Food and Agriculture Organization of the United Nations

IPM Impact Assessment Series

Guidance Document No 2:

Guidance on the Use of Environmental Impact Quotient in IPM Impact Assessment

March 2008

The IPM Impact Assessment Series aims to provide guidance to impact assessment of Integrated Pest Management (IPM) projects and programmes.

The preparation of this guidance document was commissioned by the FAO Global IPM Facility.

The status of this guidance document is that of a Project Report prepared for GCP/INT/999/SWI on Pest and Pesticide Management Policy Development, and GCP/RAS/209/NOR on Vegetable IPM in Asia.
As such, it does not necessarily reflect the official view of FAO.

Other documents in the IPM Impact Assessment Series include:

Guidance Document No 1: Introduction to the "Double Delta" Approach

Guidance Document No 3: Guidance on pesticide risk reduction impact assessment

Review No 1: IPM Farmer Field Schools: A synthesis of 25 impact evaluations

Review No 2: Use of Environmental Impact Quotient in IPM Programmes in Asia

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1. INTRODUCTION

There is an increasing demand on IPM projects to examine their economic, environmental, health and social impacts, including their achievements in reducing pesticide related risks.

The Environmental Impact Quotient (EIQ) is one of the tools that is being used to measure achievements in pesticide risk reduction. It was developed in 1992 at Cornell University, USA, and provides an indication of potential environmental and health risks of pesticides.

The EIQ has been widely used because of its simplicity and user-friendliness. Since 2000, the EIQ has been applied in several IPM projects in Asia for impact assessment and pesticide risk education. In early 2007, FAO convened an international workshop in Doson, Vietnam, to review these uses of the EIQ in IPM programmes. The resulting report "Review: Use of Environmental Impact Quotient in IPM Programmes in Asia" compares EIQ with other risk indicators, analyses the potential and limitations of the EIQ model, reviews its applicability for IPM impact assessment and its suitability as a tool for IPM decision taking and farmer education in pesticide risk reduction. A brief summary of its findings is presented in the box below.

The purpose of this Guidance Document is to provide practical guidance regarding the use of EIQ in IPM impact assessment. It is aimed at IPM project staff and contractors involved in designing and conducting impact assessment studies of IPM programmes.

Summary of conclusions from the review of the use of EIQ in IPM Programmes

<u>IPM impact assessment</u>: EIQ can provide useful additional information when assessing the impact of IPM programmes on pesticide risk reduction because it reflects both quantitative and qualitative improvements in pesticide selection and use, while most commonly used indicators only reflect quantitative results. In multi-year impact assessment studies on programme/policy level, EIQ can be applied to every participant in a study. It can therefore provide frequency distributions of potential impacts for very large number of farmers. The results can be statistically analyzed, e.g., through the double delta approach, or used to estimate pesticide externality costs. Whenever possible, other impact indicators should complement EIQ, e.g. WHO pesticide hazard classes, poisoning signs and symptoms, or environmental observations.

<u>Pesticide risk education</u>: EIQ may have some limited uses in farmer education on pesticide risks. Field Use EIQ profiles in principle could serve as a tool in FFS group discussions about diversity of risk. However, there is a high risk of misinterpretation and therefore great care should be taken when using such profiles. EIQ could also play a role in end of season review of achievements and risk reduction trends over time.

<u>Decision support tool</u>: The usefulness of EIQ as a decision support tool in IPM decisions is limited because there are many other factors that should be considered before looking at EIQ. Because of its roughness and risk of error it is not considered suitable for selection of pesticides.

2. PESTICIDE RISK ASSESSMENT IN IPM PROGRAMMES

One of the ways to reduce pesticide-related risks is through Integrated Pest Management (IPM). Numerous studies have shown that IPM reduces the amount of pesticides used and contributes to the selection of less harmful products (van den Berg, 2004). To assess the actual effects of these changes on human health and the environment requires elaborate studies measuring acute and chronic poisoning symptoms among a sample of affected humans, or changes in the population dynamics of a number of key non-target species. Such studies are difficult, expensive and time consuming to conduct. IPM programs have therefore used various proxy indicators to reflect changes in pesticide risks, e.g. number of sprays, cost, or quantity of product. However, these methods are poor indicators of actual risk because they do not consider toxicities to different organisms or routes of exposure. Thus quantifying the reduction of pesticide risks to farmers, consumers and the environment, based on a broader indicator, would be useful to assess the achievements of IPM programmes.

Pesticide risk is related to the hazard of the active ingredient, i.e. its inherent potential to cause harm, and the likelihood of exposure to the chemical to actually cause harm. Therefore risk assessments combine toxicity information with information about the use of a product, its pathway through the environment, and rate of uptake by exposed organisms. Models that can accurately assess these factors are important tools for assessing pesticide risks and achievements in more environment-friendly plant production.

Risk = Hazard x Likelihood of exposure

Over the past 20 years, many different pesticide risk indicators have been developed worldwide, often designed to address specific concerns, or sets of concerns, relevant to the countries where they are used, such as protecting certain key industries or export markets (Levitan et al., 1995; van Bol et al., 2002). Most of them originated in industrialized countries where health risks have already been reduced to a minimum through effective pesticide evaluation and registration schemes, monitoring and enforcement. Consequently, the focus of these models has been primarily on environmental risks. However, this situation differs fundamentally from many developing countries with often less developed regulatory and enforcement systems where highly dangerous pesticides are still widely used, resulting in a high incidence of farmer poisoning, food contamination and damage to the environment.

