SCAR
Standing Committee on Agricultural Research

- Report -

SCAR Collaborative Working Group on integrated pest management for the reduction of pesticide risks and use

ANALYSIS OF RESEARCH AND EXTENSION NEEDS FOR THE DEVELOPMENT OF IPM

Final report of a survey conducted among European countries

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Version 1.0

Based on responses from Member States and contributions from SCAR IPM WG members compiled by Laure Elliott-Smith, Marco Barzman and Antoine Messéan (INRA)

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Abbreviations and definitions

DSS: Decision Support System
Ecophyto: The French National Action Plan
IPM: Integrated Pest Management
MS: Member States
MRL: Maximum Residue Level
NAP: National Action Plan
Pests: collectively refers to animal pests, weeds and plant pathogens
PPP: Plant Protection Products

AT: Austria
BE: Belgium
BG: Bulgaria
CH: Switzerland
CY: Cyprus
CZ: Check Republic
DE: Germany
DK: Denmark
EE: Estonia
EL: Greece
ES: Spain
FI: Finland
FR: France
HU: Hungary
IE: Ireland
IT: Italy
LT: Lithuania
LU: Luxembourg
LV: Latvia
MT: Malta
NL: Netherland
NO: Norway
PL: Poland
PT: Portugal
RO: Romania
SE: Sweden
SI: Slovenia
SK: Slovakia
TR: Turkey
UK: United Kingdom

A. BACKGROUND, INTRODUCTION AND METHODS

I. Background

In early 2011, the French Ministries of Agriculture and Research proposed the creation of a Collaborative Working Group (CWG) on Integrated Pest Management (IPM) under the Standing Committee on Agricultural Research (SCAR) umbrella. The goal of this new CWG is to facilitate a European-level process in support of national policy, research and extension strategies enabling the development of low pesticide-input pest management in accordance with Directive 2009/128/EC, in particular with respect to article 14 and taking into consideration the potential of new areas of research and innovation.

More specifically, the specific goals of the CWG are to:

- Provide a European forum for exchange and needs on research priorities to design cropping systems reducing pesticide risk and use and to facilitate transition to such innovative systems;
- Contribute to the development of NAPs by facilitating sharing of national experiences on pesticide-related policies;
- Support the definition and implementation of national research programmes dedicated to the development of Integrated Pest Management strategies and coordinate national actions where feasible;

As Member States are involved in developing National Action Plans (NAPs), many perceived the CWG as an opportunity to learn from each other and on the longer term to identify, plan and share joint research and development initiatives. Representatives from 17 EU Member States and Associated Countries joined the new CWG entitled “Integrated Pest Management for the reduction of pesticide risks and use” which was launched in May 2011.

II. Introduction and objectives

At its first meeting, May 2011, as a preliminary step prior to identifying possible areas of collaboration, participants decided to conduct a Europe-wide survey to map out existing relevant policies, ongoing research and extension programmes and initiatives designed to support IPM implementation.

The goal of the survey is to provide information that will serve to identify research and development needed to support NAPs, and IPM in particular, to assess the added value and opportunity of jointly addressing needs and finally, to make recommendations on coordinated cross-national research initiatives.

This report includes the analysis of the survey conducted by the Member States on the evolution of IPM research. It also includes general recommendations on priority research areas to be launched at the European level.

The outcomes of the survey and ensuing discussions and analysis need to be translated into coordinated actions as soon as possible to ensure synchrony between the development of NAPs and

actual in-the-field implementation. Indeed, the Framework Directive calendar called for NAP completion by December 2012, establishing the measures and conditions for IPM by June 2013, and ensuring widespread implementation of IPM by January 2014.

The information used in **this report only includes those elements received by October 2012**. Since then, new information might have been provided by Member States (e.g., NAPs submitted to DG Sanco) which has not been analysed.

III. Methods

A survey was carried out among European countries, with a questionnaire whose answers have been further completed by phone interviews and other information resources.

a. Survey design

A core group from DE, DK, PL, IE, UK and FR in the CWG designed the survey. The scope covers the current situation on plant protection policies implementing existing and planned NAPs as required by the "Sustainable Use Directive" 2009/128/EC as well as associated research and extension relevant to IPM. The group developed a survey questionnaire comprised of 4 parts:

1. Overall policy situation
2. Research
3. Extension and advisory services
4. Evaluation

The cover letter and full questionnaire are provided in Annex I. The questionnaire was sent by email on July 20, 2011 to 38 national recipients, covering all European Member States and a number of Associated Countries.

b. Information resources

E-mail survey:

By November 2011, 17 national responses were received. The respondents were: AT, BE, CH, CZ, DE, DK, EE, ES, FI, FR, IE, NL, NO, PL, SE, TR and UK. IT and HU are members of the CWG who did not respond. Other non-respondent EU 27 MS include BG, CY, EL, LT, LU, LV, MT, PT, RO, SI and SK. The quality of the responses varied. Most were comprehensive and clear, a few (ES and AT) were incomplete regarding the thematic scope of the responses or failed to provide a national synthesis. Apart from providing information upon which potential joint actions can be identified, the survey also generates secondary benefits. For example, the process of responding to the questionnaire stimulated the interest of several countries (NO, SE, FI, EE for example) not members or not active in the CWG. Another side benefit is the body of information collected which constitutes a valuable resource that can be made available beyond the CWG.

Telephone Interviews:

In April 2012, we contacted by e-mail 31 persons from 20 countries. We asked them their availability for a phone interview about specific aspects depending on the previous answers of the e-

mail survey. We also attached the "Preliminary Report on Research needs to support IPM for the reduction of pesticide risks and use" and the "Outline of analysis of research and extension needs for the development of IPM". We had answers from 19 persons from 15 countries (BE, CH, CZ, DE, EE, ES, FI, HU, IE, IT, NO, PL, PT, SE, TR) and we interviewed 14 persons on the phone (BE, CH, CZ, DE, EE, ES, FI, IE, IT, NO, PL, PT, SE). This added Italy and Portugal to our set of respondents.

The phone interviews were based on the outline with complementary questions depending on the results of the previous survey (e-mail survey). They took place from May 9th until 23rd May. The average length of the interviews was 35 minutes, and every phone conversation generated enthusiasm and interest to give the additional information.

DG Sanco questionnaire:

In some cases, we also refer to the October 2011, "Draft Sustainable Use Directive Survey on State of the art 1st semester 2011" conducted by DG Sanco and submitted to 27 MS of which 20 responded. The questionnaire used in this survey addresses the general state of advancement vis-à-vis each measure required by the Framework Directive, whereas the SCAR CWG questionnaire focuses on research and extension pertinent to IPM.

Workshop report of the EU expert meeting:

A meeting on NAP on sustainable use of plant protection products took place in Berlin, June 5-6, 2012. At this meeting convened by the German Ministry of Agriculture, EU experts shared information on the implementation of the sustainable use directive 2009/128/EC, focusing on the status of development and main areas of action within their national action plans. In some cases, we used information from this meeting to complete our report or to add countries for which we didn't have responses, this is indicated by a footnote.

c. Analysis

We first conducted an in-depth analysis and a follow-up of the e-mail survey to rank and more specifically identify the needed research topics that are common to several MS and the added value of jointly addressing research. During the second meeting of the SCAR CWG on IPM in November 2011, we defined the most important topics to develop. The phone interviews completed the previous e-mail survey and allowed us to set the following topics which we develop in the report:

- Current national policy contexts
  - Overview
  - Policy goals
  - National IPM research programmes
  - Research related to evaluation of national policies and of research programmes

- Research and extension: state of the art and needs
  - Indicators
  - Monitoring systems and decision-making
  - Cropping system
  - Control methods
  - Managing pest evolution
  - Social aspects, economics and evaluation
  - Extension

Where pertinent, we refer to past and current initiatives such as outputs from the European network ENDURE[1].

The SCAR CWG held its third meeting, June 11-12, 2012 in Brussels and discussed the preliminary results of task 1. This report also includes the discussion and conclusion of that meeting and associated e-mail exchanges and discussions among the French coordination team.

[1] http://www.endure-network.eu/

B. CURRENT NATIONAL POLICY CONTEXTS

The new legislative framework has created a demand among policy advisers and research programme owners and managers for periodical exchange on national programmes and experiences.

I. Overview

In general, we find a widespread and high level of mobilisation among both Member States and associated countries regarding policies and programmes to reduce pesticide use and risks and to promote IPM.

All respondents, including associated countries (i.e., CH, TR, NO) indicated that crop protection and IPM in particular is a current and pertinent national policy question. They either currently have such a national policy in force or are working on it. Our study (May 2012) identified 8 out of 18 countries with agreed-upon national targets, seven of which are quantitative. Estonia, Poland and the United Kingdom indicated that quantitative targets are planned.

The survey conducted by DG Sanco indicates a similar situation where 8 out of 20 MS consider they have their National Action Plan finalised or close to finalisation with 5 out of 20 MS having adopted national quantitative targets.

IPM figures prominently in most national policies with an explicit reference to it (BE, CH, IT, NO, PL, SE, TR) or in some cases, it is part of a much broader policy (Norway with a programme on sustainable innovation throughout the food chain, or Denmark within the economic policy Green Growth). We have found some countries with an explicitly IPM-dedicated research programme. The DG Sanco survey reports that 16 out of 20 MS consider that measures to promote IPM are already in place and 8 out of 20 MS are planning to strengthen existing ones. Significant IPM-specific research or extension programmes are found in several countries (DK, NO, SE, TR). In its responses, Ireland emphasises past disappointment with IPM and the need to adapt it to the steady temperate and wet Irish conditions.

Key facts on National Action Plans for 22 European countries are provided in Table 1.

Table 1: National Action Plan at-a-glance[2]

Country	Start and end date of Ntl Programme	Do you have a national crop protection policies dedicated to pesticide use or risk reduction in force?	Do you have a national policy programme specifically dedicated to IPM?	IPM focus
AT[3]		In progress		
BE	2005-2012	Yes	No	at regional level
BG		In progress	Yes	Encourage IPM
CH	started 2008	Yes	Yes	IPM became standard
CZ[2]	2012-2020	In progress (2017-2020)	In progress	
DE	2008-2020	Yes	Yes	Within agri-environmental programmes
DK	2009-2013	Yes	Yes	Have dedicated IPM advisory programme
EE	none at this time	No	No	Estonian Plant protection Act with IPM principles
ES	2007-2012 In progress the new National programme: 2013-2016	Yes	No	No specific IPM focus
FI	started 2011	Yes	Partially dedicated	Have 9 demo farms on IPM and IPM dissemination efforts
FR	2008-2018	Yes	Yes	Most of the Ecophyto 2018 plan targets IPM
LT[2]		In progress		
LV[2]		In progress		National strategy for good agriculture practice and IPM system
IE		In progress	No	No specific IPM focus
IT		In progress	Partially dedicated	1 of 4 working groups in the national policy is dedicated to IPM
IT (Emilia Romagna)	L.R. 28/98; PSR – Rural Development Plan 2007-2013			
NL	ended 2010 - new one starts 2013	Yes	No	under discussion
NO	2010-2014	Yes	Yes	IPM focus until 2014, not clear after

[2] Based on available information in October 2012 – see the following website for up-to-date information http://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/national_action_plans_en.htm

[3] Information from the workshop report of the EU Expert Meeting on National Action Plans on Sustainable Use of Plant Protection Products (June 5,6, 2012).

Table 1 (continue): National Action Plan at-a-glance[4]

Country	Start and end date of Ntl Programme	Do you have a national crop protection policies dedicated to pesticide use or risk reduction in force?	Do you have a national policy programme specifically dedicated to IPM?	IPM focus
PL		In progress	Yes	IPM principles within the Integrated Production system
SE	2010-2013	Yes	No	No specific IPM focus
TR	Veterinary services, plant health, food and feed law initiated in 2010	Yes	Yes	Emphasis on biological control in IPM
UK	Pesticides Strategy updated annually	Yes	Yes	Under generic arable and horticultural policy

II. Policy goals

To assess whether joint research would be of significant benefit to the implementation of national policies on crop protection, the SCAR CWG needed an overview of the policy goals. The intent is not to discuss the merits of goals and targets but to gain a better understanding of various policy contexts.

Results show a great diversity of goals across Europe as well as differences in timetables for implementation. DG SANCO is publishing European NAPs as they are coming in (http://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/national_action_plans_en.htm).

The types of goals, and presumably the focus of the national policies, vary greatly. They sometimes refer to reduction of overall use (FR), risk reduction (CZ, DE, FI), reducing dependency (FR, NO, UK) environmental impact (BE, DK), water quality (SE, CH), health (BE) or may also cover all the above (TR). In some cases the goals focus on learning (NO, SE) and adoption of alternative techniques (UK).

Table 2 shows the quantitative and qualitative policy goals.

[4] Based on available information in October 2012 – see the following website for up-to-date information http://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/national_action_plans_en.htm

Table 2: Policy goals[5]

Country	Current quantitative national target	Qualitative goal
AT[6]	9 regional plans each with own target	9 regional goals planned
BG[3]		Training for users, risk reduction, reduction of exceeding of MRLs, encourage IPM
BE		Reduction of risk but not focused only on agriculture, but also gardens (ex. water herbicide contaminant from individual gardens).
CH	No impairment to health + environment + max. 0.1µg AI/l drinking water +max. 0. 1µg AI/l surface water	Reduction of risk to the environment
CZ[3]	10% residue reduction in plant commodities + reduction of underground and surface water residues.	Reduce risk of use of pesticides in protection of human health, water protection and protection of environment. Pesticide use optimisation with maintenance of scope and quality of agriculture production
DE	25% risk reduction (1996/2005-2020)	Reduction of domestic and imported food and feed products exceeding the existing MRLs (<1%)[2]
DK	2009-2013 NAP: reduce pesticide impact index from 1.7 to 1.4 2013--2015 NAP: reduce Pesticide Load Index by 40% relative to 2010	Preventing pesticides from leaking into the groundwater Balanced information about MRLs for consumers[2] Consumers should have access to balanced information on pesticide residues in food Excess of the MRL in food on the Danish marked should be reduced from the present level of 2-4% Reduction of the risks of workers No excess of pesticide limits in groundwater All professional use of pesticides follows the principles of IPM
EE	Will not be in terms of limits of volume or frequency 7 chapters of NAP on: training, advice, awareness raising, use of plant protection products, equipment testing, integrated pest management, indicators.	Increase awareness and training for risk reduction[2]
ES		Food safety and quality, productive and sustainable agriculture, Natural Resources, Marine, sea and inland waters Research
FI	Decision not to have quantitative targets[3]	Reduce risks posed to human health and the environment. Reduce dependency on chemical plant protection Reduce health and environmental risks Raise awareness Promote IPM Introduce comparative assessment
FR	50% reduction in ppp use if possible (2008-2018)	
LT[3]	No specific target, i.e. general plan overall risk reduction	Indirect qualitative targets more based on achievements of single measures

[5] Based on available information in October 2012
[6] Information from the workshop report of the EU Expert Meeting on National Action Plans on Sustainable Use of Plant Protection Products (June 5,6, 2012)

Table 2 (continue): Policy goals

Country	Current quantitative national target	Qualitative goal
LV[3]	To be determined	Risk reduction connected with use of plant protection products
IE	No	
NO	Increase from 30% to 70% pesticide users with good knowledge of IPM and 50% to use IPM	Reduce dependency on pesticides + reduce health and environmental risk
PL	Goals will involve: percentage of plant origin food samples with ppp, residues exceeding MRL, percentage of animal origin food samples with ppp residues exceeding MRL, knowledge about IPM principles among farmers	
SE	0 residues in water + 100% growers applying Integrated Plant Protection or organic farming	Reduced risk + low residue levels in food + little risk for PPP users + development of sustainable cropping systems
TR		Protect public health and provide food and feed reliability considering environment and consumers
UK	New NAP in planning stage 2008 UK Pesticides Strategy on 6 actions: human health, water, biodiversity, amateur use, amenity use, availability	Encourage uptake of alternatives, use of integrated approaches and lower plant protection product dependency

III. National IPM research programmes

Table 3 provides responses regarding the presence of national research programmes on crop protection in general and specifically on IPM. Table 4 provides some details regarding the research questions addressed by current research programmes.

