PROJECT FINAL REPORT

Grant Agreement number:	FP7 – 265865
Project acronym:	PURE
Project title:	Pesticide Use-and-risk Reduction in European farming systems with Integrated Pest Management
Funding Scheme:	Large Collaborative Project
Period covered:	from 1 March 2011 to 28 February 2015

Project co-ordinator name, title and organisation:

Name: Dr. Françoise LESCOURRET
Title: Director of Research, UR 1115 Plants and Cropping Systems in Horticulture
Organisation: Institut National de la Recherche Agronomique (INRA)
Tel: (+33) 4 32 72 24 53
Fax: (+33) 4 32 72 24 32
E-mail: francoise.lescourret@avignon.inra.fr
Project website address: http://www.pure-ipm.eu/

Figures and tables

1 Final publishable summary report

1.1. Executive Summary

Table 1: Targeted farming systems in PURE

System	Category	Region covered	Reason for the selection of the system
Winter wheat-based rotations	Annual	Northern and Eastern Europe	• Largest surface area in Europe • Rotation as a strategic lever • Availability of disease resistance varieties
Grain Maize-based rotations	Annual	Southern, Central & Eastern Europe	• Major crop heavily reliant on pesticides (notably herbicides) • Rotation as a strategic lever • Availability of IPM component methods
Field vegetables (focus on Brassica)	Annual	Mainly Northern & Central Europe	• Strong market pressure to reduce dependency on pesticides • Dynamic sector open to change • Availability of tactics, new technologies and production methods
Pomefruit	Perennial	Pan-European	• Strong market pressure to reduce dependency on pesticides • Very high frequency of chemical applications Numerous IPM component methods available
Grapevine	Perennial	Pan-European	• Single largest pesticide consumer in Europe • Numerous commercially available IPM component methods • Numerous experimental IPM component methods near implementation stage
Vegetables grown under cover and greenhouses: Tomato based system	Protected	Mainly Southern Europe	• Infrastructural technology as strategic lever • Simplified agro-ecosystem conducive to the exploitation of ecological interactions

1.2. Summary description of project context and objectives

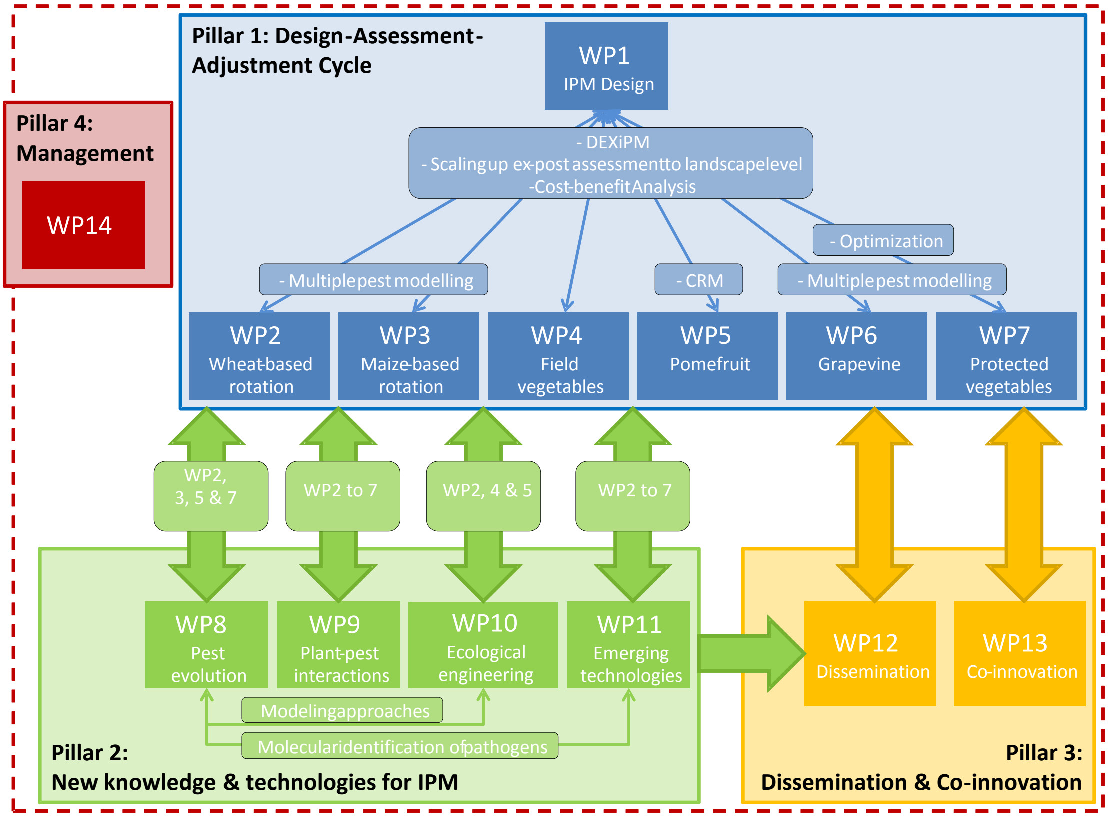


Figure 1 - PURE Structure (The fine arrows indicate tools provided by WP1 to WP2-7. The wide arrows indicate synergies between Pillars 2 or 3 and Pillar 1)

1.3. Description of the main S&T results/foregrounds

- **WP2 – Innovative IPM solutions for winter-wheat based rotations**

Figure 2.1 - Aerial photo of the experimental sites

Figure 2.2-Aerial photo of DK on-station experiment

Figure 2.3 - Most important diseases in winter wheat in the PURE experiments (left to right: septoria, yellow rust and brown rust).

