Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

24-Mar-2014

English - Or. English

ENVIRONMENT DIRECTORATE
JOINT MEETING OF THE CHEMICALS COMMITTEE AND THE WORKING PARTY ON CHEMICALS, PESTICIDES AND BIOTECHNOLOGY

REPORT OF THE OECD SEMINAR ON INDICATORS FOR INTEGRATED PEST MANAGEMENT

Series on Pesticides
No. 75

JT03354880

ENV/JM/MONO(2014)7
Unclassified

English - Or. English

OECD Environment, Health and Safety Publications
Series on Pesticides
No. 75

REPORT OF THE OECD SEMINAR ON INDICATORS FOR INTEGRATED PEST MANAGEMENT

IOMC
INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS
A cooperative agreement among FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD

Environment Directorate
ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT
Paris 2014

Also published in the Series on Pesticides

No. 1 *Data Requirements for Pesticide Registration in OECD Member Countries: Survey Results* (1993)

No. 2 *Final Report on the OECD Pilot Project to Compare Pesticide Data Reviews* (1995)

No. 3 *Data Requirements for Biological Pesticides* (1996)

No. 4 *Activities to Reduce Pesticide Risks in OECD and Selected FAO Countries. Part I: Summary Report* (1996)

No. 5 *Activities to Reduce Pesticide Risks in OECD and Selected FAO Countries. Part II: Survey Responses* (1996)

No. 6 *OECD Governments' Approaches to the Protection of Proprietary Rights and Confidential Business Information in Pesticide Registration* (1998)

No. 7 *OECD Survey on the Collection and Use of Agricultural Pesticide Sales Data: Survey Results* (1999) [see also No.47]

No. 8 *Report of the OECD/FAO Workshop on Integrated Pest Management and Pesticide Risk Reduction* (1999)

No. 9 *Report of the Survey of OECD Member Countries' Approaches to the Regulation of Biocides* (1999)

No. 10 *Guidance Notes for Analysis and Evaluation of Repeat-Dose Toxicity Studies* (2000)

No. 11 *Survey of Best Practices in the Regulation of Pesticides in Twelve OECD Countries* (2001)

No. 12 *Guidance for Registration Requirements for Pheromones and Other Semiochemicals Used for Arthropod Pest Control* (2001)

No. 13 *Report of the OECD Workshop on Sharing the Work of Agricultural Pesticide Reviews* (2002)

No. 14 *Guidance Notes for Analysis and Evaluation of Chronic Toxicity and Carcinogenicity Studies* (2002)

No. 15 *Persistent, Bioaccumulative and Toxic Pesticides in OECD Member Countries,* (2002)

No. 16 *OECD Guidance for Industry Data Submissions for Pheromones and Other Semiochemicals and their Active Substances (Dossier Guidance for Pheromones and other Semiochemicals)* (2003)

No. 17 *OECD Guidance for Country Data Review Reports for Pheromones and Other Semiochemicals and their Active Substances (Monograph Guidance for Pheromones and other Semiochemicals)* (2003)

No. 18 *Guidance for Registration Requirements for Microbial Pesticides* (2003)

No. 19 *Registration and Work sharing, Report of the OECD/FAO Zoning Project* (2003)

No. 20 *OECD Workshop on Electronic Tools for data submission, evaluation and exchange for the Regulation of new and existing industrial chemicals, agricultural pesticides and biocides* (2003)

No. 21 *Guidance for Regulation of Invertebrates as Biological Control Agents (IBCAs)* (2004)

No. 22 *OECD Guidance for Country Data Review Reports on Microbial Pest Control Products and their Microbial Pest Control Agents (Monograph Guidance for Microbials)* (2004)

No. 23 *OECD Guidance for Industry Data Submissions for Microbial Pest Control Product and their Microbial Pest Control Agents (Dossier Guidance for Microbials)* (2004)

No. 24 *Report of the OECD Pesticide Risk Reduction Steering Group Seminar on Compliance* (2004)

No. 25 *The Assessment of Persistency and Bioaccumulation in the Pesticide Registration Frameworks within the OECD Region* (2005)

No. 26 *Report of the OECD Pesticide Risk Reduction Group Seminar on Minor Uses and Pesticide Risk Reduction* (2005)

No. 27 *Summary Report of the OECD Project on Pesticide Terrestrial Risk Indicators (TERI)* (2005)

No. 28 *Report of the OECD Pesticide Risk Reduction Steering Group Seminar on Pesticide Risk Reduction through Good Container Management* (2005)

No. 29 *Report of the OECD Pesticide Risk Reduction Steering Group Seminar on Risk Reduction through Good Pesticide Labelling* (2006)

No. 30 *Report of the OECD Pesticide Risk Reduction Steering Group: The Second Risk Reduction Survey* (2006)

No. 31 *Guidance Document on the Definition of Residue* [also published in the series on Testing and Assessment, No. 63] (2006, revised 2009)

No. 32 *Guidance Document on Overview of Residue Chemistry Studies* [also published in the series on Testing and Assessment, No. 64] (2006, revised 2009)

No. 33 *Overview of Country and Regional Review Procedures for Agricultural Pesticides and Relevant Documents* (2006)

No. 34 *Frequently Asked Questions about Work Sharing on Pesticide Registration Reviews* (2007)

No. 35 *Report of the OECD Pesticide Risk Reduction Steering Group Seminar on "Pesticide Risk Reduction through Better Application Technology"* (2007)

No. 36 *Analysis and Assessment of Current Protocols to Develop Harmonised Test Methods and Relevant Performance Standards for the Efficacy Testing of Treated Articles/Treated Materials* (2007)

No. 37 *Report on the OECD Pesticide Risk Reduction Steering Group Workshop "Pesticide User Compliance'* (2007)

No. 38 *Survey of the Pesticide Risk Reduction Steering Group on Minor Uses of Pesticides* (2007)

No. 39 *Guidance Document on Pesticide Residue Analytical Methods* [also published in the series on Testing and Assessment, No. 72] (2007)

No. 40 *Report of the Joint OECD Pesticide Risk Reduction Steering Group ECHAIR Seminar on Harmonised Environmental Indicators for Pesticide Risk* (2007)

No. 41 *The Business Case for the Joint Evaluation of Dossiers (Data Submissions) using Work-sharing Arrangements* (2008)

No. 42 *Report of the OECD Pesticide Risk Reduction Steering Group Seminar on Risk Reduction through Better Worker Safety and Training* (2008)

No. 43 *Working Document on the Evaluation of Microbials for Pest Control* (2008)

.... *Guidance Document on Magnitude of Pesticide Residues in Processed Commodities - only published in the Series on Testing and Assessment*, No. 96 (2008)

No. 44 *Report of Workshop on the Regulation of BioPesticides: Registration and Communication Issues* (2009)

No. 45 *Report of the Seminar on Pesticide Risk Reduction through Education / Training the Trainers* (2009)

No. 46 *Report of the Seminar on Pesticide Risk Reduction through Spray Drift Reduction Strategies as part of National Risk Management* (2009)

No. 47 *OECD Survey on Countries' Approaches to the Collection and Use of Agricultural Pesticide Sales and Usage Data: Survey Results* (2009)

No. 48 *OECD Strategic Approach in Pesticide Risk Reduction* (2009)

No. 49 *OECD Guidance Document on Defining Minor Uses of Pesticides* (2009)

No. 50 *Report of the OECD Seminar on Pesticide Risk Reduction through Better National Risk Management Strategies for Aerial Application* (2010)

No. 51 *OECD Survey on Pesticide Maximum Residue Limit (MRL) Policies: Survey Results* (2010)

No. 52 *OECD Survey of Pollinator Testing, Research, Mitigation and Information Management: Survey Results* (2010)

No. 53 *Report of the 1st OECD BioPesticides Steering Group Seminar on Identity and Characterisation of Micro-organisms* (2010)

No. 54 *OECD Survey on Education, Training and Certification of Agricultural Pesticide Users, Trainers and Advisors, and Other Pesticide Communicators: Survey Results* (2010)

No. 55 *OECD Survey on How Pesticide Ingredients Other than the Stated Pesticide Active Ingredient(s) are Reviewed and Regulated: Survey Results* (2010)

No. 56 *OECD MRL Calculator User Guide* (2011)

No. 57 *OECD MRL Calculator MRL Statistical White Paper* (2011)

No. 58 *Report of the OECD Seminar on Pesticide Risk Reduction Strategies Near/in Residential Areas* (2011)

No. 59 *Report of the OECD Seminar on Risk Reduction through Prevention, Detection and Control of the Illegal International Trade in Agricultural Pesticides* (2011)

No. 60 *Guidance Document on the Planning and Implementation of Joint Reviews of Pesticides* (2011)

No. 61 *OECD Survey on Efficacy & Crop Safety Data Requirements & Guidelines for the Registration of Pesticide Minor Uses: Survey Results* (2011)

No. 62 *OECD Survey on Regulatory Incentives for the Registration of Pesticide Minor Uses: Survey Results* (2011)

No. 63 *Guidance Document on Regulatory Incentives for the Registration of Pesticide Minor Uses* (2011)

... Guidance Notes on Dermal Absorption - only published in the Series on Testing and Assessment, No. 156 (2011)

No. 64 *Report of the Second OECD BioPesticides Steering Group Seminar on the Fate in the Environment of Microbial Control Agents and their Effects on Non-Target Organisms* (2011)

No. 65 *OECD Issue Paper on Microbial Contaminant Limits for Microbial Pest Control Products* (2011)

No. 66 *Guidance Document on Crop Field Trials* [also published in the Series on Testing and Assessment, No. 164] (2011)

No. 67 *OECD Guidance to the Environmental Safety Evaluation of Microbial Biocontrol Agents* (2012)

No. 68 *Report of the OECD Workshop on the Development of Harmonized International Guidance for Pesticide Terrestrial Field Dissipation Studies and Crosswalk of North American & European Eco-Regions* (2012)

No. 69 *OECD Survey on Integrity of Pesticides at the Manufacturing, Import and Distribution Stages: Survey Results* (2012)

No. 70 *Report of the OECD Workshop on Integrated Pest Management (IPM) Strategies for the adoption and implementation of IPM in Agriculture Contributing to the sustainable use of Pesticides and to Pesticide Risk Reduction* (2012)

