. It is useful to look at broad categories of problems: policy, institutions, natural conditions and farm level situation.

3.1.1 Policy and Institutional Framework

National crop protection policies are those that directly or indirectly influence the use of crop protection measures, including pesticides in a country. Policies relevant to pest management can be grouped according to their main targets. One group is targeted at the prevention of pest occurrence through phytosanitary regulations and measures improving the diversity and stability of agro-ecosystems, e.g. by enhancing the use of cultural control practices. Other instruments are concerned with regulating and controlling the pesticide market.

In order to determine the current status, an analysis of crop protection policies should take place in the course of project preparation. A framework and formal instruments have been developed that combine tools for economic and institutional analysis.[2] The basic idea is to establish an overview on the factors that contribute to unfavorable framework conditions for IPM dissemination and adoption at the farmers' level.

A difference can be made between price factors and non-price factors, and between hidden and obvious ones (see Table 1). Price factors directly affect the profitability of pesticide use at the user's level. Non-price factors affect and support pesticide use decisions, but do not have a direct influence on the profitability.

2 Guidelines for policy analysis have been developed and implemented in case studies (AGNE et al., 1995; AGNE 1996; JUNGBLUTH 1996; FLEISCHER et al., 1998)

Table 1: Classification of Policy Factors Influencing Pesticide Use Levels

	Price Factors	Non-Price Factors
Obvious	*Example:* Direct subsidies on the market price for pesticide products	*Example:* Main focus of research activities is on pesticides
Hidden	*Example:* External costs of pesticide production and use are not internalized in the price paid by the user	*Example:* Lack of transparency in regulatory decision making

Source: WAIBEL (1994), see details in Annex 2

Analyzing the factors that drive the development path of national crop protection systems helps to understand the framework conditions in which the proposed intervention takes place. The purpose is to identify the relative strength of forces that affect pesticide use in a country or region. Results can be also achieved for a certain cropping system.

IPM field projects such as the FFS program do not take place in isolation and their success may depend considerably on conducive policy conditions. If the policy conditions impede a farmer-driven approach, an IPM project may first of all concentrate on a policy dialogue that aims at changing the regulatory framework and the economic policies conducive to field level implementation of the FFS type of IPM intervention.

Currently, most countries have not yet set clear targets for pesticide use levels and rates of IPM adoption. Policy makers and experts still tend to overestimate the benefits of pesticide use. IPM is often used as a ’fig-leaf’ while pursuing a pesticide-based policy by means of hidden and indirect subsidies. Several factors point to ongoing incentives for pesticide use in the national regulations and in the political decision making process (see the example of Costa Rica in Annex 2).

International agreements such as the International Code of Conduct on the Distribution and Use of Pesticides (FAO, 1990) potentially can influence national crop protection policies. Additionally, many donor organizations have guidelines describing pesticide handling in technical assistance programs, e.g. the guidelines of OECD, World Bank, regional development banks and bilateral agencies.[3]

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3 Examples are:

Though international guidelines found their way in national pesticide policy systems, implementation is often insufficient and actual impact on national policies remains unclear.

3.1.2 Cropping System Conditions

The state of the agro-ecosystem affects the choice of the intervention strategy. Parameters for describing the natural conditions can be classified into two broad categories: favorable and unfavorable for sustainable agriculture.

A cropping system is favorable for sustainability when the self-regulating forces of the ecosystem are functioning well, working towards a stable natural equilibrium. Under these conditions the probability of plant and animal organisms reaching the status of pests is small. Such favorable environments can be generally found when there is:

- a favorable ratio of agricultural land to wilderness areas
- a generally low use of external inputs in agricultural production
- a high cropping systems diversity (crops and varieties)
- a low to zero level of pesticide use.

The challenge for IPM in these areas is to ensure that sustainable intensification can take place, i.e. to use pesticides as a last resort only and limit their use to an absolute minimum level in order to avoid an entry into the pesticide spiral.

Contrary to favorable environments, the other extreme are so-called pest hot spot areas. Here the need for external regulation through inputs which are produced off-farm is evident. Such situation often has been caused by misguided interventions in the past. For example, at the beginning of the intensification process, the easy availability of chemical fertilizers and pesticides has stimulated farmers to rely on a constant access to these external inputs. They modified their cropping system by substituting self-regulation with the reliance on external interventions. Indicators of such situation are e.g.:

- a high level of pesticide input
- a high frequency of pest outbreaks
- susceptible and high yielding varieties

OECD (1995): Guidelines for Aid Agencies on Pest and Pesticide Management. OECD Development Assistance Committee, Guidelines on Aid and Environment No.6, Paris.

ADB (1994): Handbook for Incorporation of Integrated Pest Management in Agricultural Projects. Asian Development Bank, Manila.

- a tendency towards monoculture.

The strategy for IPM in such environments is to ’free’ these cropping systems from the dependence on pesticides.

3.2 Specification of Project Objectives

Thorough problem analysis is the pre-condition for defining the project purpose within the setting of overall development objectives. Sustainable development as a generally accepted goal - IPM is mentioned in chapter 14 of Agenda 21 of the United Nations Conference on Environment and Development (UNCED, 1992) - demands that an IPM project (1) improves total factor productivity, (2) stabilizes and strengthens the resilience of agro-ecosystems, and (3) considers equity issues.

Especially in project planning the proposed intervention needs to be carefully assessed if it is to meet the criteria of sustainability. For example, private sector IPM projects often limit their activities to so-called safe-use training, and product stewardship. Here, no immediate relationship to the components of the sustainability goal exists. The same is true if pest eradication programs are ’sold under the banner of IPM’.

The project purpose needs to be clearly defined and operationalized by objectively verifiable and quantitative indicators having a quality and a time dimension. It nevertheless must be kept in mind that the specification of the projective purpose is not merely an administrative procedure but should be a communicative process. It is thus an expression of the interest of the groups who participate in the project. In order to avoid conflicts during project implementation it is important to consider the major ’interest groups’ when formulating the project purpose. It is equally important to extend the discussion beyond the circle of crop protection experts. Agricultural economists from the planning departments and representatives from the health and environmental agencies should be part of the discussion of setting up the objectives of the project.

A useful exercise for ex-ante evaluation is to generate a matrix that identifies the objectives of different groups at different levels (national level, project level, target group level) and analyses the relationship among those objectives. These relationships could be competitive, complementary or neutral. Such a process allows to recognize potential conflicts in project implementation.

3.3 Identification of an IPM Strategy

As a precondition for assessing the relative advantage of different types of IPM project interventions, project activities must be functionally linked to the project purpose recognizing policy conditions which ensure the validity of its linkages. In choosing that strategy which ensures a maximum efficiency in reaching the project's purpose, criteria are needed. These differ according to the level of intervention which are: the target group (farmers, laborers, consumers), government and NGOs relevant for the project, especially the project implementing agency, the level of the national economy and the global level.

If IPM is still in its infancy in a country or region, i.e. the pesticide philosophy is still dominating in the mind of decision-makers activities focusing on changing the policy conditions should be in the forefront. If policy change is on the way, investment in training can become a priority. It is, however, not so much a question of either-or, but rather a question of the optimal combination of both activities.

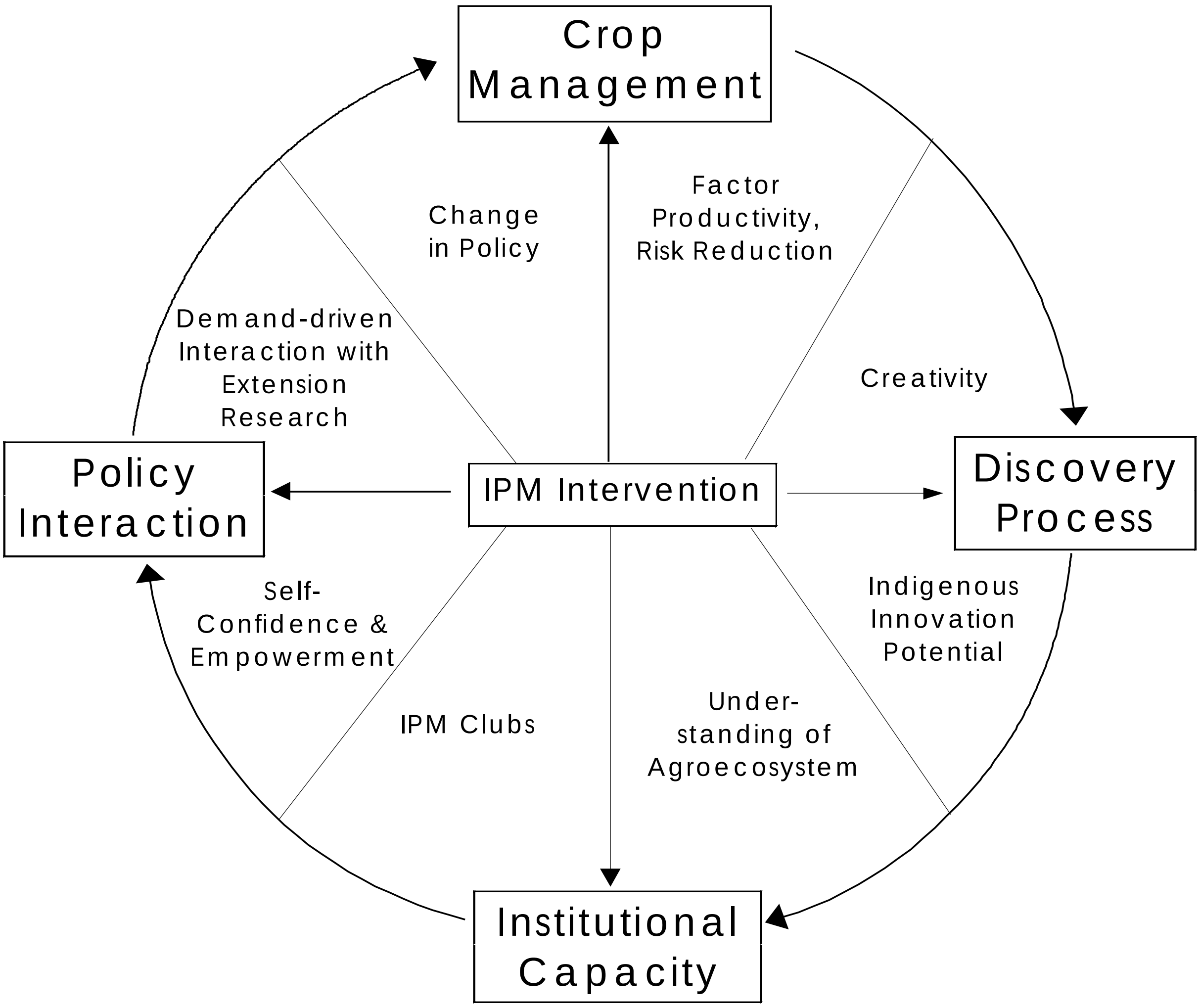
There are four main areas of intervention relevant for planning IPM projects that take a farmer-oriented approach

1) technical knowledge of the farmer with regard to crop protection and management,
2) indigenous innovation potential of the farmer,
3) the local institutional setting, and
4) the policy environment.

In principle, intervention can take place in any of the four areas, thus influencing the process (Figure 2). However, in may cases changing farmer's knowledge and understanding of the interactions in the agro-ecosystem is most likely the starting point as this will augment a process of cognitive discovery and innovation. Farmers achieve higher productivity levels in terms of yield increase and/or cost savings in their fields.

A better understanding of interactions within the agro-ecosystem forms also the basis for empowerment and self-confidence which is a stimulant for establishing local institutions. Such institutions are 'IPM village clubs' where farmers decision makers can discuss new technologies, be they imported into the village or indigenously generated by on-farm discoveries. 'IPM clubs' can become a forum for increased political interaction with regional and national authorities on the basis of a critical assessment and evaluation of technological products offered to farmers by private and government institutions. IPM clubs can also help to articulate demands to external institutions, be they government or private, in a more precise and a more effective way. Such ’empowerment of local communities’ is likely to contribute to a change in the policy environment which becomes more conducive to IPM.

Figure 2: Intervention Points for Farmer-Centered IPM Projects



Source: FLEISCHER and WAIBEL (1994), modified.

4 Methodology of Economic Evaluation of IPM Projects

Economic evaluation must start with measuring the effects of improved pest management on farmer's and society's production costs. Farmer’s production costs will be lowered by improving technical and allocative efficiency resulting in a better combination of chemical and non-chemical control measures and an optimum level of crop loss avoided (see also Figure 4 in Chapter 5). Costs of society will be lowered by reducing costs of pest control measures primarily by changing the policy which changes the incentive/ disincentive structure and by a large-scale substitution of chemical inputs for knowledge.

Quantitative cost benefit analysis implicitly connected to the project's concept of logical framework is a major communicative tool in project evaluation. Its quantitative rigor forces transparency in the assumptions made and portrays those factors mainly responsible for project benefits. At the same time it is important to place economic evaluation into the context of an overall multi-criteria evaluation rather than treating it as the sole measurement scale. Cost benefit analysis with resulting investment criteria like cost benefit ratio or internal rate of return is one element of a multi-criteria framework.

4.1 Reference System for Economic Assessment

The major task in the economic analysis of projects is the identification and quantification of costs and benefits over time. Benefits and costs depend on the type of project. In agricultural development projects, public investments in agricultural support services usually show up on the cost side. For benefits, increasing the productivity of agriculture will be the impact generally expected. However, there may be other effects that are relevant for the economic analysis of the project performance.