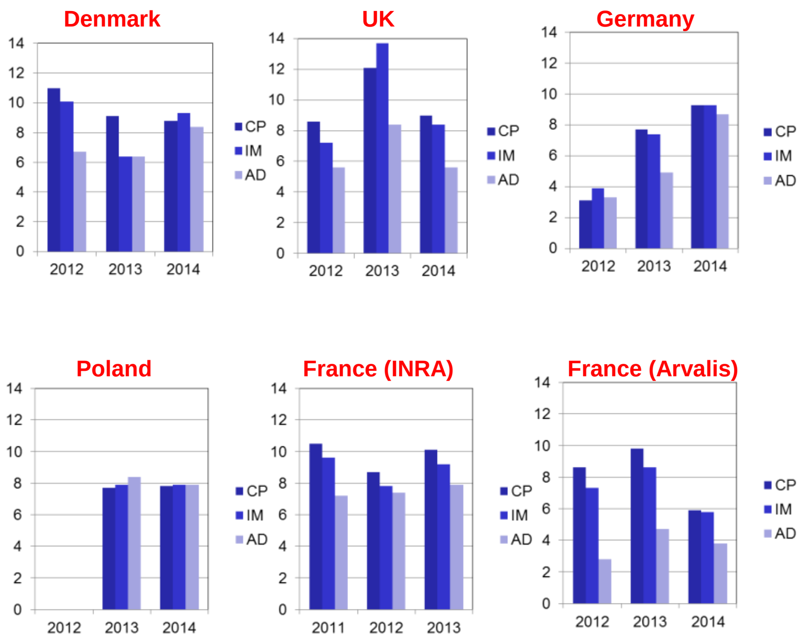


Figure 2.4 -Winter wheat yields in the 6 on-station experiments. In 2011/12 the winter wheat crops did not survive the winter in Poland. In the German trial yields were unusually low in 2011/12 due to low soil fertility. IM=IPM1 and AD=IPM2.

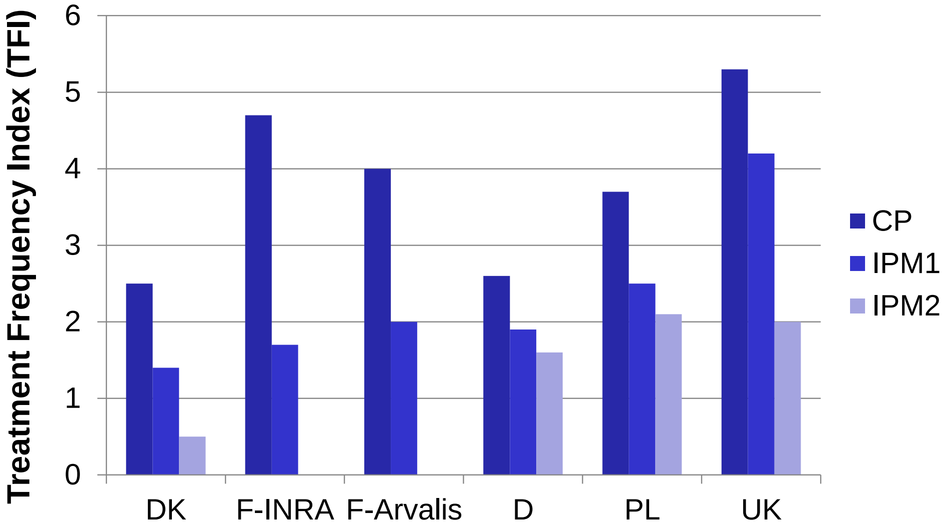


Figure 2.5 - Pesticide use expressed as the Treatment Frequency Index (TFI). As the standard doses may vary between countries TFIs are not always directly comparable between countries.

Table 2.1: Results of the DEXiPM analyses. For France (INRA) the analysis covers the years 2009 to 2014, for France (ACTA) the years 2011 to 2014 while for the remaining 4 sites the analysis was based on the results obtained from 2012 to 2014. DEXiPM analyses the whole rotation but in the UK it was done for each. The results presented for the UK are the average of the years 2012, 2013 and 2014. VL=very low, L=low, M=medium, H=high, VH=very high;

Location	System	Economic sustainability	Environmental sustainability	Social sustainability	Overall sustainability
Denmark	CS	M	VL	H	M
	IPM1	M	H	H	H
	IPM2	L	H	H	M
France (INRA)	CS	VH	M	M	H
	IPM1	H	H	M	H
	IPM2	H	VH	M	H
France (Arvalis)	CS	H	M	H	H
	IPM1	H	H	H	VH
	IPM2	M	VH	H	H
Germany	CS	H	L	H	M
	IPM1	H	M	M	M
	IPM2	M	H	M	M
Poland	CS	H	VL	H	M
	IPM1	M	L	H	M
	IPM2	M	M	H	M
UK	CS	M	L	H	M

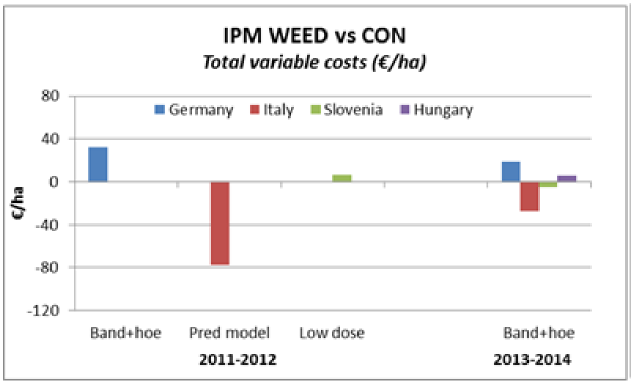
	IPM1	M	M	H	M
	IPM2	L	M	M	M

- **WP3 – Innovative IPM solutions for maize-based cropping systems**

Figure 3.1. European corn borer (*Ostrinia nubilalis* Hubn.) larvae and adults.

Table 3.1. DEXiPM results on sustainability of maize-based cropping systems tested.