No. 71 *OECD Guidance on Pesticide Compliance and Enforcement Best Practices* (2012)

No. 72 *Report of the Third OECD Biopesticides Steering Group Seminar on Characterisation and Analyses of Botanicals for the Use in Plant Protection Products* (2012)

No. 73 *Guidance on Residues in Livestock* (2013)

No. 74 *Report of the 4th OECD Biopesticides Steering Group seminar on trichoderma spp. for use in plant protection products: similarities and differences* (2013)

Published separately

OECD Guidance for Country Data Review Reports on Plant Protection Products and their Active Substances-Monograph Guidance (1998, revised 2001, 2005, 2006)

OECD Guidance for Industry Data Submissions on Plant Protection Products and their Active Substances-Dossier Guidance (1998, revised 2001, 2005)

Report of the Pesticide Aquatic Risk Indicators Expert Group (2000)

Report of the OECD Workshop on the Economics of Pesticide Risk Reduction (2001)

Report of the OECD-FAO-UNEP Workshop on Obsolete Pesticides (2000)

Report of the OECD Pesticide Aquatic Risk Indicators Expert Group (2000)

Report of the 2nd OECD Workshop on Pesticide Risk Indicators (1999)

Guidelines for the Collection of Pesticide Usage Statistics Within Agriculture and Horticulture (1999)

Report of the [1st] OECD Workshop on Pesticide Risk Indicators (1997)

Report of the OECD/FAO Workshop on Pesticide Risk Reduction (1995)

Report of the OECD/FAO Workshop on Pesticide Risk Reduction (1995)

About the OECD

The Organisation for Economic Co-operation and Development (OECD) is an intergovernmental organisation in which representatives of 33 industrialised countries in North and South America, Europe and the Asia and Pacific region, as well as the European Commission, meet to co-ordinate and harmonise policies, discuss issues of mutual concern, and work together to respond to international problems. Most of the OECD's work is carried out by more than 200 specialised committees and working groups composed of member country delegates. Observers from several countries with special status at the OECD, and from interested international organisations, attend many of the OECD's workshops and other meetings. Committees and working groups are served by the OECD Secretariat, located in Paris, France, which is organised into directorates and divisions.

The Environment, Health and Safety Division publishes free-of-charge documents in ten different series: **Testing and Assessment**; **Good Laboratory Practice and Compliance Monitoring**; **Pesticides and Biocides**; **Risk Management**; **Harmonisation of Regulatory Oversight in Biotechnology**; **Safety of Novel Foods and Feeds; Chemical Accidents; Pollutant Release and Transfer Registers; Emission Scenario Documents;** and **Safety of Manufactured Nanomaterials.** More information about the Environment, Health and Safety Programme and EHS publications is available on the OECD's World Wide Web site (www.oecd.org/chemicalsafety/).

This publication was developed in the IOMC context. The contents do not necessarily reflect the views or stated policies of individual IOMC Participating Organizations.

The Inter-Organisation Programme for the Sound Management of Chemicals (IOMC) was established in 1995 following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemical safety. The Participating Organisations are FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organisations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

FOREWORD

This document is the report of the 13th OECD Risk Reduction Steering Group (RRSG) seminar *"Indicators for Integrated Pest Management"*, organised by the OECD RRSG and co-hosted by the Ministry for Primary Industries (MPI) and the Environment Protection Authority (EPA) of New Zealand, which was held on 27 November, 2012 in Queenstown, New Zealand.

The RRSG, a sub-group of the OECD Working Group on Pesticides (WGP), is composed primarily of representatives of the 34 OECD governments and includes representatives of the European Commission, other international organisations, the (bio-)pesticide industry, and the environmental & consumer protection community. RRSG Seminars focus on key issues in pesticide risk reduction. The Seminars are intended to provide an opportunity for OECD governments to discuss these issues together with non-governmental stakeholders and to develop recommendations for further OECD activities.

The seminar was partly organised as an immediate follow–up activity to an OECD workshop[1] on Integrated Pest Management, held in October 2011, in Berlin, Germany. The seminar concluded that IPM indicators could be important at different levels and for different stakeholders, depending on how they are designed and what they aim to achieve. For example, indicators measuring IPM *uptake*, through different possible direct or indirect measurements, could show actual levels of IPM adoption and implementation. On the other hand, indicators measuring the *impact* of IPM could help demonstrate the benefits of IPM, whether to farmers, society, or governments (i.e. inside governments, when communicating to policy decision-makers, or outside governments when communicating to stakeholders and the general public).

All Seminar speakers' presentations (Annex 7) are available separately, and can be found on the OECD website in the same location as this report.

This document is published under the responsibility of the Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology which agreed to its declassification on 24 January 2014.

[1] The Report of the OECD Workshop on "Integrated Pest Management (IPM) Strategies for the Adoption and Implementation of IPM in Agriculture Contributing to the Sustainable Use of Pesticides and to Pesticide Risk Reduction" (held in Berlin, Germany, 16-19 October 2011) is published as: OECD 2012, Series on Pesticides No. 70, Environment, Health and Safety, Environment Directorate - ENV/JM/PEST(2012)32 http://www.oecd.org/officialdocuments/displaydocumentpdf/?cote=ENV/JM/MONO(2012)32&doclanguage=en

TABLE OF CONTENTS

INTRODUCTION

This report presents the results and recommendations of the *OECD Seminar on Indicators for Integrated Pest Management*. This one-day Seminar, held on 27 November 2012 in Queenstown, New Zealand, was chaired by Wolfgang Zornbach (Germany), Chairman of the OECD Pesticide Risk Reduction Steering Group (RRSG).

The Ministry for Primary Industries (MPI) and the Environment Protection Authority (EPA) of New Zealand co-hosted this Seminar and organized a field trip that took place the previous day in the Central Otago area. The field trip was focused on IPM-related production systems and comprised visits to several orchards and vineyards. The field trip proved very helpful in the context of the RRSG work, and in particular for the new set of OECD activities on IPM, including indicators and measurements.

This Seminar was the 13th in a series of Seminars organised by the RRSG, a sub-group of the OECD Working Group on Pesticides (WGP), composed primarily of representatives of the 34 OECD governments and including representatives of the European Commission, other international organisations, the (bio-)pesticide industry, and the environmental & consumer community. RRSG Seminars focus on key issues in pesticide risk reduction of concern to OECD countries and associated parties. The Seminars are intended to provide an opportunity for OECD governments to discuss these issues together with non-governmental stakeholders and to develop recommendations for further OECD activities. The OECD Pesticides Programme has made great accomplishments toward helping national governments coordinate the efficiency and effectiveness of pesticide risk reduction, in part because of Seminars such as the one held in Queenstown. Past OECD Risk Reduction Seminars are listed in Annex 1.

Members of the RRSG selected the topic of IPM indicators for the Seminar since many countries and stakeholders have for long indicated a strong interest in the topic, and have mentioned that there was currently a gap to fill in this area. In addition, this was as an immediate follow–up activity to the OECD workshop[2] on IPM, held in October 2011, in Berlin, Germany. During that workshop, participants discussed the topic of "measurement and impact of IPM adoption and implementation", reached conclusions (cf. Annex 2) and developed recommendations for further work by governments and OECD (cf. Annex 3) that clearly indicated the need for developing IPM indicators.

IPM indicators could be important at different levels and for different stakeholders, depending on how they are designed and what they aim to achieve. For example, indicators measuring IPM *uptake*, through different possible direct or indirect measurements, could show actual levels of IPM adoption and implementation. On the other hand, indicators measuring the *impact* of IPM could help demonstrate the benefits of IPM, whether to the farmers, the society, or governments (i.e. inside governments, when communicating to policy decision-makers, or outside governments when communicating to stakeholders and the general public). Of course, the type and design of indicators may vary according to the target audience. Finally, developing IPM indicators and using them for communication could play a role in fostering IPM uptake.

[2] The Report of the OECD Workshop on "Integrated Pest Management (IPM) Strategies for the Adoption and Implementation of IPM in Agriculture Contributing to the Sustainable Use of Pesticides and to Pesticide Risk Reduction" (held in Berlin, Germany, 16-19 October 2011) is published as: OECD 2012, Series on Pesticides No. 70, Environment, Health and Safety, Environment Directorate - ENV/JM/PEST(2012)32 http://www.oecd.org/officialdocuments/displaydocumentpdf/?cote=ENV/JM/MONO(2012)32&doclanguage=en

PARTICIPANTS

Attendees of the Seminar included representatives from:

- pesticide regulatory authorities of OECD countries
- pesticide and biocontrol industry
- growers' associations
- consumer and environmental non-governmental organisations, and
- other organisations with expertise in IPM.

A participant list is provided in Annex 4.

SCOPE OF THE SEMINAR

For the purpose of this Seminar, "IPM indicators" referred to both:

- **Uptake indicators** measuring IPM adoption and implementation by farmers, and
- **Impact / Performance indicators** measuring the impacts of IPM adoption and implementation on the different stakeholders involved, on the environment and eventually on pesticide risk reduction. Their purpose is to demonstrate how and whether IPM is making a difference.

In particular, the following issues were considered during the Seminar:

- current practices to measure IPM adoption and implementation in various countries/regions of the world
- existing initiatives that help determine the effects of IPM adoption/implementation (with views towards developing impact/performance indicators)
- important features of indicators for uptake and impact
- current and possible tools to measure risk (reduction) as they relate to IPM.

PURPOSE OF THE SEMINAR

As for previous Seminars, the objective of this one-day event was primarily to exchange information on a specific topic of interest to most OECD countries and other stakeholders, through presentations from countries, organisations, NGOs and industry followed by discussions and recommendations.

Within the topic of IPM indicators, the main objectives of this Seminar were to:

- Get a better overview of national/regional indicators and other related initiatives to measure IPM adoption and implementation and resulting impacts
- Identify challenges and solutions regarding IPM indicators
- Discuss and make recommendations on the appropriate roles of the OECD, member governments, and stakeholders in the development and implementation of IPM indicators
- Suggest future possible projects on IPM indicators that could ultimately help to demonstrate risk reduction and efficiencies gained as a result of the use of IPM techniques.
- Identify what indicators (or guidance/principles on indicators) would be needed for OECD to develop
- Suggest options for further steps and priorities for:
  - OECD governments and key stakeholders
  - Future OECD work on IPM indicators

STRUCTURE OF THE SEMINAR

The first part of the Seminar in the morning and early afternoon was devoted to informative presentations from governments and other stakeholders active in IPM. The second part of the afternoon consisted of a roundtable discussion that built on issues that arose from the presentations, and development of recommendations for the OECD. The Seminar Programme is provided in Annex 5.