Benefits and costs can be identified at the farmer's level, at the level of the intermediate institution, and from the viewpoint of the society as a whole. The criterion for the farmer is to maximize expected net returns which is the difference between gross returns and the private costs incurred. The gross returns are yield increases and farm cost savings from changing farming practice by adopting techniques and methods of information gathering which are in the core of IPM. However, the farmer might also incur additional costs of the chosen method as additional use of external inputs e.g. higher quality seeds and farm resources (e.g. labor) would be necessary to achieve the objective. The farmer should gain in the end an increase in the net returns which may, however, occur only with a time lag.

On the intermediate level, the financial situation of the institution that is conducting the project is important for the sustainability of project activities. In many cases, agricultural extension is conducted by government agencies that depend on a constant inflow of resources from the state’s budget. Increasingly, non-governmental organizations (NGO) are engaged in agricultural extension. For both types of organizations, adopting the FFS-type of IPM extension involves the allocation of additional resources as personnel and running costs for training activities increase.

The society's goal related to public intervention in crop protection is to maximize net social benefit. The difference between the private and the society's viewpoint occurs because the cost of investment of IPM are not fully borne by the farmer and some of its benefits occur to societal groups other than the farmer. Therefore, the sum of the benefits occurring with the individual farmer is not necessarily equal to the society's benefit.

The standard procedure for assessing the overall economic performance of a project is cost benefit analysis (CBA). For IPM projects it is of utmost importance to identify thoroughly the respective costs and benefits, and quantify them to the extent possible relative to a defined reference system. Usually, the alternative to IPM is the continuation of chemical-based crop protection with an increasing level of regulation. However, it is not justified to pick a reference scenario based on the assumption of best practice in crop protection. If currently over- and misuse of chemical pesticides is taking place, it is unlikely that this problem will be resolved by introducing new technologies and products only. If, on the other hand, the government plans future activities to improve the conditions in crop protection, these investments should be taken as a separate ‘project’ whose performance has to be compared with an alternative IPM project.

Once benefits and costs of an IPM project have been identified and quantified over the service life of the project, both payment streams must be made comparable by applying an appropriate discount rate which should reflect the time preference of the society. Such discount rate is usually lower than the interest rate of the capital market because in addition to positive market effects IPM produces public goods and reduces public “bads”. The result of this procedure is the calculation of the investment criteria like, Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR). The latter is the most frequently used criterion. It shows the actual rate of return and can be compared to a desired level of interest rate.

In short, an economic evaluation of IPM-projects requires:

1) The definition of measurable targets in terms of the economy and the environment,
2) the identification, quantification and valuation of the costs and benefits of an IPM program,
3) the identification of a reference system indicating what the situation without an IPM program would be,
4) the calculation of the rate of return of the capital invested in the project.

In order to be professionally acceptable economic evaluation of IPM has to follow the procedure generally applied in cost benefit analysisof development projects.[4]

4.2 Benefits of IPM Projects

IPM projects aim at changing farm and crop management practices in cropping systems that have become overly dependent on chemical pesticide use. Since pest management is closely linked to crop cultivation and husbandry practices, not only changes in direct pesticide and other crop protection methods have to be looked at.

Generally, the most important affects to be expected are:

- more efficient use of pesticides and fertilizers in terms of quantities and timing (reduction of unnecessary and over-use)
- changing crop yields or yield variability
- change of crop varieties, planting densities or other crop management aspects (e.g. irrigation, pruning, organic manure, ...)
- change in labor requirements
- change in occupational health hazard.

4 For details on CBA the reader is referred to standard literature, e.g. LITTLE and MIRRLESS (1974), GITTINGER, (1982).

Benefits of IPM projects at the farm level can be expected in the following areas:

- reduction in costs of pesticide use (amount of pesticides, spraying equipment, time for spraying)
- increase in yields through better crop management
- increase in product quality through better crop management, which may result in higher prices
- reduction of risk in terms of variability in net profits through better crop monitoring and improvement of the state of the agro-ecosystem
- reduction in the loss of domestic animals due to pesticide intoxication (fish, fowl, honeybees etc.)
- reduction in the health costs incurred by the applicator
- reduced negative impacts on soil fertility
- reduced probability of resistance to pesticides.

In order to arrive at the net benefits for the farmer as decision-maker, the additional costs at farm level must be accounted for (see next section).

One of the major arguments for the continued reliance on a chemical-based strategy is the perceived insurance character of pesticides. Conventional, chemical-based crop protection was perceived as low risk for the farmer, because pesticides were believed to reduce the variation in crop yields and product quality (FEDER, 1979). Consequently an IPM-strategy that leads to a significant reduction in chemicals is perceived to increase risk. However, a careful assessment of the factors that influence pesticide use gives a different picture. Pest occurrence, pest density and pest mortality as a consequence of pesticide application are in fact uncertain. Also, there are uncertainties about product prices and the attainable yield as well as the possibility of pesticide poisoning. Relative to a situation with complete information this would call for lower pesticide use. A thorough review of literature on pesticide and risk revealed that the assumption that farmers always behave risk averse in relation to pesticides as well as that pesticide use always reduce production risks cannot be maintained (PANNELL, 1991).

Reasons to use pesticides, even if the use is uneconomical for the individual farmer, are due to risk aversion, imperfect information and factors which artificially stimulate the use of pesticides. Farmers' perceptions of potential crop losses seems to be higher than the actual losses. KAHNEMAN and

TVERSKY (1979) name this phenomenon 'loss averse' in contrast to 'risk averse', i.e. farmers behave differently when it comes to potential losses as compared to being faced with potential gains. As IPM is generating a better understanding of farmers for the forces that drive an agro-ecosystem their assessment of the occurrence and consequences of pests will change. Successful IPM will turn farmers from being 'insurers' to becoming 'investors'.

Observations on changing behavior of farmers in dealing with uncertainty cannot be directly transferred into the spreadsheet calculations for estimating the internal rate of return. A good description of such changes can reinforce the assumptions made in the quantitative part. As in IPM projects analysts will almost always be faced with the argument of IPM being a riskier technology, this issue must be given attention in evaluation reports.

Because of the common property nature of the resources that play a role in applying IPM practices, some of the benefits at the farm level can only be realized if community action is achieved. Hence these cannot be measured on an individual farmer level. For example, one of the key issues of IPM is conservation of natural predators to pests. Efficient action might be only feasible by community cooperation which means that surrounding farmers have to stop spraying as well in order that one farmer can earn the benefits of this action.

Additionally, IPM generates further benefits which are enjoyed by other groups of the society and are a desirable part of the economic analysis:

- reduced health hazard of food stuff
- reduced health hazard to pesticide applicators[5]
- reduced pollution of ground and surface water
- reduced danger of biodiversity loss.

These benefits can be in principle assessed in monetary terms and included into a cost-benefit analysis of an IPM project.

5 This holds true if farm workers are not members of the farmer's household and their additional health risk from pesticide spraying is not covered by increased wages for this activity. Otherwise, the costs are already accounted for at the farm level.

Other benefits which are often associated with IPM are usually not part of the economic analysis. Such benefits - which in some cases can be monetarized by using contingent valuation methods[6] - are for example:

- increased self-confidence of farmers
- increased knowledge of farmers
- more pest control options available to farmers
- more community initiative
- better image of the agricultural sector with other groups of the society
- a generally more stable environment.

The factors listed above generally belong to the intangibles which are difficult to measure. On the other hand such effects can affect future productivity and, in principle, often occur at the farm level. Whenever possible, i.e. when quantification is possible based on other studies or based on expert judgments these should be included in the cash flow of the project. If this is not possible, it is nevertheless useful to describe these effects in a transparent manner. They can be helpful to interpret the strengths of the quantitative assumptions that are made in the economic part of the analysis, e.g. on the time span in which benefits in terms of yield increase and pesticide savings take place. For example, if farmers show a greater confidence after IPM training they are likely to be in a better position to handle new technologies which are offered to them by government and private sources. Thus if increased confidence can be established, the assumption about productivity increase at the farm level can be made with greater confidence.

4.3 The Costs

The nature of the IPM technology must be understood before costs at the farm level can be assessed. While in conventional plant protection projects, the attention of project appraisal missions is often focused on chemical methods which is rather straightforward, the assessment of IPM projects is more complex. IPM differs from conventional crop protection as it tries to make maximum use of environmental and agronomic factors to reduce the probability of pest attack. These indirect methods of control do not – like chemical pesticides – directly kill target organisms but generate a healthy crop

6 In contingent valuation one tries to estimate economic values for non-market goods based on asking people what they would be willing to pay for that good or what they would be willing to accept in compensation for loosing that good. For further reading on this rapidly expanding branch of economic evaluation, refer to: MITCHELL and CARSON (1989) and FREEMAN (1993).

environment by stimulating the self-regulating mechanisms of agro-ecosystems. Such methods are, of course, not free of charge although their costs are not always easily identifiable. Costs of indirect measures for the purpose of IPM may be grouped into pre-planting, planting, post-harvest and off-field costs.

Pre-planting costs result from additional activities undertaken before the crop is taken to the field. They are specifically targeted at reducing the probability of pest occurrence. A good example is thorough land preparation as a means of weed control. If the control measure is clearly identifiable, e.g. an additional round of harrowing, costs are separable and measurable. In many cases the additional costs in terms of time and machinery are difficult to specify and costs of control are not separable from normal agronomic activities, especially if it is a matter of quality, thoroughness and intelligent use of practices. In such cases the costs of training necessary to change farmers' knowledge, skills and practices can be used as a proxy.

Costs at planting are embodied in the seeds of cultivars. Resistant varieties are a common method of control. For conventionally bred cultivars, there is hardly a price difference due to agronomic traits like yield potential, grain quality and pest resistance. In this case the costs of control are the opportunity costs of forgone traits, i.e. there is often a trade-off between resistant varieties and e.g. grain quality which in turn has price effects. For transgenic varieties there is usually a distinct premium to be paid. On the other hand in the case of gene combinations like herbicide resistance combined with *Bacillus thuringiensis* genes in maize, a problem-specific allocation of costs is not possible.

Post-harvest measures such as removal of crop residues are usually easy to measure as direct costs of labor, material and machinery are incurred. Off-field costs are those that occur either spatially or temporally outside the target crop. The costs of trap crops can be measured in terms of the gross margin forgone from an alternative use of the land. The same is true for costs of field margins to maintain biodiversity or to satisfy requirements for the use of transgenic varieties.

Crop rotation as a means to reduce pest pressure causes costs through forgone income from crops which have a higher gross margin but are more susceptible to pest attack. In this case the costs of control also depend on the risk attitude of the decision-maker.

The most frequently occurring cost items on farmer's level are:

- opportunity costs of time for attending training, seeking new information, crop monitoring and attending village meetings
- opportunity costs of land for changing crop rotations
- material costs for monitoring devices
- material costs for other inputs due to a change in cultivation practices and farmers' research activities

Costs for other groups of the society occur when resources are used for financing IPM research and training. Financial resources, whether public or private, have alternative uses. Being tied up in IPM activities causes foregone benefits in other areas of the economy.

In most of the projects, the following cost items are relevant:

- costs of training at the various steps of the project (salaries, incentives, running costs)
- costs of IPM project related research
- costs of external advise
- costs of establishing training material
- costs of project monitoring and evaluation
- policy workshops and policy dialogue
- administrative overhead costs

The bulk of costs is caused by the activities of the personnel involved in training. The reference system has to be chosen carefully in order to determine the true costs of the project. If government staff who has been already involved in extension is switching to an IPM trainer, the opportunity costs of the previous activity should be evaluated.

Some of these costs may be passed on to the farmers through direct charges and other fiscal instruments. However, in the reality of development projects this is rather unlikely because experience with IPM project has shown that farmers need some incentive to start participating in such training activities where benefits are not immediately visible.

4.4 From Financial to Economic Evaluation

The first step of IPM project evaluation is to undertake an analysis of the project’s impact on the farmer’s level. This equates to the identification, quantification and valuation of costs and benefits which occur at the farm level. It also includes the estimation of the rate of adoption of IPM by farmers which is a necessary information for assessing the magnitude of total benefits.

For adding-up benefits and costs at the farm level, partial budget or gross margin analysis are applied (see next chapter for example). Actual farm-gate prices of products and field prices for inputs are used. This allows to conclude about the income effects through improved cropping systems management. In addition to that, benefits must also be measured at the household level as IPM may increase business opportunities and reduce the health costs experienced by the household members under a situation without IPM. The assessment of the economic impacts at the farm-household level (‘financial analysis’ in the term of CBA) forms a basis for the assessment of the impact for the society as a whole (‘economic analysis’).

The results of the financial analysis should indicate whether the project is attractive enough for farmers to participate. To a large degree this will depend on the additional net income they can expect. A ratio of 2:1 of additional benefits over additional costs is believed to be a sufficient incentive for farmers to participate. The ratio however, ignores non-monetary benefits of IPM such as the opportunity to participate in group actions and access to new information.