Site	System	Sustainability			
		Economic	Environmental	Social	***Overall***
Italy	CON	M	VL	H	***M***
	IPM1	H	M	H	***H***
	IPM2	H	H	H	***VH***
Hungary	CON	M	L	H	***M***
	IPM1	L	L	VH	***M***
	IPM2	L	H	VH	***M***
France	CON	M	VL	M	***L***
	IPM1	M	L	H	***M***
	IPM2	L	M	H	***M***



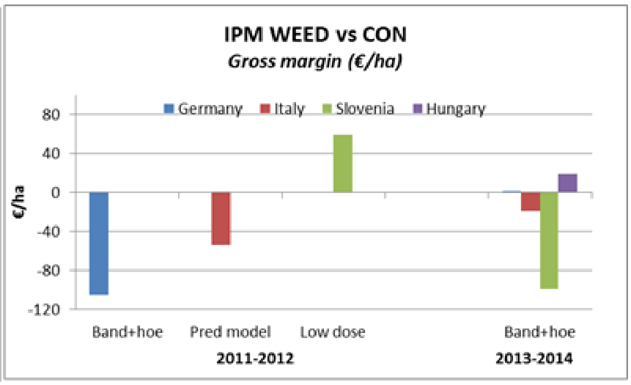


Figure 3.2. Difference in total variable costs (left, costs for herbicides and application) and gross margin (right) between IPM and CON strategies.

Table 3.2. Environmental risks for aquatic and terrestrial life of CON and IPM in on farm trials as calculated by the model SYNOPS (average of tools, sites and years; where red = high, yellow = medium, blue = low, green = very low, GE = Germany, SI, Slovenia, HU Hungary, IT = Italy)

		Acute		Chronic	
		Aquatic	Terrestrial	Aquatic	Terrestrial
GE	CON	0.60	0.00	5.32	0.01
	IPM	0.41	0.00	3.61	0.00
SI	CON	0.39	0.01	2.85	0.12
	IPM	0.19	0.00	1.24	0.02
HU	CON	0.32	0.00	3.06	0.02
	IPM	0.24	0.00	2.24	0.01
IT	CON	0.44	0.00	3.00	0.10
	IPM	0.27	0.00	1.39	0.03

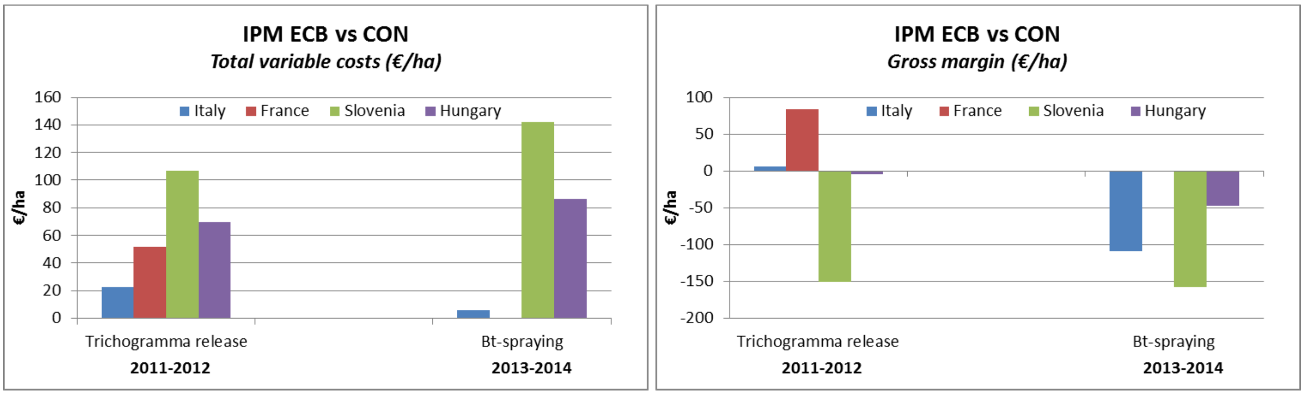


Figure 3.3. Difference in total variable costs (left, costs for pesticides/biological agents and application) and gross margin (right) between IPM and CON strategies.

- **WP4 – IPM solutions for important field vegetable crops**

Figure 4.1 - Robotic weeding with Robovator in Denmark

Figure 4.2 - Robotic weeding with Radis 2.0 in the Netherlands

Figure 4.3 – Finger-weeder (www.kress-landtechnik.de)

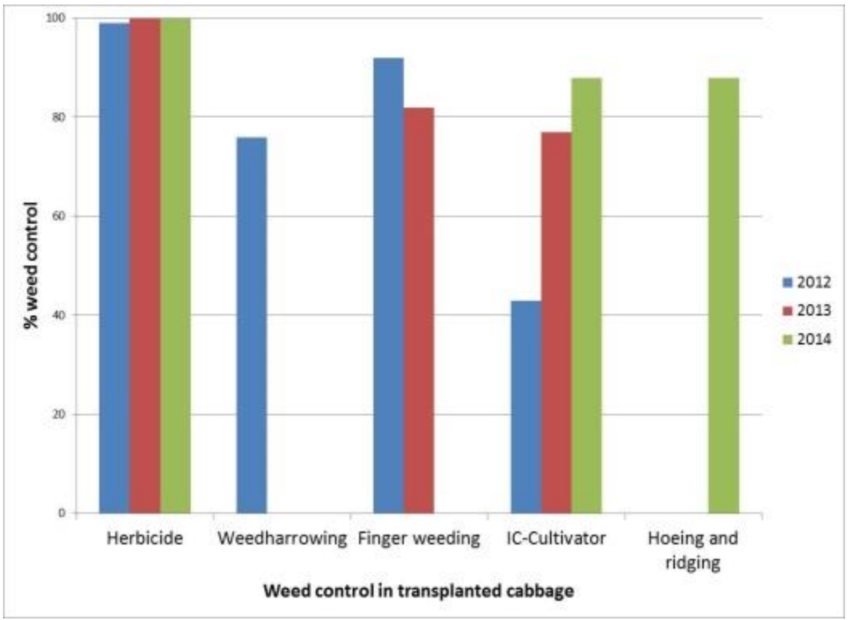


Figure 4.4 - Weed control in transplanted Brussels sprouts in the Netherlands.