PRESENTATIONS

As an introduction, the OECD Secretariat provided an overview of existing IPM indicators and introduced a background document entitled “IPM Indicators: where are we?” (in Annex 6). That document compiles and describes both uptake and impact indicators from previous OECD work, academic publications, official documents, and governmental sources.

Following the introduction, speakers from government agencies in Australia, Germany and New Zealand, from industry (representing both the chemical pesticide and biopesticide manufacturers), from a Canadian growers’ association and from national/international organisations with knowledge and expertise in IPM shared their experiences and initiatives with measuring IPM adoption, implementation and impacts. Most presentations included past, existing and new/proposed IPM measurement strategies as well as speakers’ own experience with, and suggestions for, indicators.

Listed below are the main topics covered in the presentations. More detailed and illustrative information can be found in the presentations listed in Annex 7.

Uptake indicators

A number of speakers referred to farm surveys, interviews and (self-)audits as the most common *direct* approaches to assess IPM uptake by farmers. These surveys generally consist of a series of questions or checklists that are based on IPM guidelines, standards or protocols. Because IPM guidelines are designed for specific crops, commodities, or sectors (e.g. arable crops) and for specific locations (i.e. taking into account the climatic conditions of a given region or country), more than one survey and measurement exist. The following areas can be covered in farm/farmer surveys (the list is given as an example):

- Scouting, monitoring, and record-keeping practices.
- Cultural control measures
- Pest (insect, weed and disease) management and control practices
- Use of biological controls
- Pesticide usage (and treatment thresholds), including application practices
- Communication, training, information exchange.

Once the responses to the surveys are collected, they are generally processed and, given a certain number of points, weighted according to the importance of the areas as far as IPM is concerned. The outcome (whether it is a single score or a more visual tool) then reflects the level of IPM implementation. It was noted that the outcome could also be used for other related purposes such as identifying practices that suffer low adoption and areas that need improvement, and developing relevant incentives to address barriers.

For more detail, please refer to the following presentations:

- #2 on checklists and scoring system (Germany)
- #4 on farm interviews and uptake matrix (CropLife International)
- #5 on grower surveys (US IPM Institute)
- #9 on a self-assessment tool named Sesame (IOBC).

Finally, other *indirect* ways of measuring IPM adoption and implementation also exist. Some of these indicators were outlined in presentation #7 on potential IPM indicators by Australia. For example, such indirect indicators could include:

- Amount of R&D being conducted on IPM
- Amount of public spending on IPM
- Existence of IPM guidelines
- Number of enquiries about IPM on websites
- Number of staff being trained on IPM (nationally/regionally).

It should however be noted that such kind of information mainly serves the purpose to assess whether the conditions for IPM implementation are in place or not, and does not provide any evidence about IPM practiced by farmers/growers.

Impact indicators

Seminar presentations illustrated the diversity of IPM impacts that one can envisage. However, they can be broadly grouped into the following categories:

- Environmental impacts
- Health impacts
- Economic impacts
- Social impacts

It is interesting to note that all these impacts can be considered at varying levels, from the farm to the local, regional, or national level. For example, at the farm level, the impacts would include direct impacts on operator/worker health as well as impacts on yield and farm income, whereas at a more general level, the impacts could cover those on environmental quality, e.g. water quality and impacts on public health (e.g. relating to pesticide residues in food). These impacts can be considered for different time frames, such as in the short-, medium- or long-term as well as for scenario building by modelling approaches.

As IPM programmes will contribute to risk reduction and may lead to a reduction in pesticide use and elimination of unnecessary products, the direct impacts of IPM implementation can therefore be translated into a reduction of pesticide use. Further measurement and evaluation, for example using pesticide risk assessment models, could then indicate whether IPM implies a reduction of ecotoxicological and human health risks in a given situation. In addition, some more sophisticated indexes/equations, that were mentioned during the Seminar such as the Environmental Impact Quotient (EIQ), the Environmental Hazard Index (EHI), HAIR indicators or SYNOPS that all combine several effects on health, environment, etc., can also be used to assess the impacts of IPM.

For more detail, please refer to the following presentations:

- #5 on logic models for environmental, health and economic impacts (US IPM Institute)
- #8 on experiences with indices (Canadian Growers' association)
- #10 on the possible use of a pesticide risk indicator for evaluating IPM impacts on the environment (Germany).

Attributes and characteristics of IPM Indicators

In some presentations, speakers presented possible criteria for IPM indicators. Below are some of the suggestions:

- simple (for understanding and observing trends)
- comparable (although not all measures need to be compared directly)
- communicable
- multi factorial
- integrating various levels of measurement
- low cost
- valuable to all stakeholders (and tailored to the interested stakeholders)
- linked to a goal(s)
- linked to a clear definition of IPM practices (or elements of IPM)
- usable in OECD and non-OECD countries
- developed in co-ordination with concerned stakeholders
- using existing information and data where feasible

In addition, it was mentioned that indicators could be:

- descriptive; historical or model-based systems
- direct and indirect measures

For more detail, please refer to the following presentations:

- #6 on the biocontrol industry's views on IPM indicators (IBMA)
- #7 on potential IPM indicators (Australia).

SEMINAR DISCUSSIONS

Following the presentations that addressed issues and challenges associated with IPM indicators, as reported in the above section, the floor was opened to all Seminar participants for a roundtable discussion.

As an introduction, the Chair first invited participants to discuss the purpose of collecting data and developing indicators. It was acknowledged that the goal of indicators was to measure levels of IPM uptake by countries (and in some regions to show compliance with government policies), to identify good practices for managing pests effectively and overall to support implementation of IPM strategies. Attendees agreed that both types of indicators were important. They added that an indicator of impact/performance would assist in convincing policy makers of the effect of IPM on the environment and society; and in demonstrating return on investment in R&D on IPM.

Then, the Chair suggested organising the discussion in order to first deal with "uptake" indicators and then with "impact" indicators.

Uptake indicators

After exchanging views on some aspects of uptake indicators, including the diversity of IPM systems and situations worldwide, participants discussed whether a global set of indicators was required or guidance about how to develop and use indicators was more appropriate. A number of attendees agreed that a uniform approach might not be feasible and that a guidance describing the various possible approaches might be preferable. Also, it was stressed that the purpose of indicators was not to compare countries. In addition, it was reported that the development and use of harmonised indicators would depend on the availability of IPM uptake data, which in some countries may result in additional burden on growers if the data were not available. . Moreover, harmonised indicators would not necessarily be suitable to reflect the specific situation in each country.

The possible guidance would include the following parts:

- A list of basic agreed and harmonised principles of IPM
- A toolbox of methodologies and best practices to be used by governments to enable them develop their own indicators

Regarding the first part, attendees agreed that the possible guidance should review existing IPM principles as a starting point. It was suggested to review existing texts from regional/international organisations such as FAO, EU, WHO, GlobalGap or IOBC. It was further added that all these could be consolidated and distilled to agreed, common and comparable set of criteria/ elements of IPM suitable/recommendable for the development of indicators and measurements that countries could then apply in a flexible way in order to account for country-specific variables.

It was suggested that in a second step, the guidance should identify the background, advantages, drawbacks, and shortfalls in existing measurement approaches. As the proposed toolbox for developing indicators would be aimed for use by governments and not by individual farmers, it was agreed that it would discuss farm practices (e.g. crop rotation) but would remain at OECD and country level. Again, it was stressed that there are multiple ways to achieve best practice in measuring IPM uptake and that it would be up to each country to determine the best system to address the country's specific situation.

Attendees discussed who would undertake the development of the guidance for uptake indicators. It was suggested that experienced evaluators and IPM impact assessors would be required to assess current best practice. Attendees agreed that the recently-established OECD Expert Group on IPM would be the most appropriate group to undertake this work. Attendees also agreed that this group could call on additional expertise as required.

Impact indicators

The Chair suggested that the initial focus of the discussion on impact indicators would be on environmental issues (e.g. aquatic and terrestrial impacts) and would address other areas as a second step (e.g. human health impacts, economic and social risks).

Representatives from EU countries pointed out that indicators (e.g. HAIR) existed for environmental risks and included some human health aspects such as occupational and bystander risks.

Some participants asserted that risk was only one part of IPM and that impact measurements should also include effects on income and yield factors. It was acknowledged that measures of costs/benefits were usually not included in the impacts; furthermore, socio-economic studies were rare in this area. Attendees noted that economic sustainability of IPM practices was important, in particular for farmers, and future directions should include these types of studies.

The Seminar discussed who would undertake the impact indicator work. It was noted that the OECD Expert Group on Pesticide Risk Indicators were in the process of reviewing the HAIR project in which environmental and occupational health factors were included. It was suggested that this group could investigate indicators suitable for IPM impacts (or including an IPM component) and liaise with the IPM Expert Group.

In summary, it was agreed that the OECD would work towards developing impact indicators for IPM. For environmental and occupational impacts, the Seminar recommended that the OECD Expert Group on Pesticide Risk Indicators would address them to factor in IPM criteria, in coordination with the Expert Group on IPM. It was also agreed that impact indicators for other human health and socioeconomic factors could be investigated in the future as studies become available.

SEMINAR RECOMMENDATIONS

All participants made knowledgeable interventions which contributed to a better understanding of the issues associated with IPM measurements, and helped the group reach recommendations on follow-up steps on this topic.

In summary, the recommendations from the Seminar participants are the following:

Regarding indicators measuring uptake/adoption of IPM: the Seminar recommended to develop guidance covering the following:

1. the identification of general principles and elements of IPM that already exist in various countries/regions (without getting into the endless area of IPM definitions). This initial part would aim at providing a common understanding of IPM that could also help countries set their own IPM systems (and hence serve as a basis for their own measuring systems of IPM uptake/adoption).