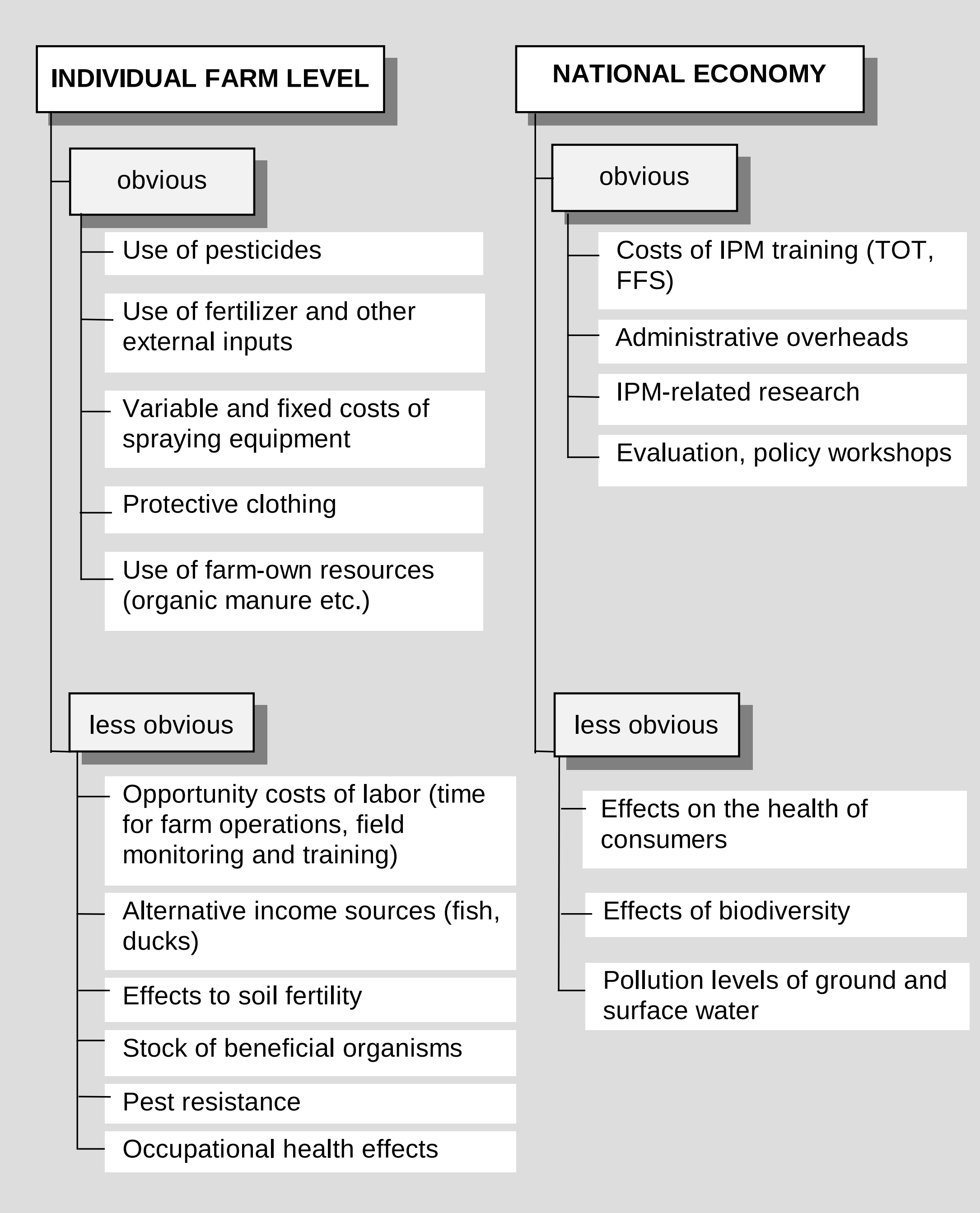
In the overall economic analysis of the project, the viewpoint of the society must be taken into account.

Here, three important areas have to be considered:

1. other benefits and costs that are not yet considered in the financial analysis of the farm-households adopting IPM
2. impacts on natural resources and human health
3. differences in the values of goods and services at the level of the individual and the society as a whole

Figure 3 provides a summary listing of the different impacts of IPM projects to be assessed. A differentiation is made in those costs and benefits which occur at the user level and those that can be identified at the society's level. At both levels there are factors which are fairly obvious and those which are not easily recognized.

Figure 3: Illustrative Impacts of IPM Project



Some effects can be directly evaluated by determining the market value, others are non-market effects, so-called externalities. In general, an externality can be defined as a positive or negative effect which can be caused by an individual, a firm or even a nation, without compensation being paid to the affected party. Negative external effects are those which are not included in private cost calculations and therefore do not influence the farmer's decision. External effects may occur immediately or with a time lag.

Because external effects are not reflected in the market price, assessment is sometimes difficult. Nevertheless such assessment, using environmental economics methods, is necessary if appropriate measures are to be implemented that allow internalizing such effects into the market process.

IPM projects are designed to reduce external effects associated with pesticide use. Although in the reality of project planning and evaluation the assessment of external costs of pesticides, in particular those latter effects, is heavily constrained by lack of data, maximum effort must be taken to come up with quantitative estimates. As a last resort reference can be made to other studies which indicate the ratio of pesticide costs to external costs (see Table 2).

Table 2: Quantitative Values for External Costs of Pesticides

Country	Ratio of External Costs to Costs of Pesticide Use	Author	Comment
Philippines, irrigated rice	1 : 1	ROLA and PINGALI (1993)	Occupational health effects of insecticides only
US, agricultural sector	2 : 1	PIMENTEL et al. (1993)	
West Germany, agricultural sector	0.23 : 1	WAIBEL and FLEISCHER (1998)	Minimum value
Thailand	1 : 1	JUNGBLUTH (1996)	

A special cost factor is **dependence on pesticides**. It is related to the status and the development of the ecosystem. Two factors play a major role here: one is the stock of beneficial organisms, which are important as a natural control factor and another is the depletion of the susceptibility of pests against pesticides, which can be considered as a natural resource. As pesticides kill beneficial organisms the need for more pesticides is created. Lowering beneficial populations increases the likelihood of pests and therefore increases potential crop loss. Results of loss and benefit assessment in a given cropping period then becomes a function of the actions taken in prior cropping stages and periods. In a study on pesticide use in the German agricultural sector a positive intertemporal relationship of pesticide use in consecutive periods could be shown, i.e. pesticide use in period t partly explained pesticide use in period t+n (WAIBEL and FLEISCHER, 1998).

The development of resistance works in the same direction. Higher dosages and/or more expensive chemicals are needed to achieve the same effect. Another, even more hidden factor is contributing to pesticide dependence: it is the direction of technological progress which is based on the assumption that upcoming problems can be solved by new pesticides or other external inputs like genetically modified cultivars. A particular difficulty in the assessment of the costs of pesticide dependence is that these are disguised as technological progress and therefore appear to be benefits. The farmer does not see the depletion of natural resources but he realizes the increasing need for chemicals while gradually loosing control options.

Box: How to estimate health costs

Among the external costs those resulting from negative health effects of pesticide use are receiving increasing attention and have been estimated in empirical studies (ROLA and PINGALI, 1993; ANTLE, CRISSMAN, CAPALBO, 1998). Exposure to pesticides can lead to health problems, including severe poisoning and death. Any symptom resulting from the exposure can lower farm productivity due to the farmers' absence from work, costs of medication and recovery. Farmers generally do not consider health costs as a cost of production. If they would do so, under the profit maximization assumption, this would result in lower use levels of pesticides because of increased costs.

Costs related to health effects correspond to the time the farmer is absent from work or is not capable of working at maximum productivity. These costs can be called the opportunity costs of farmers' time loss. The costs for hospital, medication and doctors fees can be called the treatment costs. The opportunity costs of farmers' time loss can be calculated as the net income lost due to absence from work. If this is not possible one can use local wages to estimate the net income lost. Treatment costs may be assessed through farm surveys or can sometimes be approximated through statistical data of intoxication cases and related health costs.

In order to establish the full value of the project to the national economy, corrections for prices that do not reflect opportunity costs should be made. In an open economy framework world market prices for inputs and outputs must be taken. Any transfer payment such as import taxes which do not affect the gross domestic product of the country must be eliminated[7].

For any free-market national economy, world market prices represent the opportunity costs of producing various commodities. Aside from transportation costs it is only with the introduction of tariffs, taxes or other trade barriers that

7 For details on the difference between financial and economic analysis and the specific problems of valuation, the reader is referred to the literature on economic analysis of projects, e.g. LITTLE and MIRRLESS (1974) or GITTINGER (1982).

domestic market prices and world market prices diverge and the problem of choosing between alternative prices arises. 'Border prices' should be used in the calculation of the shadow price for those inputs and outputs of a project which could be classified as tradable. Tradables are defined as goods with a potential on international markets[8]. The border price represents the costs to the economy of producing a commodity and enables the analysts to determine if the country is an efficient producer of that commodity. The border price is determined by seasonal or yearly variation in international prices, the exchange rate reflecting the opportunity costs of a unit of foreign currency to the domestic economy, and the importance of the domestic economy in the foreign trade of particular commodities.[9]

Non-tradable goods, e.g. local transport, distribution and other services, can be measured in terms of forgone production and/or consumption of tradables. However, as valuing non-tradables is quite time consuming using a measure known as the 'standard conversion factor' and multiplying it with the domestic price of the commodity is the procedure generally applied. This factor is the average ratio of shadow price to market price for those goods for which foreign exchange shadow prices have been calculated. It is used to adjust for distortions between the border prices of traded goods and the domestic shadow prices of non-traded goods.[10]

In addition to the economic impacts of an IPM project on the national level, policy change creating a more conducive environment for the diffusion of IPM can be expected. Policy change following a re-consideration of current crop protection policy measures is essential to strengthen the project's impact and to ensure sustainability of project targets. Such policy measures may include bans or restrictions on specific pesticides, reduction or elimination of pesticide subsidies, update of registration requirements, improvements of market regulations and adjustment of research priorities.

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8 Using a world market or border price in the analysis rather than a distorted, e.g. artificially high domestic price to value a commodity ensures that, in the case of an importable, the possibility of buying more cheaply from abroad is not ignored and in the case of an exportable, the potential for future markets is not hampered by encouraging the production of overpriced goods (DINWIDDY and TEAL, 1996).

9 The latter issue can be ignored in CBA as it can be assumed that developing countries are 'price takers' for the majority of commodities and their trading activities in most cases do not directly influence the world market price. (DINWIDDY and TEAL, 1996).

10 Additionally, there exist commodity specific conversion factors like the consumption conversion factor (ratio of a bundle of consumption goods at border prices to its value in domestic prices). This factor is often applied to the shadow price of labor to obtain a value of the opportunity costs of labor.

Based on the expected impact of farmers trained in an FFS, given a policy environment which is somewhat conducive to IPM, farmers would reduce their information gaps in pest and general crop management, they would improve their skills in managing their crop, allocate their scarce farm resources more efficiently and reduce the negative side-effects attributed to chemical pesticides, especially the effects on human health. Limiting the analysis of benefits of IPM to the crop level would underestimate them, because the complementarity with other production enterprises, e.g. management of aquatic organisms in rice fields, and a more informed decision-making at the household level can be a result of participatory training processes.

Finally, changes due to national IPM programs do not only occur at the farm/village level. The change in attitude, priority setting and paradigms must be assessed at the institutional level. The pressure from below may change inefficient pesticide policies and make them more conducive to IPM diffusion. For example, the recent complete ban of some pesticide compounds with high social costs in some countries (e.g. some WHO I compounds) is one indicator of such process.

4.5 Impact Assessment in a Multi-Criteria Analysis Framework

Although these guidelines concentrate on economic analysis of IPM initiatives, some notes shall be added on multi-criteria analysis (MCA). This is necessary, because in the reality of development projects the final conclusions with regards to the design, implementation or continuation of a project is not exclusively based on economic considerations. Hence, a final assessment of IPM programs during the course of ex-ante, intermediate or ex-post evaluations requires to integrate results of the economic evaluation with other impacts likely to be attributable to IPM. Sometimes a situation may occur where trade-offs have to be made, i. e. the internal rate of return may be unsatisfactory but other reasons suggest the implementation of the project.

Non-economic considerations for development projects mainly are used when issues of equity and compensation arise. Some areas or groups may have been disadvantaged and therefore need compensation. Actually, in many developing countries rural communities have been left behind in the development process, e.g. in terms of infrastructure, access to markets etc. IPM projects, especially if they involve a lot of extension activities, are sometimes considered by politicians as a way of addressing the perceived needs of farmers. Other considerations refer to environmental conservation and human health protection. As pointed out earlier, some of these arguments can be dealt with in the CBA, as long as they are quantifiable and monetarised. If this is not the case, a MCA framework is needed.

A transparent integration of the results of economic analysis with other project effects can be achieved by using multi-criteria analysis. Both, CBA and MCA, are aiming at the maximization of social welfare. They are different responses to the problem how to compare and quantify interpersonal utility resulting in increased social welfare. Differences between CBA and MCA exist in the degree of stakeholder involvement. While the CBA concentrates on efficiency and results in monetary value terms, the MCA is not limited to number and type of criteria but on the weights of the criteria (PELT et al., 1990). In order to make impacts comparable the necessity to compare quantitative and qualitative criteria can occur. Careful thoughts have to be given to the choice of an appropriate technique taking into account the political, economic, social and ecological context of the analysis (JOUBERT and LEIMAN, 1996).

The usual stages of a MCA are:

1) Identify the decision makers and stakeholder groups
2) Identify an initial set of alternatives
3) Identify a hierarchy of goals or objectives
4) Stakeholder groups identify criteria with which they will judge the performance of alternatives
5) Identify context specific ranges of the criteria
6) Determine non-linearities of the criteria
7) Scores are given to each alternative based on each criterion separately indicating strengths of preference for each alternative
8) The criteria are scaled so as to make them commensurate and as to indicate the trade-offs between them
9) Lower level criteria are aggregated
10) Sensitivity analyses within and between stakeholder groups
11) Consensus seeking - joint workshops

The final outcome of MCA is subjective since the weights of different goals must be determined by various interest groups of the society. However, it is a means to make the process of decision-making in development projects more transparent.