Table 3: Responses to Q 2 b and c on national research programmes

Country	Do you currently have a specific national research programme supporting an existing national crop protection policy dedicated to pesticide use or risk reduction?	Do you currently have a national research programme supporting the national policy programme specifically dedicated to IPM?
AT	Yes	Yes
BE	Individual projects	At regional and provincial levels
CH	Yes	Yes
CZ	Yes	Programme of the Ministry of Agriculture, 2013-2018, Comprehensive sustainable systems in agriculture "CSS". Ministry of Agriculture provided € 0.9 million from its budget, programme has been opened since March 2012
DE	Yes	Yes "on necessary minimum in ppp"
DK	Yes	Individual IPM projects
EE	No	Individual IPM projects
ES	Individual projects	Individual IPM projects
FI		Life project, Reducing environmental risks in use of plant protection products in Northern Europe
FR	Yes	Yes, 1- 1.5 M € allocated to Ecophyto-specific call for research proposals covering 2013-16 (total research budget for Ecophyto is significantly higher than this). In 2012, total R&D funding for Ecophyto Plan is €41 million, not including in-kind contributions from many participating institutions
HU	No	No
IE	Yes	Not specifically, but IPM approach incorporated where appropriate.
IT	In progress	
IT (Emilia Romagna)	Yes, at regional level	
NL	In progress	In progress

Table 3 (continue): Responses to Q 2 b and c on national research programmes

Country	Do you currently have a specific national research programme supporting an existing national crop protection policy dedicated to pesticide use or risk reduction?	Do you currently have a national research programme supporting the national policy programme specifically dedicated to IPM?
NO		IPM research is within a research programme called "The Food Programme" or "research programme on Sustainable Innovation in Food and Bio-based Industries"
PL	Yes	Yes most of research topics are dedicated to IPM
SE	Yes	Yes, start in 2014
TR	Yes	Individual IPM projects. Current IPM research programme budget is 470 000€ for 2012.
UK	Yes	No, but part of the funds

Table 4: Responses to Q 2 b and c on main national research areas

Country	Name the five most important research areas under the national research programme. Name the five most important research areas under the IPM focus of the national research programme
AT	2011-2015: - Soil born diseases and protection management - Research on phytosanitary pests in cooperation within EUPHRESCO ERA-Net - IPM in arable farming and horticulture - pesticide use and environmental risk reduction
CH	- sustainable or even pesticide-free plant protection strategies - selection/identification of disease resistant or robust cultivars - test of crop rotation systems by annual crops - production of green fodder without or with very limited use of pesticides - influence of non-cultivated areas on biodiversity
CZ	(individual projects) - new plant protection strategies - resistance of different hosts to pathogens - resistance of pathogens to pesticides - methods of detection of pathogens - decision support systems - standard method for detection of residues in food resources, fodder for livestock, water and soil - development of method for risk assessment resulted from PPP´s use
DE	Within the "Innovation Promotion Programme", only projects that contribute to the necessary minimum in plant protection and to risk reduction will be supported. Examples of themes in focus: - Improvement of pesticide resistance management - DSS, GIS based measures, precision farming - Plant protection equipment and measures in particular with respect to loss and drift reduction, savings of pesticides, and resource protection - Methods for targeted identification of host-pest/diseases/parasite interactions and resistance mechanisms of plants against pests and diseases - Methods for fast identification of plant protection products in particular with respect to counterfeit products - Innovative structures for networking between partners to speed up technology transfer into practice.
DK	Most important research areas in 2011: - Environment – Water: Effects of pesticides in streams, lakes and groundwater - Environment – Nature: Fate and effects of the use of pesticides on the biodiversity of arable lands and nature - Indicators for the harmful effects of plant protection products - Research initiatives on IPM, developing decision support system and alternative plant protection products
EE	National agricultural research and development programme (2009-2014). In 2011, two plant protection projects closely related to IPM: - Development of an internet based decision support system in plant protection - Study chemical and mechanical control of weeds on field crops

Table 4 (Continue): Responses to Q 2 b and c on national research main areas

Country	Name the five most important research areas under the national research programme. Name the five most important research areas under the IPM focus of the national research programme
ES	Not a national research programme but have projects with three priorities: - Improvement of production and products processing in agrifood sector, - Production and processing of safe, healthful and high quality products, - Agricultural production in the context of environmental conservation and integrated land use. Only 34% of priority lines aimed IPM. - Plant-protection diagnosis - Epidemiology and integrated control of pests and diseases - Current and emerging models for reduction effectiveness, efficiency and accuracy in the use of pesticides.
FI	- Support the development and updating of NAP - Find benefits and weaknesses of IPM methods - Devising a co-operation network on plant protection nationally and in the Northern Zone - Decreasing the amount and frequency of PPP leaching - LCA and CSR; pesticide influences in food chain
FR	Priority research items under Ecophyto 2018: - Implementation and validation of indicator series: farming practices-burden-impact - Improvement of the monitoring network by addressing absence of thresholds, extending it to cover beneficials, weeds and emerging pests, exploring the body of knowledge underpinning the network, identifying ways in which other approaches to pest management, observation methods, and technologies could be integrated into the system - Follow up on non-intentional effects on useful biodiversity - Design, develop and evaluate DSS integrating a diversity of levers - Production of references within the network DEPHY[7]
IE	- Identifying changes in fungal pathogen sensitivity to fungicides in key cereal and potato diseases - Determining the genetics that underpin sensitivity change /resistance development - Development of comprehensive disease control strategies appropriate for our climate, crops and changing pathogen populations - Evaluation of Cereal breeding lines for improved disease resistance to Septoria and associated molecular studies to aid incorporation in future cultivars.
IT	At the moment the main research areas for what concerns the project funded by the Ministry of agricultural food and forestry policies are the following: - Development of sustainable plant protection systems - Genetic improvement for introduction of resistance in several crops - Development of diagnostic protocols for emerging diseases - Pest risk analysis

[7] Demonstration, Experimentation and reference Production on PHYtosanitary efficient systems.

Table 4 (Continue): Responses to Q 2 b and c on national research main areas

Country	Name the five most important research areas under the national research programme. Name the five most important research areas under the IPM focus of the national research programme
IT Emilia Romagna	- Plant protection strategies for vegetable, fruit crops, grapes and arable crops - Resistance of main pathogens and pests to pesticides - Methods of detection/monitoring of pathogens/pests - Finding new methods that combines preventive, physical and chemical methods to control pests and diseases - IPM crop specific guidelines - Biological Control - Toxicological and Ecotoxicological - DSS for forecasting model of diseases
NO	- Programmes answer to a short term need in the agricultural sector
PL	- IPM crop specific guidelines - Decision support systems in plant protection adapted to Polish conditions - Analysis of statistic data concerning use and trade of PPP - Analysis for PPP residues presence in crops - Protection of minor crops - Pests resistance to PPP
SE	- Finding new methods that combines preventive, physical and chemical methods to control pests and weeds - Developing of decision support systems and thresholds - Developing strategies that take into account the properties of the pesticides - Developing systems that take full advantage of cultivar properties
TR	- Integrated Pest Management - Biological Control - Biotechnological Control - Toxicological and Ecotoxicological - Forecasting
UK	- Integrated control of pests, diseases and weeds in the main arable, vegetable, fruit and protected crops to reduce use and environmental impacts from pesticides - Biological pest control by natural enemies - Find alternatives, following impending withdrawal of some crop protection products, across a broad cross-section of UK crops

IV. Research related to evaluation of national policies and of research programmes

Indicators serve many purposes at many different levels. They can be used to reflect any element of the causal chain that links human activities to their ultimate environmental impacts and the societal responses to these impacts (DPSIR: Driving forces, the resulting environmental Pressures, the State of the Environment, Impacts resulting from changes in environmental quality and societal Response to these changes in the environment)[8].

They are mentioned here because they can be used to evaluate national policies and research programmes. In some cases global indicators of national programmes relate to research needs, for example if the indicators themselves and the evaluation procedures need to be further developed. Indeed, some countries are starting from scratch while others are already using large scale aggregated indicators. That is why MS with little expertise on this topic showed a keen interest in sharing information and experience.

At the European level, the project HAIR[9,10] (HArmonized environmental Indicators for pesticide Risk) proposed that all MS simultaneously use 19 different risk indicators. The intent is to calculate trends in aggregated risk at national scale in support of the evaluation of EU policies, based on compound properties from EFSA and pesticide sales and usage from EUROSTAT databases. At the SCAR CWG meeting, it was noted that this approach may be excessively demanding in terms of the required inputs and investments. In any case, DG Sanco will provide a list of potential risk indicators that could be used across Europe.

Future efforts could focus on risk indicators or on any broad and pertinent programme evaluation procedure and assess which research might be needed to increase their relevance to support policies and facilitate their use in practice.

[8] see for example http://www.eea.europa.eu/publications/TEC25 , the DPSIR model from the European Environment Agency
[9] http://www.hair.pesticidemodels.eu/home.shtml
[10] http://bit.ly/MJO6GQ

C. RESEARCH AND EXTENSION: STATE OF THE ART AND NEEDS

Table 5 provides a general overview of general research areas identified as research needs by respondents. These research areas are explored and analysed in further detail in sections I-VII.

Table 5: Responses to Q 2 e on research needs

	Where do you see the needs for additional research related to the mandatory implementation of IPM in the longer term?	**Countries**
Indicators	Impact indicators, environmental risk evaluation, economic indicators	DK, ES, FR, PT, TR
Monitoring systems and decision-making	Organisational set-up	BE, DE, DK, FR, PL, PT
	Modelling and decision-making process	CH, CZ, DE, EE, FR, FI, IE, PT, TR (PL&IE: DSS regionally adapted)
	Nature of data, frequency and density of data collection	CZ, EE, FR, PL, PT, SE
	Information systems	PL
Cropping system	Design and ex-ante evaluation of integrated solutions	FR
	Agronomic methods	EE, FI, FR, IE, PT, SE
	Cropping system experiments	FR, PT?
Control methods	Chemical control	CH, DE Minor uses : (CZ, PL, PT)
	Biological control agents, alternative products and landscape manipulation for crop protection	DE, ES, FR, IE, PL, PT, SE, TR
	Plant genetic resistance as a tactical option	CZ, DE, IE, PL, PT
	Mechanical control methods	
	Combining control strategies	AT, CZ, DE, PL
Managing pest evolution	Resistance to pesticides	CZ, ES, FI, SE
	Overcoming of plant genetic resistance	
	Emergence of existing and invasive pests, climate change	CH, DE, NO, PT
Social aspects, economics and assessment	Farm-to-fork strategy	CZ, DE, DK, ES, FI, FR, TR
	Interdisciplinary research	CZ, DE, FR, NO (others subjects, more on social aspects)
Extension	Co-innovation	CH, DK, IE, NO, PT
	Advice	Guidelines: CZ, DE, DK, EE, IT, NO, PL, TR… FI (advisors)
	Training	
	Information systems	
	Production of references	

I. Indicators

The development of indicators is of concern to all involved in NAP implementation. A particularly difficult question is the one regarding the relationship between use and impact. Considering the challenge, this could be an important research question to address jointly.
To enable country comparisons and information sharing, harmonisation of selected indicators is another potential area for joint action.

This study does not pretend to provide an in-depth insight into this complex issue. However, telephone interviews clearly showed widespread interest in the development and use of indicators. Most respondents also point out the challenge it represents. Many indicated work in progress regarding the development of indicators (CH, CZ, DE, FR, IE, IT). The types of indicators sought cover farming practices (e.g., via surveys, IE, FR), environmental burden (e.g., pesticide use BE, CH, FR, SE, UK) and impact (health and environment: BE, CH, DE, NO, SE, UK). Denmark has developed a new indicator, the "pesticide load index" which, compared to the TFI, also covers non-sprayed areas and is based on the inherent properties of active substances with respect to human health, non-target organisms and environmental fate. In some cases indicators already exist but need to be extended from local to national use (IT).

The respondent from Portugal indicated interest in harmonisation at the European level. Indeed there is great variation in indicators between countries. The European network ENDURE, when comparing fungicide use in wheat in four countries, found in 2010 that the methods used for collecting data and calculating the Treatment Frequency Index are different between the countries, and are based on sales data and representative surveys at farm level or national monitoring systems. In Denmark, it is based on sales data of active ingredients, whereas in France, Germany and England it is based on common practices assessed via official surveys or monitoring. Moreover, for some active substances, the standard dose used to calculate TFI also varies in each country. Obviously, to conduct precise and reliable comparisons, the same standard doses and methods of calculation are needed.

The harmonisation of indicators between countries may not be a priority but comparing the value of harmonised indicators would help MS learn from each other. DE and DK proposed to compare national strategies and indicators among the various Member States as a way to evaluate the impact of IPM implementation.

Furthermore, availability of indicators is a priority for DG Sanco as demanded by the Framework Directive on the sustainable use of pesticides[11]. Such comparisons would need to reduce geographical biases and explore the extent to which differences between countries are due to environmental conditions or to crop protection strategies.

[11] Article 15, Framework Directive states: "Harmonised risk indicators as referred to in Annex IV shall be established. […] The commission shall calculate risk indicators at Community level by using statistical data collected in accordance with the Community legislation concerning statistics on plant protection products and other relevant data, in order to estimate trends in risks from pesticide use."