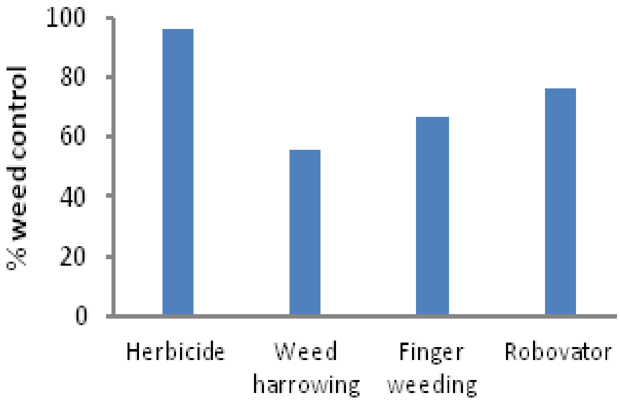


Figure 4.5 - Weed control in transplanted white cabbage in Denmark.

Figure 4.6 - Cabbage aphid (*Brevicoryne brassicae*), cabbage moth (*Mamestra brassicae*), cabbage white butterfly (*Pieris rapae*), and diamond back moth (*Plutella xylostella*) (from left to right).

Figure 4.7- Adult cabbage root fly (*Delia radicum*), maggot, and pupae (from left to right).

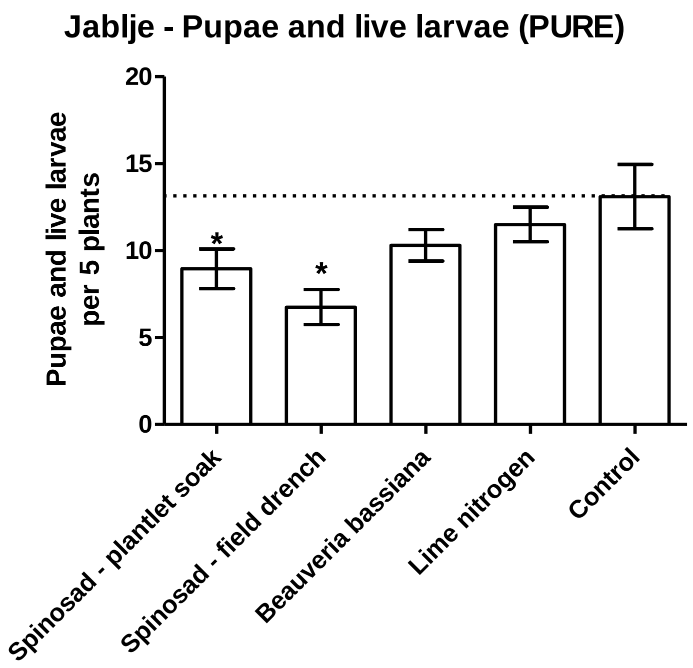


Figure 4.8 - Number of cabbage root fly pupae in an on-station trial in Slovenia.

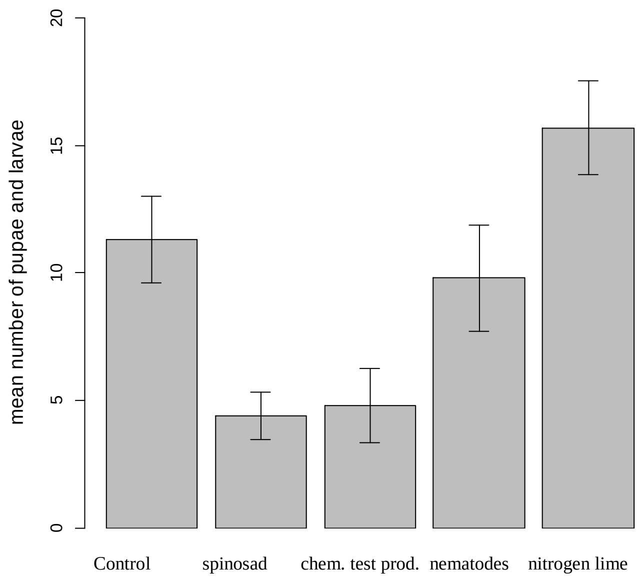


Figure 4.9 - Number of cabbage root fly pupae in an on-station trial in Germany.

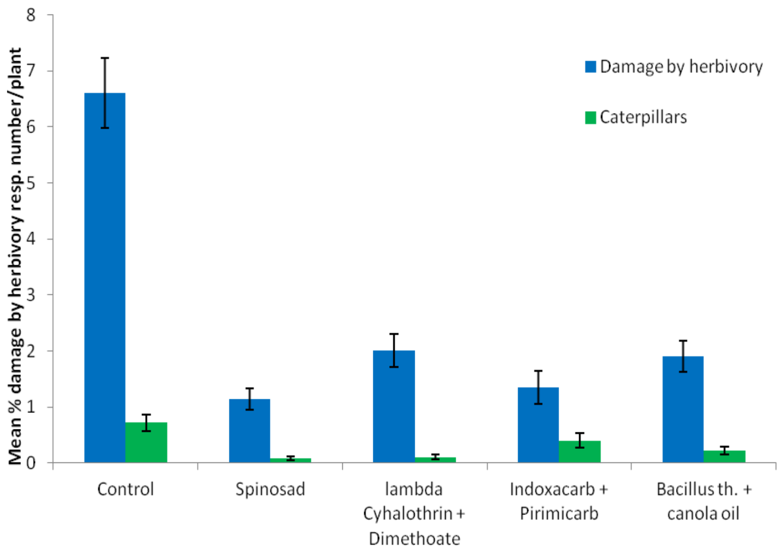


Figure 4.10 - Mean percentage of damage by herbivory as well as number of caterpillars per white cabbage plant in relation to different treatments at harvest in 2012

- **WP5 – Innovative IPM pome fruit systems**

Figure 5.1 - *Venturia inaequalis* (sexual form)

Figure 5.2 - *Cydia pomonella* (Codling moth) – adult and larvae within an apple

Figure 5.3 - Brown spot, symptoms caused by *Stemphylium vesicarium* on leaf and pear

Figure 5.4 - Pear psylla (pear sucker) - Cacopsylla pyri : Picture of different stages (egg and adult forms)

- **WP6 – IPM solutions to reduce pesticides reliance in grapevine**

Botrytis cinerea (grey mould)