2. a simple "toolbox" for governments containing various options to help them develop their measuring systems of IPM uptake/adoption. The 'toolbox' would compile existing measurement methodologies, would review them with an analysis of the pros & cons of their characteristics and would possibly recommend a small number of the best options. This would eventually enable countries to adopt/develop measuring systems that could vary according to the different national/regional situations (e.g. different crops and practices, different incentives around IPM, data availability).

Regarding indicators measuring impact/performance of IPM: the Seminar recommended to work on two levels:

1. for "environment/human health" indicators, covering the effects that IPM has on aquatic/groundwater, terrestrial & biodiversity ecosystems, including some occupational/bystander health effects, these aspects would be referred to the on-going work on pesticide risk indicators. That work would need to include IPM criteria or process data from IPM-farms/production systems in order to account for IPM-related impacts.

2. for indicators dealing with socio and economic impacts of IPM, including impacts on public health, the work would start with an overview of existing/published studies on those impacts. Later on, the work on developing indicators (or guidance on indicators) could follow.

Note:
The recommendations developed by the Seminar participants will be forwarded to the relevant bodies of the OECD Pesticides Programme, the members of which will consider these recommendations and agree on which one(s) to initiate, if any, and which existing expert group(s) to involve.

ANNEX 1: List of OECD Seminars on Pesticide Risk Reduction

Title of Seminar [references of publication]	**Date**	**Place**
Compliance and Risk Reduction *ENV/JM/MONO(2004)6 (*Series on Pesticides No. 24)	10 March 2003	Paris, France
Minor Uses and Pesticide Risk Reduction *ENV/JM/MONO(2005)4 (*Series on Pesticides No. 26)	4 Nov. 2003	Canberra, Australia
Pesticide Risk Reduction through Good Container Management *ENV/JM/MONO(2005)12 (*Series on Pesticides No. 28)	22 June 2004	Bonn, Germany
Risk Reduction through Good Pesticide Labelling *ENV/JM/MONO(2006)13 (*Series on Pesticides No. 29)	1 March 2005	Paris, France
Pesticide Risk Reduction through Better Application Technology *ENV/JM/MONO(2007)3 (*Series on Pesticides No. 35)	30 Nov. 2005	Wellington, New Zealand
Joint OECD/EC Seminar on Harmonised Environmental Indicators For Pesticide Risk (HAIR) *ENV/JM/MONO(2007)27 (*Series on Pesticides No. 40)	13 Nov. 2006	Bonn, Germany
Risk Reduction through Better Worker Safety and Training *ENV/JM/MONO(2008)9 (*Series on Pesticides No. 42)	21 March 2007	Brno, Czech Republic
Risk Reduction through Education / Training the Trainers *ENV/JM/MONO(2009)35 (*Series on Pesticides No. 45)	15 Nov. 2007	Mexico City, Mexico
Risk Reduction through Spray Drift Reduction Strategies as Part of National Risk Management *ENV/JM/MONO(2009)36 (*Series on Pesticides No. 46)	12 June 2008	Paris, France
Pesticide Risk Reduction through Better National Risk Management Strategies for Aerial Application *ENV/JM/MONO(2010)22* (Series on Pesticides No. 50)	24 Feb. 2009	San Francisco, US
Pesticide Risk Reduction Strategies near/in Residential Areas *ENV/JM/MONO(2011)5* (Series on Pesticides No. 58)	17 November 2009	Tokyo, Japan
Risk Reduction through Prevention, Detection and Control of the Illegal International Trade in Agricultural Pesticides *ENV/JM/MONO(2011)6* (Series on Pesticides No. 59)	19 May 2010	Paris, France

The reports from these Seminars are available on the OECD public web site at: http://www.oecd.org/env/pesticides, under the section “Risk Reduction”

ANNEX 2: Measurement of IPM uptake (Extract from the 2011 OECD Workshop Report)

Extract from the 2011 OECD Workshop Report, Part 4 Workshop Conclusions

Measurement of IPM uptake

Data and information are useful to measure the adoption and implementation of IPM. In addition, assessments demonstrating the benefits of IPM for farmers and for the society should work as incentives and valuable tools to foster IPM uptake.

The choice of what is measured and criteria of measurement should involve governments (in consultation with other stakeholders such as grower groups and scientists). A simple measurement of IPM adoption rate (and some additional measurements of impacts, success stories) was preferred although it was recognized that more detailed assessments would contribute to more precise information.

For assessing the economic viability of IPM tools and strategies, the use of case studies was seen as the most practical way when it is not possible to do it at a general level. Such case studies, as well as the assessment of data which are already collected at the farm level in a mandatory way, should ensure that no additional administrative burden is imposed on farmers. When farm data are used, ownership of the data should automatically be held by farmers.

Benchmarking countries' and regions' current level of tools and technologies available for facilitating adoption of IPM (e.g. through the use of a questionnaire to generate data for benchmarking) was discussed as an option to assess IPM uptake. Such benchmarking could result in a set of minimum standards for IPM adoption and a plan could be developed for a progressing process within regions and countries to achieve minimum standards. This could also be used to establish next levels of IPM progression.

Activity Indicators

Farm-based measurement is one of the main tools to identify bottlenecks or barriers in IPM implementation. However, further identification of research needs and incentives aiming to make IPM more attractive to farmers is necessary.

It was recognised that activity indicators for adoption of IPM (e.g., farmer self assessment, sales figures for biocontrol agents, treatment frequency index, degree of recruited extension services) are difficult to choose as each measure has certain shortcomings to be broadly applicable. Therefore, a general set of principles on IPM should be established in order to allow each country to measure the extent of IPM implementation. The auditing related to such principles or certification could be carried out by a third party.

Performance Indicators

There is a need to have a measure of risk reduction that is directly related to the implementation of IPM. Current risk indicator models should be reviewed to determine if they can be used for this purpose.

ANNEX 3: Recommendations to Governments (Extract from the 2011 OECD Workshop Report)

Extract from the 2011 OECD Workshop Report, Part 5 Workshop Recommendations

Recommendations to Governments

Measurements and impacts of IPM adoption and implementation

Governments should develop indicators and ways to measure implementation and impacts of IPM. In particular they should:

- Coordinate with stakeholder bodies (board, farmer group, etc.) to obtain and develop an inventory of data that is already being collected.
- Invest in cost-benefit measurement models, showing to farmers and the society the costs (research, implementation, management) and benefits (economic, environmental, social) of IPM uptake
- Undertake research on IPM benefits and impacts that can be easily measured
- Fund demonstration projects (and leverage other stakeholders to fund demonstration projects) on:
    - Implementation
    - Measurements of effect on pest management
    - Environmental and risk indicators
    - Economic impact (cost/benefit)

Recommendations to the OECD

Measurements and indicators

- Develop indicators measuring IPM adoption and implementation
    - Develop an inventory of available data and measurement tools
    - Provide guidance as to what type of information would be the most useful (in cooperation with stakeholders' bodies, e.g. farmers groups and boards)
    - Set up a set of IPM implementation indicators to be used by governments including minimum standards/principles for IPM to be used as the basis for the measurement of IPM adoption and implementation
- Develop performance indicators
    - Determine if the effect of IPM adoption on risk reduction can be measured within the context of risk indicator models (with a view to developing performance indicators) and encourage cooperation to measure the benefits of IPM
- Monitor IPM adoption and implementation and the benefits of it
    - Develop benchmarking tools regarding countries' levels of IPM implementation
    - Measure progress in IPM adoption and implementation in various countries and regions

ANNEX 4: LIST OF PARTICIPANTS

OECD Seminar on IPM Indicators
Tuesday 27 November 2012, Queenstown, New Zealand

Australia/Australie

Dr. Eva BENNET-JENKINS
CEO
Australian Pesticides & Veterinary Medicines Authority
PO Box 6182
2604 Kingston
Australia

Mr. Gary FAN
Senior Policy Advisor
Agricultural and Veterinary Chemicals Section
Department of Agriculture, Fisheries and Forestry
GPO Box 858
ACT 2601 Canberra
Australia

KELLY MARC
Department of Agriculture Fisheries and Forestry
GPO Box 858
2600 Canberra
Australia

Colin O'MULLANE
Agricultural and Veterinary Chemicals Section
Department of Agriculture, Fisheries and Forestry
GPO Box 858
ACT 2601 Canberra
Australia

Ms. Jolanta SAMOC
Department of Agriculture Fisheries and Forestry
Agricultural and Veterinary Chemicals Section
18, MARCUS CLARKE ST
2601 Canberra
Australia

Ms. Bronwyn WALSH
Department of Fisheries and Agriculture Western Australia
Western Australian Government
Locked Bag 7
Bentley Delivery Centre
6983 Perth
Australia

Dr. Donald WARD
Manager, Agricultural and Veterinary Chemicals
Australia Government Department of Agriculture, Fisheries and Forestry
GPO Box 858
2601 Canberra
Australia

Germany/Allemagne

Mr. Wolfgang ZORNBACH
Deputy Head
Plant Protection Unit
Federal Ministry of Food, Agriculture and Consumer Protection (BMELV)
Rochusstr. 1
53123 Bonn
Germany

Ms. Silke DACHBRODT-SAAYDEH
Expert
Julius Kuehn-Institute (JKI) Federal Research Centre for Cultivated Plants
Stahnsdorfer Damm 81
14532 Kleinmachnow
Germany

Japan/Japon

Mr. Yoshiyuki TAKAGISHI
Section Chief
Agricultural Chemicals Office, Plant Products Safety Division, Food Safety and Consumer Affairs Bureau
Ministry of Agriculture, Forestry and Fisheries
1-2-1 - Kasumigaseki
100-8950 Chiyoda-ku
Japan

Ms. Atsuko HORIBE
Deputy Director
Risk Assessment Division, Food Safety Commission Secretariat
Cabinet Office
Akasaka Park Building 22F, 5-2-20 Akasaka, Minato-ku,
107-6122 Tokyo
Japan

Netherlands/Pays-Bas

Dr. Susanne SÜTTERLIN
Senior Officer
Directorate Agriculture
Ministry of Economic Affairs, Agriculture and Innovation
Plant Protection
PO Box 20401
NL 2500 EK The Hague
Netherlands