Whenever possible, project evaluators, during the course of evaluations should try to organize stakeholder meetings where the integration of CBA results into multi-criteria analysis could be demonstrated and implicit assumptions could be revealed.

The use of logical frameworks in project planning and cost benefit analysis in evaluation are comparative static approaches, which limit their assessments and measurements to defined points in time. Going beyond that, other tools of a multi-criteria framework would be to include an interest group analysis, political science analysis and practice assessment (BIGGS and FARRINGTON, 1991).

In ***interest group analysis*** the gains and losses of different groups affected will tackle the equity implications of the project with regard to income, employment, access to resources and other relevant criteria. For example, an argument often brought forward is that reduced pesticide inputs will lower employment of hired laborers for spraying and reduce the income of pesticide dealers. Although the productivity effects are included in economic cost benefit analysis the distribution effects can cause defensive measures which may negatively influence project success.

Political science analysis is analyzing how the project is likely to fit into the existing power structure and its potential to change these structures towards a better information environment and a strengthening of weaker groups in crop protection decision making. To some degree, political science analysis may be derived from a crop protection policy country study. It is however important to continuously monitor the change in the political climate relative to the conduciveness of IPM implementation.

The third addendum to cost benefit analysis is ***practice assessment*** which refers to the skills and the confidence of IPM practitioners in responding to new problems. It thus goes beyond a mere assessment of practical skills and economic performance. It would allow conclusions to be drawn with regard to the likely response of the target group to unexpected situations. For example, practice assessment would indicate how farmers would respond to impending pest outbreaks or to, for example, a new chemical is being introduced by a company. One could measure this from the way farmers ask questions and how they approach the use of introduced newly external inputs.

4.6 Sustainability Indicators for IPM Projects

Sustainability is a concept that has entered the discussion on development objectives in international fora. The most important reference for the concept of sustainability is AGENDA 21 where IPM is mentioned in chapter 14 as contributing to the goal of sustainability. Therefore, it is mandatory that an IPM project evaluation includes a statement on the contribution of the project to sustainable development. Hence, indicators must be found that allow such conclusions to be identified.

The effect of IPM projects on the sustainability of natural resources relevant for agricultural productivity in particular and overall sustainable development in general can only be assessed when bench marks have been set beforehand, for example as numbers of species observed and numbers of individuals per species counted. A simple measure for the contribution to sustainability is the amount of pesticides reduced in kg active ingredient as a proxy for the amount of ecosystem pollution avoided.

Briefly, sustainability has at least three different dimensions, an ecological dimension, an economic dimension and a social dimension. On all three dimensions four criteria can be applied: Economic viability, systems stability, systems resilience and equity. Using these criteria it is possible to identify indicators that may allow to conclude whether the project will help to conserve natural resources, increase farmers' welfare and survival probability of the farm, and help to conserve the options available for future generations. The exact indicators then depend on the socio-economic and environmental situation.

Some examples of measurable indicators can be given for the different criteria. Economic viability for example is referring to the increase in net return sufficient for farmers to adopt IPM, while economic resilience is referring to the project's contribution to enabling farmers to better overcome external economic shocks as compared to a situation without project. On the ecological dimension, stability of an ecosystem may refer, for example, to the reduced probability of pest outbreaks because the conservation of beneficials is expected to have a stabilizing effect on the agro-ecosystem. Finally, on the social dimension, the equity criterion refers to a better access to information and greater participation in decision-making at the community level by participating individuals, which helps to overcome the 'social dilemma' that exists with pests as a public bad and beneficials as a public good.

A word of caution against oversimplified and overly optimistic assessments with regard to the contribution of IPM projects to sustainable development must nevertheless be made. As sustainability is dealing with the 'very long run' the degree of uncertainty associated to any such statement is high. Therefore, the contribution of the project to sustainability cannot be proven nor can it be measured per se but can only be expressed in terms of sustainability indicators.

4.7 Summary

In practical cost benefit analysis, two levels must be considered: financial analysis which measures the economic impact of the project from the private point of view, i.e. the farmer. Secondly, the economic analysis which takes the society's viewpoint and values all project outputs at shadow prices. For all internationally tradable goods this is the world market price, for non-tradables the opportunity costs must be calculated.

It must be stressed that in economic analysis of IPM, benefits are solely based on the revealed preferences of the society, i.e. through prices of products and the opportunity costs of production factors. Intentions, aspirations and beliefs in relation to IPM or alternative pest management approaches, which are being laid open by different interest groups and which may be reflected in political decisions, are beyond the scope of economic analysis and therefore cannot be treated as economic benefits. In cost benefit analysis economics must be separated from politics. Political objectives can come into the evaluation during the course of multi-criteria analysis where the results of economic analysis are just one among other elements.

On the cost site of IPM projects, account must be taken of the investment in public institutions and the operational costs for training activities. On part of the farmer, costs of information and human capital enhancement form the main part. As a result of adjusting the cropping system to bring into play the agronomic factors of pest control costs will occur either as opportunity costs of land or labor and material costs.

To reach a conclusion on the economic feasibility of the project, costs and benefit streams must be estimated over time and made comparable by a discount rate that reflects the time preference of society. Indicators of economic feasibility can then be calculated as Internal Rate of Return (IRR), Benefit Cost Ratio (BCR) or Net Present Value (NPV).

The result of the economic analysis qualifies the project for the multi-criteria analysis (MCA). If the project shows to yield a favorable rate of return it usually has a good chance of being implemented. On the other hand, if the economics of the project are unsatisfactory MCA can identify trade-offs and make the process of decision-making more transparent.

5 Sources of Data for Economic Evaluation

The quality of economic evaluation of IPM projects depends decisively on the access to relevant data. The common situation is that data collected for other purposes than economic evaluation must be used and processed in order to draw some conclusions about the effect of the project on the productivity of plant production.

The most important data source is information from the farm-household. Relevant data may be collected during the Farmer Field School training sessions itself, or with the help of surveys that are conducted in the course of the project. This can be complemented by data from experiments with alternative pest control treatments, on-farm trials, cross-sectional input-output farm data that were collected for other purposes and by use of models.

5.1 Farm Household Data

5.1.1 Monitoring and Self-evaluation of Trained Farmers

Recent experiences with participatory monitoring and self-evaluation methods have renewed the interest for quantitative information. Farmers and other members of the household have a definitive interest in the impacts of project measures since it affects their economic position. FFS participants and project staff may find a joint interest in assessing the extent to which the training has achieved its objective.

Practically, participatory quantitative data collection can be introduced in several ways:

- Include in the curriculum of FFS training tools of economic analysis. For example, farmers can establish a crop budget as a joint learning process on the initial situation and the potential for improvements.
- Establish a forum for self-evaluation and monitoring of trained farmers. This group learning forum, possibly held as a follow-up to FFS training, could serve as a basis for stocktaking of the individual achievements and for identification of future action. Qualitative and quantitative indicators may be used (GUIJT 1998; ABBOT and GUIJT, 1998).

Quantitative data to be collected are yield and external input use. These are the impacts that are the most immediate and the most visible to the farm household. Qualitative indicators to be collected would be more suitable to get insights on the capacity of farmers to understand agro-ecological principles, gather relevant information and make informed decisions.

5.1.2 Farm/household surveys

A full set of production and farm-household level data may be in most cases only available by means of surveys. Information has to be obtained from field surveys in the project area about yield increase, adoption rate of IPM, pesticide reduction levels, and cost savings. It must also be determined whether yield increases and pesticide reductions are results of the project only or of other influencing variables such as policy changes. This can only be found by means of a control group of farmers where the project has no or only minimal influence.

The assessment of changes in crop yields may be problematic as measurement of field sizes and yields are difficult and differences might not be statistically significant. It, therefore, might be advisable to conduct pilot level studies on yield differences. Reduced variability of yields might be more easy to assess.

It is of utmost importance that in cost benefit analysis of IPM projects the analyst does not limit his/her conclusions to the production level but also includes the level of the farm household covering the important changes taking place beyond the field level.

Care must be given to the design of studies/comparisons. Variations in local conditions always cause problems which generally make the use of control groups as a benchmark against treatment group farmers questionable (CASLEY and LURY, 1987).

To measure the full impact of IPM as defined above it is insufficient to undertake a 'with and without' comparison, i.e. to compare villages that have undergone IPM training and those that did not. A 'before and after' comparison must be added to the 'with and without' approach. The reasons for this are twofold.

- Firstly, there may be systematic differences among the villages right from the start of the project, e.g. the IPM village may have been at a higher level of intensity. So even after training pesticide levels can be above the one of the reference village. Even with a large sampling size it must be realized that the sampling unit – in fact – is the village. There is a considerable danger that one cannot compensate for such effects simply through replications.

- Secondly, it is not only the differences in pest control practices (e.g. the number of sprays per season) that need to be measured but the appropriateness of decision-making conditional to the state of the agro-ecosystem (e.g. pest pressure). In a sole 'with and without' comparison the analysis would be much affected by the conditions of the specific season of the comparison. A random sampling procedure for impact studies – even if done in a stepwise manner – is inappropriate. Explorative interviews should be done during the pre-sampling phase in order to make a proper selection of villages and respondents.

Furthermore, the sampling procedure is crucial if the true effects of IPM shall be identified in project evaluation or more thorough impact studies that may precede such evaluations.

- Because one is looking for differences in farm/crop/pest management capabilities one needs groups that are as much as possible identical with regards to productivity and intensity, socio-economic characteristics (education, access to information), natural conditions (history of pest problems).
- The quality of government statistics is often poor. Therefore it is mandatory to include the opinion of local experts in the selection of villages. Areas where conflicting events (e.g. ecological disasters) and specific strategies of other players (e.g. heavy advertisement by chemical industry) took place should be excluded from the sample as such items will heavily distort comparisons.
- The overall methodology in IPM impact studies from an economic point of view must not be tailored to measure only static efficiency. The full impact of FFS - IPM requires a dynamic scale, i.e. including the assessment of human capital formation, i.e. endogenous innovation potential (e.g. "insect zoos" in Indonesian FFS), improvement in the problem solving capacities of villagers and local communities. Also, FFS - IPM can be expected to enhance community action, which in turn leads to a better management of pests as 'public bads'. To measure these effects – which may well be the most important ones – one needs to look at changes over time in addition to point estimates among trained and untrained villages.
- If only a 'before and after' comparison is chosen one has to correct for factors that change over time, e.g. prices. The two time periods need to be long enough, i.e. at least three seasons if meaningful averages are to be computed.

Due to the process-oriented concept of a ’FFS - IPM’, it is necessary to design and establish a monitoring system prior to the start of the project and re-visit the same farmers after IPM training. This approach has been used by the FAO Inter-Country Program for Integrated Pest Control in Rice in Southeast Asia in the framework of the Vietnam National IPM Program (FAO-ICP, 1997; see Annex 3). The advantage of this approach is that farmers serve as their ’own control group’ with less bias by the random selection of treatment and control groups.

A further aspect to be observed is that data taken from on-farm trials as well as from surveys of trained versus untrained farmers are taken from pilot project areas. This can result in errors in up-scaling, i.e. transferring pilot area results to larger regions. There is a danger of overestimation of the project’s impact, because pilot areas often represent special conditions which assure favorable results.

Again, the survey design has to be carefully chosen in order to arrive at a representative basis for up-scaling results to the project level. It is not advisable to carry out random selections of farmers and villages because of the many disturbing factors that can come in, such as extreme (low or high) pest pressure, counter-attacks by chemical companies and significant, location-specific changes in government programs. Purposive sampling with a careful assessment of prior information is preferable.

Furthermore, a sociological anthropological survey, conducted before and within the project’s implementation phase, should be included. It should deliver indicators on how farmers who participated in the FFS gained experience and capability to solve new arising crop protection problems in a more sophisticated manner. These findings will not be part of the economic analysis, but would be attributed to project benefits in a multi-criteria framework.

Educational gains can be assessed as the degree to which family members of FFS participants and neighbors are interested in IPM. Similarly, changes in non-participating villages within and beyond the project area could be monitored. Of special importance is the management of the non-target crops by FFS participants.

In the same manner changes that occur at the institutional level of administrators and policy makers in terms of the change in their paradigms and priority setting need to be taken into account.

5.2 Other data sources

5.2.1 Experiments in Research Stations

Trials conducted in experiment stations with pre-designed control treatments can be used to indicate yield loss and to conclude on costs and returns of pest control measures. A good example of such experiments are the IRRI insecticide treatment trials conducted in the seventies in four Philippine research stations (HERDT et al., 1984). If the treatments reflect farmers' practices, conclusions can be derived regarding possible efficiency gaps that could be overcome by an IPM project. Nevertheless, these data need to be used with great care for three reasons:

1) The conditions met in experiment stations are often not comparable with the situation in farmers' field. Planting in experiment stations may be off-season and the multitude of experiments may heavily distort the fauna of pest insects and their natural enemies.
2) The design of such trials does not always allow to arrive at statistically significant differences. Hence it remains uncertain whether differences are due to treatments or due to random events of nature.
3) Experiments often do not include realistic alternatives, because the purpose of these experiments is not tailored towards economic evaluation. Therefore, the reference system used in these trials is mostly a 'no-control' or 'no spray' treatment. The designed treatments are not always technically efficient and often they do not reflect the resource position of farmers. Therefore, economic evaluation e.g. by calculating the marginal rate of return may be misleading.