Erysiphe necator (powdery mildew)

Plasmopara viticola (downy mildew)

Lobesia botrana (European Grapevine Moth)

Figure 6.1 – Main pests and diseases targeted in PURE WP6

- **WP7 – IPM solutions for protected vegetables**

Figure 7.1 – Whiteflies: *Bemisia tabaci* (A) and *Trialeurodes vaporariorum* (B)

Figure 7.2 - *Tuta absoluta* (adult form) and its damages on fruit

- **WP9 – Plant-pest-enemies interactions**

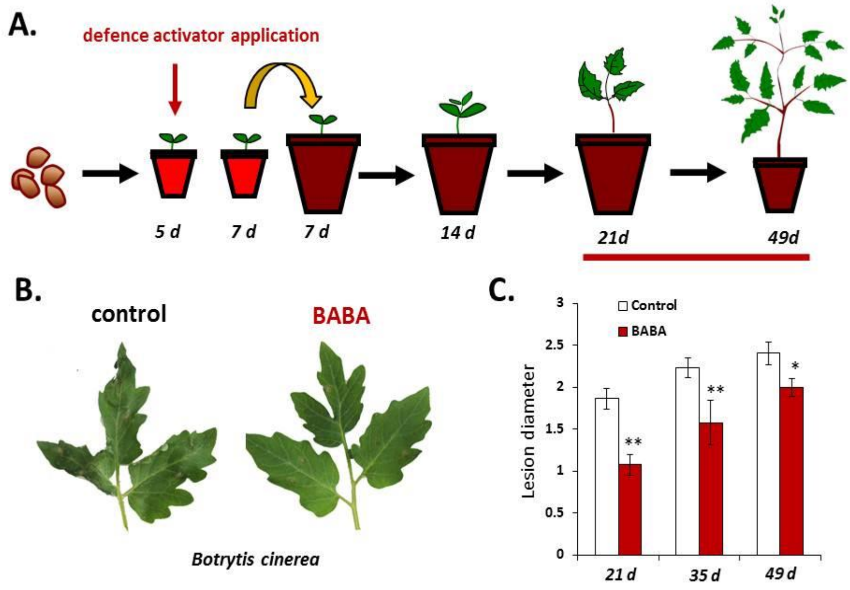


Figure 9.1. Long-lasting induced resistance in tomato against grey mould (*Botrytis cinerea*) upon seedling treatment with beta-amino butyric acid (BABA) A: Experimental procedure of seedling treatment B: representative differences in disease at 21 d after induction treatment and 5 d after inoculation with *B. cinerea*. C: Lesion size (cm) at 21d, 35d and 49d after induction treatment and 4 d after inoculation with *B. cinerea*.

- **WP11 – Emerging Technologies**

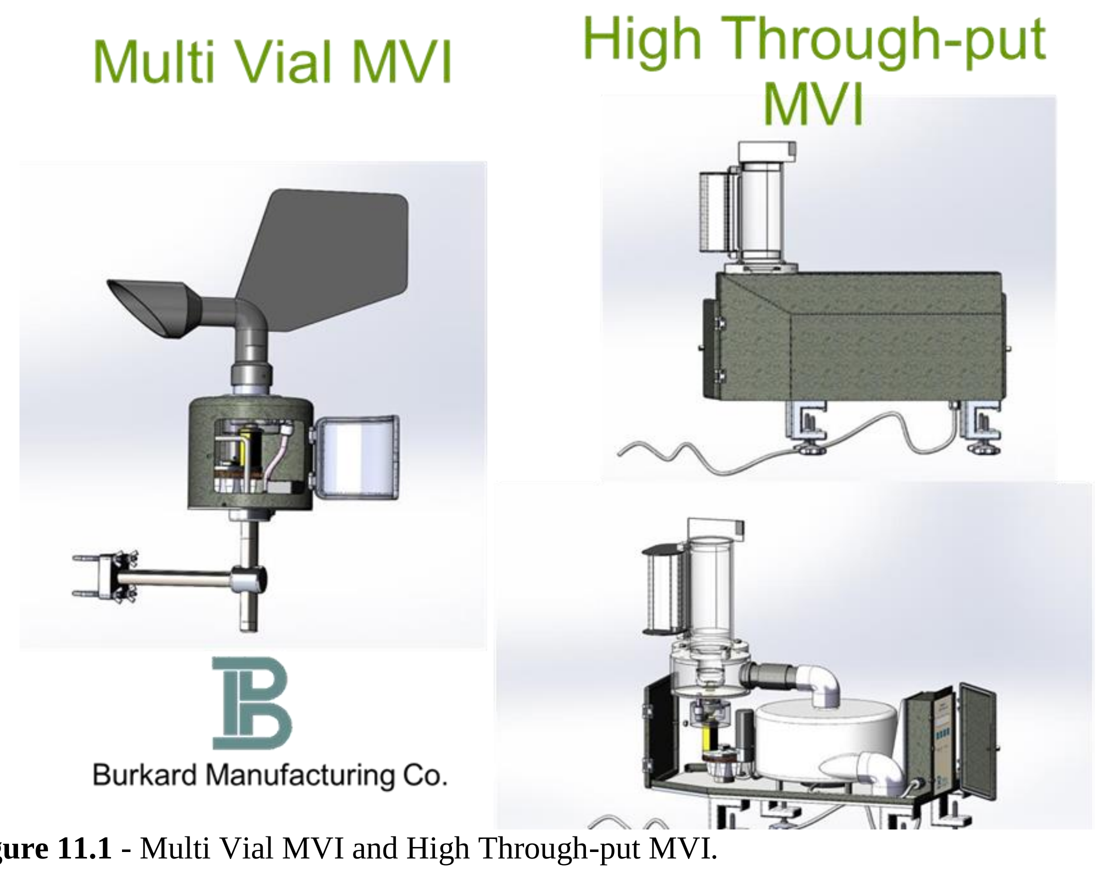


Figure 11.1 - Multi Vial MVI and High Through-put MVI.