The relationship between practices, burden, and impact is notoriously difficult to establish. In 2012, the French research plan addresses this question. Pesticides impact the environment through a complex process of transfer, storage, transformation, exposition, organism reactions, adaptation and evolution of populations and ecosystem change. These various processes progress at different speeds, with effects more or less deferred in time. The perception of impacts is temporally and spatially disconnected from the initial burden causing impact. As a result, there is a lack of correlation between data on burden and on impacts. On the farmers scale, pertinent indicators on burdens related to their own practices are needed, without these indicators farmers don't have frames to improve the way they manage the environment.

Research actions on this chain of indicators, should be addressed in order to end up with a comprehensive understanding of the relationship between practices, burdens and impacts, considering the necessary changes at different spatial and temporal scales and at different steps of the chain of processes.

Several countries have developed models to calculate risk according to pesticide use data[12]. The implementation of IPM practices would benefit from a better knowledge of the relation between individual practices and their contribution to environmental impacts/benefits at different time and space scales. This is an important research area for all programmes that will need to demonstrate that IPM does *in-fine* reduce environmental impact.

The main conclusion here is that it will be useful to conduct joint research on the relationship between practices and their contribution to environmental impacts and benefits at various temporal and spatial scales.

[12] SYNOPS; SYNOPS, I-PHY, PRZM; Pesticide Risk Mitigation Engine

II. Monitoring systems and decision-making

Programme managers face several new challenges regarding participatory data collection approaches and the centralisation of data and knowledge for better accessibility. This challenge points to a priority research need. Expertise from information sciences, social research and management sciences could help identify new organisational structures and information systems (including users).

Sharing pest monitoring data across borders was identified as useful, for example Diabrotica in the France-Germany or Poland-Germany areas. But differences in data requirements and languages represent challenges.

Considering that there is a high demand to improve monitoring and decision making, and that many emerging systems are already in place, this is probably one of the areas most ready for joint actions.

Note: In parallel to this study, another in-depth survey on pest monitoring system is currently in-progress within the framework of this same SCAR collaborative working group. The results from this other survey will eventually be merged with the current study.

a. Organisational set-up

The general trend emerging from the telephone interviews is increasingly toward the coordination of multiple institutions and actors to make in-season monitoring data widely available. In Finland, for example, a diversity of advisors, some from Proagria, a non-profit and non-governmental agency, and some from the governmental research-extension institute, MTT, pool their data into Kasper (www.mtt.fi/kasper), an internet system providing threshold, forecast and real-time pest information to all farmers and advisors. Sweden and Denmark have similar systems for in-season monitoring in place. In Norway, monitoring networks are not currently in regular usage but they are planned. Similarly in the United-Kingdom, in-season aphid monitoring is sponsored through a combination of Government, charitable and industry funding and is used to provide in-season bulletins of flight times, aphid abundance and virus incidence. The collection and centralisation of monitoring information from different institutions including farmers, for-profit and public sector should be improved with respect to both technical and intellectual property aspects. In France for example, there are several large-scale pest monitoring systems in arable crops (e.g., the one set up in 2009 with the production of weekly bulletins mentioned below, the "Performance" network on the wheat pathogen strains, and a trapping network on corn borers).

In some cases, state employees are the key agents carrying out the task of collecting data (CZ, PT). In all cases, there are private companies involved in monitoring who play an important role particularly where advisory services are entirely in the private sector (NL). When private companies are involved in monitoring, results are not always in tune with IPM. When promoting DSS, advisers may generate increased pesticide use due to associated economic interests. Also, the collection of valuable monitoring information may not always be available to public institutions. This underlines a

problem of knowledge transfer between institutions and also fails to generate enriched knowledge. The key question is on how to centralise monitoring information and make it quickly available to a large number of advisers and farmers.

In Italy, some information is organised at the regional scale, and the difficulty is to make it available at the national scale. In its efforts to set up an information system where all relevant information can be easily found in a single place, the French respondent highlighted the need to develop effective governance and mechanics of monitoring networks. In fact, many respondents called attention to the need for a web-based information system on IPM that is easy to find, easy to understand and helps farmers identify their pest problems and the control methods available (DE, DK, ES, FI, FR, SE). Beyond a web-based repository of information, some are calling for a web-based expert-system to help farmers implement IPM at the farm level (NO).

b. Modelling and Decision-making process

DSS are usually exploited for real time information but they can also provide information for longer term questions. With contextual information on cropping systems and farming practices, it becomes possible to interpret DSS tactical information and better understand a whole range of factors that affect pest population dynamics. The high price of specific information like weather data should be taken into account in the development of DSS.

Improvements with forecasting models and DSS are widely perceived to hold a high potential to help farmers optimise decision-making. Although many DSS have been developed, few are deemed satisfactory. The Irish respondent, for example, underscored the need to develop DSS for Septoria on wheat that are adapted to the particular Irish weather conditions. Work to improve DSS is widespread (CH, DE, DK, EE, FR, IT (Emilia Romagna), SE, TR, UK) and there is already some experience in multi-country coordination. DSSHerbicide[13], for example is a collaboration between Denmark, Germany and Poland. In another example, Estonia has established an online advisory system generated in collaboration with Denmark, Poland, Lithuania and Latvia.

France (INRA) is investing in an international research initiative aiming at a multi-criteria analysis on causes and consequences of crop losses. The initiative named DAMAGE thus addresses crop losses caused by agricultural pests and the consequences of crop losses with economic, ecological, and social standpoints.

Many respondents emphasized the determination of specific thresholds for each crop as a priority research need (BE, CH, DE, EE, FI, FR, IE, PL, PT, SE). Ireland specifically mentions the determination of robust thresholds as a research need. While it is true that sound threshold values are essential components for decision making and that they have an important role to play in IPM, it should be realised that they may fluctuate in time, may not always apply, may not always be available, and may not be sufficient. For example some of the responses underline difficulties with obsolete thresholds not adapted to the current production situation (BE), not adapted to local

[13] http://www.dssherbicide.eu/#

climatic situation (Septoria threshold in IE) and not adapted to the type of pest targeted (weeds in EE).

France is very much interested in improving on its already significant monitoring and decision support network. One part of the June 2012 ECOPHYTO-specific call for proposal focuses on the detection and identification of pests with molecular methods integrated within new protocols and data collection networks. With these new tools, France wishes to develop pre-symptomatic diagnostics and, potentially, new strategies to fight pests. Seven research areas are proposed:

- Develop of DSS that consider the consequences of different practices in a longer temporal perspective e.g. over the life span of perennial crops.
- Develop DSS explicitly accounting for practices acting on the plant status that might decrease plant susceptibility to pests.
- Epidemiological models to help farmers make local decision using regional observations,
- Design new types of thresholds or sets of "markers" which translate observations into indications of crop yield and quality, and pest population.
- Understanding how farmers come to a decision. Understanding the different ways the monitoring and decision support network and the weekly Bulletin de Santé du Végétal are used and how they influence farmer risk perceptions and behaviour.
- Exploiting the database beyond real time decision making to understand how changes in cropping-system, cultural and phytosanitary practices affect pest populations and how we can learn from the non-intentional effects of farming practices.
- Development of molecular tools to detect and identify pests: exploit the capacity of new technologies to improve the management and the efficacy of the monitoring and decision support network.

The ENDURE network conducted a review of 82 DSS across Europe and identified the best parts with the perspective of building new DSS concepts to be unified at a European level. This work has the potential to build simple and operational DSS, to cover diseases in potatoes, codling moth in pome fruit and weeds in maize[14].

Beyond the tools made available, the way the decision-making process is supported varies among respondents. Most programmes offering decision support (DE, ES, FI, TR …) provide advice that includes prescriptions on the optimal time of pesticide application. In many cases, DSS support explicitly aims at improving the use of PPPs (DK, FI). In the French government-sponsored monitoring programmes, however, care is taken to avoid prescriptions. Indeed, the French Bulletin de Santé du Végétale offers weekly information on the pest situation and an interpretation of it but carefully refrains from recommending treatments, or referring to active substances or products. This approach is designed to promote reflection and critical thinking on the part of users. The respondent from Portugal expressed support for the development of DSS designed for strategic rather than tactical decision-making.

[14] http://www.endure-network.eu/about_endure/all_the_news/dss_helping_farmers_make_smart_decisions

c. Nature of data, frequency and density of data collection

In 2009, France set-up a large nation-wide pest monitoring network. The system is designed to ensure quick detection of pests and make this information widely available. In 2012, 5,000 weekly bulletins generated by 3,826 observers from 11,805 plots were produced. They provide free information on pests. Most countries have an existing large-scale monitoring system (CZ, DE, DK, FI, IE, UK). In 2007, Portugal had to drastically reduce the number from 5,000 technicians who were monitoring, with the collaboration of farmers.

Many respondents wish to invest in harmonisation of data collection (CZ, FR), for the purpose of pooling the data and to better integrate them into a regional or national monitoring and surveillance network (BE, CH, DE Länder, EE, FR, NO). France has already started to standardize biological observation protocols on both pests and natural enemies regarding when, where and how monitoring is carried out.

Monitoring systems on weather for warning and forecasting are ubiquitous and usually well developed. However, the cost and availability of these data may represent a barrier. Also, data associating weather to pest incidence are sometimes available whereas data linking weather and pest populations to farmer practices are seldom available. These data sets are needed to provide an understanding of the relationship between these three factors.

Knowledge on the movement of pests along borders can help control invasive alien species. The development of cross-border monitoring to generate distribution maps of pests emerged as valuable investment. Work on the creation of new models valid for larger regions by sharing existing monitoring systems and models should be carried out.

Monitoring can also encompass data on undesired effects of crop protection. In the French Ecophyto programme, for 2012, the pest monitoring network is due to include observations on non-intentional effects of pest management on 500 fields. These observations will be on health and environmental impact, emergence of resistance to pesticides and new pest species, and overcoming of plant genetic resistance. Other non-intentional effects taken into account during decision making which were highlighted in the interviews include effect on natural enemies (BE). Exceptionally, impacts on honeybees (DE) or loss of plant genetic resistance against diseases (IE) is monitored over a limited period. Including this sort of data in DSS adds a strategic dimension to a tool usually used for short-term decision making. Switzerland explicitly emphasised the need for comparative field data on the impact of pesticides on non-target and beneficials as key information guiding IPM strategies.

Regarding resistance to pesticides, respondents were aware of the problem, but don't always monitor it or at least not in a planned way. CZ, ES, FI, IE, PL, SE, UK identify this specific issue as a research priority. The CZ web-based information system on IPM crop standards includes information on the risk of pest resistance to PPPs and on available anti-resistance strategies. Respondents from Finland underscored the high cost of monitoring resistance to pesticides.

d. Databases

On the website of the Swedish Board of Agriculture, there is a database with 1,2 million data collected since 1988[15]. This database also provides information on the present situation on different pests and diseases and detects early attack to increase awareness. It allows farmers to follow the development of attacks throughout the season. The data are also used to evaluate forecasting models.

In France, the monitoring network under Ecophyto is using protocols harmonised across all of France. All the data collected on pests are planned to be pooled into a unique database called EPIPHYT.

Regarding pest monitoring systems and decision making, several potential joint actions are identified. Improving sharing of monitoring information among farmers and for-profit and public sectors with respect to both technical and proprietary aspects would be helpful. There is an opportunity to harmonise monitoring protocols to compare data and create new models, especially in border areas. Collect information in epidemiological models, on pest but also on beneficials, and new technologies to improve the detection and efficiency of pest monitoring systems. Increase the biogeographical area where DSS are applicable by sharing and adapting them across regions. DSS are usually used for real time tactical decision making, however the idea of adapting them for longer term strategic decision making should be explored.

[15] http://www.ssd.scb.se/databaser/makro/start.asp?lang=2

III. Cropping system

The continuous use of a single method to control a given pest, be it the most favourable solution initially, will rapidly induce pest populations to evolve and overcome this method, whether a chemical one or not. That is why achieving lasting control requires work at the cropping system level and the combination of multiple control strategies. However, cropping-system research requires long-term studies which are expensive. This basic difficulty can be minimised if several European countries work together on this subject.

When referring to IPM most respondents looking at the actual practices involved refer to reduced dosage, frequency, choice of PPP, augmentative biological control, systems to identify optimal treatment time. Some respondents (IE, FR, PT, SE) also mentioned the need to manipulate the entire system or to combine a set of tactics.

Although this area may not yield results quickly, the types of results expected are key to devising more robust solutions. Initially, joint actions could involve sharing on, or coordination of existing cropping-system experiments.

a. Design and ex-ante evaluation of integrated solutions

Scientists at INRA, France's National Institute for Agricultural developed DEXiPM, a modelling program which makes it possible to conduct qualitative assessments of the sustainability of new systems using a range of criteria. In addition to evaluating existing cropping systems, it can also be used via an engineering design approach to assess the sustainability of virtual arable cropping systems, particularly integrated crop management systems with a limited use of pesticides.

This is a new concept, not familiar to most respondent but may constitute an interesting area of inquiry.

b. Agronomic methods

Several countries expressed interest in manipulating crop sequence as well as other agronomic practices with the aim of maintaining pest population at a satisfactory level. IPM principles and their application require a broad perspective on current farming practices, one that considers production through a systems approach for example referring to cropping systems rather than to individual crops. In fact, many of the levers that can be manipulated to achieve more robust agro-ecosystems are to be found at the cropping systems level.

A French study[16] concluded that to go beyond a reduction of 30% in pesticide use while maintaining high levels of productivity, system-level changes would be required. That is why the French National Action Plan emphasises the manipulation of agronomic practices as a lever for crop protection. As a consequence it has funded a number of experiments on crop sequence, sowing date

[16] http://www.international.inra.fr/the_institute/advanced_studies/ecophyto_r_d

and density, introduction of non-conventional crops, etc. Similarly, the respondent from Ireland expressed interest in better understanding the role of agronomic practices in pest management strategies, referring specifically to rotation, cultivation methods and nutrition manipulation, in particular to reduce disease pressure in cereals.