5.2.2 Experiments in Farmers' Fields

As traditional IPM heavily relies on researcher-determined economic thresholds as a means to rationalize pest control practices of farmers, many trials in farmers' fields have been conducted. In these trials comparisons were made between farmers' practices and the recommended economic threshold. Empirical studies from rice in Asia show that the economic thresholds developed by researchers do not outperform farmers' practices. These thresholds usually do not account for the varying field conditions farmers face. Thus, unless the economic thresholds have been subjected to extensive field testing such trials may not be a good source for determining benefits and costs of IPM as one would tend to underestimate the project's true benefit.

5.2.3 Generating Information by Models

Although rarely available, ecological, bio-economic and economic models may be a good tool to conclude about impacts of IPM projects.

Ecological models, developed by plant protection scientists are helpful in generating probability distributions of pest situations and translating these events into yield loss scenarios. If valid pest density/yield loss relationships are available interpretation of existing pest density information is straightforward. Unfortunately, the conversion of ecological models into economically interpretable results is often hampered by the difference in concepts and paradigms. For example, a commonly found mistake in crop loss assessment is to simply multiply yield losses with an average price. This can lead to wrong conclusions because crop prices react to significant shifts in supply as a result of pest outbreaks.

In **bio-economic simulation models** plant protection and economic aspects are integrated. Usually, a criterion function representing net returns of alternative pest management strategies is being maximized for simulated pest events. The major problem with these models is that they are normative and generally do not adequately take into account farmers' actual behavior. In many cases, such models are still limited to one pest only.

Economic models can include linear programming sector models, trade models, computable general equilibrium models and models of regional factor demand and product supply functions based on duality theory. The development of such models is time consuming so that only in exceptional cases would a project analyst be able to draw on such sources.

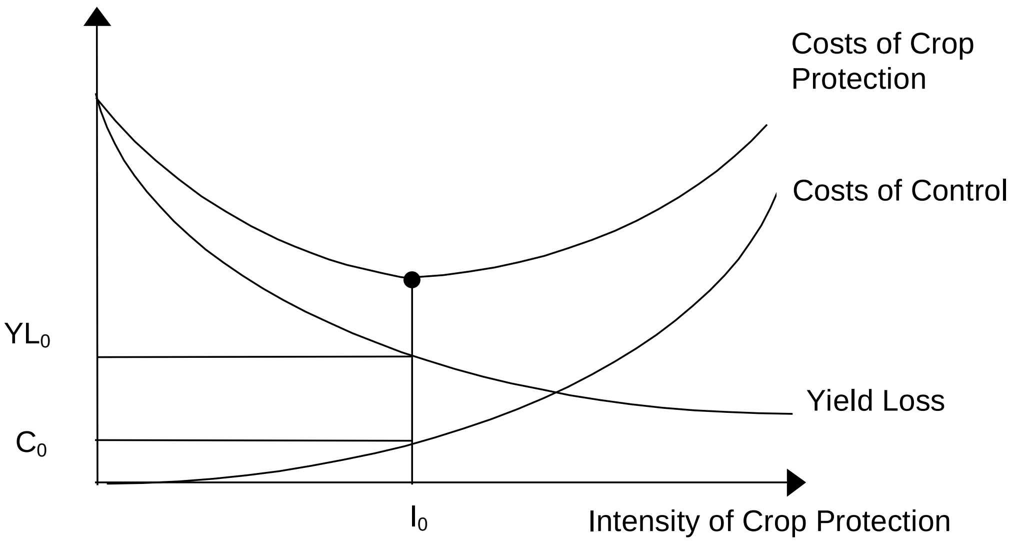
5.2.4 Crop Loss Data

Special consideration is given to crop loss data, because these kind of data are often used as major justification for crop protection projects. The results of CRAMER (1967) has been widely cited for global crop loss of around 30 %. More recently, even higher figures on crop loss on a global scale were published (OERKE et al., 1994).

Although pest control is about reducing crop losses from pests such figures are of limited use in the planning and evaluation of IPM projects. The main purpose of IPM – unlike traditional pest control projects – is not only to reduce crop loss but primarily to stabilize and improve agro-ecosystems.

The validity and precision of crop loss information ranges from general estimates to results of experiments and damage coefficients. Crop loss information is useful in indicating what could still be gained from better pest control. However, one has to be careful in concluding from crop loss information to existing efficiency gaps in pest management practices of farmers. This is a frequently found misconception by planners dealing with pest management decision-making. It is not economical to reduce damage caused by pests by 100 per cent because of the costs of control including costs of negative externalities. Figure 4 conceptualizes the interaction between the level of crop protection intensity and costs. Costs of crop protection include the costs of pest control and the monetary value of yield loss. Clearly, as yield loss is being reduced costs of control go up, hence total crop protection costs do have a minimum as shown in Figure 4. Whereas the justification of a traditional IPM project was based on the general magnitude of crop loss, the justification for any IPM project is the assumed deviation of the current pest management practices from a hypothetical minimum of the costs of safeguarding harvests, i.e. the total costs of crop protection. The latter deviation can be called economic loss.

Figure 4: Crop Loss and the Optimum Level of Control



YL_0 = Optimal Level of Yield Loss
C_0 = Optimal Level of Control Costs
I_0 = Optimal Intensity of Crop Protection

In most cases existing crop loss data do not consider the economic loss and therefore may not give the right conclusions as regards the impact of an IPM project.

Especially in ex-ante project evaluation crop loss data can be misleading. First of all the evaluator of an IPM project proposal has to be aware of problematic crop loss definitions. A clear distinction has to be made between yield loss, crop loss and economic loss. It is important to note that economic loss should not be confused with simply yield reduction times price, because:

- The price basis should be without crop loss, as prices after crop loss can increase.
- The economic loss is the difference in net benefit between two alternative strategies that consider the actual adjustment potential of farmers.

The possibility of misinterpreting crop loss data is high if it is expressed in monetary terms. This has to do with the price assumptions made in expressing value of yield loss. Price assumptions must be based on a 'with control scenario/with adjustment scenario'. Price effects are overestimated in a 'no-control' scenario. They are determined by elasticity of supply and demand. Price elasticity very much depends on the situation. For example in commercial crops demand elasticity is high as prices are influenced by the world market. Therefore, a severe pest outbreak has less effect on prices. On the other hand, in subsistence agriculture risks of severe pest outbreaks, as in the case of locust attacks, generate coping strategies of farmers such as an expansion of the area planted, which may again lessen the price effects.

5.3 Summary

Selection of data is crucial for the quality of economic evaluation in the context of project evaluation of IPM. Although there are never sufficient data in terms of quality and quantity there are a few rules one can follow to minimize errors and misinterpretations.

Firstly, a careful assessment of the various data sources is necessary. Generally speaking, experiment station data are not a suitable base for concluding about the farmer's and the society's benefits of IPM. Better suitable are experiments in farmers field, although treatments used in such trials must be carefully assessed with regards to compatibility with farmer's resources.

Secondly, in case pilot schemes on IPM were implemented before the onset of a large-scale project, results from these pilot schemes can be used. However it is necessary to make appropriate corrections for up-scaling as pilot area results often represent above average conditions and therefore benefits would be overestimated.

Thirdly, benefits and costs must be identified on the farm household level. The plot level is insufficient, because FFS - IPM aims at changes in decision-making and therefore is supposed to lead to a more efficient allocation of resources on the household level. Furthermore, it may have specific intra-household effects which require gender to be taken into account.

Fourthly, models can be useful tools of IPM evaluation if adjustments can be made to capture the dynamic effects induced by IPM such as changes in the state of the local ecosystem. However, models themselves do not determine the result of the evaluation but only are an input to an expert discussion.

Finally, a special warning is emphasized regarding the use of crop loss data in evaluation because of their underlying ’spray - no spray’ paradigm. Physical crop loss data should never be used without accompanying economic interpretation. In summary, the data for economic evaluation of IPM must allow to make conclusions with regards to changes in technical efficiency, allocative efficiency, innovative potential, institutional capacity, gender, the state of the ecosystem and the organizational implications of the FFS concept on the large scale.

6 Economic Analysis of an IPM Project: An Example

In the following, an example of an IPM project evaluation is presented which uses some of the methods explained in the previous chapters. The example necessarily has to remain brief and mainly aims to demonstrate to the project analyst less familiar with economic analysis the computational steps to arrive at meaningful conclusions about the economic impact.

The project is located in a fictive country called Asialand. An outline of the data required is given. The conduct and the results of the economic assessment are discussed.

6.1 Situation Analysis at the Farm-Household Level

Typically, IPM projects of the FFS type start with a pilot phase involving a small number of trainers and farmers in a selected area. After having gained successful experiences, a gradual expansion of the project usually is made. In principle, before each step of upscaling a review of the economic impacts achieved can be made. However, financial resources are limited so that decisions on the appropriate timing have to be made.

In our case study example, we choose a five-year period in which the project has been implemented in a pilot phase. Before the second phase follows, the economic performance of the approach shall be assessed.

In order to analyze correctly the costs and impacts over time, the sequence of activities has to be determined. The project started with one Training-Of-Trainers (TOT) course which was held by master trainers previously educated abroad. The village-level trainers conduct 4 FFS during the year with on average 20 participants each. The performance of the project shows the following success rates: The number of trainers available for field activities declined from 20 after the course was held, to 16 at the beginning of the fifth year, due to relocation of staff etc. The percentage of successfully trained farmers, i.e. those graduating after the season long training, was 75 %. In total, 5,400 farmers were considered as actual participants of the FFS. The distribution of the trained farmers over time is shown in Table 3.

Table 3: Performance of FFS Training

Year	**1**	**2**	**3**	**4**	**5**
Number of trainers available	20	19	18	17	16
Number of FFS held (4 per trainer)	80	76	72	68	64
Number of farmers trained (20 per FFS)	1600	1520	1440	1360	1280
Number of farmers graduated (75 %)	1200	1140	1080	1020	960
Cumulative number of farmers graduated	1200	2340	3420	4440	5400

About the impacts of training at farm-household level, the following basic information is available from a representative survey among FFS participants:

- yield: increase of 1 % for the targeted crop.
- external inputs:
  insecticide: one insecticide application abandoned, second insecticide maintained
  fungicide use: drop by 45 %
  fertilizer: drop of urea use by 18 % and that of other fertilizer by 27 % due to better timing and management
- labor: use of hired labor remained unchanged
  use of family labor for spraying decreased by one half, additional labor used for field monitoring and cultural practices (24 %)
- costs for equipment and animal traction reduced slightly due to less need for sprayer hire
- costs for land and seed remained unchanged.

Based on this information, a crop budget for the average FFS participants can be established (Table 4). Due to the yield increase and the cost savings, farmers were able to raise their net revenues by about 12 %.

On the farm-household level, the increase in net revenues from the targeted crop translates directly into household income. Additionally, expansion at the expense of other crops and farming activities has to be considered. Here the difference between the gross margin between the targeted crop and the replaced one has to be calculated (not shown in this example).

The reduction in pesticide use is likely to improve the health status of FFS participants and their family members. In principle, data can be established by means of health surveys. In economic terms these effects can be expressed as reduced costs for medical expenses and less labor days lost as compared to a situation with routine chemical control. However, in many cases, reference will be made to standard values from other studies. In this case, it is assumed that the average farmer saves two working days which have been lost before due to occupational health symptoms.

Intangible benefits such as improved problem-solving and decision-making capabilities of farmers and others as mentioned in Chapter 4 - are not quantified in this example. However, they must be nevertheless mentioned as these may significantly affect the sustainability of productivity gains.

Table 4: Crop Budget of an Average Rice Farmer in Asialand (MU)

	Unit	Without IPM			With IPM		
		Quantity	Unit Value	Total	Quantity	Unit Value	Total
Yield	**kg**	**4,000**	**1.5**	**6,000**	**4,040**	**1.5**	**6,060**
Costs							
Seed				**70**	unchanged		**70**
Purchased	kg	25	2	50			
Own production	kg	20	1	20			
Fertilizers				**935**			**720**
Urea	kg	220	2	440	180	2	360
Other	kg	110	4.5	495	80	4.5	360
Pesticides				**250**			**146**
Insecticide 1	kg	8.5	9	77			
Insecticide 2	l	1	50	50	1	50	50
Fungicide	l	1.1	80	88	0.6	80	48
Other	var			35			48
Equipment/ Animal Traction				**185**			**180**
Tractor/Bullock hire	ha	1	150	150	1	150	150
Sprayer hire	day	4	2.5	10	2	2.5	5
Equipment maintenance	var			25			25
Hired labor		**60**	10	**600**	unchanged		**600**
Family labor		**80**		**800**	**86**		**960**
Pesticide application	day	4	10	40	2	10	20
Other	day	76	10	760	94	10	940
Land	ha	**1**	**1,250**	**1,250**	unchanged		**1,250**
Other costs				**100**	unchanged		**100**
Transport	var			40			
Irrigation fee	ha	1	60	60			
Total costs				**4,190**			**4,030**
Net Revenue				**1,810**			**2,026**
Net Incremental Revenue							**216**

Source: Own Example

6.2 Cost Benefit Analysis of Project Impact

For assessing the economic viability of the FFS-IPM program, the wider implications beyond the individual farm-household have to be taken into account. The leading question for the economic analysis is: Does the project achieve a satisfactory rate of return for the investment made?