New Zealand / Nouvelle-Zélande

Mr. Asela ATAPATTU
Manager, Applications (New Organisms)
Environmental Protection Authority
New Zealand

Mrs. Cora DRIJVER
Advisor, Hazardous Substances
Applications and Assessment
Environmental Protection Authority
New Zealand

Mrs. Beth DYE
Senior Adviser (Chemistry)
Ministry for Primary Industries
New Zealand

Mr. Warren HUGHES
Principal Adviser, ACVM Standards
Systems, Support and ACVM Directorate
Ministry for Primary Industries
Pastoral House - 25 The Terrace
6140 Wellington
New Zealand

Ms. Sarah KENWARD
Team Leader Hazardous Substances
Environmental Protection Authority
Level 10 - 115 Lambton Quay
6140 Wellington
New Zealand

Mr. Philip MANSON
General Manager Sustainability
New Zealand Winegrowers
New Zealand

Stephen OGDEN
Director
Market Access Solutionz Ltd
New Zealand

Dr. Geoff RIDLEY
Principal Scientist - Biology
Policy and Legal
Environmental Protection Authority
Private Bag 63002, Waterloo Quay
6140 Wellington
New Zealand

	Mr. David TEULON Portfolio Manager - Bioprotection Plant & Food Research New Zealand
	Mr. Jim WALKER Plant & Food Research, Private Bag 1401 Havelock Nth New Zealand
PAN	**Jo DAVIES** Pesticide Action Network Aotearoa New Zealand PO Box 296 Ostend - Waiheke Island Auckland New Zealand
	Dr. Meriel WATTS Co-ordinator, Pesticides Action Network Aotearoa New Zealand PO Box 296 - Ostend Waiheke Island 1971 Auckland New Zealand
Business and Industry Advisory Committee (BIAC)/Comité consultatif économique et industriel (BIAC)	**Dr. Felix MEIER-MANZ** Head Regulatory Support Syngenta Crop Protection AG WRO-1004.4.37 - Schwartzwaldallee 215 CH-4058 Basel Switzerland
CropLife International	**Dr. Bernhard JOHNEN** Director International Regulatory Policy CropLife International 326 avenue Louise - box 35 1050 Brussels Belgium
	Dr. Keith JONES Director Stewardship & Sustainable Agriculture CropLife International 326 avenue Louise, box 35 1050 Brussels Belgium
International Biocontrol Manufacturers Association	**Mr. David CARY** Executive Director International Biocontrol Manufacturers' Association 15 Shalford Road GU4 8BL Guilford United Kingdom

OECD/OCDE

Ms. Beatrice GRENIER
ENV/EHS
OECD
Marshall Building 0356
2 rue André-Pascal
75016 Paris
France

Mme Sylvie PORET
Principal Administrator
ENV/EHS
OECD
Marshall Building 0356
2 rue André-Pascal
75016 Paris
France

IOBC

Dr. Barbara BARRATT
IOBC (International Organisation for Biological and Integrated Control of Noxious Animals and Plants)
AgResearch Invermay
9029 Mosgiel
New Zealand

Other experts/Autres experts

Dr. Thomas GREEN
President
IPM Institute of North America
4510 Regent St
53705 Madison
United States

Canadian Growers Association

Mr. Craig HUNTER
Specialist, Crop Protection and Research
Ontario Fruit and Vegetable Growers' Association
Unit 105,
355 Elmira Road North
N1K 1S5 Guelph
Canada

ANNEX 5: Seminar Programme

13th OECD Seminar on Pesticide Risk Reduction (organised by the Risk Reduction Steering Group, RRSG)

Indicators on Integrated Pest Management (IPM)

Tuesday 27 November 2012

Queenstown, New Zealand
Rydges Lakeland Resort

Programme

Chair: Wolfgang Zornbach, Germany

9.00 am	**Introduction** **Opening and welcoming remarks** – New Zealand (by Warren Hughes, Ministry for Primary Industries) **Purpose and structure of the seminar,** including recommendations from the 2011 OECD workshop on IPM – by Seminar Chair (Wolfgang Zornbach, Federal Ministry of Food, Agriculture and Consumer Protection, Germany, and Chair of the RRSG) **Tour de table** to introduce participants
9.30 am	**Presentations** The presentations will start in the morning and will continue in the afternoon as necessary. Each presentation will last about 20 minutes, followed by 5-10 minute questions and answers. Below is the list of presentations and speakers, in a *preliminary* order. The actual order of the presentations may change. As far as possible, the initial presentations will address "uptake" indicators while the later ones will cover "impact" indicators.

	1. **OECD**: IPM indicators: where are we? (by Beatrice Grenier, OECD Pesticides Programme) 2. **Germany** : A scoring system for IPM evaluation on demonstration farms in Germany (by Silke Dachbrodt-Saaydeh, Julius Kühn Institute (JKI)) 3. **New Zealand:** Sustainability initiatives in New Zealand horticulture (by Jim Walker, Plant & Food Research) 4. **Pesticide industry**: Measuring IPM: a tool for measuring uptake and identifying gaps (by Keith Jones, CropLife International) 5. **US:** IPM: Answering the "So what?" question (by Tom Green, IPM Institute) 6. **BioPesticide industry**: How the biocontrol industry contribute to and view IPM indicators (by David Cary, IBMA) 7. **Australia:** Exploring the potential IPM indicators for Australia (by Bronwyn Walsh, Department of Fisheries and Agriculture Western Australia) 8. **Grower association from Canada:** Food Systems 2002, IPM Approach and Evaluation, Ontario Canada (by Craig Hunter, Ontario Fruit and Vegetable Growers' Association) 9. **IOBC**: Guidelines for Integrated Production and Endorsement' performance indicators (by Barbara Barratt, Global IOBC) 10. **Germany** : An approach to use the environmental risk indicator SYNOPS for the assessment of IPM "performance" on regional level (by Silke Dachbrodt-Saaydeh, Julius Kühn Institute (JKI)
12.30 (around)	Lunch Note: coffee breaks will be organised in the morning and in the afternoon
Afternoon	**Round-table Discussions (non–exhaustive list)** General topics • Challenges and solutions with IPM indicators • Link between uptake indicators and performance indicators / Link with pesticide risk indicators • Appropriate roles of the OECD, member governments, and stakeholders in the development and implementation of IPM indicators • Identification of indicators (or guidance/principles on indicators) that would be needed (for OECD and/or others) to develop: o for who (target audiences) o at what level: farm, national, regional, OECD? o for what purposes / what are the drivers for IPM indicators o on what IPM guidelines would be based "uptake indicators" o what type of data would be most useful and/easy to collect o for what outcomes: IPM adoption rate? Information on risk reduction (as it relates to IPM implementation [what impacts can be easily measured]

	• Suggestions for future possible projects on IPM indicators for OECD that could ultimately help to demonstrate risk reduction and efficiencies gained as a result of the use of IPM techniques. More detailed and specific discussion could focus on: • Identifying what type of specific data could be collected: e.g. questionnaires to farmers, farmers self assessment, direct and indirect measurements (e.g. farm-based measurements, number of acreage/hectares under IPM, number of farmers trained for IPM, residue levels, natural enemy levels, pesticide use - statistics data on sale and use) • Discussing the need to develop an inventory of data already collected (that could help get a baseline level of risk) • Communication and coordination aspects with IPM stakeholders to develop indicators • Coordination mechanisms with stakeholders (e.g. farmers) to obtain data • Considering cost-benefit models o costs: research, implementation, management o benefits: economic, environmental, social
	Summary of the discussion and Ideas for follow-up **Recommendations** The Seminar could develop recommendations on: • The benefits of monitoring IPM adoption and implementation and of the impacts of IPM • What type of information would be the most useful for OECD members? Set of indicators? Guidance on indicators? • Suggest options for further practical steps, priorities and timing for : o for OECD governments and key stakeholders o for OECD future work (e.g. pilot project, expert group, guidance development, etc)
Between 5.00 and 6.00 pm	End of the Seminar

ANNEX 6: Background Document on IPM Indicators

IPM INDICATORS: WHERE ARE WE?

Background Document for Participants at the OECD Seminar on Integrated Pest Management Indicators at Queenstown, NZ (27 November 2012)

INTRODUCTION

During the most recent OECD workshop on Integrated Pest Management (IPM) in Berlin (October 2011), the topic of "measurement and impact of IPM adoption and implementation" was discussed (OECD, 2012). Moreover, measuring the impact and adoption of these policies falls into a greater OECD project on Green Growth[3] indicators. Food and Agriculture has been identified as a key area for Green Growth by the OECD (OECD, 2012) and the input of the pesticides programme as well as the work on IPM are important inputs in this process. As a consequence, at the upcoming seminar in Queenstown, New Zealand, the OECD Risk Reduction Steering Group (RRSG) will initiate discussions on the issue of "IPM indicators" further and in depth. This paper constitutes a compilation of existing indicators for measuring IPM adoption and implementation from previous OECD work, academic publications, official documents, and governmental sources. The purpose of this paper is to gather the progress that has been made to this day on the topic of IPM indicators as well as to provide a basis for further discussion, development, and follow-up work on indicators among attendees at the mentioned seminar.
Pests, and therefore IPM techniques, are known to be crop- and location-specific. This uniqueness is a contributing factor to the difficulty in measuring and comparing different levels of adoption and impact of IPM (Vandeman, Fernandez-Cornejo, Jans, & Lin, 1994). As stated in previous meetings, there is a need for a "general set of principles" that can allow each country and organisation to measure the extent of IPM implementation and impact, as well as benchmarking of the current level of adoption in different countries in order to assess progress (OECD, 2012). Therefore, this need for generality and comparability becomes the greatest challenge to designing sound indicators for IPM, and should be taken into account in the discussion and design process. In this context, the European Commission has suggested the adoption of the SMART approach for developing indicators (Specific, Measurable, Achievable, Realistic, and Timely) (European Commission, 2008).