There is an interest in developing mechanical weeding as an alternative to herbicide use in arable crops (DK, DE, EE, FR). But, in their efforts to reduce reliance on pesticides, several countries noted the particular challenge caused by weed management. Indeed, weed management with reduced pesticide input is emerging as a bottleneck and the use of herbicides contributes significantly to overall pesticide use. The implementation to non-chemical solution to weed management tends to lead towards cropping system level changes. Alternative solutions[17], like mechanical control, require more time and are expensive. Rotation is also an answer but research is still needed. There can also be trade-offs between different objectives. For example, regulations for soil conservation, such as low-tillage methods, can cause higher herbicide use. These comments reveal potential conflicts between different control methods and consequently, underline the value to optimize weed management at the cropping system level.

c. Long-term cropping system experiments

Some countries have experience in systems experimentation**.** For example, our inquiry found example of well-established sites where systems experiment (i.e., where a number of factors are studied in parallel, in the field and over more than one year) are carried out regarding crop protection research questions in:

- Germany (Julius Kuehn-Institut) on field/arable crops in Braunschweig and Dahnsdorf
- Germany (Julius Kuehn-Institut) on apples and pears in Dossenheim
- France (Institut National de la Recherche Agronomique, CETIOM, Arvalis) on arable crops in Epoisses, Versailles, Grignon, Boigneville, Lyon and Sendets
- France (Institut National de la Recherche Agronomique) on apples and pears in Gotheron
- Denmark (Aarhus University) on field/arable crops in Flakkebjerg
- Italy (Scuola Superiore Sant'Anna) on arable crops in Pisa
- Poland (Institute of Plant Protection - National Research Institute) on wheat-based rotations in Winna Gora
- Sweden (Faculty of Natural Resources and Agricultural Sciences) on a diversity of tillage systems, nutrient losses, nutrient turnover and model development, rotations, and weed management
- UK (James Hutton Institute) on wheat-based rotations at Balruddery Farm

These typically test combinations of factors involving different crop sequences, varietal mixtures, weeding and soil management regimes.

A useful first step would be to share information and results on such cropping systems research and set up an EU-level network of IPM experiments. The added value will be to increase

[17] ENDURE leaflet on Integrated Weed Management

variability and save national efforts. On the long-term, experiments could benefit from coordinated objectives and protocols. One topic of interest would be to share the knowledge available on cultivars that can be used under IPM, and other tactics, in order to integrate them in an existing system or to combine them.

One obvious recommendation is to share information and results on cropping systems research and set up a EU-level network of IPM experiments. Managing weeds while adopting a low pesticide input approach is emerging as a major challenge. The recommendation here is to integrate sets of alternative weed control methods and address weed management at the cropping system level. To this purpose, model-based design of innovative strategies for integrated weed management in arable cropping systems should be address jointly.

IV. Control methods

When preventive measures, such as manipulation of cropping-systems, are not feasible or sufficient, direct control options become necessary.

Approaches involving chemical control, bio-pesticides and biological control, plant genetic resistance, mechanical control alternatives and their combination concern a large number of actors, a broad diversity of disciplines and usually imply a key role for the for-profit sector. Therefore, joint actions in this area need to be particularly multi-disciplinary, to be structured via public-private partnerships, and address multiple sectors of intervention including policy (e.g., rules for registration of biological agents or products and new cultivars).

a. Chemical control

Some programmes invest significant effort in encouraging farmers to resort to those PPPs that have reduced unwanted effect (BE, CH, DE, IT). For example, lists of preferred pesticides recommended within an IPM program are drawn up (CH, IT). In Belgium recommended PPPs are chosen according to the active substance. Germany is concerned about ensuring the availability of practical low-risk pesticides. In Italy, farmers have access to a database on PPPs that excludes the most toxic ones. This database provides information and recommendations on the use of each product.

When resorting to chemical control, precision farming techniques can significantly reduce pesticide inputs and their movement (CH, ES, NL). This is a fast evolving area of technological development.

Denmark has a long experience with using reduced herbicide and fungicide dosage to achieve significant reductions in treatment frequency. Appropriate and lower doses can be recommended as long as information on pest level, weed size, and canopy is included in decision-making. But even Danish researchers believe that true IPM should go beyond the mere reduction of dose rates.

It may be noted here that a range of crops not considered as “major crops” face the challenge of reduced pesticide availability for minor uses. In this case, research on PPPs is not well covered by commercial interest and should be addressed. Research and development and sharing information on low-pesticide input and Integrated Pest Management is therefore needed to reduce pesticide dependency of speciality and other minor use crops.

b. Biological control agents, alternative products and landscape manipulation

There is a need to ensure the availability of practical non-chemical alternatives (DE, FR, IT (Emilia Romagna) such as new bio-pesticides (ES), use of beneficial organisms (TR), and the machinery to deliver these products (ES) or release organisms.

The low availability of biological control products is identified as a barrier for their development. For example, their access is non-existent (IE, SE) or respondents indicate that too few agents are registered (BE: Flanders, FR, NO[18]). Here, the need for registration procedures for new low-risk products, such as fast-tracking, is inferred.

Turkey appears to have significantly invested in biological control approaches. It is calling for the development of more efficient biological agents, improvement in manipulating native biological agents. A number of respondents identified biological control as a priority research area (DE, ES, PL, SE, TR, UK).

Many identify the need for non-chemical alternatives presumably including bio-pesticides (DE, ES, PL, SE, TR).

Use of biological regulations of pest population at the landscape level to reduce pesticide dependency has been identified as a promising tool[19]. However, development of reliable and cost-effective measures is far from reality and joint effort might speed up emergence of practical solutions. Further research should be done on the exploitation of landscape management and habitat manipulation for the conservation of natural predators and consequently for bio-control methods. This type of research requires investment and European coordination could facilitate it.

c. Plant genetic resistance

The development and use of resistant and tolerant cultivar is recognised as a major component of IPM. Sometimes, appropriate resistant cultivars are available but farmers need to have more information to select their cultivars (PT). In general, it is widely pointed out that there is a need for research and development of new resistant and tolerant cultivars (CZ, DE, FR, IE, PL, PT, SE, UK). Research on plant genetic resistance can generate good results but it's an expensive task and requires time. Two options can be proposed: (i) focus on developing valuable varieties to be sure that the investment will generate profit or (ii) leave this research activity to industries because the SCAR CWG considers it is mainly of interest to the for-profits sector.

As in (b) above, policy changes may be needed, for example regarding the use of new criteria for the registration of new cultivars which take into account a broader diversity of cropping systems, or more generally which consider cultivars "in-situ".

[18] Annette Sundbye, NJF seminar 458, Tallinn, Estonia, 7-8 November 2012
[19] IOBC Working Group on Landscape management for functional biodiversity

d. Mechanical control

In some cases mechanical control methods are widely developed in organic systems (IT). There might be high benefits in adapting them to conventional systems. This approach is intimately associated with the design of cropping-systems.

e. Combining control strategies

The combination of control strategies focuses on interactions and complementarities between strategies with the aim of optimising IPM. Non-chemical methods often produce less satisfactory results relative to chemical ones, i.e., they can be considered as partial effect methods. They therefore need to be complemented or combined to generate synergies and yield satisfactory results. There is a realisation that the efficient combination of methods is a needed new field of research. Austria mentions the need to better understand interactions between plant genetic resistance, agronomy and pesticide use. Several respondents emphasized the value of the combination of control methods (i.e., plant genetic material, precision agriculture, biological control methods…) to reduce PPP use (CZ, DE, FR, IT (Emilia Romagna), PL, SE).

It should be noted here that the stepwise improvement of existing methods and the addition of single tactics will often lead to considerations involving the entire cropping system. In other words, this approach may be considered as a gradual path toward the development of cropping systems inherently less reliant on pesticides.

A promising area for joint research regards the exploitation of landscape management and habitat manipulation for the conservation of beneficials. Regarding the particular challenge of minor use crops, the general recommendation here is to diversify control methods.

Also many member states expressed their interest in bio-control methods, whether they are already involved in or plan to be. Research to develop efficient and reliable bio-control methods and then integrated them into IPM strategies, should be done jointly.

V. Managing pest evolution

The management of new or quickly evolving pests with respect to pesticide resistance or sustainable plant genetic resistance is a relatively new area widely recognised as deserving attention. However, there are few existing research initiatives and the required monitoring systems are not in place. New collaborations would therefore need to build on scant pre-existing resources.

Climate change and globalisation accelerate the rate of exotic pests establishing in Europe. At the same time, an accelerated rate of evolution of existing pest populations is observed. The European network ENDURE and the Institute for Prospective Technological Studies (IPTS) organised an international workshop in Brussels in November 2011 to identify critical research priorities and policies to better respond to such changes. The group concluded that it will be important to develop strategies that are dynamic and make use of diversity as a lever in crop protection to contribute to locally adapted cropping systems more resilient in the face of new and fast-evolving pests.

In the present study, respondents were aware of the problem and expressed concern over this issue. As for monitoring of non-intentional effects (see II.c), there is general awareness of the problem, but actually managing the evolution of pest resistance to pesticides or the overcoming of plant defences by pests is neither widespread nor systematic.

a. Resistance to pesticides

While a few respondents noted some existing systems to monitor the occurrence of resistance to pesticides, no existing significant actions to manage the phenomenon were mentioned. Nevertheless, many identified the latter as a priority research area (CZ, ES, FI, IE, SE, UK). The respondent from Ireland specifically called for research to "*elucidate the genetic changes responsible for decreased sensitivity of cereal fungal pathogens as well as potato late-blight pathogens to fungicides"*.

It can be mentioned here the existence of international initiatives specifically on this issue. The Pesticide Resistance Action Committees (RAC) IRAC, FRAC, and HRAC are industry-led international groups providing advice on the prevention and management of insecticide, fungicide, and herbicide resistance, respectively.

b. Overcoming of plant genetic resistance

There is a growing awareness that developing and using resistant or tolerant cultivars is not sufficient to ensure the sustained management of pests. As with pesticides, the way resistant or tolerant cultivars are used must also be taken into account to extend their lifespan. Some respondents (FR, NL, PL) have identified this issue as a research priority. Several Member States expressed their interest in research on modelling to ensure the sustainability of resistance. INRA, France's main agricultural research organisation, organised an international conference "Sustainability of Plant Resistance 2012" on the subject in Nice, France in October 2012. Also, the

European Foundation for Plant Pathology organised in October 2012 in Wageningen, The Netherlands, "IPM 2.0 – Towards future-proof crop protection in Europe", a conference inspired from pioneering work on the quick diagnostic of potato late blight associated with its management via the manipulation of cultivars.

c. Emergence of existing and invasive pests, climate change

It is widely recognised that climate change impacts many aspects of pest management and in particular the invasion and spread of new pests and their adaptation to native crops or changes in the behaviour of existing pests. Several respondents called for research to better understand and develop management responses to these changes (CH, DE, FR, IT (Emilia Romagna), NO, PT). France and Norway pointed out their participation in the Joint programming Initiative "Agriculture Food Security and Climate Change" (FACCE)[20].

The ENDURE-IPTS workshop mentioned above recommended collaborative efforts between two historically compartmentalised research communities: plant health (phytosanitary) and crop protection.

Indeed, the plant health community's approach is based on a three-step sequence:

1. prevent arrival of new pests
2. eradicate newly arrived populations to prevent permanent establishment
3. contain them to prevent spread to other regions

New collaborations between the two R&D communities would open up a new field of inquiry on how cropping systems can be manipulated to reduce risks associated with Invasive and Alien Species and rapidly evolving pest species within the context of climate change. One major player within the plant health research community is EUPHRESCO[21].

Pest Risk Assessment (PRA) is an important anticipation tool in this context. It identifies pest species that present the highest risk for European cropping systems. Linking crop protection researchers to PRA experts would make it possible to propose cropping system adaptations in advance or to conduct research on the ecological requirements and/or control options related to pest origins. Much progress could be made with PRA if it could be made more spatially explicit or based on "hotspots" or case-studies so that site-specific conditions affecting the likelihood of establishment are taken into account.

[20] http://www.faccejpi.com/

[21] http://www.euphresco.org/ EUPHRESCO is a network of European phytosanitary research funders which aims to increase cooperation and coordination of national statutory plant health research programmes.

The workshop identified existing initiatives on:

- the promotion of rotations to manage Diabrotica on maize in Hungary
- making use of opportunistic native natural enemies against Tuta absoluta on tomato in Spain
- A decision making system for the management of Colorado Potato Beetle in Finland
- Diagnostics and monitoring for the emergence of new virulent strains of yellow rust on wheat in Denmark.

These initiatives represent possible areas for collaboration.

The workshop also noted that advisory services would need to adapt from the current emphasis on optimising existing systems to making them more resilient. Diversifying cropping systems in general with strategies such as diversifying rotations were seen as major leverage points that can be addressed via extension.

Discussions regarding Invasive Alien Species and quickly evolving pests led to the conclusion that reducing their emergence and mitigating their impact would be best achieved by developing robust or resilient systems. Another research topic should be on the sustainable use of pesticides to prevent the occurrence of resistance to pesticides.

VI. Social aspects, economics and assessment

Obviously, farmers are not entirely free to adopt new practices. They must compose with a diversity of external pressures. Programme managers wishing to promote more sustainable farming practices cannot limit themselves to purely technical aspects, they must take into account broader social and economic constraints and ensure that the practices promoted fit within the wider food system. To understand the impact of a given practice on the entire system, particularly in light of sustainability, multi-criteria assessment is useful. Aside from such purely economic pressure, individual farmers operate within a social environment which influences their values, attitudes and behaviours. Therefore collective processes need to be better understood so that they can be acted upon. Austria (BOKU University), Finland (University of Helsinki), France (INRA), The Netherlands (Wageningen University) and United Kingdom are investing in a long term international research initiative on "lock-in" and transition. This initiative named "LOCKIN" examines (i) the extent to which agricultural organisations are locked in by past socio-technical choices and (ii) possible mechanisms of transition to more sustainable systems can be considered by all actors.

Actions such as IPM-related policies can have unintended social consequences. Italy indicated that impact of public policy on the social make-up of rural areas constitutes a research priority.

Interdisciplinary research where agronomy, biology and ecology join human and social sciences is needed to work at the level of the entire food chain because many bottlenecks involve stakeholders downstream and upstream of the farmgate.

Several respondents indicated interest in this area, many of which emphasised the influence of supermarket strategies on farmer practices (BE, CZ, EE, IE, IT). For example, the Irish respondent said: "*Supermarkets are demanding a huge emphasis on visual quality, that's a big challenge".* Some respondents alluded to the social effects of market requirement, for example respondent from Estonia "*Supermarkets have their own farmers and sell their products. Other farmers have difficulties to get in the market."* Supermarkets' excessive focus on MRLs was pointed out (BE). There can be situations where exclusive focus on MRLs can have counter-productive effects with respect to IPM (more treatments prior to the pre-harvest period or reliance on broad spectrum pesticides to reduce the number of different active substances). Norway will initiate a large scale research programme covering important parts of the knowledge-based bioeconomy focusing on the entire food value chain with attention paid to IPM. France will in the longer term give priority to interdisciplinary research. Germany will fund socio-economic research on regional interactions between stakeholders to support farmers. The Czech Republic is engaging in IPM vertical programs based on farm-to-fork strategy for key commodities. The Czech respondent also mentioned interest in direct marketing strategies such as farmer markets as an alternative to supermarket.

The scope of IPM is not restricted to PPP use in the field. It also concerns PPP use in stored products. In Belgium, for apples and pears, if PPP are needed for the stored crops, less products will be used in the fields. But for some countries, as the famers don't store their harvests, their

"specifications" on IPM don't cover stored crops (CH, PT, SE). As this type of information was not in the scope of the first questionnaire and only a few responses on this subject were obtained from phone interviews, the study may have overlooked this aspect.