Some of the pesticide risk indicator models are very sophisticated and take into account variability of soil, crop, climate, agricultural practice, and land use pattern, thus requiring large and specific data inputs. Others are more simple, but also less accurate, and consider only published physical-chemical properties of the active ingredient. Generally, the latter are more attractive to developing country situations where easily understood and user-friendly systems are important and essential to a widespread application. Therefore a relatively simple model like EIQ represents a possible tool for assessing pesticide risk reduction achieved by IPM programmes in developing countries.

In IPM programmes, individual or composite pesticide risk indicators potentially could be useful for the following purposes:

- assess the positive impact of IPM programmes on the environment;
- compare relative risks of different pest and pesticide management strategies;
- monitor trends in the progress and success of risk reduction policies;
- contribute to the development of economic instruments that consider the potential of individual pesticides to cause environmental damage (e.g. taxation schemes to discourage use of products that have considerable negative impact on the environment);
- contribute to the development of broad simplified criteria for ‘green’ labelling of agricultural produce and influence consumer opinion and market behaviour;
- play a limited role in pesticide risk education.

3. WHAT IS THE ENVIRONMENTAL IMPACT QUOTIENT?

3.1 The EIQ model and its origin

The Environmental Impact Quotient (EIQ) was developed in 1992 at Cornell University, USA, to organize the published environmental impact information of pesticides into a usable form in order to help growers and other IPM practitioners make more environmentally sound pesticide choices. It represents a method to calculate the potential environmental and health impacts of pesticides and addresses a wide range of the environmental and health concerns that are encountered in agricultural systems, including impacts on farm worker, consumer, wildlife, health and safety (Kovach et al., 1992). Its results give a rough indication of the overall risk of a product. Therefore, the EIQ model makes it possible to estimate the potential environmental and health impact of different pesticides and compare the relative risks of different pest management strategies or programs.

However, like all risk indicator models, this method does not estimate or measure actual pesticide risks in a given situation since it does not take into account specific routes of exposure and actual uptake; it only generalizes possible risks based on toxicological data and chemical and physical properties.

3.2 How are EIQ values derived?

Distinction is made between “EIQ value” and the “Field Use EIQ”. The EIQ value is a figure calculated for a specific active ingredient. It serves as a basis for the calculation of the “Field Use EIQ”, which provides an indication of the potential environmental impact of specific pesticide formulations at the prescribed dosage. (This difference is further explained in section 3.4).

The EIQ value for a particular active ingredient is calculated according to a formula that includes parameters such as toxicity (dermal, chronic, bird, bee, fish, beneficial arthropod), soil half-life, systemicity, leaching potential, and plant surface half-life (Table 1). Each of these parameters is given a score of 1, 3 or 5 to reflect its potential to cause harm. Six of these ratings are based on measured or known properties and five others on general judgments according to low, moderate or severe impact.

Table 1: The parameters and rating system used to calculate the EIQ value for specific active ingredients (Kovach et al., 1992)

Variables	Symbol	Score 1	Score 3	Score 5
Long-term health effects	C	Little-none	Possible	Definite
Dermal toxicity (Rat LD_{50})	DT	>2000 mg/kg	200-2000 mg/kg	0-200 mg/kg
Bird toxicity (8 day LC_{50})	D	>1000 ppm	100-1000 ppm	1-100 ppm
Bee toxicity	Z	Non-toxic	Moderately toxic	Highly toxic
Beneficial arthropod toxicity	B	Low impact	Moderate	Severe impact
Fish toxicity (96 hr LC_{50})	F	>10 ppm	1-10 ppm	<1 ppm
Plant surface half-live	P	1-2 weeks pre-emerg. herbic.	2-4 weeks post-emerg. herbic.	>4 weeks
Soil residue half-live (TI/2)	S	<30 days	30-100 days	>100 days
Mode of action	SY	Non-systemic; all herbicides	Systemic	
Leaching potential	L	Small	Medium	Large
Surface runoff potential	R	Small	Medium	Large

These eleven parameters are used to calculate eight environmental impact (EI) indicators by using algebraic equations that combine the numerical ratings with relative weights assigned to each of these effects: effect to applicators, harvester/pickers, consumers, ground water, fish, birds, honey bees and beneficial arthropods (Table 2). These scores are then further aggregated to express the environmental impact on the three main compartments: farm worker, consumer and environment. The final composite EIQ score is the average of the three scores. The maximum possible EIQ score for an active ingredient is 210, while the minimum is 6.7.

Table 2: EIQ Components and Formula

Components	Aggregate	Total
EI Applicator: C x (DT x 5) EI Picker: C x (DT x P)	**EI Farm Worker** = EI Sprayer + EI Picker	**EIQ** (EI Farm Worker + EI Consumer + EI Ecology) /3
EI Consumer: C x ((S + P)/2) x SY EI Ground Water: L	**EI Consumer** = EI Consumer + EI Ground Water	
EI Fish: F x R EI Bird: D x ((S + P)/2) x 3 EI Honey Bee: Z x P x 3 EI Natural Enemies: B x P x 5	**EI Ecology** = EI Fish + EI Bird + EI Honey Bee + EI Natural Enemies	

Full Formula:

EIQ={C[(DT*5)+(DT*P)]+[(C*((S+P)/2)*SY)+(L)]+[(F*R)+(D*((S+P)/2)*3)+(Z*P*3)+(B*P*5)]}/3

The relative weight of the 3 main components varies with the final EIQ score. Figure 1 shows the weight distribution for the maximum and minimum EIQ score. For the minimum score the weight distribution is 60% for EI Ecology, 30% for EI Farm Worker and 10% for EI Consumer. As expected from an environmental indicator, most weight is assigned to ecological impact. Within the EI Ecology component emphasis is on impact on natural enemies. The latter makes up about a quarter of the final EIQ value.

