TOOLS T 13	# IPM in winter crop based cropping systems
	Systems

Date (10/02/2012)

WHAT IS…	IPM in winter crop based cropping systems (WCCS) is targeted at **minimising the pest problems** that occur from having a **non-varied crop rotation**, by introducing other crops and techniques in the crop rotation. The estimated pesticide reduction potential is up to 37 % under Danish conditions
WHY	Although winter crop based cropping systems are and have been attractive to many farmers due to **high yields and good fodder production**, continuous growing of winter crops inevitably leads to **increased problems,** especially with weeds. When a resistant weed population has been established, it is very difficult and expensive to get rid of it again. IPM in winter crops is therefore targeted at preventing the build-up of resistant weed populations. There is of course also the problem with resistant diseases (septoria, powdery mildew etc.). The IPM solutions mentioned here are however focused on minimising weed problems.
HOW	Previously, **ENDURE** has worked with re-designed crop rotations for farmers traditionally having a very strenuous winter crop based cropping systems. Crop sequences should ideally have a much stronger mixture of annual crops with varied sowing times (spring versus autumn) and periods with perennial crops to counteract unwanted and severe pest problems, thereby limiting the need for pesticides. However, only **moderate modifications** of WCCS are likely to be accepted by Danish farmers owing to **economic considerations**. These altered systems can form the basis for a discussion with a group of farmers or advisers. For this you can use the ENDURE document (see Sources) and use it during a training session using participatory methods (see Methodology). If it is a small group, it will be a benefit to focus on individual farms, and talk about/calculate the impact on farm economy that changes to the crop rotation will have. We are suggesting two crop sequences that balance crop preferences among farmers and the inclusion of spring-sown break crops for impeding severe pest problems, without

	jeopardising the farm's economy, under Danish conditions: **Sequence I**: W. barley – W. rape – W. wheat – W. wheat + catch crop – S. barley, especially designed to prevent the proliferation of annual grass weeds, cleavers and foliage diseases occurring at low levels. **Sequence II**: W. barley – W. rape – W. wheat - W. wheat + catch crop – S. barley + catch crop/undersown ley – S. barley, especially designed to manage detrimental infestations of annual grass weeds and cleavers. Both sequences produce substantial forage grain and are not expected to threaten the own production of Danish pig producers. The potential **pesticide reduction is up to 37 %** under Danish conditions. The same exercise has been done for French and UK cropping systems. Here the potential pesticide reduction is estimated to be in the range of 62-94 % (France) and 6-20 % (UK), of course depending on the techniques and cropping changes adopted. Read more in the corresponding leaflet **PURE** Continues the work of ENDURE, by testing various IPM solutions in practice in 5 EU countries (UK, DK, DE, PO, FR)
SOURCES	► Find more information in the three leaflets about Winter Crops Based Cropping Systems on ENDURE Publications list: http://www.endure-network.eu/endure_publications/endure_publications2 1:'IPM in Danish winter crops based cropping systems' 2:'Redesigning Cropping Systems in three French regions' 3:'Reducing pesticide input in winter cropping systems in the UK' ► On the ENDURE website with deliverables: http://www.endure-network.eu/endure_publications/deliverables DR1.2 (Best control practices of diseases in winter wheat) DR2.16 (Designing innovative crop protection strategies in arable rotations: Winter Crops Based Cropping Systems) DR2.3 Mechanistic Winter Wheat Simulation model (WHEATPEST) linking European production situations and injury profiles to crop losses DR2.8 ROTATION: Follow-up report on implementation of arable crop system studies. ► On the ENDURE Information Centre: http://www.endureinformationcentre.eu/ Keywords: crop > cereals *or* rape ► On the PURE website: http://www.pure-ipm.eu/taxonomy/term/27

TOOLS 14

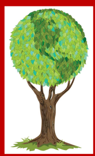
How to design viable maize based rotations

Systems

Date (10/02/2012)