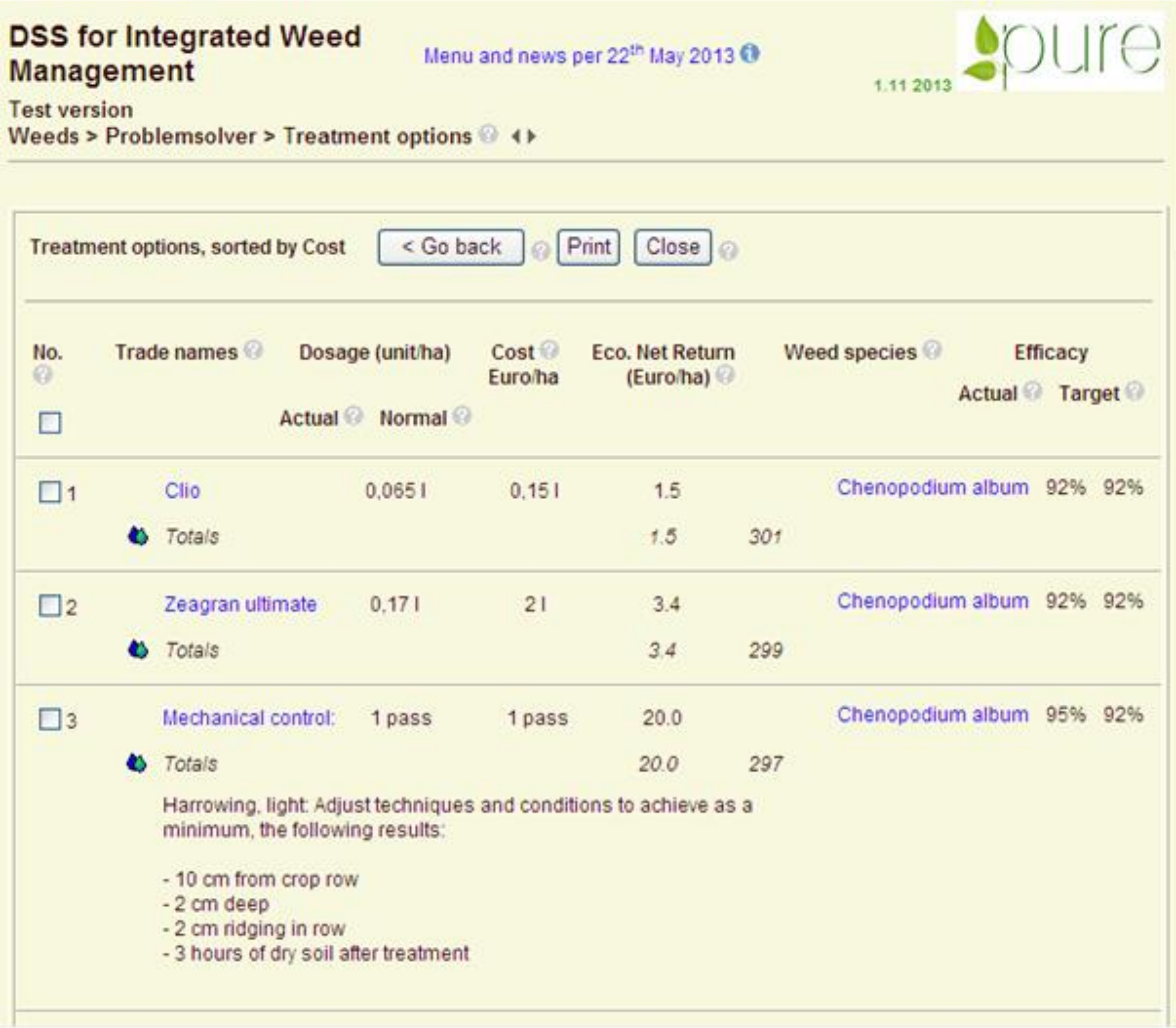


Figure 11.2 - Interphase of the DSS for integrated weed management.

Figure 11.3 - Electromagnetic shaker for mating disruption of *Scaphoideus titanus* in grapevine.

Figure 11.4 - The Canopy Density Sprayer for pomefruit trees.

Figure 11.5 - VisionSpray mounted on a tractor.

- **WP13 – Co-innovation of IPM**

Table 13.1 – Links to the video on co-innovation lessons learnt

Topic	Link
Introduction on co-innovation	http://video.dlbr.dk/video/10795326/introduction-to-co-innovation-1
Evaluation of co-innovation approach	http://video.dlbr.dk/video/10795335/introduction-to-co-innovation-2
French pilot	http://video.dlbr.dk/video/10795344/experiences-from-pilots-france
Dutch pilot	http://video.dlbr.dk/video/10795363/experiences-from-pilots-netherlands http://video.dlbr.dk/channel/843220/landbrugsinfo
Danish pilot	http://video.dlbr.dk/video/10795524/danish-pilot http://video.dlbr.dk/video/10795600/experiences-

	from-pebringsgaard-in
German pilot	http://video.dlbr.dk/video/10795615/by-silke-dachbrodt-saaydeh-martin-hommes

1.4. Potential impact, the main dissemination activities and exploitation of results

- **WP12 – Knowledge interaction, dissemination, training and technology transfer**

Table 12.1: total number of publications by type

Publications	Scientific and technical reports	e-learning materials	Deliverables	Booklets
194	89	22	61	22