Several respondents have developed IPM or Integrated Production labels (IT, PT). A few (CH, FI) consider that their entire production is under IPM. Some (CZ) consider labels secondary or believe there are too many competing existing labels (EE), whereas others know of instances where such labels were successful[22]:

- United Kingdom retailer-driven initiatives such as LEAF (Linking Environment And Farming), a farming charity at the forefront of sustainable agriculture, promoting Integrated Farm Management and benefiting from an association with Waitrose supermarkets.
- Marks&Spencer in the UK and Albert Heijn in the Netherlands have Pesticide Residue Monitoring Programmes and encourage Integrated Crop Management among their contracted farmers.
- A similar scheme involving the successful use of a South Tyrol label for apples produced either via integrated production or organic methods, recognised in Italy, Switzerland and Austria.

There is a lack of knowledge on economic aspects of IPM. Therefore, a joint effort to work on the relationship between IPM and the impact on the yield of the crops and more generally on farm economics should be developed. Some Member States (DE, UK, IT) define research on economic viability of IPM as a priority. A number of supermarkets could be used as case studies for IPM schemes used by retailers (Delaize in BE, Carrefour, Waitrose and Sainsbury in UK, "long S" in IT,...).

To understand how change affects the system relative to environmental economic and social criteria, assessment tools can be used. DEXiPM is one such multicriteria assessment tool which was mentioned in III.a above as a tool use to design innovative cropping systems, but it can of course also be used for assessment purposes. Another tool includes SALCA (Swiss Agricultural Life Cycle Assessment), a life cycle assessment method and database developed by Agroscope Reckenholz-Tänikon ART used to analyse and optimise the environmental impacts of agricultural production.

Many research possibilities emerged when discussing social and economic aspects. Nevertheless, research on the relationship between IPM and its impact on yield and on farm economics appeared as a priority area. Also, it is felt that assessing the value of IPM labels, certification schemes and standards as well as gaining a better understanding of the role of supermarket procurement policies is very valuable.

[22] See: Linking Environment And Farming: http://www.leafuk.org/leaf/farmers/LEAF's%20IFM.eb
Marks & Spencer: http://www.marksandspencer.com/Fruit-Veg-Our-Sourcing-About-Our-Food-MS-Foodhall-Food-Wine/b/46530031
Albert Heijn supermarket: http://www.ah.nl/

VII. Extension

Even though investment in extension may not be usually recognised as research per se, dissemination, communication, co-innovation, facilitation of collective processes, training and advice, i.e. all the interactions linking farmers to researchers, are widely recognised as major bottlenecks to mainstreaming IPM. Furthermore, this sector is an essential part of the innovation process. Existing innovative extension initiatives should be taken advantage of as sources of inspiration and agricultural knowledge systems should be better understood.

The efficacy of an agricultural production system has to take into account advisory services which are key players in the decision making process of farmers. Also, the way knowledge is spread is important to IPM implementation, therefore information on how knowledge is disseminated to or co-generated with farmers in the different countries should be known and shared.

Topics on agricultural knowledge systems, advising approaches, the relationship between researchers, advisors and famers, co-innovation, the use of IPM guidelines, training resources, clearly emerged from the phone interview and the questionnaire.

a. Co-innovation

At field level, adopting IPM is not merely a matter of adopting new techniques; it is part of a multi-actor innovation process and the product of individual farmer histories and the social relationships they establish over time within their professional environment and with society.

There is a wide perception among advisors that there is a growing gap between scientists and the primary agricultural community. Several respondents argue in favour of breaking this barrier when IPM tools are developed to ensure that scientists understand the challenges of industrialized farming and that information flow and dialogue between farmers, advisers and scientists is improved (BE, DK, EE, FR, PT, UK).

Even though some respondents have set-up well established partnerships between research institutes, advisors and farmers (CH, IE) there is a widespread desire to further improve and build on new forms of advice that are more collective, participatory and in the field (DK, NO). The Swiss respondent suggested the creation of grower forums which have decision-making power regarding research priorities. These types of forums already exist in Switzerland for specialty crops but could be extended to arable crops. The respondent from Ireland expressed much interest in an existing EU project (New Advisers) which is testing via real-life situations in several countries innovative approaches for advisers to facilitate a learning process among farmers. Many respondents emphasised the importance of advice and discussions via internet (DE, EE, FI, SE).

There are a number of recent or current initiatives developing alternative relationships between researchers, advisers, farmers and other stakeholders. The European research project

PURE[23] (2011-2014) has devoted a work package on concretising the concept of co-innovation in four on-farm experimentation sites in France and Denmark (both on winter-wheat based systems), and in Germany and the Netherlands (both on cabbage-based field vegetables systems). The goal is to develop a generic approach for co-innovation of IPM technology and methods by farmers, advisors, local policy makers and scientists.

The European vocational education and training Leonardo project "New Advisers" is currently developing innovative learning approaches to equip trainers and advisers with tools and methods that can be adjusted according to the audience and local circumstances. Within the context of reducing pesticide use, the project is testing and fine-tuning training methods in Portugal, Spain, Ireland, Germany, Sweden, Hungary, Slovenia and France[24].

The "Farming with Future" initiative (2003-2010) in the Netherlands created local alliances among researchers, farmer organisation, water boards, chemical companies and other stakeholders to field-test, develop and promote best practices for sustainable crop protection[25].

One part of the French National Action Plan, the DEPHY[26] reference farms is designed to promote learning on low-pesticide input cropping systems among the farmer community. To-date, it has established a network of 178 farms facilitated by 18 "network engineers" aiding farmers describe their systems, and evaluate and demonstrate results[27].

The European network ENDURE has produced and compiled 14 training sheets on farmer participatory methods. These sheets (Post-it, Hum group, Info hunt, Before and after, Highlight hierarchy, Restitution, Follow-up, Facilitation, Field visit, Training assessment, How to make a webquest, How to make an IPM card game, and Checklist) are freely available online[28]. ENDURE is currently planning a European-level thematic workshop with farmers and advisors on co-innovation to be held in 2013.

The European Commission launched in February 2012 a new guiding strategy, the European Innovation Partnership[29], "Agricultural Productivity and Sustainability". The European Innovation Partnership (EIP) aims to provide a working interface between agriculture, bio-economy, science and others at EU, national and regional level. It is expected to serve as a catalyst for innovation by promoting the creation of consortiums in multi-actor research projects through both Horizon 2020 and the Rural Development Programming. The strategy covers all aspects of agriculture production including crop protection.

[23] http://www.pure-ipm.eu/
[24] http://www.adam-europe.eu/adam/project/view.htm?prj=8802
[25] http://bit.ly/SVnhhX
[26] Demonstration, Experimentation and reference Production on PHYtosanitary efficient systems.
[27] http://agriculture.gouv.fr/Ecophyto-in-English-1571
[28] http://www.endurenetwork.eu/content/download/5807/44463/file/Methodology_Complete%20chapter.pdf
[29] http://ec.europa.eu/agriculture/eip/index_en.htm

b. Advice

Some countries are concerned about harmonizing advisory services (Poland for example is conducting a national training for advisors programme to ensure high and uniform level of advisory service). In contrast, the UK advisory service, which involves a number of different organisations, is quite decentralised. There are some countries where advisory services appear to be entirely in the private sector (CZ, NL) or depend on private/public funding (BE). Some respondents emphasized the importance of independent and neutral advice on IPM in general or concerning the use of PPP (CH, DE, EE, PL).

Many respondents identified the development and use of crop-specific guidelines as a major first step in IPM development (CZ, DE, DK, EE, IT, NO, PL, TR). It can be noted that the International Organisation for Biological Control has been a pioneer in the development of such guidelines. Other countries such as France seem to adopt an approach that favours learning rather than following standardised practices. For example it is investing significantly in the production of learning manuals such as the "STEPHY guide on strategies for crop protection less reliant on pesticides" which focuses on the principles underpinning the manipulation of cropping-system.

c. Training

Many countries have farmer training programmes to reduce risks associated with pesticide use. The UK, for example, established in 2001 a large programme promoting responsible pesticide use. It is called the Voluntary Initiative and is funded by government and implemented by an alliance of crop protection stakeholders[30]. Training which includes IPM and therefore goes beyond responsible use is now required by the new European legislation Indeed, article 5 of Directive 2009/128/EC requires that all professional users receive training in a number of subjects including IPM. Also, *Article 55 of* Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC under "Use of plant protection products" states:

"Plant protection products shall be used properly. Proper use shall include the application of the principles of good plant protection practice and […]. It shall also comply with the provisions of Directive 2009/128/EC and, in particular, with general principles of integrated pest management, as referred to in Article 14 of and Annex III to that Directive, which shall apply at the latest by 1 January 2014."

Some countries have already initiated this training programme (Certiphyto in France for example). Some respondents felt it is important that at least a part of the training take place in the field in addition classroom sessions (CH, NO)

[30] Voluntary Initiative: http://www.voluntaryinitiative.org.uk/

d. Information systems

Telephone interviews and SCAR CWG discussions on information systems in support of IPM — for strategic thinking rather than real-time decision-making — identified two types of initiatives.

The first type concerns the development of national websites on IPM dedicated to supporting farmer and advisory services. Although language barriers must be addressed, there is an option to link such websites to share national information across Europe. Denmark offers a good example of an operational national website dedicated to supporting IPM among farmers and advisers: www.landbrugsinfo.dk/Planteavl/Plantevaern/IPM. The website provides information on IPM projects, concrete examples of IPM in Denmark, farmer and adviser blogs, online tests and inspirational sheets to promote learning. It is updated every three months with a new theme or campaign linked to ongoing initiatives. Topics already covered include inter-row cultivation and diseases in arable crops. Many Member States are currently developing such online support services. France is developing EcophytoPIC, a web gateway designed to provide access to all IPM-related resources in France and selected links to national websites elsewhere in Europe. It will be structured according to cross-cutting topics on the one hand, and to six platforms organised by cropping system on the other hand. Another French information system, named Agro-PEPS makes available to farmers, advisors and agricultural school teachers, a series of information sheets on specific practices to achieve specific environmental goals. This resource is ready to produce information covering 150 techniques dealing with 51 specific environmental objectives. Agro-PEPS information sheets are designed to evolve via a collaborative (wiki-like) online application to share technical information and experiences. At the European level, the ENDURE Information Centre has brought together 1,200 documents from across Europe, each with at least one summary in English. It covers scientifically sound but practical information tailored to the needs of advisers[31]. At the international level, CABI has developed PlantWise[32]. It is gathering and disseminating knowledge via a knowledge bank which offers online diagnosis and treatment support information as well as practical on-the-ground training for potential plant doctors. It was originally designed to serve the needs of developing country smallholders.

The second type of information system discussed is based on the opportunity to take full advantage of databases originally designed for tactical within-season decision-making by exploiting them in information systems for longer term strategic thinking. This is a challenging and innovative idea where the wealth of monitoring information for DSS and warning and forecast systems could be supplemented with contextual information (farm practices, pedo-climatic conditions, etc.) to fuel a reflection at larger temporal and spatial scales.

[31] www.endureinformationcentre.eu
[32] www.plantwise.org

e. Production of references

Some MS are investing significantly in generating data and making it widely available. France for example, by the end of 2012 will have 2,000 networked reference farms covering 30 different cropping-system types.

Germany also has a network of reference farms. These are used retrospectively to evaluate their programme and communicate on the feasibility of further reducing pesticide inputs with farmers. Here we only address real-time pests monitoring systems designed for short-term decision making. The references farms concern 86 arable cropping farms, 20 vegetable producing farms, 20 fruit farms, 9 viticulture farms and 3 hop farms.

In 2010, Denmark established seven demonstration farms on IPM set to run until 2015. Each farm has a main IPM theme such as weed mapping and other monitoring systems, advanced spraying techniques, crop rotation and grass weeds. Each is associated with a local adviser and a crop protection specialist from the national Knowledge Centre for Agriculture who offer focused advice on the IPM tools used daily. Host farmers receive economic support but still make the decisions on the farm. As hosts, farmers are required to hold at least four events on the farm every year to inform other farmers, advisers, policy makers, members of the public and other stakeholders about IPM in practice.

In the UK, the farmer-led LEAF programme has set up a network of 42 demonstration farms and Innovation Centres across England and Scotland. Although the programme covers the broader concept of Integrated Farm Management, many participating farms address environmental issues linked to crop protection. As part of the PesticideLife project "Reducing environmental risks in use of plant protection products in northern Europe", Finland has established nine IPM demonstration farms covering a diversity of issues, including:

- Monitoring insect pests and assessing weed and disease pressure
- Thresholds and forecasting models aphids, wheat midges, plant diseases
- Untreated plots in field
- Follow-up effect, yield, quality, price analysis for yield

There are a number of innovative extension initiatives scattered across Europe. One joint action achievable in the short term is to share information on how knowledge is disseminated to or co-generated with farmers. Another recommendation is to explore agricultural knowledge systems including advisory approaches, training, the relationship between researchers, advisors and farmers, farmer networks, and new collaborative approaches for technological and organisational innovation which draw from different economic sectors, areas of expertise and practice. Another valuable joint action which would be relatively easy to achieve in the short-term is to share approaches, results and develop connections among demonstration farms across Europe.

D. RECOMMENDATIONS FOR FUTURE JOINT ACTION

Through this process, i.e., the survey analysis and the ensuing discussions in the SCAR CWG, several priority topics regarding potential multi-MS joint actions emerge. These research, extension and knowledge management priorities are described and listed in Table 6 below.

I. Develop relevant and science-based indicators

The development of indicators is of concern to all involved in NAP implementation. A first area for joint action is to enable countries to compare and share information as well as to harmonise the selected indicators. This is an ongoing task under the Framework Directive on the sustainable use of pesticides. Harmonization of indicators will help assess to what extent differences between countries are due to environmental conditions or to crop protection strategies.

The relationship between pesticide burden or practices in general and their impact is not clear. There is a lack of understanding on how farming practices and pesticide use which occur in a particular space and time, relate to environmental impacts which often emerge at a different time and space. As a result there is no guiding principles for farmers to adjust their practices with a certain degree of assurance that such adjustments will translate to reduced impact. To identify which management practices should be implemented and to facilitate their adoption by operators, this major bottleneck needs to be addressed.

Priority research 1. Conduct joint research on the relationship between practices and their contribution to environmental impacts and benefits.

II. Optimise pest monitoring systems and decision support

Regarding pest monitoring systems and decision making, several potential joint actions have been identified to optimise current monitoring systems:

- Help share monitoring information among farmers and among for-profit and public sectors with respect to both technical and proprietary aspects;
- Harmonise monitoring protocols to compare data and create new models, especially in border areas;
- Increase the biogeographical area where existing DSS are applicable by sharing and adapting them across regions.