WHAT IS…	Maize based crop rotation systems are crop rotation systems reliant on significant **maize production in time** (i.e. continuous maize production is common) **and space** (maize production is significant in the region).
WHY	In some regions maize is the **most important economic crop** or, due to **environmental factors**, such as relief, environmental surroundings or precipitation, there is no alternative crop that can be produced. In these regions maize production is significant in time and space, and in some fields maize is produced continuously. However, in an increasingly large part of Europe, continuous maize production is endangered by pests, diseases and weeds, including western corn rootworm (*Diabrotica virgifera virgifera* LeConte), corn borer (*Ostrinia nubilalis*), eyespot (*Kabatiella zeae*) and leafspot (*Drechslera sp.)*. In areas where economic driving forces and specific local conditions do not favour the decision of farmers to rotate maize with alternative crops, maize based cropping systems have to be developed with intensive risk estimation and risk management.
HOW	There are three steps for designing viable, maize based crop rotation systems: **1. Agro-Ecosystem Analyses (AESA)** is observations of biotic (for example, plant, weeds, pests and diseases) and abiotic (for example, soil and weather) factors in the fields. The goal of an AESA is to assess what type of action will be needed to best produce a profit for the farmer, as well as to estimate the hazard of yield loss in the case of continuous maize production. **2. Risk estimation:** Based on data from the AESA, farmers should analyse the risks and benefits of continuous maize production. They should focus on: ► Pest population ► Weed management ► Subsidies ► Potential income ► Costs of plant production

	3. Risk management: Based on the result of the risk estimation, a decision should be taken on whether to grow crops in rotation or to grow maize continuously in each and every field. Continuous maize production should only be conducted in fields where the risk is low and the expected benefits high. The decision making process should focus not just on a single field, but on the whole farm. In the PURE project, innovative IPM solutions for maize-intensive productions will be identified, tested and validated both on-farm (in: FR, DE, HU, IT, SL) and on-station (in: FR, HU, IT, NL). Cost/benefit evaluation of relevant IPM solutions will play an important role. See "sources" for more info on PURE
SOURCES	► On the ENDURE website with deliverables: http://www.endure-network.eu/endure_publications/deliverables 'DR2.17 SWOT analysis of existing Maize Based Cropping Systems in four regions' 'DR3.7, DR1.18 & DR1.19 Final report on the Maize Case Study' ► On the ENDURE Information Centre: http://www.endureinformationcentre.eu/ Keywords: crop > maize ► On the PURE website: http://www.pure-ipm.eu/taxonomy/term/28

TOOLS 15	IPM-solutions for important field vegetable crops
	Systems

Date (10/02/2012)

WHAT IS…	The production of field vegetables is dependent on effective control of weeds, diseases and pests, as any attack will be detrimental to the yield and/or quality of the crop. At the same time, the consumer awareness states that field vegetables for human consumption should be as free as possible for pesticide residues. This calls for IPM solutions. It is therefore no surprise, that the vegetable growers were among the first to introduce IP-thinking in their production, e.g. by introducing warning systems, decision support systems and other methods, to improve the timing of pesticide application, thereby decreasing the number of sprays and quantity of pesticides
WHY	The European retailers have a massive focus on the pesticide use in field vegetables in Europe. Any case of pesticide residues exceeding the MRL will be devastating to the company and farmer. As the retailers are the primary buyers of the produce, the farmers are also keen on exploring alternative production ways or at least options to keep the pesticide use at a minimum. Also, the number of pesticides allowed to be used in field vegetables is decreasing, due to legal issues, why it is even more important with alternative solutions less reliant on chemical control.
HOW	Among other things, IPM in field vegetables relies on various tools to improve the effect of sprayings, e.g. warning and decision support systems. It is essential, that the vegetables are not sprayed, unless attack is observed or predicted. Therefore, there is a constant need for new knowledge and improved models, to assist the farmers. In ENDURE, the focus was on summarizing the already available alternative methods, and identification of the gaps of knowledge across the EU Member States (see Sources) In PURE, alternative strategies based on releasing and