Fig. 1a: Relative EI Weights at maximum EIQ Score (210)

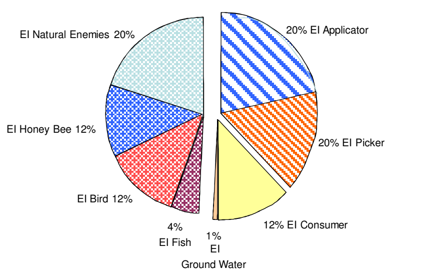
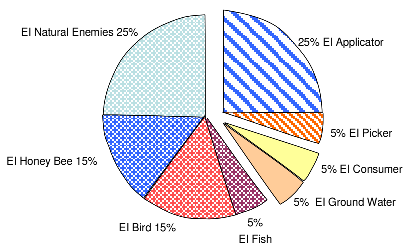


Fig. 1b: Relative EI Weights at minimum EIQ Score (6.7)



3.3 How to obtain EIQ values for different active ingredients?

Lists of EIQ values have been published and periodically updated by Cornell University. They can be downloaded in PDF or Excel formats (http://www.nysipm.cornell.edu/publications/eiq/). These lists contain the EI scores for the individual components along with the overall EIQ value. In 2009, there were data for 398 products listed.

In case a product is not on that list, then the missing EIQ value can be calculated by using the following steps:

1. Look up the technical information about the pesticide
2. Use Table 1 to determine the score for each variable
3. On the basis of these scores, calculate the EIQ as shown in Table 2

Technical information can be obtained from reference books (e.g. Pesticide Compendium) or from databases provided by various internet sites such as WHO, FAO, USEPA, EU, EcoToxNet or PAN (see Annex 1 for links and further information). Care should be taken when using information from less established internet sources.

Below are two examples for the calculation of EIQ values for pesticides that were not on the Cornell list (Tables 3 and 4).

Table 3 : EIQ Ratings for Monocrotophos (Product: Azodrin. Pesticide type: Insecticide)

Variables	Symbol	Score 1	Score 3	Score 5	Final Score
Chronic toxicity	C			X	5
Dermal toxicity	DT		X		3
Bird toxicity	D			X	5
Bee toxicity	Z			X	5
Beneficial arthropod toxicity	B			X	5
Fish toxicity	F		X		3
Plant surface half-live	P	X			1
Soil half-live	S	X			1
Systemicity	SY		X		3
Leaching potential	L		X		3
Surface runoff potential	R		X		3

EI Applicator: C x (DT x 5) = 75
EI Picker: C x (DT x P) = 15
} EI Farmer = 90

EI Consumer: C x ((S + P)/2) x SY = 15
EI Ground Water: L = 3
} EI Consumer =18

EI Fish: F x R = 9
EI Bird: D x ((S + P)/2) x 3 = 15
EI Honey Bee: Z x P x 3 = 15
EI Natural Enemies: B x P x 5 = 25
} EI Ecology = 64

EIQ = (90+18+64)/3 = 57.3

Table 4 : EIQ Ratings for Hexaconazole (Product: Anvil 5L. Pesticide type: Fungicide)

Variables	Symbol	Score 1	Score 3	Score 5	Final Score
Chronic toxicity	C			x	5
Dermal toxicity	DT	x			1
Bird toxicity	D	x			1
Bee toxicity	Z		x		3
Beneficial arthropod toxicity	B	x			1
Fish toxicity	F	x			1
Plant surface half-live	P		unknown		2
Soil half-live	S			x	5
Systemicity	SY		x		3
Leaching potential	L	x			1
Surface runoff potential	R		unknown		2

EIQ=40.0

The Cornell list contains pesticides registered for use in the US. Many developing countries still use older products that are no longer registered in the US and EU. For a number of these products the EIQ has been calculated by IPM projects in Asia. These data can be found in the EasyEIQ database (see 5.2).

The EIQ Model is based on concerns and impact on species relevant to Northern America. To modify the EIQ model for local or specialized applications, relevant research results such as toxicity on local species (e.g. fish, bees, natural enemies) could be used to change some of the scores and calculate more fitting EIQ values. However, in order to maintain comparability, this then would need to be done for all pesticides that are being compared, which may not be realistic if many pesticides are involved in the study.

3.4 How to calculate Field Use EIQ.

Since the EIQ value is a hazard indicator, additional calculations are required to obtain an indication of the pesticide risk. To account for exposure, a simple equation called the Field Use EIQ was developed. This rating is calculated by multiplying the EIQ value for a specific chemical by the percent active ingredient in the formulation and its dosage rate per hectare or acre used (usually in liter or kilogram or pints or pounds of formulated product).

Field Use EIQ = EIQ x % Active Ingredient x Dosage Rate

To calculate the Field Use EIQ, it is necessary to collect the required information from pesticide users. Sometimes this can be difficult when farmers cannot read labels, especially when they are written in a foreign language. In such cases, data collection requires that the enumerators are knowledgeable of the pesticides found in the area so that they can translate farmer's descriptions into usable information. A reference book with pictures of pesticide labels may facilitate the identification of the correct active ingredient and formulation of the products used. Despite these efforts, it is sometimes necessary to base the Field Use EIQ calculations on assumptions and include proxy values in the calculation.