In our example, it has been established by project personnel that changes in crop management practices are taking place in the project area only. It is assumed that no other farmers than those being trained have been inspired on a farmer to farmer knowledge transmission basis. We also do not include induced innovations and other institutional changes but limit the analysis to impacts of the direct effects of this hypothetical project.

Following the methodology of CBA, farm level benefits will be aggregated and valued at economic prices while transfer payments will be excluded. Benefits enjoyed by other groups must be added and the costs of implementing the IPM project should be included. For the period ahead of the point of time of the evaluation, assumptions on the sustainability of the achieved productivity increase and other benefits have to be made.

Establishing the value of the productivity gains at farm level for the national economy follows standard procedures given in the literature (see GITTINGER 1982). In our example, the farm gate price of the targeted crop is below its shadow price which is derived from the relevant world market price (see Table 5). For the input factors, there is no difference between market and shadow price assumed for simplicity of the calculation.[11]

11 In reality, there might be also distortions to specific input factors. For example, fertilizer and pesticides are often directly and indirectly subsidized. This results in underestimation of the true economic benefits of external input savings.

Table 5: Calculation of the Shadow Price for Targeted Commodity (in monetary units <MU> per ton)

	Financial Analysis	Economic Analysis
Export price	**2230**	**2230**
Port charges	30	30
Export tax	50	-
Transport costs	300	300
Wholesaler's margin	100	100
Local tax on agricultural produce	50	-
Local trader's margin	200	200
Farm gate price	**1500**	**1600**

Thus, the benefits of the IPM project at the farm-household level are actually higher (4 MU) than calculated with farm-gate prices in the gross margin analysis.[12]

For the first five-year period, it has been established that the net incremental benefit of the project in terms of yield increase and external input cost savings was achieved by trained farmers throughout the whole period. However, assumptions have to made for the coming years since the future behavior of the farmers is not yet known. Moreover, it can be expected that the conditions in the pilot region do not represent those which can be found in other regions. If the IPM program spreads to other locations, less benefits can be expected.

Therefore, instead of calculating with deterministic figures for expected values, different scenarios will be applied:

1. Optimistic scenario: the net incremental benefit achieved in the pilot phase will remain for the following 10 years. Trained farmers will retain the knowledge and change in attitude that they gained in the FFS.
2. In-between scenario: the impact of the training will gradually decrease (on average 20 MU per year and hectare starting in the sixth year of the project)
3. Pessimistic scenario: improved practices of the farmers will cease in the eighth year of the project. Project follow-up activities also end by this date.

The project level analysis includes all costs for assessing and implementing the IPM project. Costs for the TOT course, farmer's training, project staff, surveys, pilot studies and opportunity costs of farmer's time for participating in

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12 The yield increase of 40 kg is worth in shadow prices 64 MU instead of 60 MU (see Table 4).

the FFS have to be considered[13]. Furthermore the reduction of external costs initiated by the project should be included to the degree possible. In our case, health benefits associated with reduced pesticide use could be identified and are included in the calculation. Similar relations may be valid for example for reduced soil erosion, reduction of resistance, air and ground water pollution. For a complete assessment these benefits should be at least mentioned although they may not yet be quantifiable.

The format of the CBA brings together the different benefit and cost items which accrue over time. The total net benefits of the project are used to calculate the indicators on the economic performance, including health benefits of pesticide reduction.

Whether or not a public investment in IPM is justifiable depends on the rate of return to the capital invested. This is usually judged by means of the NPV and IRR.[14] The internal rate of return (IRR) obtained in the optimistic scenario is 17.3 percent, meaning that even if the money spent on the project has to be borrowed at 17.3 percent an investment in the project is still economically viable. Normally, the project should achieve an acceptable rate of return on the investment made, which is under conditions of developing countries at least 8 to 10 %. If this is not the case, there should be strong indicators for additional benefits that could not be assessed in economic terms, in order to justify a lower return on capital.

If the in-between scenario for the development of benefits over time is used, the project still yields an acceptable result. However, the pessimistic scenario which assumes that project impact ceases after a period of three years, the IRR falls below the acceptable threshold (see Table 6).

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13 The opportunity costs of farmers' time belong strictly spoken, to the financial analysis at the farm-household level. However, since those cost are an initial investment of the farmers, they are better dealt with here.

14 The benefit cost ratio is less often used because of methodological inconsistencies in assigning benefits and costs. Nevertheless, it is shown in Table 6. In our example, the health benefits could be also counted as reduction in external costs, and opportunity costs of farmers' time would reduce the benefits from productivity increase.

Table 6: Economic Performance Indicators of the IPM Project in Asialand

Scenario	Optimistic	In-between	Pessimistic
NPV	1,921,616	151,495	-650,981
IRR	17.3	10.8	4.9
BCR	1.37	1.03	0.87

Source: Calculations in Annex 4.

The major assumptions made in the calculation of project benefits, are the impact on crop yields, the reduction in external input use and the improvement in the health status by reduced pesticide use. These assumptions should be verified in case studies during the entire phase of the project. These are part of project monitoring activities. If survey results show that the impact is lower than assumed corrective action in the project design should be the consequence.

Table 7: Example for an Economic Evaluation of a Five Year IPM Project in Asialand (MU) (Optimistic scenario)

Year	0	1	2	3	4	5	6-15
Cumulative number of farmers trained		1200	2340	3420	4440	5400	5400
Benefits							
Productivity increase (economic value)		264,000	514,800	752,400	976,800	1,188,000	1,188,000
Health benefit		24,000	46,800	68,400	88,800	108,000	108,000
Costs							
Program costs, general	800,000	800,000	800,000	800,000	800,000	800,000	50,000
TOT course	800,000						
FFS training (100 MU per farmer)		160,000	152,000	144,000	136,000	128,000	
Opportunity costs of time of farmers		96,000	91,200	86,400	81,600	76,800	
Incremental benefits		288,000	561,600	820,800	1,065,600	1,296,000	1,296,000
Incremental costs	1,600,000	1,056,000	1,043,200	1,030,400	1,017,600	1,004,800	50,000
Incremental net benefits	-1,600,000	-768,000	-481,600	-209,600	48,000	291,200	1,246,000
NPV (10 %)	1,921,616						
Internal rate of return	17.3 %						
Benefit cost ratio	1.37						

Source: Own calculations, see Annex 4, Table A-3.

7 Salient Points of Economic Evaluation

7.1 Major Traps

In analyzing IPM projects and approaches it is first of all important to clarify what one is trying to measure. IPM is more than simply ’less pesticides’ but means making better decisions at the crop, the farm and even at the household level. Improved decision-making must help to overcome technical and allocative inefficiencies in a dynamic perspective.

The major source of error, is the omission of a reference situation. References can be of different nature. The best reference is an economic survey before the project begins. Even so there may be a snag, because development in the desired direction might have proceeded even without project.

To avoid this problem, the choice is to make an economic evaluation of a control area, treated rather as a dummy project, in the same way and at the same time as the final project evaluation. Apart from the high costs, the risk of creating misinformation is considerable for various reasons. Experience has shown that it is extremely difficult to find two areas which are really identical at the start of the project. Reason 2 is that the development in the control area may be influenced by that in the project area, so that the control area no longer provides an independent control. Reason 3 is that minor differences between the two areas, not noticed at the beginning of the project, may lead to different developments in the two areas, even without a project.

Misinterpretation of results may be due to the ’pampering’ effect. Farmers in the project area are, to some degree, ’pampered’ and spoiled by attention not only given by project officers, but also by visitors such as a Minister of Agriculture, journalists or expatriate scientists. The effect is well known in educational experiments.

Farmers interested in change, here change toward IPM, may be the better farmers anyhow. Similarly, farmer-owners may be more interested in change than share-croppers and renting farmers. This means that the samples of yes-IPM and no-IPM farmers are far from random with respect to farmer quality, farmer status and yield, therewith obviating any objective statistical comparison.

During the course of the project, the labor situation may change drastically, e.g. when male farmers find good jobs in the cities and female farmers must take over many of the farm duties. Crop monitoring, an essential prerequisite in

IPM, takes time and requires knowledge. Serious monitoring is easily given up or replaced by a quick glance. A quick glance may be good enough for the trained eye under normal conditions, but the untrained eye may err, certainly under abnormal conditions.

A most disconcerting problem may be the unexpected pest which has not received much attention during the Farmer Field School. Panic may occur and upset IPM. Politicians, scientists and pesticide salesmen may utilize the unexpected pest for their own purposes and feed the panic. Adequate 'panic management' should be part of the IPM system, but little scientific information on panic management is available.

These examples show that economic evaluators should not take the calculated rate of return as the final conclusion. Drastic and unexpected events may completely disrupt the initial assumptions made. Applying risk analysis techniques can capture some of this uncertainty but is nevertheless limited to the observed range and the assumed distribution of random variables.

When the project has come to an end, a new situation arises because the interest shown by experts, non-local nationals and politicians stops too. Even if the project was a success, technically and economically, its continuation may be threatened. Pesticide salesmen may flock in and buy their way, and old habits may be taken up again. The socio-economic context may change, e.g. by enlargement of fields and farms or by increase of off-farm labor. The technical context may change too, as exemplified by direct seeded rice replacing transplanted rice, new varieties, new pests, or poor water supply. The viability of IPM, seen as continuity and continuous adjustment, may be endangered.

Therefore, a maintenance system of IPM may be considered by the project consisting of three components:

1) Bottom-up interest in a locally institutionalized form e.g. comparable to the 'grower study clubs' in several western countries.
2) Top-down interest from local politicians, challenged by the farmers, and national politicians, challenged by consumer and conservationist groups (among them NGOs).
3) Scientific interest from universities and research institutions to constantly monitor and evaluate IPM performance and to do supportive research.

In conclusion it should be pointed out that an economic evaluation of IPM projects has to start with the classic cost benefit (CBA) concept applied in other sectors of development assistance. However, the concept of static economic efficiency, which is implied in CBA remains important but is no longer a sufficient basis for decision-making in view of the paradigm shifts taking place in development. CBA can only be as good as the data allow to be. To a considerable degree, this depends on the efforts one is willing to spend in looking for what really causes and makes a difference. If no difference can be found, it does not mean that no difference exists.

It is no longer acceptable to measure what can be easily measured or just give it an arbitrary value. In the past it was too often and too quickly concluded that if something cannot be easily measured it may not be important or it may not even exist.

7.2 Economists and Plant Protectionists: Some Common Interdisciplinary Communication Gaps in the Economics of Pest Management

Experience has shown that there are some persistent philosophical differences between economists and plant protection specialists in the economic analysis of plant protection. As project evaluation is always a good exercise of interdisciplinary discourse some hints shall be given here on how to better achieve a common understanding. This is done by pointing at some frequently occurring ’misunderstandings’.

A common misunderstanding between crop protection specialists and economists stems from the interpretation of crop loss data in relation to decision-making in crop protection. Crop protection experts tend to base decisions in crop protection on the magnitude of crop loss. Their common definition of crop loss is the difference in attainable yield and the actual yield. This definition ignores economic considerations. Instead, an economic definition of crop loss refers to the difference between the economic yield and the actual yield. The economic yield is defined as the maximum yield where methods to limit yield losses are economically justified, i.e. the yield where the costs of pest control do not exceed the prevented loss in monetary terms.

The second commonly made error in the economic analysis of plant protection is in the choice of the reference system. Oftentimes reference is made to an ’unsprayed control’. This completely ignores the adjustment potential which exists for farmers faced with a sudden loss in a technology option. A farmer who is no longer allowed to use herbicides is unlikely to continue his cropping system in the same way. He will chose a least cost adaptation to the new situation. The correct reference system therefore should be the optimized crop management strategy taking into account available non-chemical options in case pesticides are taken out of the system. Choosing the wrong reference system is the major cause for the prevailing overestimation of pesticide benefits and the resulting over-reliance on a ’chemical path to crop protection’. This overestimation is further augmented because the intertemporal pest-pesticide interaction may induce artificial benefits which is usually being ignored in such analyses.

The third issue is the interpretation of some other effects attributable to crop protection measures[15]. Some societal groups tend to attribute some effects of crop protection as benefits which however are not economic benefits. Some typical perceived or actual non-economic benefits are:

- Improved food security through higher domestic production,
- food prices lower than market equilibrium
- higher food price stability
- a more diversified diet,
- decreased encroachment of agriculture upon wilderness areas, and
- more leisure time, e.g. when using herbicides.

Clearly, such effects must be attributed to political priorities in relation to trade, income distribution, employment and other factors. Because their value cannot be derived from market prices such effects should be included in the economic analysis of IPM projects nor in any other type of crop protection project. These effects can only be dealt with in the framework of a multi-criteria analysis (MCA) where the trade-off between economic efficiency and social or political objectives could be evaluated by different stakeholders.

15 This refers to chemical as well as non-chemical methods of control.

8 Glossary of Economic Terms

Alternative Uses.

Scarce resources have alternative uses which can be in production as well as in consumption. The scarcity of goods requires choices or tradeoffs by individuals and society, i.e. to choose among goods and services that satisfy various wants and desires. You will buy a good only if its value for you is at least as much as the price of that good.

Allocation over Time.

Time is an important element in economic decisions. Someone must decide whether to use a resource today or in the future.

Benefit.

Benefits include any object, process or concept which enhances value (including extra monetary income, and a better environment or greater sense of security). They also include anything which saves resources. In economic terms, benefits refer to the contribution of a project to social welfare, usually measured in terms of national income at world market prices.