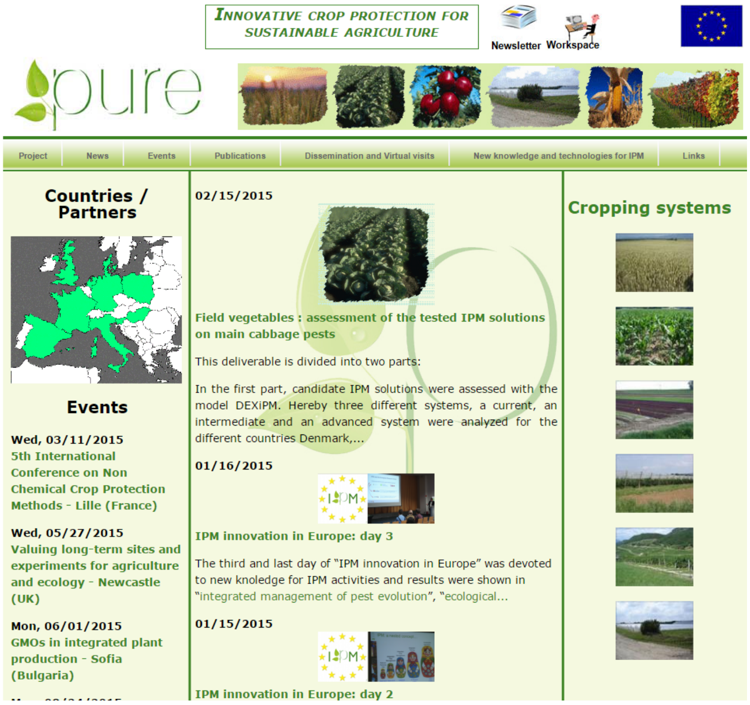


Figure 12.1- example of PURE website homepage

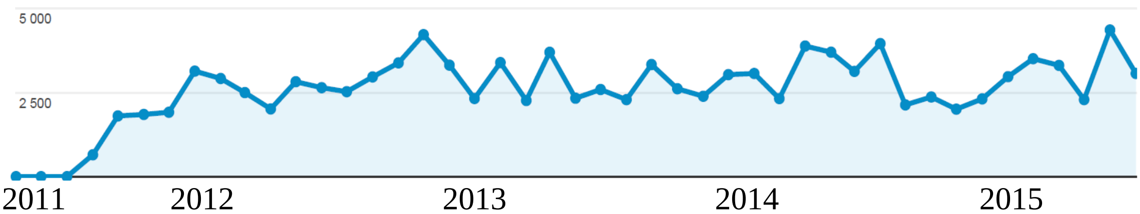


Figure 12.2: number of visits on the website per month (google analytics datas)

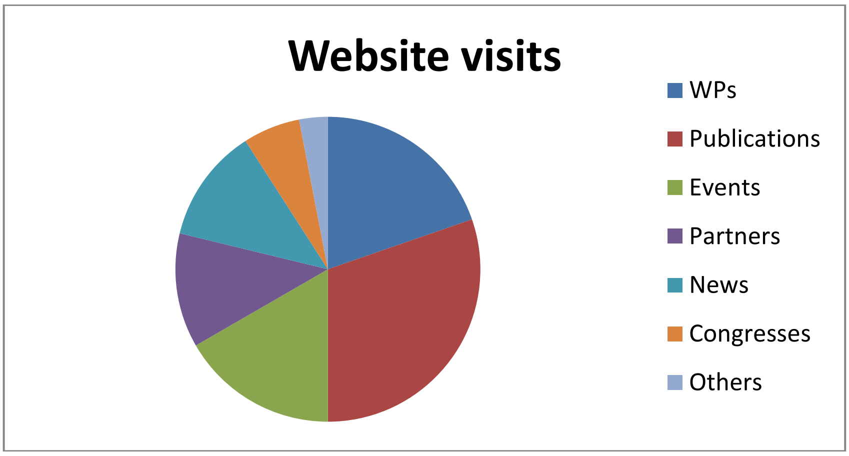


Figure 12.3 - Repartition in main categories of website visits

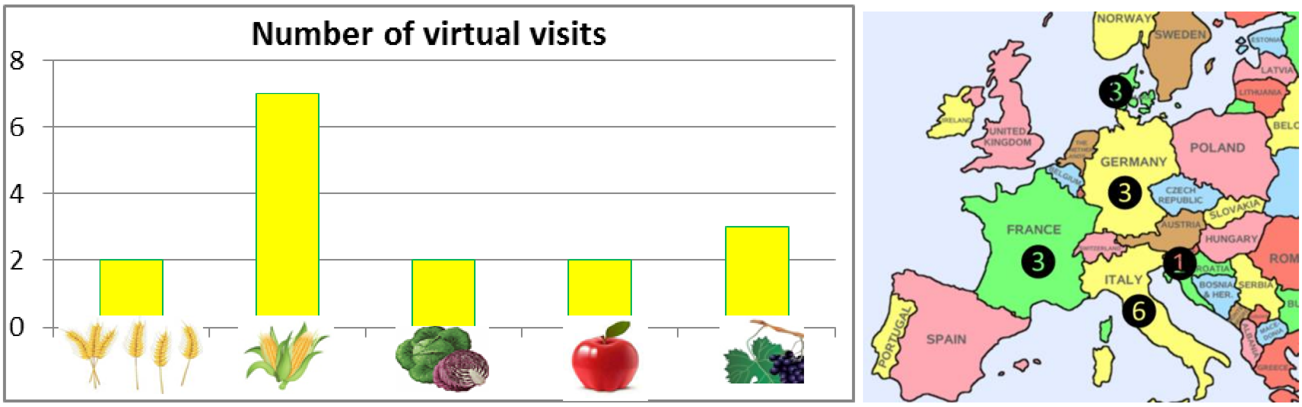


Figure 12.4 - Number of virtual visits by cropping system (left) and by country (right)