The following data are needed to calculate the Field Use EIQ:

a. The EIQ value for the active ingredient

   To find the EIQ value, one needs to know the common name (active ingredient) of the product concerned.

   A pesticide's common name is normally listed on the product label. If not available, it must be researched in company information or in lists of pesticide products.

   If farmers mix different products ('cocktail') or apply commercially available mixtures, the EIQ must be calculated for each active ingredient separately unless an EIQ value for the commercial mixture has already been calculated and is known.

If unknown products have been used, or if the EIQ value cannot be found on a list, one may use a proxy value of 27.3 for the calculations; this figure assumes missing data for all parameters. However, this introduces a major inaccuracy and therefore it would be better to try to calculate the EIQ value as described above.

b. The percentage of active ingredient

Product labels usually give the % active ingredient(s) in the formulation, together with the % inert materials. In addition, a number in the product name sometimes indicates the percent of the active ingredient in the formulation, e.g. Azodrin 50 (=50%), Bent 600 (= 60%), Furadan 3G (=3%), U-T 70 (70%), Anco 720 (=72%). Mixtures may give the total of all active ingredients, e.g. Ridomil 72 (= 60% copper oxide and 12% mefenoxam). If a cocktail is used, all the percentages of all active ingredients in the mixture must be specified and calculated separately.

If the formulation of a product cannot be determined, one may be able to use its most common formulation as used in the country concerned since most active ingredients are formulated in typical concentrations. For unknown formulations, a 50% active ingredient may be assumed as a proxy value. However, this could introduce a considerable error, particularly for some of the newer products that are formulated in low concentrations.

c. The dosage rate

This information is collected from users in terms of total quantity of the formulated product (usually in ml or g, or number of packages) that was applied to a particular plot size or to the total area when several plots were treated at the same time. To express the dosage rate in kg/l per hectare, the actual quantity of product used is divided by the square meter of the treated area and multiplied by 10,000. For pesticide mixtures, the full dosage rate has to be used for each of the ingredients.

In case the amount used cannot be determined, one may assume the recommended dose on the label or from other sources. As a last resort, a dosage rate of 1 kg/l per hectare would be a reasonable estimate for most liquid applications and 50 kg/ha for granular products.

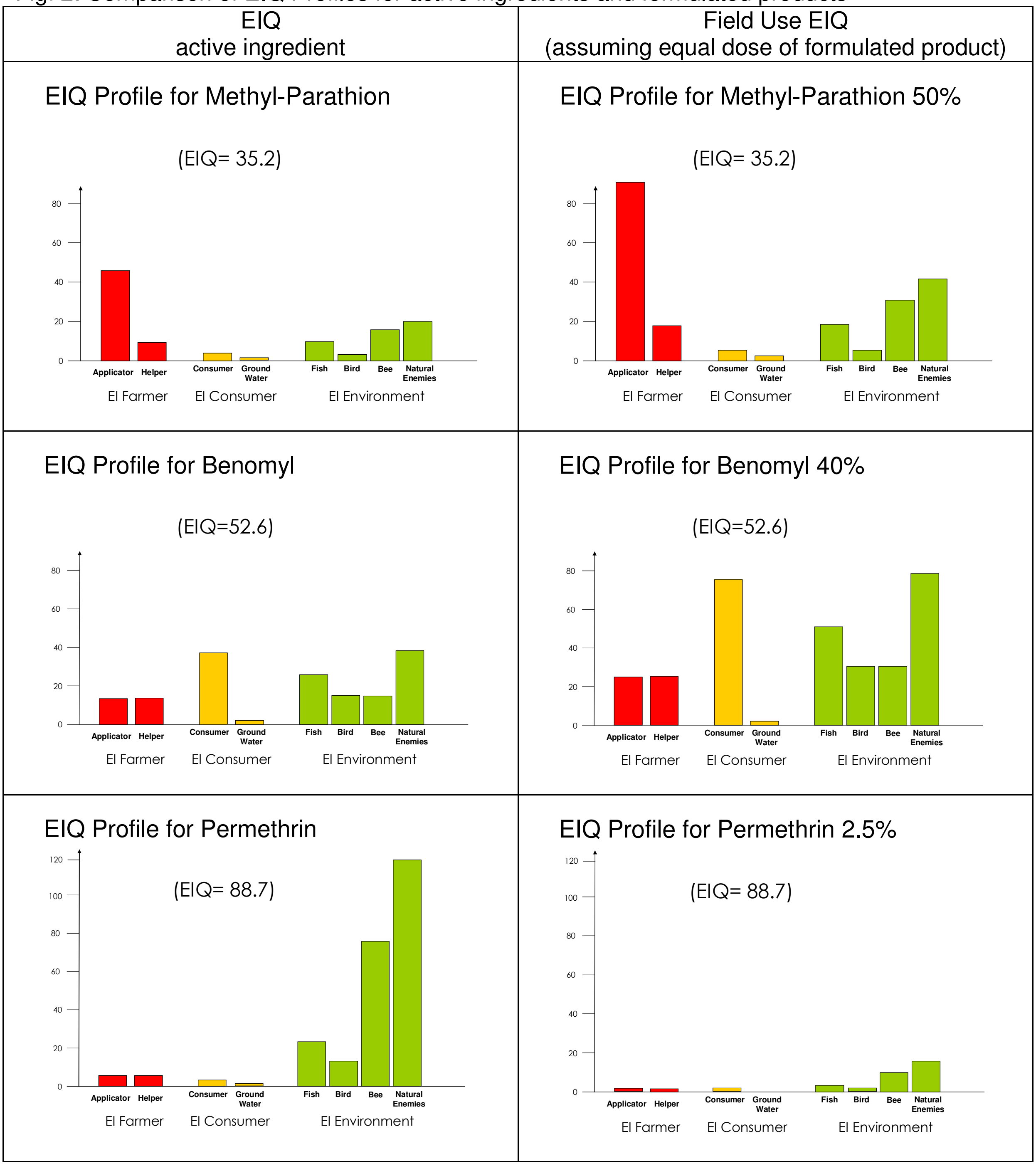
Different pest management regimes can be compared by adding up the Field Use EIQ values for all applications throughout the season or cropping cycle. The sum represents the total seasonal environmental impact (environmental load) of the particular strategy.