Benefit Cost Ratio (BCR).

The benefit cost ratio is the sum of the discounted incremental benefits divided by the sum of the discounted incremental costs. Because of problems in assigning impacts to costs or benefits, this performance indicator is less often used.

Cash Flow.

In project analysis the term is used to express the difference of benefits and costs over time.

Conversion Factor.

A number, usually less than 1, that can be multiplied by the domestic market price, opportunity cost, or value in use of a non-traded item to convert it to an equivalent border price that reflects the effect of trade distortions on domestic prices of that good or service. A standard conversion factor is the reciprocal of 1 plus the foreign exchange premium stated in decimal form.

Cost (see also opportunity costs)

A measure of what must be given up in order to obtain something whether by way of purchase, exchange or production. Economists usually employ the concept of opportunity cost which measures costs as the value of all of the things which must be foregone, lost or given up in obtaining something.

Discount Rate.

The discount rate is the interest rate used to determine the present worth of a future value by discounting. These present worth can be called the discounted benefits.

Discounted Benefit = Discount rate ($Period_t$) * Net incremental benefit ($Period_t$)

Discount Rate = 1/ (1+i)N   i = interest rate, N = Number of years

Efficiency - Static and Dynamic.

In economic theory, efficiency is realized in the pareto-optimum, i.e. a condition where the welfare of one party cannot be increased without lowering the welfare of another. Thus, efficiency is a state, where, with a given set of technology, production, respectively welfare of a society cannot be enhanced.

While static efficiency refers to a fixed point in time, dynamic efficiency takes into account long term effects and developments.

Elasticity of Demand.

Price elasticity of demand is the percentage change in the quantity of a good or service demanded in response to a given percentage change in price, *ceteris paribus* (E_d = percentage change in quantity demanded / percentage change n price).

There are two measures for price elasticity of demand. If the price that changes is the price of that good, the elasticity value is the good's own-price elasticity of demand. If the price that changes is that of another good (a substitute or a complementarity good), the elasticity value is the cross-price elasticity of demand.

Elasticity of Supply.

Price elasticity of supply is the percentage change in the quantity of a good or service supplied in response to a given percentage change in its price, ceteris paribus. The coefficient of the elasticity of supply (Es) can refer to the rate of change at any point on a supply curve, or it may refer to the relative percentage change in price and quantity supplied between any two points on the curve. They are computed using the same formula as used in the calculation of the elasticity of demand:

E_s = % change in quantity supplied / % change in price

External Costs.

The opportunity costs of production which are not borne by, or paid by producers. External costs are not reflected in market prices, and so the decision of the consumer or firm creating the externalities does not take its effect into account.

External Effects.

External effects - also known as externalities, spillovers and neighborhood effects - are the discrepancies between private and social costs, or private and social benefits, respectively. The key aspect of externalities is interdependence without compensation. Some individual or firm benefits without paying, or causes others to have higher costs without compensation.

Gross Margin.

The gross margin is obtained by subtracting the variable costs (e.g. wages, salaries, rents, fuel, raw materials) from the gross output. It therefore represents the difference between receipts and money outlays incurred directly in carrying on the operations of the firm.

Internal Rate of Return.

That rate of interest which, when used to discount the cash flows associated with an investment project, reduces its net present value to zero. It gives a measure of the ’break-even’ rate of return on an investment, since it shows the highest rate of interest at which the project shows neither a profit nor a loss. If the internal rate of return is greater than the rate of interest that has to be paid, this would suggest that a project is economically justifiable.

The internal rate of return is compared with the investor’s cost of capital in order to determine whether a proposed project should be accepted or not. It is sometimes (also) known as the marginal efficiency of capital, the discounted cash flow yield and the investors yield.

$$E = \sum_{t=1}^{N} \frac{B_t - C_t}{(1+i)^t}$$

E = initial capital expenditure in the initial time period,

B_t - C_t *= net cash flow (incremental benefits minus incremental costs) of project in any year of its life (t = 1...N)*

$$i = 1 - \left(\frac{\sum_{t=1}^{N} B_t - C_t}{C}\right)^{-t}$$

i = interest rate

Net Present Value.

The NPV is the sum of the present worth of the incremental net benefits over the total project period.

$$NPV = \sum_{t=1}^{N} \frac{B_t - C_t}{(1+i)^t}$$

Net Revenue.

Similar to gross margin, except that depending on the purpose only some components the variable costs may be deducted (see also partial budget)

Opportunity Costs.

The cost to an individual or a firm of using a good for one purpose is equal to the value that the good could have earned in another use, i.e. its best alternative. This value in an alternative use is called opportunity cost. For example, if a farmer uses a tractor for one job, the opportunity costs to do so is equal to what that tractor would have contributed in its next best alternative use. The choice to do one thing is the value of the forgone opportunity.

Partial Budget.

A partial budget is used in planning a proposed change, within the overall plan, and only shows the extra expenses and the extra revenue resulting from the change. The net revenue or loss can be expressed as a percentage of the extra (or marginal) capital involved, thus giving a preliminary basis for comparing the percentage returns on capital which could be earned in alternative projects.

Payback Period.

It is the time required for an investment to generate sufficient increments of cash to recover the initial capital expenditure. It thus takes into account the capital expenditure on a new project and relates that to the net cash flow of that project. It takes no account of cash flows emanating after the payback period, and it does not take account of the pattern of flows within that period.

Private Costs.

The opportunity costs of production which are borne by the producer. If market goods are concerned, this is normally the price of the good the farmer has to pay for its use in the production process.

Resource Scarcity.

A resource is an input provided by nature and modified by humans using technology to produce goods and services that satisfy human wants. Resources include land, labor, equipment, and machines, as well as mineral and vegetable resources such as coal, iron ore, forests, and water. Resources are sometimes called factors of production because they are necessary to produce goods and services. One common characteristic of resources is that they have economic value. A producer generally has to pay to use them. The supply of most resources is limited.

Shadow Price.

The estimation of shadow prices is facilitated by dividing economic resources into tradable and non-tradable items. Tradables and non-tradables are treated differently. The values of directly imported or exported goods and services are already known in border prices, that is, their foreign exchange costs converted at the official exchange rate. Locally purchased items whose values are known only in terms of domestic market prices, however, must be converted to border prices by multiplying the former prices by appropriate conversion factors.

Border (Shadow) Price = Conversion Factor * Domestic (Market) Price. The shadow price of a good is the “true” price to the society.

Social Costs.

The opportunity cost for the society of all resources used in the production of goods and services. It is the sum of private plus external costs.

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Annex 1: Definitions of IPM

IPM is rich in definitions of which we will mention only two, one gentle and objectives-oriented (Box 1); the other cruder and more means-oriented (Box 2). The latter, defined by FAO in 1968, is still valid and applicable.

Box 1: **An objectives-oriented definition of IPM.**

A durable, environmentally and economically justifiable system whereby damage caused by pests, diseases and weeds is prevented through the use of natural factors (including cultural controls) which limit the population growth by these organisms, if needed supplemented with appropriate control measures.

Source: GRUYS, 1976, transmitted by J.C. VAN LENTEREN

Box 2: **A means-oriented definition of IPM as adopted by the FAO Panel of Experts on Integrated Pest Control, Rome, 1968.**

For the purpose of this Panel, Integrated Control (lutte intégrée, lucha integrada, integrierte Bekämpfung) is defined as a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing economic injury. In its restricted sense, it refers to the management of single pest species on specific crops or in particular places. In a more general sense, it applies to the coordinated management of all pest populations in the agricultural or forest environment. It is not simply the juxtaposition or superimposition of two control techniques (such as chemical and biological controls) but the integration of all suitable management techniques with the natural regulating and limiting elements of the environment.

Source: Report of the First Session of the FAO Panel of Experts on Integrated Pest Control. Rome, FAO, 1968.

Annex 2: Methodology for Analysing Policy Factors Influencing Pesticide Use

The framework for analyzing the factors that typically deviate pesticide use from its social optimum and create conditions that are not conducive for IPM adoption, is the so-called '2 by 2 subsidy box' (WAIBEL 1994). There are price and non-price factors which can be each obvious and hidden (Annex Table 1).

Annex Table 1: Factors Leading to Overuse of Pesticides

	Price Factors	Non-Price Factors
Obvious	**I** – Subsidies or free distribution of pesticides through government or development organizations – Subsidies for agro-chemical industry – Enclosure of pesticides in credit programs – Subsidies for complementary inputs – Preferential rates for tax or exchange rates	**III** – Main focus of research in pesticides – Government activities in reducing pesticide damage – Diversification of production to pesticide intensive crops – Export promotion of agricultural products – Inadequate government research in environmentally benign pest management
Hidden	**II** – Plant protection service, Outbreak Budget – Externalities of pesticide production – Externalities of pesticide use	**IV** – Lack of adequate procedures for the definition of crop loss and pests – Lack of transparency in regulatory decision making – Insufficient information about risks and alternatives – Curricula of agricultural extension and education – Misinformation of farmers by chemical industry

Source: WAIBEL (1994)

The first group of factors (I) contains measures which are visible in the pesticide market and directly affect farmers' demand for pesticides. The most extreme case would be governmental shops which sell pesticides below the market price. Most common are governmental loans on pesticides often embedded in a package of other agricultural inputs. Another important subsidy are preferential taxes or exchange rates for pesticides which may stimulate the use of pesticides. The second group (II) of subsidies contains those where government provides pesticides under certain conditions usually related to pest outbreaks. Often such subsidies comprise a substantial part of the chemical market. Also, administrative procedures require the budget to be spend whether or not there is an outbreak. Pesticide externalities occur during their production and use. They can have serious effects on human health and the environment. Therefore, external costs should be added to the pesticide price.

Group three (III) contains those factors which increase pesticide use due to misguided government activities in mitigating environmental and health damage or due to other governmental actions leading to higher than necessary pesticide use. The dominance of pesticide topics in research has significantly diminished knowledge on non-chemical alternatives. Thus research indirectly contributes to the promotion of excessive pesticide use.

Group four (IV) includes institutional factors which pre-condition pesticide use. These include concepts and procedures used in crop protection which are based on scientific paradigms that do not comply with the principles of welfare theory but refer to artificial scientific conditions. One good example is crop loss assessment where attainable yield is compared to primitive yield totally ignoring economic factors. Another example is the process of pesticide regulation where the pre-conditions for transparent decision making is often not fulfilled as a selected group of experts decide on behalf of society which pesticides should be registered. The political economy which drive such decision-making processes may not adequately reflect the interests of consumers, farm-laborers and environmentalists. A third factor are the curricula of agricultural education and extension where the focus is on pesticides, while the ecological and economic principles of pesticides are rarely discussed.

Many of the factors mentioned may be found in most developing countries. The factors actually are constraints and disincentives to IPM implementation. Their relative strength needs to be assessed and strategies put in place to overcome these forces.

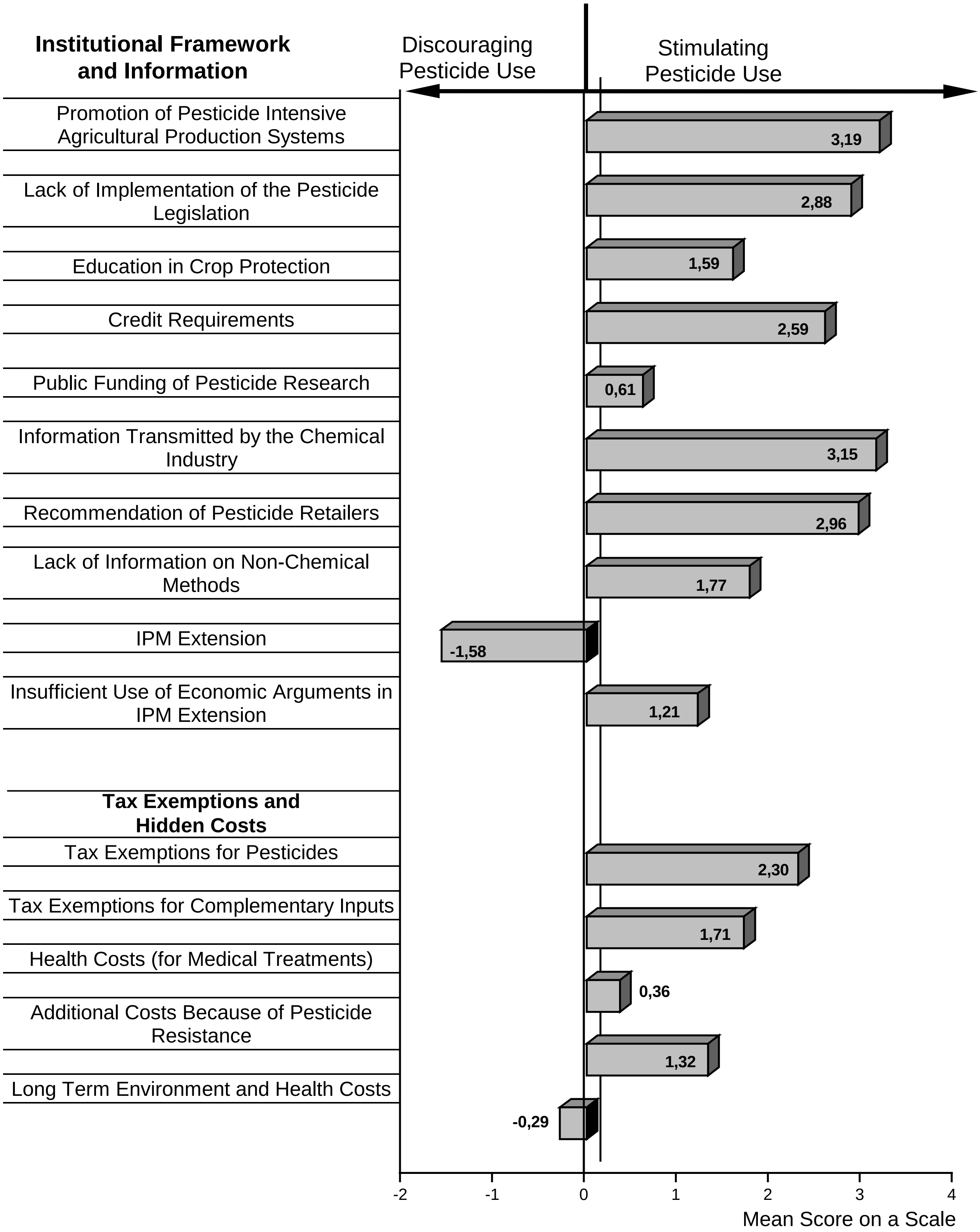
Ideally a country study on the national crop protection policy is available prior to the preparation of the project. Such studies have been carried out in Costa Rica (AGNE, 1996), Thailand (JUNGBLUTH, 1996) and Ivory Coast (FLEISCHER et al., 1998). In case these kind of study results are not available a minimum version is highly recommendable. This requires an input of about four person-months, ideally jointly carried out by an agricultural economist and a plant protection specialist. It contains three major subjects :