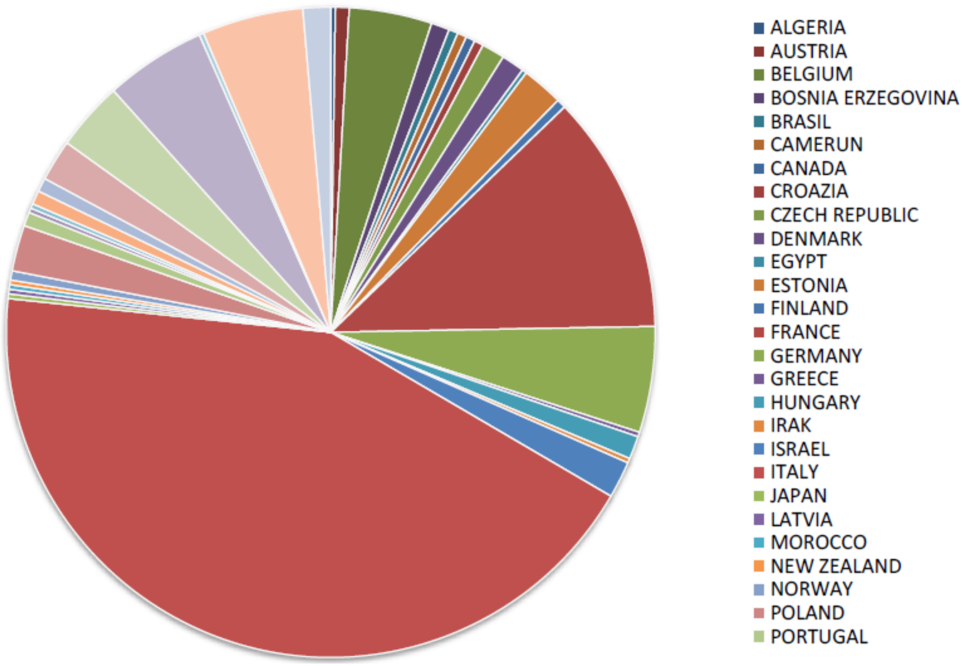


Figure 12.5 - Number of participants at the Riva del Garda congress per country

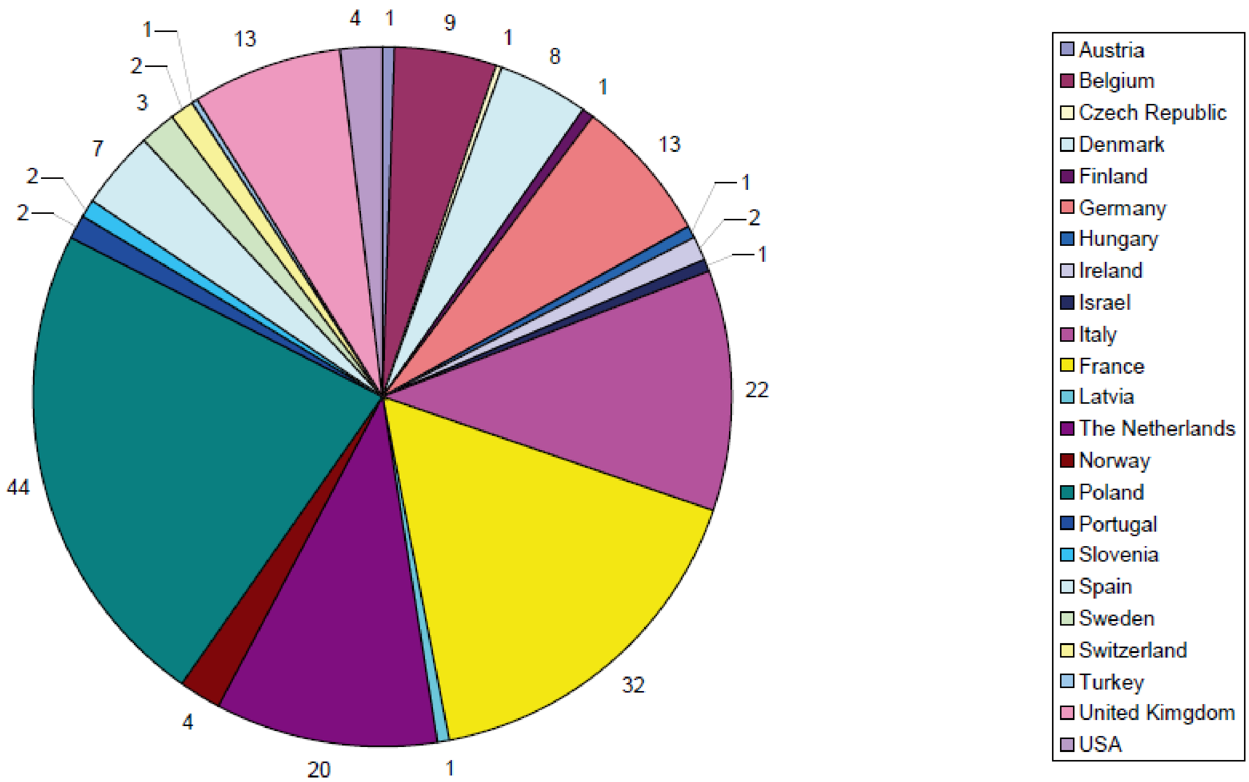


Figure 12.6 - number of participants at the Poznan congress per country

1.5. Project website

Project website: http://www.pure-ipm.eu/

Project logo:

pure

Innovative crop protection for sustainable agriculture

Relevant contacts for the project:

- Coordinator of the scientific work: Françoise Lescourret (INRA) – Francoise.Lescourret@avignon.inra.fr
- Dissemination leader (WP12): Philippe Delval (ACTA) – Philippe.Delval@acta.asso.fr
- WP1 leader: Jean-Noël Aubertot (INRA) – Jean-Noel.Aubertot@toulouse.inra.fr
- WP2 leader: Per Kudsk (AU) – per.kudsk@agro.au.dk
- WP3 leader: Maurizio Sattin (CNR) – maurizio.sattin@ibaf.cnr.it

- WP4 leader: Martin Hommes (JKI) – martin.hommes@jki.bund.de
- WP5 leader: Bart Heijne (DLO) – bart.heijne@wur.nl
- WP6 leader: Ilaria Pertot (FEM) – ilaria.pertot@iasma.it
- WP7 leader: Christine Poncet (INRA) – christine.poncet@sophia.inra.fr
- WP8 leader: Wopke van der Werf (WU) – wopke.vanderwerf@wur.nl
- WP9 leader: Toby Bruce (RRES) – toby.bruce@rothamsted.ac.uk
- WP10 leader: Graham Begg (JHI) – Graham.Begg@hutton.ac.uk
- WP11 leader: Marleen Riemens (DLO) – marleen.riemens@wur.nl
- WP13 leader: Pieter de Wolf (DLO) – Pieter.dewolf@wur.nl