In order to calculate the Field Use EIQ for an entire season or cropping cycle, each application should be recorded separately. If the same product is used several times at the same dosage rate, its standard dosage rate may be multiplied by the number of sprays per season.

3.5 Using EIQ Components

Break down of EIQ Field Use into its components can provide an indication of relative differences in risk scores on individual EIQ components for different pesticides. In order to make such comparisons one would need to look at Field Use EIQ figures, as shown in Fig. 2 below. When comparing three active ingredients, methyl-parathion poses a relatively high risk to applicators, benomyl to consumers and permethrin to bees and natural enemies. However, among the formulated products, permethrin poses the least risk due to its low concentration, despite of its high EIQ rating. These comparisons emphasize the need to calculate the Field Use EIQ figures when assessing risk and not to rely on the EIQ values.

Fig. 2: Comparison of EIQ Profiles for active ingredients and formulated products



As indicated above, these profiles can only be used for comparison of relative differences in risk scores on specific components (Farmer, Consumer, Environment) for different formulated products. They can not be used to compare risks to different components for a single product, because the authors of the formula assigned different weights to different components to construct an indicator that serves a specific purpose. Such weight attribution is always arbitrary and based on assumptions. This does not matter when one combines several factors in one formula that is applied in the same manner for all products. It means, however, that one cannot dissect the formula into different components and then draw conclusions on differences in scores between components.

With good understanding of the above limitations, the comparison of EIQ field use profiles of different products or crop protection strategies may help identify specific risk areas that have scope for improvement. These could then be further analysed, which could lead to specific measures to further reduce specific risks.

As such, profiles may draw attention to important risk areas that can be overlooked by other risk assessments procedures that focus primarily on acute mammalian toxicity.

However, one would first need to "convert" EIQ scores for individual risk components into EIQ Field Use scores for these components. This could be done through a spreadsheet as mentioned in section 5.2.

4. LIMITATIONS OF THE EIQ

The EIQ is a useful indicator for impact assessment of IPM programmes because it not only measures reductions in the use of pesticides, but also improvements in the selection of pesticides. As such, the environmental and health benefits of IPM tend to come out stronger if these are expressed in reduction in Field Use EIQ, instead of reduction in number of pesticide applications or in the amount of active ingredient applied. It also enables impact assessment studies to say something about changes in environmental risks.

However, one should always be aware that EIQ is a rough indicator that has its limitations. This section lists a number of these limitations.

- The EIQ model was developed in the US and the manner in which the various components are expressed and weighed against each other reflects concerns about the risks in the US, which are not necessarily the same in developing countries.

- The EIQ is appreciated for its simplicity and ability to give useful though crude indications of pesticide risks. But for the sake of simplicity and user-friendliness, the model sacrifices accuracy and specificity. Consequently, there is a high risk of indicating potential harm where there is none (false positives) or indicating a product to be relatively harmless when it poses a serious risk (false negatives).

- Outcomes from risk indicator models cannot be linked to actual human and environmental effects in the field without further verification. The accuracy of EIQ in predicting actual effects on human health and the environment has not been validated.

- Since EIQ can only give rough indications, there is a danger of over-interpreting the ratings generated by the model. This limitation is compounded by the fact that about half the scores are based on incomplete datasets. The information most frequently missing is toxicity data for natural enemies, which is often not required for registration, but have the biggest weight in the EIQ formula. In a few cases, as many as five or more data requirements are missing. When the EIQ was recalculated with newer information, some values changed considerably, demonstrating the general inaccuracy and roughness of the model. In addition, the impact of pesticides on beneficial organisms other than arthropods is not reflected in the EIQ index.

- In order to use EIQ as a tool in impact assessment studies, EIQ values need to be available for all pesticides used in the area covered by the study, which is not always the case. The Cornell list only contains EIQ values for products registered in the US. Although the model does take into account the potential impact of high-volume low-toxicity products such as oil and soaps, it does not reflect these very accurately because of the absence of zero or near-zero values in the scoring system. As a result, the risks of such products get over-rated. This concerns several of the products that IPM Programmes may be promoting as alternatives to chemical pesticides.

- Risks caused by improper handling of pesticide, wrong application or non-observance of pre-harvest intervals are not captured by the EIQ. In practice, these are often areas where IPM programmes achieve significant improvements that constitute important contributions to overall pesticide risk reduction.

For a detailed analysis of technical limitations of the EIQ, reference is made to the "Review of the Use of EIQ in IPM Programmes in Asia" (www.vegetableipmasia.org/ImpactAssessment.htm)

5. USING EIQ AS A TOOL FOR IMPACT ASSESSMENT STUDIES

5.1 When to include EIQ in impact assessment studies

Before deciding to include EIQ as a parameter in an impact assessment study, one should carefully consider:

(i) the reasons and justification for such an inclusion,
(ii) the feasibility in terms of availability of data,
(iii) the extra work involved and the associated cost implications.