As for research, the potential of DNA-based technologies to improve the detection of invasive and quickly evolving pests has been demonstrated but needs joint effort to make them applicable to a full range of European pests, easily available in databanks and reliable. This could complement the development of ICT-based diagnostic tools for farmers and advisors.

In addition to these information systems, a new generation of Decision-Support Systems is needed. Indeed, whereas pesticide use is usually based on real-time tactical decision-making (one crop/one pest/one technique), IPM requires a more strategic and dynamic approach based on a

combination of diverse techniques. Epidemiological models should be used in the context of the cropping systems and consider crop damages.

Considering that there is a high demand to improve monitoring and decision-making, and that many emerging systems are already in place, this is probably one of the areas most ready for joint actions.

Priority research 2. Characterisation, detection and identification of harmful and beneficial organisms for crop health: new, fast and reliable tools, information systems and databanks;

Priority research 3. Pest monitoring systems and predictive models to inform strategic and tactical decisions: mapping the effect of cropping systems, pest pressure, climate and environments on crop damages at various temporal and spatial scales.

III. Design cropping system that prevent or minimise pest pressure

Although this area may not yield results quickly, the types of results expected are key to devising more robust solutions. Initially, joint actions could involve sharing on, or coordination of existing cropping-system experiments.

One obvious recommendation is to share information and results on cropping systems research and set up a EU-level network of IPM experiments. Managing weeds while adopting a low-pesticide input approach is emerging as a major challenge for arable crops across Europe. One specific recommendation here is to integrate sets of alternative weed control methods and address weed management at the cropping system level.

Priority research 4. Design sustainable cropping systems at the landscape level that prevent or minimise pest pressure (sustainable management of disease resistance, habitat manipulation, diversification, etc.);

Priority research 5. Integrated Weed Management in arable cropping systems in a context of global change: model-based design of innovative strategies and evaluation of their sustainability under various scenarios;

Priority research 6. Set up a EU-level network of IPM experiments.

IV. Diversify direct control methods

Approaches involving chemical control, bio-pesticides and biological control, plant genetic resistance, mechanical control alternatives and their combination concern a large number of actors, a broad diversity of disciplines and usually imply a key role for the for-profit sector. Therefore, joint actions in this area need to be particularly multi-disciplinary, to be structured via public-private partnerships, and address multiple sectors of intervention including policy (e.g., rules on registration of biological agents or products and on the development of new cultivars).

A promising area for joint research regards the exploitation of landscape management and habitat manipulation for the conservation of beneficials (see "section C III "Cropping system"). Regarding the particular challenge of minor use crops, the general recommendation here is to diversify control methods.

The potential of biological control methods needs to be further developed in terms of the diversity of products, their availability, reliability and use.

Priority research 7. Develop efficient and reliable bio-control methods and integrate into IPM strategies.

V. Manage pest evolution

The management of new or quickly evolving pests with respect to pesticide resistance or sustainable plant genetic resistance is a relatively new area widely recognised as deserving attention. However, there are few existing research initiatives and the required monitoring systems are not in place. New collaborations would therefore need to build on scant pre-existing resources.

The reduction of the emergence of Invasive Alien Species and quickly-evolving pests as well as the mitigation of their impact will be best achieved by developing robust or resilient systems.

Priority research 8. Develop robust and sustainable IPM systems to reduce emergence and mitigate the impact of Invasive Alien Species and quickly evolving pests;

Priority research 9. Integrated and sustainable deployment of crop health strategies based on plant genetic resistance and sustainable use of pesticides preventing resistance to pesticides.

VI. Social aspects, economics and assessment

Interdisciplinary research where agronomy, biology and ecology join human and social sciences is needed to enable work at the level of the entire food chain because many bottlenecks involve stakeholders downstream and upstream of the farmgate.

There are a number of research possibilities regarding social and economic aspects. Research on the relationship between IPM and its impact on yield and on farm economics appears as a priority area. Assessing the value of IPM labels, certification schemes and standards as well as gaining a better understanding of the role of supermarket procurement policies is also very valuable.

Priority research 10. Assess the value of IPM labels, standards and guidelines, and the role of supermarket procurement policies;

Priority research 11. Economic and social barriers to and opportunities for IPM implementation at both farm and supply chain levels.

VII. Facilitate extension for IPM

Even though investment in extension may not be usually recognised as research per se, dissemination, communication, co-innovation, facilitation of collective processes, training and advice, i.e., all the interactions linking farmers to researchers, are widely recognised as major bottlenecks to mainstreaming IPM. Furthermore, this sector is an essential part of the innovation process. Existing innovative extension initiatives should be taken advantage of as sources of inspiration and agricultural knowledge systems should be better understood.

There are a number of innovative extension initiatives scattered across Europe. One joint action achievable in the short term is to share information on how knowledge is disseminated to or co-generated with farmers. One recommendation is to explore agricultural knowledge systems including advising approaches, the relationship between researchers, advisors and farmers, co-innovation, and the use of IPM guidelines and training resources. Another valuable joint action which would be relatively easy to achieve in the short-term is to share approaches, results and develop connections among demonstration farms across Europe.

Priority research 12. - Explore agricultural knowledge systems including advisory approaches, training, the relationship between researchers, advisors and famers, farmer networks, and new collaborative approaches for technological and organisational innovation which draw from different economic sectors, areas of expertise and practice;

Priority research 13. Network demonstration farms across Europe: share approaches, results and develop connections.

The above research priorities still need further description and ranking, which will be part of the final IPM report. The final report will provide a detailed description of proposed joint actions, identify their added value and its priority level as well as the type of support foreseen by European countries.

Table 6: Set of priority research areas identified by the SCAR CWG on IPM

DEVELOP RELEVANT AND SCIENCE-BASED INDICATORS

- Conduct joint research on the relationship between practices and their contribution to environmental impacts and benefits.

OPTIMISE PEST MONITORING SYSTEMS AND DECISION SUPPORT

- Characterisation, detection and identification of harmful and beneficial organisms for crop health: new, fast and reliable tools, information systems and databanks,
- Pest monitoring systems and predictive models to inform strategic and tactical decisions: mapping the effect of cropping systems, pest pressure, climate and environments on crop damages at various temporal and spatial scales.

DESIGN CROPPING SYSTEM THAT PREVENT OR MINIMISE PEST PRESSURE

- Design sustainable cropping systems at the landscape level that prevent or minimise pest pressure (sustainable management of disease resistance, habitat manipulation, diversification, etc.),
- Integrated Weed Management in arable cropping systems in a context of global change: model-based design of innovative strategies and evaluation of their sustainability under various scenarios,
- Set up a EU-level network of IPM experiments.

DIVERSIFY DIRECT CONTROL METHODS

- Develop efficient and reliable bio-control methods and integrate into IPM strategies.

MANAGE PEST EVOLUTION

- Develop robust and sustainable IPM systems to reduce emergence and mitigate the impact of Invasive Alien Species and quickly evolving pests,
- Integrated and sustainable deployment of crop health strategies based on plant genetic resistance and sustainable use of pesticides preventing resistance to pesticides.

SOCIAL ASPECTS, ECONOMICS AND ASSESSMENT

- Assess the value of IPM labels, standards and guidelines, and the role of supermarket procurement policies,
- Economic and social barriers to and opportunities for IPM implementation at both farm and supply chain levels.

FACILITATE EXTENSION FOR IPM

- Explore agricultural knowledge systems including advisory approaches, training, the relationship between researchers, advisors and famers, farmer networks, and new collaborative approaches for technological and organisational innovation which draw from different economic sectors, areas of expertise and practice,
- Network demonstration farms across Europe: share approaches, results and develop connections.

ANNEX I

Participants to at least one meeting:

FR: Pascal Bergeret, Marie Luccioni (Ministry of Agriculture), Marco Barzman, Laure Elliott-Smith, Antoine Messéan (INRA)

AT: Elfriede Fuhrmann (Federal Ministry of Agriculture, Forestry, Environment and Water Management)

BE: Annie Demeyere (Department of agriculture and fisheries), Jean-Pierre Jansen (Walloon Agricultural Research Center)

CH: Fabio Cerutti (Bundesamt für Landwirtschaft), Benno Graf, Joerg Samietz (Agroscope ACW)

CZ: Jiban Kumar (Crop Research Institute), Stepanka Radova (State Phytosanitary Administration)

DE: Silke Dachbrodt-Saaydeh (Julius Kühn-Institut), Till Schneider (Federal Office for Agriculture and Food, BLE)

DK: Per Nielsen Kudsk (Aarhus University)

ES: José Luis Alonso, Inmaculada Larena (Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, INIA), Jesús Avilla (Institut de Recerca i Tecnologia Agroalimentàries)

HU: Béla Darvas (Hungarian Academy of Sciences, Plant Protection Institute), Zsofia Palinkas (Permanent Representation)

IE: Dermot Forristal (Teagasc)

IT: Giuseppe Ciotti , Annamaria Marzetti (Ministry of Agriculture)

NL: Eric Regouin (Ministry of Economic Affairs, Agriculture and Innovation)

PL: Edward Arseniuk (Plant Breeding and Acclimatization Institute), Jerzy H. Czembor (IHAR)

SE: Agneta Sundgren (Swedish Board of Agriculture)

TR: Birol Akbaş Alev Burcak, Zuhal Erenler (Ministry of Agriculture)

UK: Jemilah Bailey, David Cooper, (Defra, Farming and Food Science), Nigel Chadwick (Chemicals Regulation Directorate)

DG Research: Juli Mylona

DG Sanco: Karin Nienstedt, Patrizia Pitton

DG Agri: Marc Duponcel

Phone interview participants who did not participate to meetings:

CH: Laurent Nyffenegger, (Federal office of agriculture, OFAG)

FI: Sanni Junnila (MTT), Sari Peltonen (Proagria)

IE: Jim O'Mahony (Teagasc)

NO: Kirsti Anker-Nilssen (The Research Council of Norway)

PL: Krzysztof Kielak (Ministry of Agriculture)

Survey respondants who did not participate to meetings:

CZ: Jan Nedělník (Czech Academy of Agriculture Sciences)

DE: Benno Kleinhenz (ZEPP), Monika Fischer (Federal Office for Agriculture and Food, BLE)

DK: Jørn Kirkegaard (Ministry of Energy and the Environment)

EE: Mati Koppel (Plant Breeding Institute)

ES: Enrique Moltó, Francisco Piñeiro Salvador (Instituto valenciano investigaciones agrarias, IVIA)

FR: Frédéric Vey (Ministry Agriculture)

NL: Johanneke Wingelaar (New Food and Product Safety Authority)

UK: Adrian Dixon (Chemicals Regulation Directorate)

ANNEX II

Survey of plant protection policies across Europe and associated research and extension relevant to integrated pest management

18 July 2011

The "Collaborative Working Group on integrated pest management for the reduction of pesticide risks and use" is conducting a Europe-wide survey of plant protection policies and associated research and extension relevant to Integrated Pest Management (IPM). The Collaborative Working Group (CWG) was established in May 2011 under the Standing Committee on Agricultural Research (SCAR) to provide recommendations on research needs to the EC's DG Research and Innovation and to Member and Associated States. The 17 countries currently in the CWG share the goal of improving plant protection strategies through information sharing and joint initiatives.

Goal of this survey

The goal of this Europe-wide survey is to map out the current situation on plant protection policies implementing existing and planned National Action Plans (as required by the "Sustainable Use Directive" 2009/128/EC) as well as associated research and extension relevant to IPM. This information will serve to identify what research and development is needed to support these, assess the added value and opportunity of jointly addressing needs and finally, make recommendations on cross-national initiatives.

Expectations

By inviting Member States and Associated States to contribute to this survey, the CWG expects to have an overview at European level regarding national policies and strategies, research, extension and knowledge base on plant protection in general and on IPM in particular. It will identify added values and opportunities to jointly address these questions.

The findings of this survey will be a good starting point and may help develop policy, new knowledge and effective dissemination and implementation processes in the area of plant protection for the reduction of pesticide risks and use. The findings of the CWG could also be interesting to the Commission, in particular in view of building the Horizon-2020 initiative. Your participation in this survey could open up opportunities for future joint initiatives and we are committed to sending back to you a summary and analysis of survey results.

How to respond

Please forward this survey to the person(s) in your country that can best cover the following areas of plant protection:

- national policies and strategies
- national-level research

- national-level extension and knowledge management.

Provide brief answers (about 10 lines per answer) in English to the 10 questions below. In addition, you may include links or attachments to relevant documents.

If possible, please compile answers into a single national response and send back by **September 15, 2011** to:

marco.barzman@grignon.inra.fr & elisabeth.lancesseur@grignon.inra.fr

Questionnaire

Question 1. Overall policy situation

a. Name, organisation and position of respondent to Question 1:

_____

_____

email:

_____

b. Do you have national crop protection policies dedicated to pesticide use or risk reduction in force?

If yes, please briefly describe these policies.

c. Is there a national target in terms of pesticide use and risk reduction (e.g., volume, frequency of use or risk or impact)? Or is one planned?

If yes, please briefly describe this goal.

d. Do you have a national policy programme specifically dedicated to IPM? Or is one planned?

If yes, please briefly describe this programme.

Question 2. Research

a. Name, organisation and position of respondent to Question 2:

_____

_____

email:

_____

b. Do you currently have a specific national research programme supporting an existing national crop protection policy dedicated to pesticide use or risk reduction?

If yes, please name the five most important research areas funded, briefly describe the objectives of the programmes and which organisation oversees the programme(s).

c. Do you currently have a national research programme supporting the national policy programme specifically dedicated to IPM?

If yes, please name the five most important research areas funded and briefly describe the objectives of the programmes.

d. Are you planning new research programmes related to the mandatory implementation of IPM in the near future?

If yes, please describe briefly.

e. Where do you see the needs for additional research related to the mandatory implementation of IPM in the longer term?

Question 3. Extension and advisory services

a. Name, organisation and position of respondent to Question 3:

_____

_____

email:

_____

b. For any of the following do you have dedicated programmes supporting IPM or reduction of pesticide risks and use:

Advice, training, demonstration farms, monitoring networks, web-based information systems? Or are such programmes planned?

If yes, please briefly describe these programmes

c. Please tell us what types of information, technologies, tools or documents and information you feel are most needed by advisory services for successful implementation of IPM.

Question 4. Evaluation

a. Name, organisation and position of respondent to Question 4:

_____

_____

email:

_____

b. What is the current or planned approach to evaluate the progress and results of the programme?