To this date, OECD and other institutions have carried out extensive research, design, and development of Pesticide Risk Indicators (PRI's) (OECD). While PRI's constitute a part of IPM impact indicators, there are other aspects that may need to be covered such as the economic, social, and remaining environmental impacts of IPM programmes. In other words, a reduction in pesticide risk (as revealed by a certain PRI), will constitute a positive impact of IPM implementation, but it fails to paint the full picture of IPM impacts (positive or negative) and take other variables into consideration, such as e.g. the profitability of IPM to farmers or the public/human health improvement. The general considerations and limitations presented in this introduction should be taken into account along with the examples and case studies provided further on to enhance the discussion and design of IPM indicators.

ADOPTION INDICATORS

Adoption indicators are used to measure the level of IPM technology "uptake" or degree of IPM adoption. That is, roughly the extent to which farmers in a certain country or region apply IPM farming practices.

[3] Green Growth is defined as "fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies". More information on Green Growth and its relation to IPM indicators can be found in Appendix 3 at the end of this paper.

Even though certain crops and circumstances call for "selective adoption" of IPM, this in turn makes the assessment process an extremely difficult task (Wearing, 1988).

At the OECD level, as part of the work on agri-environmental indicators, there has been only one adoption indicator used to this day and only for a few countries: "Share of the total arable and permanent crop land area under integrated pest management" (OECD, 2001). This indicator is a starting point and provides a reasonable estimate of the level of adoption of IPM in a certain country. However, it has one main problem: it does not specify exactly what IPM "adoption" means, and whether what would be considered IPM in one country would also be considered IPM in another country. In order to properly assess the "true" adoption of IPM, it would be necessary to consider a variety of indicators that can provide a wider picture that takes into account the circumstantial and case-specific nature of IPM.

In Box 1 we can find a non-exhaustive compilation of existing adoption indicators present in previous OECD workshops, institutional reports, and the academic literature.

Box 1. List of IPM Adoption Indicators, sources, and units of measurement.

Name (and description)	Source(s)	Units
Treatment Frequency Index: the Treatment Frequency Index (TFI) was developed as an alternative to using "Sold Amount of Active Ingredient" given the rise in the use of low-dose products. The TFI is the average number of pesticide applications per year, provided a fixed standard dose is used. $TFI = \sum_{All\ Active\ Ingredients} \frac{(\frac{SAactiveingredient}{SDcroptype})}{AGRAyear}$ SA: Sold Amount SD: Standard Dose AGRA: Area of Arable Land	(PAN Europe, 2003) (OECD, 2012) (European Commission, 2008)	N/A
Amount of growers using IPM	(Isaacson & Lanthier, 2011)	(Number of growers, %)
Number of growers using extension services/consultants	(OECD, 2012)	(Number of growers, %)
Pesticide (and bio pesticide) sales data	(MAPAQ, MDDEP, MSSS, UPA., 2011)	($, $/year)
Pressure Index: expressed in amount of Active Ingredient per hectare.	(MAPAQ, MDDEP, MSSS, UPA., 2011) (FAO, 2004)	(Kg/Ha)
Farmer Self Assessment: the farmers themselves are asked whether they apply IPM principles or not.	(OECD, 2012)	(Number of growers, %)
IPM training programs to date	(FAO, 2004)	(farmers, workshops/year)
Share of the total arable and permanent crop land area under integrated pest management	(OECD, 2001)	(Ha, %)
Research and development programmes/spending on IPM	(MAPAQ, MDDEP, MSSS, UPA., 2011)	($, $/year)

Alternatively, the actual measurement of a certain level of IPM "adoption" has been, in a variety of scales, carried out through the use of farmer/grower surveys (Robertson, Zehnder, & Hammig, 2005) (Hollingsworth & Coli, 2001) (Vandeman, Fernandez-Cornejo, Jans, & Lin, 1994). Throughout the

literature, the main approach is usually to group different farms into 3 groups in terms of their IPM adoption level: High, Medium, or Low. This assessment can be done by sending out surveys to farmers containing questions (Robertson, Zehnder, & Hammig, 2005) relative to:

- Scouting, monitoring, and recordkeeping practices.
- Cultural pest management and control practices (including the use of biological pesticides).
- Pesticide usage and treatment thresholds.
- Pesticide application practices.

Once the data has been gathered, one can have a better idea of the level of IPM adoption depending on the number of different practices present in the survey. If data is gathered for a number of years, then assessment of progress over time is also possible. In (Robertson, Zehnder, & Hammig, 2005), the IPM score is obtained by multiplying the "importance" of a certain practice by the "frequency" with which the practice takes place (never=0, seldom=1, often=2, always=3). Consequently, the final scores are distributed as follows: low (0-165 points), medium (166-330 points), and high (331-495 points).

The methodology used in (Hollingsworth & Coli, 2001) is special because it distinguishes between crops and then assigns a level of adoption (low, medium, high) depending on the amount of certain crop-specific IPM practices carried out by the farmer; such as management of soil, nutrients, weeds, diseases/insects, and education. In this way, not only is measurement feasible at a large scale but it also become possible to compare IPM adoption independently of the specific crops. Since all the IPM practices are crop-specific, there is a chance for every farm that participates in the survey to obtain full points; this would not be the case if the same questionnaire were applied for every single crop. This methodology is explained further in Appendix 1 at the end of this paper.

One advantage of using surveys is that they can ask more general questions without directly asking whether IPM is being adopted or not. This is believed to be the most reliable method, as farmer self assessment has been found to be confusing or at least to overestimate actual IPM adoption (McDonald & Glynn, 1994). Moreover, an industry-driven scoring system (in which the design and implementation is carried out by members of the farmer industry, rather than public institutions) with 320 points overall (320 being maximum adoption of IPM) in order to measure IPM has also been suggested (Swinton, IPM Assessment and Risk: Framing the Issues and Vocabulary, 2003). This system would work in a participatory manner and would have enough points to make all participants feel "successful" by avoiding negative feedback.

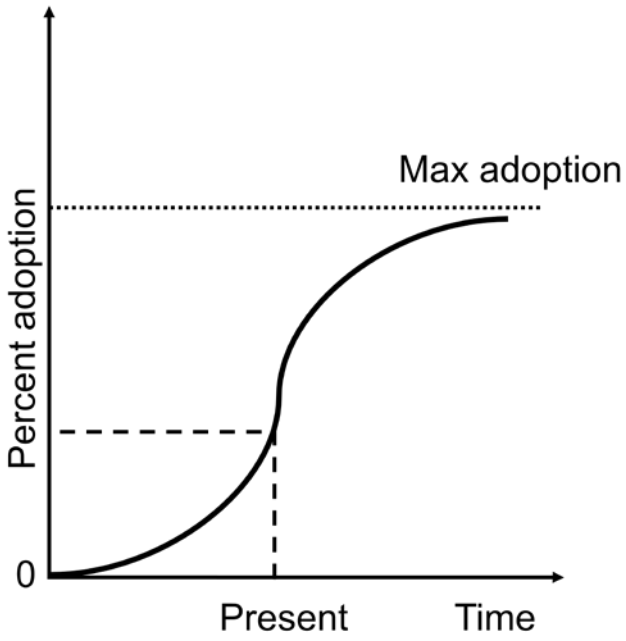
While the survey method has been more common, others have been able to measure the adoption level of IPM through the use of interviews (McDonald & Glynn, 1994), audits (IOBC) or even certification. When conducting interviews, it is important to avoid asking the direct question: do you apply IPM or not? In the case of (McDonald & Glynn, 1994), the interviewers do not even mention IPM for the first two hours of the interview. Instead, IPM is measured by asking 52 different questions, and constructing nine indexes:

- Maintenance of scouting records.
- Maintenance of fungicide application records.
- Pest monitoring devices.
- Disease monitoring devices.
- Use of economic threshold and insect tolerance numbers.
- Approved pesticide measurement before spraying.
- The use of biological controls.
- Planting of cover crops and other cultural practices.
- Selectivity and information gathering.

According to these indexes, the results of the questionnaire are then compared with the recommended IPM practices to obtain a certain "adoption level" by using factor analysis statistical methods.

However, regardless of the method used to measure IPM adoption, it is important to know how and when this adoption is going to take place. According to academic sources, IPM adoption is likely to have the shape of a cumulative normal distribution function (Fernandez-Cornejo, 1998) (Swinton, Economic Assessment of IPM Programs, 2003), also described as the IPM continuum (Hollingsworth & Coli, 2001). This means that adoption will grow exponentially faster over time and slow down substantially after reaching 50-70% of adoption. An example of an IPM adoption function can be seen in figure 1 below.

Figure 1: IPM Adoption Function (Swinton, Economic Assessment of IPM Programs, 2003)



Acknowledging this function is important in order to establish desired outcomes of IPM promotion. In order words, it helps measure what level of adoption should be expected and therefore what the adoption goal could be. For example, "target" adoption could be set at 90%, as any extra adoption may be difficult or inefficient to obtain.

Finally, it is important to ask the question for assessment work: "why measure IPM adoption?" Although reasons and answers are not developed further in this paper, some authors (Hollingsworth & Coli, 2001) have pointed out the need to verify compliance with (government) programmes or policy targets.

In conclusion, in order to measure IPM adoption/uptake, it would be important as a first step to define a set of criteria, principles, or guidelines defining IPM. The design of indicators would then be based on this set. Initial discussion could focus on the "minimum/necessary" criteria for IPM. A number of organisations already have some in place, such as the European Union, IOBC, FAO and others.

IMPACT INDICATORS

As important as measuring the extent to which IPM practices are being adopted is the impact that those practices are having on the different stakeholders and affected agents in the environment, and on pesticide risk reduction. The measurement of this impact, or "performance", can therefore be important at different levels. For example, reduced health risks are to be measured to assess the effectiveness of IPM adoption, but economic profitability for farmers is just as relevant. Because of this characteristic, the number of variables taken into account in assessing whether IPM is actually having the desired effect could be greater than the variables needed for the measurement of adoption. Given the number and diversity of IPM impacts, they can be conveniently divided into 5 groups:

- Farming, pesticides, and risk impacts.
- Environmental impacts.
- Health impacts.
- Economic impacts.
- Social Impacts.

Farming, Pesticides, and Risk Impacts

This category of Impact indicators has to do with how the implementation of IPM affects farming practices, pesticide application practices, and the risk associated to the use of pesticides. Two important variables to consider are the yield variation (whether the use of IPM is able to increase the yield compared to the case without IPM) and the avoided risk due to the implementation of IPM. Even though a reduction in risk is one of the most important components of IPM impact, there is already past and on-going OECD work on this specific issue (by the Expert Group on Pesticide Risk Indicators) and therefore escapes the scope of this paper.