The usefulness of including EIQ in impact assessment may depend on the stage of an IPM programme and the extent to which pesticides are used as part of an ecology-based IPM set of 'best practices'. For example, in an intensive pesticide use situation, IPM may be able to reduce the number of applications initially from 15 to 5. In such cases, the reduction in quantity would appear to be an adequate success indicator and EIQ values would not add much. However, for a further reduction from 5 to 3 applications, the EIQ might be more descriptive if it can show a substantive improvement in the quality of pest control products used

The EIQ may be particularly useful when there are no changes in the quantity of pesticides, but when less harmful products are used. In addition, EIQ can show the compounded effect of fewer applications and better products, as it would be the case in most IPM programmes.

However, one should be aware that a constant figure for seasonal compounded EIQ could also reflect higher pesticide use with less toxic products, or lower pesticide use with higher toxic products. In such cases, further explanation of the particular circumstances would be needed.

While lower Field Use EIQ figures suggest benefits to the human health and the environment, it would be risky to use these figures as indications of positive effects on human health and the environment without further validation. Effects on human health can only be conclusively shown by a reduction of poisoning signs and symptoms among farm workers. Likewise, the Ecology component cannot substitute for actual field observations.

The ultimate impact of IPM on the environment needs to be documented separately. Case studies have shown significant increases in natural enemy populations and predator-pest ratios in IPM plots, as well as an increase in the total number of species, substantiating the positive impacts of IPM on the environment indicated by the pesticide reduction and lower Field Use EIQ values.

The relevance of different impact assessment parameters depends on the objective of the programme. Typical parameters are yields, profit, pesticide use reduction and reduced farmer poisoning. Adding Field Use EIQ estimates as an additional parameter could be particularly useful if the objective, and associated budget source, is related to environmental protection or general pesticide risk reduction.

Because the EIQ Value lumps together, and averages out, diverse aspects (occupational risks, food safety and environmental contamination) it will not be useful if one is interested in a specific concern (e.g. human health, residues on crops). In those cases it would be more appropriate to choose a single indicator directly relate to the primary concern.

5.2 How to include EIQ in impact assessment studies

5.2.1 Data collection

To assess the reduction on pesticide-related risks requires complete information on the amounts and types of pesticides used throughout a growing season. Obtaining a high quality of data requires good preparation and training of farmers on how to record the information on the same day as the products are applied. They would need to write down the name of the product, preferably with its active ingredients and percentages in the formulation, the total quantity of product used and the area treated. Extension staff or special enumerator would need to check the records regularly for completeness and consistency and make necessary corrections after consulting with farmers. Only reliable information should by used for further analysis.

Before collecting pesticide use data, the active ingredients of all trade names in circulation in the study area should be known. Picture books of pesticide packages have proven useful to identify the products used by farmers if they could not read the label or forgot to write down the details. In addition, the existence of EIQ values should be checked for all pesticides used in the area. Values missing on the Cornell list should be calculated as described under 3.4 or obtained from other investigators.

Practical tips for data collection

If the model is used for impact assessment, high quality of data should be ensured, which requires good preparation and training of facilitators to assist farmers in the recording of information.

- Before collecting pesticide use data, the active ingredients of all trade names should be known. Picture books with pesticide labels have proven useful to identify the products used by farmers.
- EIQ values should be available for all major pesticides used. Where missing, EIQ values should be calculated by using available pesticide data sheets, even with some information missing.
- Project staff needs to check data, and if necessary verify and correct these, before they are used for EIQ calculations.
- If one has to work with recall data, the recommended dose (as on the label) may be used as a proxy if field use data are incomplete.

When data were not recorded continuously by farmers but were collected through interviews at the end of the season (recall data), special care needs to be taken with information that is no longer correctly remembered. For example, the dosage rate of application should be checked against the recommended dose on the label to eliminate possible errors. Unknown active ingredients and formulations can be added if the pesticide labels can be verified. Only as a last resort, proxy values as described in section 3.4 should be used.