ANNEX III

Survey
of plant protection policies across Europe and associated research and extension relevant to integrated pest management

compiled Nov. 3, 2011

completed November 14th, 2012

[Only the research section is shown here]

Question 2b: **Do you currently have a specific national research programme supporting an existing national crop protection policy dedicated to pesticide use or risk reduction?** **If yes, please name the five most important research areas funded, briefly describe the objectives of the programmes and which organisation oversees the programme(s).**		Respondent
AT	Research on plant protection and IPM is part of the overall Research Programme of the Ministry PFEIL10 and PFEIL15 (2006 – 2010; 2011 -2015) and is administrated by the Ministry. www.dafne.at Most important research areas are: - Crop protection and new pest management - Soil born diseases and protection management - Research on phytosanitary pests in Cooperation within EUPHRESCO ERA-Net - IPM in arable farming and horticulture - Pesticide use and environmental risk reduction	Elfriede FUHRMANN Head of Division II/1 Agricultural Research and Development; Federal Ministry of Agriculture, Forestry, Environment and Water Management; Austria. email: elfriede.fuhrmann@lebensministerium.at
BE	No, but there are several research programmes related to this topic financed by National, Regional and Provincial institutions.	Jean-Pierre Jansen CRA Gembloux Annie Demeyere Flemish government Dep. Agriculure and Fisherie email: labecotox@cra.wallonie.be annie.demeyere@lv.vlaanderen.be
CH	The current national research performed by the Federal Research stations "Agroscope" is focused on sustainable or even pesticide free plant protection strategies, the breeding, selection/identification of disease resistant or robust	Dr. Joerg Samietz Agroscope Changins-Wädenswil Research Station Postfach

	cultivars and testing of crop rotation systems by annual crops and production of green fodder without or with very limited use of pesticides. As sustainable approaches depend on a good information basis about pest and disease populations and phenology, monitoring and forecasting systems for pests and diseases are viewed as the most important tools for implementing IPM. Further research projects focus on the influence of non-cultivated areas such as field margins, buffer strips and ecological compensation areas on biodiversity and the promotion of beneficials as well as on pesticide strategies aimed at the protection of in-crop beneficials.	CH 8820 Wädenswil email: joerg.samietz@acw.admin.ch
CZ	No specific national research programme on plant protection topics exists recently, but there are individual projects focused on plant protection area (study of new plant protection strategies, study of resistance of different hosts to pathogens or study of resistance of pathogens to pesticides, methods of detection of pathogens etc.) in many research programmes announced by Ministry of Agriculture. In a new research programme of Ministry of Agriculture is one of the main point topic "Innovation of ecological and integrated plant protection systems of agricultural crops and products against harmful organisms including modern diagnostic methods".	Jan Nedělník, Czech Academy of Agriculture Sciences, Department of Plant Protection, chairmanciences email: nedelnik@vupt.cz Jiban Kumar Kundu, Crop Research Institute, Division of Plant Health, Head email: jiban@vurv.cz
DE	Federal Government: The research programme of the Julius Kühn-Institute, Federal Research Centre for Cultivated Plants, is in the field of plant protection and plant breeding mostly dedicated to IPM. This is the same with research institutions of the federal states. Additionally specific programs have been established to support IPM approaches. Besides the above mentioned BÖLN the programme "Federal Innovation Programme" was established in 2006 with an unlimited period of validity by the Ministry of Food, Agriculture and Consumer Protection (BMELV). The programme focuses on technical and non-technical support of innovation and applied research in the field of nutrition, agriculture and consumer protection. Plant breeding and plant protection are covered with a discrete chapter. The BMELV has earmarked 28.5 million € for the total programme in 2011 and it is planned to increase the budget up to 38 million €. Since 2008, funds from this programme of about 14 million € have supported 96 projects dealing with plant protection or plant breeding. The Federal Office for Agriculture and Food (BLE) - as a service authority within the area of responsibility of the BMELV - oversees the projects and is responsible for the procedural handling of project applications and for monitoring of the approved projects (www.ble.de/innovationsfoerderung). For contact: Monika Fischer, Federal Office for Agriculture and Food (BLE), e-mail: monika.fischer@ble.de One example from Rheinland-Pfalz (Rhineland-Palatinate):	Benno Kleinhenz, ZEPP, e-mail: kleinhenz@zepp.info

	Rhineland-Palatinate and other federal states are financing a permanent Central Institution for Decision Support Systems and Programs (German acronym ZEPP; www.zepp.info). Its main aim is to develop and introduce forecasting models and DSS into practice in order to limit the use of plant protection products. For contact: Benno Kleinhenz, ZEPP, e-mail: kleinhenz@zepp.info	
DK	Since 1989 the Ministry of Energy and the Environment has had a Research Program financed by a levy on sales of pesticides. Pesticides include plant protection products and biocides (e.g. rodent control products and wood preservatives). The two categories include both chemical and microbiological products. The objective of the research programme is therefore to elucidate the spread of pesticides and their impact on the environment and health in order to achieve a better understanding of how pesticides affect the environment and health and to provide a better basis for regulation of pesticide consumption. Furthermore the programme aims at better opportunities for reducing the total impacts on the environment and health, including develop alternative pesticides and prevention methodologies. The long-term goal is to develop cultivation strategies which reduce agriculture's dependency on pesticides so that their use is minimised as far as possible, and also to encourage international focus on the need for reductions in consumption. 5 most important research areas 2011: 1. Health: Pesticides and their auxiliary substances' effects on health and combination effects of active substances in pesticides 2. Environment – Water: Effects of pesticides in streams, lakes and groundwater 3. Environment – Nature: Fate and effects f the use of pesticides on the biodiversity of arable lands and nature 4. Indicators for the harmful effects of plant protection products 5 Research initiatives on IPM, developing decision support system and alternative plant protection products	Jørn Kirkegaard, Danisk EPA, senior adviser email: jki@mst.dk
EE	No, we don't have a specific national research programme.	Mati Koppel, Jõgeva Plant Breeding Institute, Director email: mati.koppel@jpbi.ee
ES	Respondent: Enrique Moltó: There is no specific national research programme dedicated to pesticide use or risk reduction. I am leading a research project under the national research programme funded by Ministerio de Ciencia e Innovación and FEDER. Its objectives are related to the improvement of the quality of plant protection product applications while maintaining the efficiency in controlling the pests, thus reducing the negative environmental impact. Specifically this project proposes:	Enrique Moltó email: molto_enr@gva.es Francisco Piñeiro Salvador Servicio de Sanidad Vegetal (Conselleria de Agricultura)

	• the integration of the spatial position of the machine and the location of vulnerable areas and meteorological conditions during application, in order to reduce contamination risks • mechanization of biopesticide treatments to make them affordable for the growers • to grant full traceability of the treatment, identifying the specific conditions of application, the exact quantification of the product amount and machine position • development of CFD tools for modeling drift and subsequent estimation of risk drift. Objective quantification of drift mitigation measures • assessment of the influence of proposed solutions on the biological efficacy of the treatments This research targets the most important Mediterranean fruit crops: citrus, fruit trees and vines. I am also getting funds from private companies to conduct research aimed at establishing good agricultural practices for copper fungicide applications on olive and fruit trees under IPM programmes. Respondent: Francisco Piñeiro Salvador: Zero Waste. Development of alternative farming methods that reduce pesticide usage or so that do not appear residue in agricultural production. IVIA and Plant Health Service (VSS). Sterile insect technique. IVIA Breeding and releasing natural enemies. IVIA and SSV Use of sexual confusion. SSV and Institute of Chemical Technology, Universidad Politécnica de Valencia (ITQ-UPV) Respondent Mª Inmaculada Larena Nistal: There is not a specific national research programme supporting an existing national crop protection policy dedicated to pesticide use or risk reduction. However, INIA (National Institute for Agricultural and Food Research and Technology) is a national research institute that manages and distributes the national budget for the agricultural national research program, different national research projects are developed for the research in the area of reduction of use of PPP, for alternative control methods. This national research program includes three priority themes areas: 1. IMPROVEMENT OF PRODUCTION AND PRODUCT PROCESSING IN AGRIFOOD SECTOR; 2. PRODUCTION AND PROCESSING OF SAFE, HEALTHFUL AND HIGH QUALITY PRODUCTS; 3. AGRICULTURAL PRODUCTION IN THE CONTEXT OF ENVIRONMENTAL CONSERVATION AND INTEGRATED LAND USE. Only some of its main lines are related to control diseases, pests and weeds.	email: pinyeiro_fra@gva.es Mª Inmaculada Larena Nistal, SGIT-INIA, Departamento de Protección Vegetal *ilarena@inia.es*
FI		
FR	A group of research experts (GER) participating in Ecophyto 2018, the FR National Action Plan, defined six chapters covering present research needs to be addressed: Chapter 1: Indicators providing information on the entire process covering from	Frédéric Vey (from the GER report, 2012)

	PPP use to impacts. Chapter 2: Monitoring support network: from observation to decision Chapter 3: Design and assessment of integrated solutions to protect crops Chapter 4: Diversify control methods and limit the use of PPP Chapter 5: Sustaining the efficacy of technical solutions in the context of evolving pests: selective pressure, emergence, invasion Chapter 6: Socio-economic transition toward low-pesticide input agriculture: co-innovation, advice, training, governance and coordination of stakeholders, and policies.	
IE	Yes, We have in particular crop disease control programmes (primarily for cereals and potatoes) which deal principally with the achievement of satisfactory disease control, against a background of continuously changing pathogen populations, reduced fungicide sensitivity and high crop yield potential in a temperate climate. 1) Monitoring cereal fungal pathogen sensitivity shifts including the elucidation of the genetic changes responsible for decreased sensitivity. This work is aimed at rapidly identifying fungal pathogen changes which may impact rapidly on the effectiveness of disease control programmes. (Teagasc) 2) Monitoring potato late-blight pathogen development and the genetic changes associated with sensitivity shifts. This work also focuses on the impact of pathogen changes on disease control measures in potatoes (Teagasc) 3) Evaluation of winter wheat breeding lines for improved resistance/tolerance to Septoria with a view to incorporation of associated genetics into future varieties for temperate western European regions. While there is no wheat breeding programme in Ireland, molecular technologies will allow the factors which confer disease tolerance/resistance to be incorporated by breeders in varieties aimed at wetter climates. (Teagasc) 4) Agronomic approaches to reducing disease pressure and targeting disease control strategies in cereals. Irelands exceptional cereal yield potential depends on satisfactory disease control. This research focuses on the development of satisfactory disease control measures to ensure optimum yield. (Teagasc)PT	Dermot Forristal, Researcher, Crop Science Department, Oak Park Research Centre, Teagasc, Ireland dermot.forristal@teagasc.ie
IT		
NL	Yes, we do have a national research programme which is now finishing in 2011. 5 programmes (not in order of priority): • 2 programmes Sustainable Crop Protection (innovation and development) • Sustainable use of soil • Growing out of soil • Plant protection products and environment • Bees These programmes are runned by Wageningen University and Research	Johanneke Wingelaar, new Food and Product Safety Authority email: g.j.wingelaar@minlnv.nl
NO	Currently, there is no specific national research programme supporting national crop protection policy dedicated to pesticide use or risk reduction. Thematically these kinds of questions belong to a research programme called Nature-based Industry. There are no current projects on these research questions.	Senior adviser Kirsti Anker-Nilssen, The Research Council of Norway (RCN) email: kan@rcn.no
PL	Yes. The research program for years 2011-2015 has been adopted for Institute of Plant	Krzysztof Kielak, Ministry of

	Protection – National Research Institute in Poznań. The Program will support realisation of National Action Plan. The following task are planed to be realised: 1) preparation of IPM crop specific guidelines; 2) adaptation decision support systems in plant protection to Polish conditions and making them available for farmers and advisors; 3) analysis of statistic data concerning use and trade of ppp; 4) conducting analysis of quality of ppp in trade; 5) conducting analysis for ppp residues presence in crops. Moreover, the program will also deal with following problems: 1) protection of minor crops, 2) pests resistance to ppp. The Program will be available on the web-site of Ministry of Agriculture and Rural Development. The Program is overseen by Ministry of Agriculture and Rural Development.	Agriculture and Rural Development, Head of Division of Quarantine and Plant Protection. email: Krzysztof.kielak@minrol.gov.pl
PT		
SE	National research program on plant production includes parts about pesticide use and risk reduction. The Swedish Farmers' Foundation for Agricultural Research is the organisation that handles the programme. The objectives of the programme include sustainable methods in plant production and fulfilling the consumers demand for safe food. IPM has been a part of that, see point c. The most important research areas funded that concerns crop protection should be systems for plant production, increased precision in cropping, for example concerning application of pesticides, safe food for example factors concerning pesticide residues. The Swedish Board of Agriculture handle a programme about reducing the risks with pesticides. In this program trials with reduced doses and new plant protection strategies are tested and some other trials aiming to reduce the risks with pesticides are performed.	Agneta Sundgren, the Swedish Board of Agriculture email: agneta.sundgren@jordbruksverket.se
TK	1- Integrated Pest Management Researches The first IPM project in Turkey was started in 1970. Several IPM projects on different crops have been applied up to now and 16 Countrywide IPM projects on important crops such as wheat, maize, vegetables grown undercover, potato, chickpea, lentil, cotton, apple, cherry, citrus, peach, olive, vineyard, pistachio and hazelnut. 2- Biological Control Researches Biological Control Researches come after the IPM Researches in Plant Protection Research Policy and Strategy, because of its importance. The classical Biological control studies in Turkey were started in 1912 and an increasing importance has been given to them since 1970s. Most of the pests are being suppressed by their natural enemies now and no chemical control is being required against them in Turkey. The following subjects have the priority in the determined Biological Control Research Policy and Strategy: • To widespread the Biological control against the pests where possible, so as to prevent the human health, environment and the natural balance, • To conserve and increase the efficiency of the natural enemies available in Turkey, during the Biologic Control studies, The Ministry of Food, Agriculture and	Dr. A. Alev BURÇAK Organization: General Directorate of Agricultural Research and Policies, The Ministry of Food, Agriculture and Husbandry, TURKEY. E-mail: aburcak@tagem.gov.tr Zühal ERENLER Organization: General Directorate of Agricultural Research and Policies, The Ministry of Food, Agriculture