1) The situation of the agricultural sector containing a quantification of its role in the national economy, the agricultural policy setting, existing pest problems and dominant pest management practices, evidence and extent of external effects caused by pesticides and the status of social responses to pesticide issues.
2) An analysis of the market-based incentives as they affect pesticide use, such as input and output pricing policies. Furthermore an analysis of the institutional setting in plant protection as already mentioned in Annex Table 1.
3) Farm and crop characteristics affecting pest management including indications of the economic efficiency of available control methods, also taking into account external effects occurring at farm level, is part of such a study.

The problem analysis should be carried out in a participatory manner, i.e. conducting an assessment of the situation of crop protection in the cropping system or region where the IPM project is going to be launched.

After basic prior information is made available through the country study, problem analysis is best carried out in a workshop environment during the initial state of project design. Participants of the workshop should be the different groups affected by pest management decisions, such as farmers, farm laborers, researchers, extension workers – both government and NGOs – local industry representatives and consumers. A formal procedure can be applied. This would allow assessing the factors as they are responsible for inefficient and non-sustainable pest management, especially pesticide use deviating from the socially optimal level. An example of such a formalized procedure carried out during a workshop in Costa Rica is shown in Annex Table 2.

Annex Table 2: Determinants of Pesticide Use and Their Impact According to an Expert Survey in Costa Rica



Source: AGNE (1996)

The policy workshop was carried out including some 20 experts from ministries, national and international governmental organizations, research institutions, and private sector representatives. These experts were given a questionnaire during the seminar which allowed them to give an assessment of pre-selected factors as well as to mention those factors which they found to be important in explaining the current situation of pesticide use in Costa Rica. Participants ranked the impact on a scale to -5 to +5. A negative value implied a discouraging effect on pesticide use, a positive value indicated a stimulating effect. Factors which were assumed to have no impact at all were given a zero value.

It turned out that institutional factors and information were perceived to be the most important determinants of excessive pesticide use. Tax exemptions for pesticides as well as for complementary inputs and external effects of pesticides were considered as relevant too. Overall, the workshop showed that the majority of the factors have a strong stimulating effect on pesticide use with the only exception of IPM extension and health costs.

Annex 3: Microeconomic Study of IPM Impacts in Ha Tay Province, Vietnam

The IPM impact studies consisted of before and after surveys of a large sample of farmers drawn randomly from the population of new Farmer Field Schools (FFS) entrants. These data enabled the survey team to track a range of simple indicators of behavioral change among farmers participating in the program. They were not sufficiently detailed, however, to provide much information on the mechanisms through which these changes take place, or to measure the technical and allocative efficiency of IPM farmers as compared to farmers who have yet to take part in an FFS. The analysis of farmers' behavior before and after IPM training indicates that farmers' crop management practices change significantly after participation in an FFS. IPM farmers achieve the same or better yields with less risk while reducing input use. These results suggest that IPM farmers increase the technical efficiency of rice production (producing the same output with use of less physical inputs) as well as the allocative efficiency of farming (maximizing profits given a set of market prices) through improved decision making.

Testing this hypothesis requires detailed information on the management of (variable and fixed) capital and labor. Data are also required on agro-ecological conditions in the fields surveyed, since the quality of management decisions depends on the context in which these decisions are made.

The IPM microeconomic study underway in Ha Tay province attempts to test this hypothesis in the context of rice cultivation in the Red River Delta. Randomly selected farmers are being surveyed in three communes: a commune which has already hosted several IPM FFS, a commune which had its first FFS in the 1997 Winter Spring season, and a comparison commune. Both IPM and non-IPM farmers will be surveyed in the first and second communes. The study format therefore provides both longitudinal (over time) and latitudinal (across groups) comparisons of IPM and non-IPM farmers.

Five kind of data are being collected, including:

- Economic data at the plot level;
- Agro-ecological data at the plot level collected in the form of weekly observations;
- A survey of farmer knowledge to assess the basis on which farm management decisions are made;
- Price data for the construction of a locally sensitive price index;
- Commune level data.

Source: FAO-ICP (1997)

Annex 4: Example of an Economic Evaluation of a Five-Year IPM Project (Different Scenarios)

Table A-3: ASIALAND IPM-FFS-PROJECT : OPTIMISTIC SCENARIO

	year unit value	0	1	2	3	4	5	6
Number of farmers trained in FFS			1600	1520	1440	1360	1280	
Number of farmers graduated from FFS			1200	1140	1080	1020	960	
Cumulative number of farmers graduated from FFS			1200	2340	3420	4440	5400	5400
Benefits								
Productivity increase (economic value)	220		264000	514800	752400	976800	1188000	1188000
Health benefit	20		24000	46800	68400	88800	108000	108000
Costs								
Program costs, general		800000	800000	800000	800000	800000	800000	50000
TOT course		800000						
FFS training (per farmer)	100		160000	152000	144000	136000	128000	0
Opportunity costs of time of farmers	60		96000	91200	86400	81600	76800	0
Incremental benefits			288000	561600	820800	1065600	1296000	1296000
Discounted benefits	0.1	0	261818.2	464132.2	616679.2	727819.1	804714	731558.2
Incremental costs		1600000	1056000	1043200	1030400	1017600	1004800	50000
Discounted cost	0.1	1600000	960000	862148.8	774154.8	695034.5	623901.7	28223.7
Incremental net benefits		-1600000	-768000	-481600	-209600	48000	291200	1246000
Discounted net benefits	0.1	-1600000	-698182	-398017	-157476	32784.6	180812.3	703334.5
NPV (10 %)	**$1,921,616**							
IRR	**17.3%**							
BCR	**1.37**							

Annex Table A-3 (cont.): ASIALAND IPM-FFS-PROJECT : OPTIMISTIC SCENARIO

	year unit value	7	8	9	10	11	12	13	14	15
Number of farmers trained in FFS										
Number of farmers graduated from FFS										
Cumulative number of farmers graduated from FFS		5400	5400	5400	5400	5400	5400	5400	5400	5400
Benefits										
Productivity increase (economic value)	220	1188000	1188000	1188000	1188000	1188000	1188000	1188000	1188000	1188000
Health benefit	20	108000	108000	108000	108000	108000	108000	108000	108000	108000
Costs										
Program costs, general		50000	50000	50000	50000	50000	50000	50000	50000	50000
TOT course										
FFS training (per farmer)	100	0	0	0	0	0	0	0	0	0
Opportunity costs of time of farmers	60	0	0	0	0	0	0	0	0	0
Incremental benefits		1296000	1296000	1296000	1296000	1296000	1296000	1296000	1296000	1296000
Discounted benefits	0.1	665052.9	604593.6	549630.5	499664.1	454240.1	412945.5	375405	341277.3	310252.1
Incremental costs		50000	50000	50000	50000	50000	50000	50000	50000	50000
Discounted cost	0.1	25657.91	23325.37	21204.88	19277.16	17524.69	15931.54	14483.22	13166.56	11969.6
Incremental net benefits		1246000	1246000	1246000	1246000	1246000	1246000	1246000	1246000	1246000
Discounted net benefits	0.1	639395	581268.2	528425.6	480386.9	436715.4	397014	360921.8	328110.7	298282.5

Annex Table A-4: ASIALAND IPM-FFS-PROJECT : IN-BETWEEN SCENARIO*

	year unit value	0	1	2	3	4	5	6	7
Number of farmers trained in FFS			1600	1520	1440	1360	1280		
Number of farmers graduated from FFS			1200	1140	1080	1020	960		
Cumulative number of farmers graduated from FFS			1200	2340	3420	4440	5400	5400	5400
Benefits									
Productivity increase (economic value)	220		264000	514800	752400	976800	1188000	1080000	972000
Health benefit	20		24000	46800	68400	88800	108000	108000	108000
Costs									
Program costs, general		800000	800000	800000	800000	800000	800000	50000	50000
TOT course		800000							
FFS training (per farmer)	100		160000	152000	144000	136000	128000	0	0
Opportunity costs of time of farmers	60		96000	91200	86400	81600	76800	0	0
Incremental benefits			288000	561600	820800	1065600	1296000	1188000	1080000
Discounted benefits	0.1	0	261818.2	464132.2	616679.2	727819.1	804714	670595	554210.8
Incremental costs		1600000	1056000	1043200	1030400	1017600	1004800	50000	50000
Discounted cost	0.1	1600000	960000	862148.8	774154.8	695034.5	623901.7	28223.7	25657.91
Incremental net benefits		-1600000	-768000	-481600	-209600	48000	291200	1138000	1030000
Discounted net benefits	0.1	-1600000	-698182	-398017	-157476	32784.6	180812.3	642371.3	528552.9
NPV (10 %)	**$151,495**								
IRR	**10.8 %**								
BCR	**1.03**								

* Assumption: The impact of the training will gradually decrease (on average 20 MU per year and hectare starting in the sixth year of the project).

Annex Table A-4 (cont.): ASIALAND IPM-FFS-PROJECT : IN-BETWEEN SCENARIO

	year unit value	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Number of farmers trained in FFS									
Number of farmers graduated from FFS									
Cumulative number of farmers graduated from FFS		5400	5400	5400	5400	5400	5400	5400	5400
Benefits									
Productivity increase (economic value)	220	864000	756000	648000	540000	432000	324000	216000	108000
Health benefit	20	108000	108000	108000	108000	108000	108000	108000	108000
Costs									
Program costs, general		50000	50000	50000	50000	50000	50000	50000	50000
TOT course									
FFS training (per farmer)	100	0	0	0	0	0	0	0	0
Opportunity costs of time of farmers	60	0	0	0	0	0	0	0	0
Incremental benefits		972000	864000	756000	648000	540000	432000	324000	216000
Discounted benefits	0.1	453445.2	366420.3	291470.7	227120	172060.6	125135	85319.33	51708.68
Incremental costs		50000	50000	50000	50000	50000	50000	50000	50000
Discounted cost	0.1	23325.37	21204.88	19277.16	17524.69	15931.54	14483.22	13166.56	11969.6
Incremental net benefits		922000	814000	706000	598000	490000	382000	274000	166000
Discounted net benefits	0.1	430119.8	345215.5	272193.6	209595.4	156129.1	110651.8	72152.76	39739.08

Annex Table A-5: ASIALAND IPM-FFS-PROJECT: PESSIMISTIC SCENARIO*

	year unit value	0	1	2	3	4	5	6	7	8
Number of farmers trained in FFS			1600	1520	1440	1360	1280			
Number of farmers graduated from FFS			1200	1140	1080	1020	960			
Cumulative number of farmers graduated from FFS			1200	2340	3420	4440	5400	5400	5400	5400
Benefits										
Productivity increase	220		264000	514800	752400	976800	1188000	1188000	1188000	1188000
(economic value)										
Health benefit	20		24000	46800	68400	88800	108000	108000	108000	108000
Costs										
Program costs, general		800000	800000	800000	800000	800000	800000	50000	50000	50000
TOT course		800000								
FFS training (per farmer)	100		160000	152000	144000	136000	128000	0	0	0
Opportunity costs of time of farmers	60		96000	91200	86400	81600	76800	0	0	0
Incremental benefits			288000	561600	820800	1065600	1296000	1296000	1296000	1296000
Discounted benefits	0.1	0	261818.2	464132.2	616679.2	727819.1	804714	731558.2	665052.9	604593.6
Incremental costs		1600000	1056000	1043200	1030400	1017600	1004800	50000	50000	50000
Discounted cost	0.1	1600000	960000	862148.8	774154.8	695034.5	623901.7	28223.7	25657.91	23325.37
Incremental net benefits		-1600000	-768000	-481600	-209600	48000	291200	1246000	1246000	1246000
Discounted net benefits	0.1	-1600000	-698182	-398017	-157476	32784.6	180812.3	703334.5	639395	581268.2
NPV (10 %)	**$ 650,981**									
IRR	**4.9%**									
BCR	**0.87**									

* Assumption: Improved farmer's practice lasts only up to the 8th year of the project. Project activities also cease after that date.

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