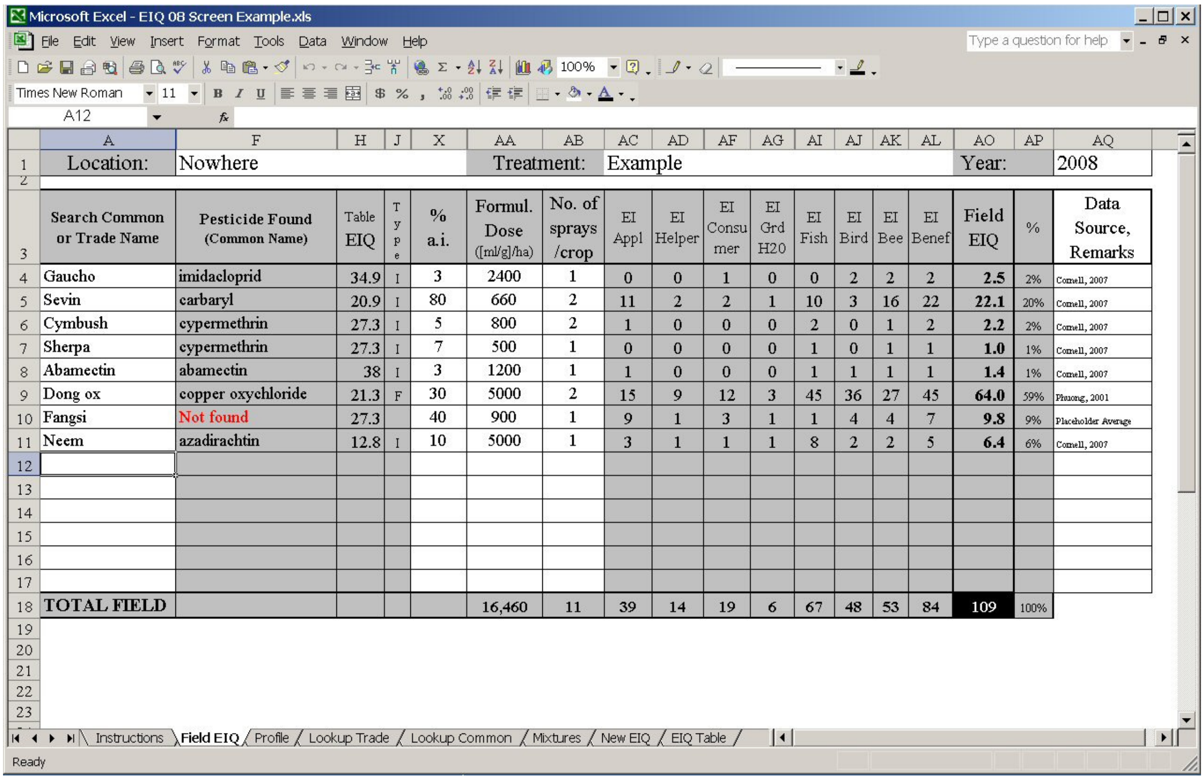
5.2.2 Data processing

Calculations of Field Use EIQs are generally done by professional staff, often using spreadsheets such as EIQEasy to minimize calculation errors.

<u>Use of EIQEasy spreadsheet calculations</u>

Computer applications can be used to facilitate the calculation of Field Use EIQs. The FAO-EU IPM Programme for Cotton in Asia developed an Excel based computer programme called EIQEasy (Fig. 3), which only requires users to enter the pesticide's trade or common name, its percentage of active ingredient, dosage rate and number of sprays. It then automatically looks up the EI values for the chemical from an electronic table and calculates the overall Field Use EIQ as well as the individual Field Use EI values for the eight EIQ components. The spreadsheet and more detailed instructions can be downloaded from the website of the Vegetable IPM Programme in Asia (http://www.vegetableipmasia.org/impactassessment1.html). As EasyEIQ was prepared for cotton in Asia, its underlying product data-base may be less complete for other crops in other continents. Before using EasyEIQ it would be necessary to check with the Cornell list whether any of the EIQ values have been updated and to adjust these accordingly, and to add missing products to the database in order to have the full range of products that are being used in the study area incorporated.

Fig. 3: Screen image of EIQEasy


Microsoft Excel - EIQ 08 Screen Example.xls

Location: Nowhere | Treatment: Example | Year: 2008

Search Common or Trade Name	Pesticide Found (Common Name)	Table EIQ	Type	% a.i.	Formul. Dose ([ml/g]/ha)	No. of sprays /crop	EI Appl	EI Helper	EI Consumer	EI Grd H20	EI Fish	EI Bird	EI Bee	EI Benef	Field EIQ	%	Data Source, Remarks
Gaucho	imidacloprid	34.9	I	3	2400	1	0	0	1	0	0	2	2	2	2.5	2%	Cornell, 2007
Sevin	carbaryl	20.9	I	80	660	2	11	2	2	1	10	3	16	22	22.1	20%	Cornell, 2007
Cymbush	cypermethrin	27.3	I	5	800	2	1	0	0	0	2	0	1	2	2.2	2%	Cornell, 2007
Sherpa	cypermethrin	27.3	I	7	500	1	0	0	0	0	1	0	1	1	1.0	1%	Cornell, 2007
Abamectin	abamectin	38	I	3	1200	1	1	0	0	0	1	1	1	1	1.4	1%	Cornell, 2007
Dong ox	copper oxychloride	21.3	F	30	5000	2	15	9	12	3	45	36	27	45	64.0	59%	Phuong, 2001
Fangsi	Not found	27.3		40	900	1	9	1	3	1	1	4	4	7	9.8	9%	Placeholder Average
Neem	azadirachtin	12.8	I	10	5000	1	3	1	1	1	8	2	2	5	6.4	6%	Cornell, 2007
TOTAL FIELD					16,460	11	39	14	19	6	67	48	53	84	109	100%	

(Screen print example from 2007. Note that most of the EIQ values have changed since then)

5.3 Interpretation and presentation of results

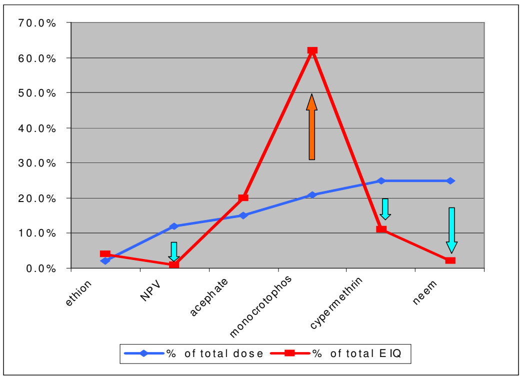
Analysis of EIQ data may provide the following information:

- Achievements or trends in pesticide risk reduction
- Comparison of risks associated with different pest management strategies
- Distribution of risk among different regions or different crops

Comparison of the 'percent of dosage' and 'percent of Field Use EIQ' values for all pesticides used in an application scheme can help identify those individual products that contribute disproportional to the total environmental load. This may help in setting priorities for improvements in pest management strategies.