	Husbandry especially gives importance to this subject, • Mass production of the natural enemies of the pests in the laboratories and insectariums, whose biological control is not possible and the release of them to nature, • To investigate the possibilities of using the insects and disease agents in the biological control of weeds, • Researches on the side effects of the pesticides on the natural enemies, • Determination of the beneficial organisms that gained resistance to pesticides, establishment of the races that are resistant to pesticides and possibilities to use them in biological control 3- Biotechnological Control Researches: Priority is given to the following subjects during the Biotechnological Control Researches: • To fasten the researches related with the insect pheromones that have an important role in the Biotechnological control researches, • To make studies for future, in order to produce and develop the pheromones in the country, • Using and widespreading of the developed techniques (serological, molecular etc.) in the identification and illustration of the viruses, bacteria, fungi and the nematodes. 4- Toxicological and Ecotoxicological Researches: Priority is given to the following subjects for the Toxicological and Ecotoxicological Researches; • Increase and widespread the studies related with the side effects of the pesticides • Development of the effective and fast methods for the determination of the resistance against the pesticides ; establishment of the resistance management programmes against the pesticides, 5- Researches related with Forecasting and Warning Researches related with the prevention from the unnecessary or late applications by warning the farmers beforehand and pointing out the period when the control studies have to start and the pesticides to be used without exceeding the economic thresholds determined by following the population changes of the diseases, pests and weeds, have great importance. The following strategies have been determined related with the Forecasting and Warning studies: • Improvement of the forecasting and warning methods, • To give action and to develop the Forecasting and Warning organization, that has been determined between The Ministry of Food, Agriculture and Husbandry, Research Institutions and Extension Services. These programmes are overseen by General Directorate of Agricultural Research and Policies, The Ministry of Food, Agriculture and Husbandry, TURKEY.	and Husbandry, TURKEY e-mail: zerenler@tagem.gov.tr
UK	The Chemicals Regulation Directorate (CRD) of the UK Health and Safety Executive manages a programme of research on pesticides for the Department for Environment, Food and Rural Affairs (Defra). In this context, pesticides means plant protection products as defined in the EU approvals legislation. The strategy	Jemilah Bailey, Department for Environment, Food and Rural Affairs,

	for this R&D programme is led by Defra's overarching evidence strategy and by an evidence plan which sets out the policy rationale for both R&D and non-R&D evidence and the priorities for future R&D work. Effective regulation of pesticides protects human health (users, the public and food consumers) and the environment from potential harmful effects of pesticides, and also boosts consumer confidence to the benefit of British industries. Priorities include: 1) Developing the human health and environment risk assessments, including monitoring and epidemiological data to reflect new application technologies and techniques, evidence to enable the use of appropriate and validated exposure assessment models, and to support the regulatory risk assessment and on wider ecosystem issues associated with the sustainable use of pesticides. 2) Evidence to support policy implementation of the EU thematic strategy on the sustainable use of pesticides and related EU legislation. 3) Analytical chemistry – improving the methods used for food residue or wildlife monitoring programme and in formulation analysis. 4) Resistance - evidence supporting the development of resistance management strategies to support secure and sustainable crop production. 5) Evidence to help reduce reliance on conventional chemical pesticides by developing novel alternative technologies.	Science Policy Advisor jemilah.bailey@defra.gsi.gov.uk Adrian Dixon Policy Implementation Team Chemicals Regulation Directorate adrian.dixon@hse.gsi.gov.uk
Question 2c: **Do you currently have a national research programme supporting the national policy programme specifically dedicated to IPM?** **If yes, please name the five most important research areas funded and briefly describe the objectives of the programmes.**		
AT	Same as Question b.	
BE	No national structured program but regional and provincial initiatives. Information on the most important areas are fluctuating and not easily accessible	
CH	Nearly all Swiss farmers outside organic production schemes produce under IPM labels. Therefore, from the Swiss point of view all research activities related to plant production and plant protection have to be related to IPM.	
CZ	The same answer as question 2b. Only individual research projects exist under wider aimed research programmes.	
DE	Federal Government: The research programmes of the federal and state research facilities are ongoing. Within the "Innovation Promotion Programme", in 2011 there was a 2-step call about "sustainable use of plant protection products". Only projects will be supported that contribute to the necessary minimum in plant protection and to risk reduction. Therefore, the following themes are in the focus: (a) biological, chemical and other plant protection measures, (b) improvement of pesticide resistance management, (c) DSS, GIS based measures, precision farming, (d) plant protection equipments and measures in particular with respect to loss and drift reduction, savings of pesticides, and resource protection, (e) fast, sensitive and specific diagnostic tools for pests and diseases, (f) methods for targeted identification of	Monika Fischer, Federal Office for Agriculture and Food (BLE), e-mail: monika.fischer@ble.de

	host-pest/diseases/parasite interactions and resistance mechanisms of plants against pests and diseases, (g) crop or sector specific IPM guidelines, (h) methods for fast identification of plant protection products in particular with respect to counterfeit products, (i) innovative structures for networking between partners to speed up technology transfer into practice. The start of the projects is expected for 2012. For contact: Monika Fischer, Federal Office for Agriculture and Food (BLE), e-mail: monika.fischer@ble.de	
DK	No, but in the Pesticide Research programme include some projects about IPM.	
EE	No, we don't have a national research programme specifically dedicated to IPM. But we have the National agricultural research and development programme 2009-2014 within which in year 2011 are financed 3 plant protection research projects and 2 of them are closely related to the IPM: - Development of an internet based decision support system in plant protection - Study ways to control weeds on fields under grain crops contaminated with difficult exterminated weeds. (contain chemical and mechanical extermination).	
ES	There is no specific national programme specifically dedicated to IPM. There are projects funded by the national research programme related to the development of IPM strategies, mostly related to biological control of pests. Respondent Mª Inmaculada Larena Nistal: There is not a specific national research programme supporting an existing national crop protection policy dedicated to pesticide use or risk reduction. However, INIA is a national research institute that manages and distributes the budget for the agricultural national research program, different national research projects are developed for the research in the area of IPM. Just note that within priority themes areas listed above, there are only 34% of priority lines aimed at IPM: 1. IMPROVEMENT OF PRODUCTION AND PRODUCT PROCESSING IN AGRIFOOD SECTOR: a. Breeding to obtain new varieties of fruit trees and other woody species; b. Genetic improvement of vegetable, grain legumes and other crops; c. Diagnosis of plant diseases and development of strategies and systems for sustainable prevention and control. Verticilosis. Control of pests and weeds. Improving decision-making; d. Analysis of the agents and socio-economic conditions of the food chain. Socio-economic evaluation of new products and processes (4 main lines of 14). 2. PRODUCTION AND PROCESSING OF SAFE, HEALTHFUL AND HIGH QUALITY PRODUCTS: a. Effects of food processing conditions on the survival of pathogens that affect food safety; b. Food quality: development of techniques for determining the origin, traceability and authenticity of themselves and their health inspection. Identification of residues (2 main lines of 7); 3. AGRICULTURAL PRODUCTION IN THE CONTEXT OF ENVIRONMENTAL CONSERVATION AND INTEGRATED LAND USE: a. Reduced environmental impact of production and processing systems; b. Strategies for protection and restoration of soil: reducing erosion and degradation; c. Development of organic production systems, integrated and improved production systems adapted to local or regional; d. Characterization and standardization of organic products and local varieties (4 main lines of 11).	Enrique Molto, IVIA email: molto_enr@gva.es

FI	PesticideLife Project (Reducing environmental risks in use of plant protection products in Northern Europe) 2010-2013, financed 50 % by EU LIFE+ programme. The partners MTT (90%), TUKES and NSL. Demonstration study, which concentrates in cereal production. 1) Support the development and updating of NAP 2) Find benefits and weaknesses of IPM methods 3) Devising a co-operation network on plant protection nationally and in the Northern Zone 4) Decreasing the amount and frequency of PPP leaching 5) LCA and CSR; pesticide influences in food chain Main part of work happens on 9 demonstration farms in three regions on 25-30 cereal fields were IPM methods are tested. New plant disease forecast model has been evaluated. Dissemination and making IPM common among farmers and stakeholders is essential. www.mtt.fi/pesticidelife In addition in Finland: - IPM-APU (2011-13, Makera) outdoors horticulture: MTT, TUKES, SYKE, ProAgria, KSS - IPM guidelines, national IPM forum, networking, knowledge change - IPM training in vegetable production (2011-2013, ELY), MTT Lännen Tehtaat, Pyhäjärvi instituutti - Integrated use of data storages, collaboration with contract farmers, customer-oriented problem solving - Change Laboratory Ansari in greenhouses (2010-2012, Makera) MTT, ProAgria ÖSL, HY.	Sanni Junnila, MTT Plant Production, Research Scientist, Project Manager email: sanni.junnila@mtt.fi
FR	Within the Ecophyto 2018 research chapters (Q2b), the five most important research areas are: - Implementation and validation of indicator series: farming practices-burden-impact - Improvement of the monitoring network by addressing absence of thresholds, extending it to cover beneficials, weeds and emerging pests, exploring the body of knowledge underpinning the network, identifying ways in which other approaches to pest management, observation methods, and technologies could be integrated into the system - Follow up on non-intentional effects on useful biodiversity - Design, develop and evaluate DSS integrating a diversity of levers - Production of references within the network DEPHY On June 2012, an ECOPHYTO-specific call for proposal has been published including 3 of the research areas already mentioned: - Implementation and validation of indicator series - Improvement of the monitoring network - Production of references within the network DEPHY The budget of this ECOPHYTO-specific call for proposal is between 1 and 1,5 millions €.	(from the GER report, 2012) ECOPHYTO-specific call “Pour et Sur le Plan Ecophyto 2018” http://agriculture.gouv.fr/Ecophyto-PSPE
IE	No, not specifically as we do not currently have a national policy specifically dedicated to IPM. However the programme areas outlined in (b) above contribute	

	to an IPM approach.	
IT		
NL	See above. The Netherlands are in between the policy programme 2003-2010 and a new national action plan (NAP), which will be starting from 2013 and is developed currently. At this moment the former policy is evaluated in a programme. This will serve as input for the new programme and NAP.	
NO	Currently there is no national research programme supporting the national policy programme dedicated to IPM. Thematically these research questions belong to a research programme called The Food Programme. Currently there is no research projects focusing on these research questions per se, but there are some projects who partly deals with plant protection/integrated pest management. The actual pest in question will vary, and there is no long term strategic reason for the choice of pests in each project. The projects are generated (and financed) more as an answer to a sudden/short term need in the agricultural sector. In cooperation with RCN both The Foundation for Research Levy on Agricultural Products and The Agricultural Agreement Research Fund finance projects regarding these short term applied research questions mentioned above.	
PL	Yes. Most of research topics of the Program described in answer for the question b are dedicated to IPM.	
PT		
SE	For 2009-2011 there has been a research programme especially dedicated for IPM and alternative plant protection methods. It has been a part of the National research program on plant production that The Swedish Farmers' Foundation for Agricultural Research oversees. Research areas that are especially asked for are finding new methods that combine preventive, physical and chemical methods to control pests and weeds, developing of decision support systems and thresholds, strategies that take into account the properties of the pesticides and finding a system to utilize the properties among the cultivars.	Agneta Sundgren, the Swedish Board of Agriculture email: agneta.sundgren@jordbruksverket.se
TR	Names of the Projects: 1- Integrated Pest Management Research, Implementation and Training Project on Protected Vegetables 2- Integrated Pest Management Research, Implementation and Training Project in Cherry Orchards 3- Integrated Pest Management Research, Implementation and Training Project in Apple Orchards 4- Integrated Pest Management Research, Implementation and Training Project on Grape 5- Integrated Pest Management Research, Implementation and Training Project on Maize Also IPM programs have been carried out on wheat, chickpea, lentil, cotton, potato, citrus, olive, apricot, peach, hazelnut, pistachio subjects. General Objectives of the Programmes: 1- Determination and utilization of parasitoids and predators against pests	

	2- Determination of biological efficacy of biotechnical methods to decrease pesticide use 3- Decreasing of economical threshold levels, 4- Utilization from low-volume pesticide application techniques 5- Optimization of pesticide application techniques 6- Determination of national MRLs 7- Determination of control methods alternative to chemicals 8- Research on new possible areas for forecasting and optimization of present forecasting methods, 9- Research on pesticide resistance 10- Research on plant resistance to diseases and insects	
UK	While there is no dedicated research programme Defra funds strategic IPM research to support Defra's Crops Hub policy (see Q 1d), through cross-cutting research programmes for Sustainable Farming Systems and Biodiversity (pre-farm gate) and Resource Efficient and Resilient Food Chain (Post-Harvest), which focus on finding a balance between increasing productivity, consistent with market needs, and at the same time reducing the environmental impact of food production. Ongoing work is developing integrated control of pests, diseases and weeds in the main arable, vegetable, fruit and protected crops to reduce use and environmental impacts from pesticides and encourage biological pest control by natural enemies. Defra also funds collaborative and applied research with industry through the Sustainable Arable and Horticulture LINK programmes (now closed to new proposals) and through the Sustainable Agriculture and Food Innovation Platform [3] (SAF IP) in collaboration with the Technology Strategy Board[4] and the Biological and Biosciences Research Council[5] . The first SAF IP competition held, on new approaches to crop protection, provides £13m of Government support, matched by industry investment, to help find alternatives, following impending withdrawal of some crop protection products, across a broad cross-section of UK crops. Examples include successful research through the Arable LINK programme which identified sources of Orange Wheat Blossom Midge resistance in wheat that has been successfully incorporated into commercial varieties and the development of decision-support software used to improve timing of pesticide application to control Bean Seed Beetle. Strategies for combating resistance to insecticide, fungicide and herbicides, using IPM approaches, have also been developed collaboratively with industry. The long-standing programme, managed by CRD, on alternative means of crop protection supports research to devise novel biologically-based approaches and technologies for crop protection that prevent or greatly reduce the development of populations of pests, diseases and weeds, without causing concerns to consumers or damage to the environment. Technologies being developed for controlling insect pests typically involve disruption of natural processes of feeding, reproduction and development. Developments from this programme (separately or with other funders) encourage integrated or biological control in arable and horticultural commodities and potentially also benefit organic production. Two related examples of projects (jointly funded with industry) which aim to develop a novel technology for insect and slug control, respectively, are based on orally	

	delivered fusion proteins containing specific naturally occurring toxins. A further promising example, involves research to induce natural plant defences against pests, and potentially also plant diseases through seed treatments with a naturally occurring plant compound. Lastly, in a biological control example, research is exploring the potential for a predatory beetle (Atheta coriaria) to contribute to cabbage root fly control through delivery of the predators in commercial module-raised brassicas. There has also been work in the past under this programme on assessing a small number of biopesticide registration dossiers against the regulatory requirements for these products. Top 5 research areas: 1) Genetic improvement of crops for pest and disease resistance 2)Improved understanding of pest, disease and weed biology to inform management systems 3) Development of integrated management systems, including improved biological controls and advances in technology 4) Control of post-harvest pests and disease (and related mycotoxins) 5) Improved understanding and management of on-farm habitats to improve pest control by natural enemies and enhance biodiversity More basic research into these topics and crop protection generally, is funded by the Biotechnology and Biological Science Research Council (BBSRC) The Agriculture and Horticulture Development Board , funded from statutory levies paid by farmers, growers and processors, also funds applied research and knowledge transfer including crop protection for arable and horticultural crops to meet industry needs. [3] http://www.innovateuk.org/ourstrategy/innovationplatforms/sustainableagricultureandfood.ashx [4] http://www.innovateuk.org/ [5] http://www.bbsrc.ac.uk/	