Name (and description)	Source(s)	Units
Pesticides Risk Indicators (e.g. OECD ARI/TERI, HAIR, SYNOPS, SyPEP, etc.)	Many	N/A
Fertiliser Use	(FAO, 2004)	(Kg/Ha)
Pesticide Use	(FAO, 2004) (Van Den Berg & Jiggins, 2007)	(Kg/Ha)
Avoided Risk due to IPM: it is calculated by subtracting the risk after IPM implementation from the risk before IPM implementation. $$\boldsymbol{Avoided\ Risk\ due\ to\ IPM} = \boldsymbol{ES_{ij}(No\ IPM) - ES_{ij}(IPM)}$$ $$\boldsymbol{ES_{ij}} = \left(\boldsymbol{IS_j}\right) \times (\%\boldsymbol{AI_i}) \times (\boldsymbol{Rate_i})$$ $\boldsymbol{ES_{ij}}$**:** Eco-Rating score for active ingredient i and environmental category j.	(Cuyno, Norton, & Rola, 2001)	(%)
Yield	(Van Den Berg & Jiggins, 2007)	(Tons, Kg/Ha)
Yield Increase	(Van Den Berg & Jiggins, 2007)	(%)
Damages caused by pests and diseases	(OECD, 2012)	
Use of Low-Risk Pesticides	(US Federal IPM Coordinating Committee)	(Kg)

Purchases of Precision Application Technology	(US Federal IPM Coordinating Committee)	($)
Pesticide Residue Levels (in food, in surface/ground water, etc.)	National surveys	(mg/kg, ppm)
Changes in farmers' attitude/practices	(FAO, 2004)	(% rational decisions as decisions backed by observation and data)
Improvement of farmers' knowledge and skills (increased human capacity)	FAO (2004)	(Number of field experiments, advice giving, management scores)

Environmental Impacts

Environmental Impact indicators help measure the effect that IPM adoption has on its surroundings (biodiversity, ecosystem, nearby streams of water...). The most comprehensive way to measure the environmental impact is by using changes in the Environmental Impact Quotient equation (Kovach, Petzoldt, Degnil, & Tette, 1992). This equation computes toxicity levels of certain pesticides for mammals (humans), birds, bees, water, fish, beneficial arthropods... and therefore constitutes an all-encompassing way to measure potential toxicity. Increases or decreases in the EIQ equation can be measured as IPM impact indicators. A variety of additional environmental indicators can be found on the American Farmland Trust website (American Farmland Trust).

Name (and description)	**Source(s)**	**Units**
Environmental Impact Quotient (EIQ)	(Kovach, Petzoldt, Degnil, & Tette, 1992)	N/A (range: 1-5)
Environmental indicator models	(OECD, 2005)	N/A
Harvest Damage	(Waldner, et al., 2011)	(%)
Chemical Insecticide Residue	(Waldner, et al., 2011)	PPM
Increase in environmental stability	(FAO, 2004)	N/A
Number of Pests/Natural Enemies	(FAO, 2004)	Number of Pests
Observed Biodiversity	(FAO, 2004)	Number of Species

Health Impacts

Health impacts of IPM are a major component to be considered. IPM reduces the use of pesticides thus minimizing potential negative health effects on both producers and consumers. There is not much literature on the subject and might be difficult to measure precisely at a large scale, but should definitely be a centrepiece of any IPM overall impact assessment programme.

Name (and description)	Source(s)	Units
Environmental Impact Quotient (EIQ)	(Kovach, Petzoldt, Degnil, & Tette, 1992)	(1-5)
Pesticide-related lost work days	(FAO, 2004) (US Federal IPM Coordinating Committee)	Days/year
Pesticide-related health expenditures	(FAO, 2004) (US Federal IPM Coordinating Committee)	$/year
Customer/Community Health Impact	(FAO, 2004)	(poisoning cases, workdays lost)

Economic Impacts

Economic impacts of IPM are especially relevant in making IPM attractive to both farmers and policy makers (in order to guarantee the efficiency of expenditures in programmes promoting and researching IPM). It must be assessed through the collection of data whether a win-win situation can be achieved. This would imply raising profit for farmers and simultaneously providing health benefits and protecting the environment. Whether an IPM programme is profitable to society as a whole can be established through a Cost Benefit Analysis (CBA) and alternatively (or together) by using Contingent Valuation methods (CV). The specifics of these two types of analyses will be covered in Appendix 2 (Fleischer, Jungbluth, Waibel, & Zadoks, 1999). In the case of Contingent Valuation, agents involved or affected by IPM are asked how much they would have been willing to pay to obtain (or avoid) a certain service (uncontaminated drinking water, for example). This can be established through the use of surveys and can be extrapolated to a greater population.

Name (and description)	Source(s)	Units
Employment Creation/Destruction	(FAO, 2004)	(Number of jobs, % unemployment rate)
Seed Cost	(FAO, 2004)	($/Ha)
Fertiliser Cost	(FAO, 2004)	($/Ha)
Cost of Pesticide Use	(FAO, 2004)	($/Ha)
Profit Margin	(FAO, 2004)	($/Ha)
Price of Agricultural Inputs	(FAO, 2004)	($)
IPM Certification Adoption	(US Federal IPM Coordinating Committee)	(Number growers, % growers)
Value of Ecosystem Services	(US Federal IPM Coordinating Committee)	($)
Farmer's improved income	(FAO, 2004)	($/farmer)
Government cost/benefit assessment	(Fleischer, Jungbluth, Waibel, & Zadoks, 1999)	($)

Social Impacts

Social impacts of IPM most commonly show up in IPM impact assessments in the context of developing countries. While not all may be so relevant from an OECD standpoint, some social impact indicators may be worth considering in order to measure the more "social" aspect of IPM.

Name (and description)	Source(s)	Units
Communication Among Farmers (Advice Giving Frequency)	(FAO, 2004)	(Frequency of advice giving per time period)
Impact on Management Skills	(FAO, 2004)	(Frequency of experimentation, observation, and record keeping)
Level of public awareness about IPM	N/A	N/A
Public attitude towards farmers adopting IPM	(OECD, 2012)	N/A

To conclude, as can be derived from the various categories into which these indicators can be divided, IPM impact indicators can exist at a variety of levels (from on-farm to regional use) and contexts. This characteristic makes IPM impact measurement complicated and much effort will necessarily have to go into the collection of data and design of indicators. Alternatively, impacts of IPM could be reflected in success stories/case-studies rather than fixed outcomes.

BIBLIOGRAPHY

American Farmland Trust. (n.d.). *AFT Center for Agriculture and the Environment*. Retrieved October 2012, from http://www.aftresearch.org/ipm/risk/

Bauske, E. M., Zehnder, G. M., Sikora, E. J., & Kemble, J. (1998). Southeastern Tomato Growers Adopt Integrated Pest Management. *HortTechnology , 8* (1).

Caldeira Monteiro, R., & Stachetti Rodrigues, G. (2006). A System of Integrated Indicators for Socio-Environmental Assesment and Eco-Certification in Agriculture – Ambitec-Agro. *Journal of Technology Management and Innovation , 1* (3), 47-59.

Cuyno, L. C., Norton, G. W., & Rola, A. (2001). Economic analysis of environmental benefits of integrated pest management:a Philippine case study. *Agricultural Economics , 25*, 227-233.

European Commission. (2008). *Development of guidance for establishing Integrated Pest Management Principles.* European Commission 07.0307/2008/504015/ETU/B3.

FAO. (2004). IPM-FFS Impact Assesment: where are we? *Impact Assesment Workshop.* Bangkok, Thailand.

Fernandez-Cornejo, J. (1998). Environmental and economic consequences of technology adoption: IPM in viticulture. *Agricultural Economics , 18*, 145-155.

Fleischer, G., Jungbluth, F., Waibel, H., & Zadoks, J. (1999). *A Field Practitioner's Guide to Economic Evaluation of IPM*. Hannover: Universität Hannover.

French Ministry of Agriculture and Fisheries. (2008). *EcoPhyto Report 2018.* French Ministry of Agriculture and Fisheries.

Galassi, T., Guario, A., Marano, G., D'Ascenzo, D., & Saglia, A. A. (2009). IPM implementation in Italy. *Workshop Endure, 5 November 2009.* Bologna, Italy.

Hollingsworth, C. S., & Coli, W. M. (2001). IPM Adoption in Northeastern U.S.: An Examination of the IPM Continuum. *American Journal of Alternative Agriculture , 16* (4), 177-183.

Isaacson, P., & Lanthier, M. (2011). Integrated Pest Management Practices:Analysis of the Canadian Ornamental Nursery Industry. *OECD Workshop on IPM*. Berlin, Germany.

Kovach, J. (2003). Putting an Environmental Price to Pesticide Use. *4th IPM Symposium American Farmland Trust.* Indianapolis, Indiana.

Kovach, J., Petzoldt, C., Degnil, J., & Tette, J. (1992). A Method to Measure the Environmental Impact of Pesticides. *New York's Food and Life Sciences Bulletin , 139.*

Levitan, L., Merwin, I., & Kovach, J. (1995). Assessing the relative environmental impacts of agricultural pesticides: the quest for a holistic method. *Agriculture, Ecosystems and Environment , 55*, 153-168.

MAPAQ, MDDEP, MSSS, UPA. (2011). The Quebec Agricultural Phytosanitary Strategy 2011-2021. *OECD Workshop on IPM*. Berlin, Germany.

McDonald, D. G., & Glynn, C. J. (1994). Difficulties in measuring adoption of apple IPM: A case study. *Agriculture, Ecosystems and Environment , 48*, 219-230.

Murguido Morales, C. A., Vazquez Moreno, L., Ibis Elizondo, A., Neyra, M., Velazquez, Y., Pupo, E., et al. (2002). Manejo Integrado De Plagas de Insectos en el Cultivo del Frijol. *Fitosanidad , 3* (6).

OECD. (2001). *Environmental Indicators for Agriculture: Volume 3 Methods and Results.* OECD Publications.