Fig. 9: EIQ Product Profile
India, average of 37 post-FFS farmer samples

ranked by % formulated dose



In India (Fig. 9) monochrotophos use amounted to 21% of the total pesticide dose, but made up 62% of the total Field Use EIQ. Neem and NPV products, on the other hand, were 37% of the total quantity, but contributed only 3% to the environmental risk.

<u>Feeding back to farmer groups</u>

If EIQ data are used in impact assessment, then it might also be useful to present the results in FFS group discussion at the end of the season to determine to what extent EIQ scores correspond with actual observations from the field. As part of end of season evaluations, EIQ tables may also be useful to help find explanations for specific events. For instance, if during the season there was a sudden dying of fish, it might be useful to review the pesticides used for their score on fish toxicity.

When the Field Use EIQ is calculated repeatedly for a group of farmers, the results may be useful to show trends over time regarding the combined effect of pesticide use reduction and improvement in the quality of pesticide selection.

Farmer groups may also be interested to know how their performance is rated in relation to other groups. Plotting the Field Use EIQ values for a large number of farmers will generate a distribution curve between the minimum and maximum EIQ values found. This curve can be used to show farmers how they are doing compared to others.

Informing policy-makers

The ultimate responsibility for reducing pesticide risks to farmers, consumers and the environment lies with regulators and policy-makers. To improve the effectiveness of their efforts, they require credible information about the distribution and trends of these risks. Furthermore they need to get feedback on the effectiveness of different pesticide risk reduction efforts in order to determine how to allocated scarce resources most effectively.

Presenting data in terms of trends or distributions may also be useful for policy makers. They may demonstrate the value of IPM as an approach to reduce risks for farm workers, consumers or the environment. They may be also be useful as an early warning when Field Use EIQ values are rising. Even though Field Use EIQ data are not indicators of actual risks, they could be used to stimulate discussions about improving risk management.

EIQ could also play a role in analysis of distribution or trends of pesticide risks in different regions, production systems or among farming populations. Such information may help prioritize efforts to mitigate unnecessary pesticide risks.

Caution

Plant Protection specialists involved in preparing such reporting would need to have a full understanding of EIQ and its limitations. If EIQ is being used in reporting to policy-makers about trends in pesticide risks, or impact of IPM programmes, then it may be important to provide a brief explanation of what EIQ is and how the figures should be interpreted. For instance, one may want to indicate to what extent changes in Field Use EIQ have been verified by actual observations. If such verification is missing, one may want to point out that "The EIQ is an index that generalizes possible pesticide risks based on toxicological data and chemical properties; it does not represent actual risks measured in the field".

6 Concluding remarks regarding the use of EIQ in assessment studies

- Field Use EIQ may be used at the end of a season or in rigorous, multi-year impact assessment studies to assess achievements of farmer groups on programme/policy level;
- Field Use EIQ is useful as retrospective assessment tool if no specific studies on health or environmental impact have been done;
- Field Use EIQ is particularly useful to show the combined effect of pesticide use reduction and improvements in pesticide selection. The latter are not reflected in general pesticide use indicators;
- However, it is important to recognize that EIQ is an index that reflects a generalized potential risk and it is not a direct measure of impact. Changes in EIQ can not be linked to actual impacts without validation through case studies in the field;
- Based on project objectives, other impact indicators should be considered to complement EIQ, e.g. WHO pesticide hazard classes, poisoning signs and symptoms, etc.;
- Impact assessment requires solid farm records about pesticide use, preferably recorded continuously during the season and not collected as recall information at the end;
- EIQ in principle can be applied to every participant in a study; it can therefore show frequency distributions of potential impacts for very large number of farmers. As such it lends itself for rigorous statistical analysis, e.g., through the double delta approach.

Annex: 1 Links to Internet Resources

EIQ

Cornell EIQ website
http://www.nysipm.cornell.edu/publications/eiq/

Cornell EIQ list
http://www.nysipm.cornell.edu/publications/eiq/files/EIQ_values_09.pdf

FAO Review of the use of EIQ in IPM programmes in Asia
http://www.vegetableipmasia.org/ImpactAssessment.htm

Planteforsk EIQ website
http://fou02.planteforsk.no/eiq_english/

General Search Sites

USEPA: Models and Databases (starting point):
http://www.epa.gov/pesticides/science/models_db.htm#databases

Material Safety Data Sheets on the Internet:
http://www.ilpi.com/msds/index.html

Compendium of Pesticide Common Names
http://www.alanwood.net/pesticides/

National Pesticide Information Retrieval System : NPIRS Public
http://ppis.ceris.purdue.edu/npublic.htm

Pesticide Fact Sheets

International Programme on Chemical Safety
http://www.intox.org/databank/index.htm

WHO Classification of Pesticides by Hazard
http://www.inchem.org/documents/pds/pdsother/class.pdf

The EXtension TOXicology NETwork
http://extoxnet.orst.edu/

USEPA Pesticide Programme
http://www.epa.gov/pesticides/

USEPA Integrated Risk Information System
http://www.epa.gov/iris/

Pesticide Reregistration Status EU
http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=activesubstance.selection

PAN Pesticides Database
http://www.pesticideinfo.org/Index.html

Scorecard. Pollution Information Site of the Environmental Defense Fund :
http://www.scorecard.org/chemical-profiles/

Northwest Coalition for Alternatives to Pesticides:
http://www.pesticide.org/factsheets.html

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