OECD. (2012). *Food and Agriculture, OECD Green Growth Studies.* OECD Publishing http://dx.doi.org/10.1787/9789264107250-en.

OECD. (n.d.). *OECD*. Retrieved November 2012, from Agricultural Pesticides and Biocides: Risk Indicators: http://www.oecd.org/env/chemicalsafetyandbiosafety/agriculturalpesticidesandbiocides/pesticidesriskindicators.htm

OECD. (2005). *OECD Environmental Indicators.* Paris, France: OECD Publishing.

OECD. (2012). *Report of the OECD Workshop on IPM (Strategies for the adoption and implementation of IPM in Berlin, October 2011: ENV/JM/PEST(2012)3.*

OECD. (1999). *Report of the OECD/FAO Workshop on Integrated Pest Management and Pesticide Risk Reduction: ENV/JM/MONO(99)7.*

PAN Europe. (2003). Reducing Pesticide Dependency in Europe to Protect Health, Environment, and Biodiversity. Copenhagen, Denmark.

Robertson, M. J., Zehnder, G. W., & Hammig, M. D. (2005). Adoption of Integrated Pest Management Practices by South Carolina Cotton Growers. *Journal of Extension , 36* (6).

Sarandon, S. J., Zuluaga, M. S., Cieza, R., Gomez, C., Janjetic, L., & Negrete, E. (2006). Evaluacion de la sustentabilidad de sistemas agricolas de fincas en misiones, Argentina, mediante el uso de indicadores. *Agroecologia , 1*.

Swinton, S. M. (2003). Economic Assessment of IPM Programs. *4th National IPM Symposium.* Indianapolis.

Swinton, S. M. (2003). IPM Assessment and Risk: Framing the Issues and Vocabulary. *4th National IPM Symposium.* Indianapolis.

US Federal IPM Coordinating Committee. (n.d.). Retrieved September 2012, from http://www.ipm.gov/logicmodels/samplemeasures.cfm

Van Den Berg, H., & Jiggins, J. (2007). Investing in Farmers—The Impacts of Farmer Field Schools in Relation to Integrated Pest Management. *World Development , 35* (4), 663–686.

Vandeman, A., Fernandez-Cornejo, J., Jans, S., & Lin, B.-H. (1994). *Adoption of Integrated Pest Management in US Agriculture.* Washington DC: USDA.

Waldner, W., Varner, M., Mattedi, L., Marani, G., Melandri, M., Pradolesi, G., et al. (2011). Pheromones Biological Pest Prevention in Modern IPM. *OECD Workshop on IPM*. Berlin, Germany.

Wearing, C. H. (1988). Evaluationg the IPM Implementation Process. *Annual Review of Entomology , 33*, 17-38.

Other sites of interest
http://ec.europa.eu/environment/ppps/pdf/final_report_ipm.pdf

http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/Code/Policy_2010.pdf

http://www.fao.org/docrep/006/ad487e/ad487e00.htm

http://www.vegetableipmasia.org/docs/IA%20Guidance%20on%20Double%20Delta.pdf

http://www.vegetableipmasia.org/docs/EIQ%20Guidelines%20Fin.pdf

http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTARD/EXTPESTMGMT/0,,contentMDK:20631451~menuPK:1605318~pagePK:64168445~piPK:64168309~theSitePK:584320,00.html#Principles

http://ipmprime.org/cigipm/

APPENDIX 1

IPM ADOPTION MEASUREMENT METHODOLOGY USED IN HOLLINGSWORTH 2001.

In this 2001 paper, Craig S. Hollingsworth and William M. Coli present a mechanism for measuring IPM adoption at a large scale via surveys handed out to farmers.

In order to measure the adoption of IPM, the authors gather survey data from sweet corn, strawberry, apple, and potato growers in the United States. Taking each crop type separately, specific management practices are identified as Integrated Pest Management techniques. These practices then add up to the total "practice points" for a specific crop. Examples of total practice points per crop type are: 275 (sweet corn), 225 (strawberry), 230 (potato), and 235 (apple). Given these total practice points and the different crops, the survey data for each grower is then compared with the total in order to classify them into three categories according to level of adoption:

1. Low (bottom 1/3 of the points)
2. Moderate (1/3-2/3 of the points)
3. High (2/3 to maximum points)

By following this classification, the measure of IPM adoption is relative, rather than absolute. In other words, this measure makes it possible to compare IPM adoption among growers and regions regardless of the crop type. Moreover, the authors suggest it is more reliable than farmer self-assessment, which can lead to confusing results and might over-estimate actual IPM adoption.

APPENDIX 2

A FIELD PRACTITIONER'S GUIDE TO THE ECONOMIC EVALUATION OF IPM. FLEISCHER 1999, FAO.

This report presents a multi-criteria framework for the measurement of Integrated Pest Management adoption and impact. This framework includes the analysis of IPM impacts through the use of Cost-Benefit Analysis (CBA), Internal Rate of Return (IRR), and Contingent Valuation Methods (CV). Even though these methods are more micro-oriented and difficult to apply at a large scale, they have important insights for evaluation of IPM adoption and impact.

When considering costs and benefits of IPM programs, it is important to identify all agents affected in the process. This is a preliminary step to identifying and designing all relevant indicators. According to the authors, three levels of costs and benefits must be considered:

- As they affect the farmer
- As they affect the interim institution (if there is a training program involved)
- As they affect society as a whole

Benefits of IPM

At the farm level, multiple benefits can be easily identified: reduced expenditure on pesticides, variation in crop yield, product quality, increased market price, decreased occupational health hazard, impacts on soil fertility, and reduced health costs associated to the use of pesticides. However, benefits can also be calculated at the society level, as not only farmers are affected by Integrated Pest Management.

At the societal level, mostly health benefits are relevant: reduced health hazard of food, reduced health hazard to pesticide applicators, reduced pollution of ground and surface water, and reduced danger of biodiversity loss.

Contingent Valuation benefits: other benefits associated to IPM might be even more difficult to include in an economic analysis. These benefits can be monetarized by using contingent valuation methods. These benefits can include: value of improved health, increased self-confidence of farmers, increased knowledge, and more community initiative. Generally, these costs and benefits can be quantified by asking those affected by a policy how much they would have paid to obtain (or avoid) the mentioned service or policy. However, these can be difficult and costly to measure.

Costs of IPM

At the farmer level, costs of IPM can be divided into *direct* and *indirect* costs. In the case of indirect costs, these can be classified into pre-planting (land preparation, weed control), planting (seed cost), post-harvest (costs of labour and material), and off-field costs. In terms of direct costs, farmers can face the opportunity cost of attending training (what they could have earned if they chose to work instead of attending a training session), the costs of farming inputs, health costs, opportunity costs associated to health (value of work missed due to health reasons).

The costs to society as a whole are mainly borne by the interim institution (if there are IPM training sessions organized). In this case, the cost of training, organizing workshops and administration must be taken into account. In more general terms and concerning other agents of society (such as the government

and private companies), we must also take into consideration the costs of carrying out IPM related research and monitoring and evaluation costs.

Time and economic evaluation of IPM

When attempting to calculate the economic impact of IPM, it is important to take timing into consideration. For example, certain IPM projects might not be profitable for the first few years but then obtain profits after that (mainly due to fixed costs of adoption). This is usually considered in analysis by using the Internal Rate of Return to see if the project is profitable in the long run. This concept could provide some insight into analysis of IPM adoption and impact.

APPENDIX 3

GREEN GROWTH INDICATORS AND THEIR RELATION TO IPM

In the context of an ongoing horizontal project at OECD on Green Growth, recent work has been developed on Green Growth indicators, presented in the report "Towards Green Growth: Monitoring Progress: OECD Indicators". IPM has been identified as a potential future component of Green Growth and therefore IPM indicators could fall within the scope of Green Growth indicators. To this day, four indicator groups have been identified:

1. Indicators of environmental and resource productivity of the economy (is growth becoming greener?)
2. The natural asset base (is there a risk of future shock to growth?)
3. Indicators of environmental dimension of the quality of life (how the environment affects people)
4. Economic opportunities from environmental considerations and policy responses (how green helps growth and employment)

We have identified indicator groups 3 and 4 as possible categories for IPM indicators. In particular, IPM could fit into the following topics defining each Green Growth indicator:

- Environmental health and risks (category 3).
- Technology and Innovation (category 4).
- Regulations and management approaches (category 4)

More information can be found in: OECD (2011), *Towards Green Growth: Monitoring Progress: OECD Indicators*, OECD Publishing. http://dx.doi.org/10.1787/9789264111356-en

ANNEX 7: List of presentations

Please refer to separate publication for full Annex 7
ENV/JM/MONO(2014)7/ADD

OECD Seminar on IPM Indicators
Tuesday 27 November 2012, Queenstown, New Zealand

Presentation 1
OECD: IPM indicators: where are we?
by Beatrice Grenier, OECD Pesticides Programme

Presentation 2
Germany : A scoring system for IPM evaluation on demonstration farms in Germany
by Silke Dachbrodt-Saaydeh, Julius Kühn Institute (JKI)

Presentation 3
New Zealand: Sustainability initiatives in New Zealand horticulture
by Jim Walker, Plant & Food Research

Presentation 4
Pesticide industry: Measuring IPM: a tool for measuring uptake and identifying gaps
by Keith Jones, CropLife International

Presentation 5
US: IPM: Answering the "So what?" question
by Tom Green, IPM Institute

Presentation 6
BioPesticide industry: How the biocontrol industry contribute to and view IPM indicators
by David Cary, IBMA

Presentation 7
Australia: Exploring the potential IPM indicators for Australia
by Bronwyn Walsh, Department of Fisheries and Agriculture Western Australia

Presentation 8
Grower association from Canada: Food Systems 2002, IPM Approach and Evaluation, Ontario Canada
by Craig Hunter, Ontario Fruit and Vegetable Growers' Association

Presentation 9
IOBC: Guidelines for Integrated Production and Endorsement' performance indicators
by Barbara Barratt, Global IOBC

Presentation 10
Germany: An approach to use the environmental risk indicator SYNOPS for the assessment of IPM "performance" on regional level
by Silke Dachbrodt-Saaydeh, Julius Kühn Institute (JKI)