	promoting beneficials, the use of biological pesticides or more selective pesticides, and the use of innovative cell sprayers will be in focus. This will help reducing the treatment frequency, pesticide volume, environmental impact, and the risk of exceeding MRL in field vegetables. There will be a number of practical experiments, i.e. 5 On-station experiments (located in: DK, FR, DE, SL, UK) and 4 On-farm experiments (located in: FR, DE, NL, SL)
SOURCES	► On the ENDURE website: Deliverables: http://www.endure-network.eu/endure_publications/deliverables DR1.17 (Protection methods available for 5 major crops), DR1.20 Field vegetables: Guidelines for alternative methods, DR1.21 Field vegetable case study: gaps of knowledge on methods, ► On the ENDURE Information Centre: http://www.endureinformationcentre.eu/ Keywords: crop > vegetables plants ► On the PURE website: http://www.pure-ipm.eu/taxonomy/term/29

TOOLS 16	**Innovative IPM pome fruit systems**
	Systems

Date (16/12/2011)

WHAT IS…	The objective is to design innovative IPM solutions in pome fruit which will substantially and realistically contribute to a reduced risk to human health and environment. These new designed innovative IPM solutions are tested on efficacy, economic, health risk and environmental aspects under well controlled conditions and as total IPM systems in commercial orchards
WHY	Pesticide residues in fruits have been signalled almost unanimously as the major market concern. Therefore introducing a new IPM tool (for example a new variety) requires the use of marketing efforts and is accompanied with high risks. For growers, bottlenecks linked to time management and to the farm organisation are important. Moreover, knowledge and technical gaps for orchard monitoring and orchard management e.g. for resistant cultivars have to be further studied.
HOW	With growers, it is first important to implement a system and multipest approach, initially focusing on the key pests and diseases of pome fruit, and aiming to integrate the most promising innovative IPM tools into advanced fruit production strategies. Among these tools, available decision support systems and prophylactic methods like sanitation has to be improved and implemented for the key pests and diseases. Biological control through habitat conservation can be extended to lepidopteran pests and aphid communities. The evolution of hail nets towards pest exclusion netting has to be evaluated on the whole system. New tools (BCAs, apple scab antagonists, cover crops) issued from research activities could be tested. It is also important to use a repetitive cycle over the years with aid of the farmers, where an IPM strategy is designed, tested using multi-factorial experimentation under controlled condition and on-farm experiments, assessed, improved and redesigned. By that, newest insights are incorporated. Note that key pests and diseases can be different for different European regions and consequently, developed innovative IPM

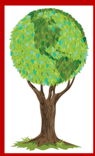
	solutions will be different for different regions. At the end, assessments will be done with emphasis on expected benefits in terms of health risks for workers, environmental aspects and reduced dependency on pesticide use on the one hand side and on possible economic and institutional hindrances to implement promising IPM tools and solutions in practice on the other hand side.
SOURCES	► On the ENDURE website: Deliverables: DR 1.8 & DR 1.9 : Survey and analysis of "the state of art of scab, brown spot and codling moth prevention and control strategies" DR 2.10 : Orchard advisors analysis of possibilities to implement tools of integrated control strategies DR 2.7 : Orchard: Inventory and analysis of possible social and economic bottlenecks to implement integrated control tools ► On the ENDURE Information Centre: Keywords: crop > pome fruits ► On the PURE website: http://www.pure-ipm.eu/taxonomy/term/30

TOOLS 17	**IPM solutions to reduce pesticides reliance in grapevine**
	Systems

Date (01/02/2012)

WHAT IS...	The overall objective on grapevine is to provide indications on how to reduce the use chemical pesticides of 10-30 % compared to the current situation by integrating microbial biocontrol agents, low impact substances, agronomic practices and innovative technologies (IPM solutions).
WHY	Grapevine is the number one user of pesticides in terms of tons of active ingredients consumed; it alone accounts for 38% of the total volume. IPM methods have the potential to drastically reduce pesticide use in terms of number of applications, frequency index and environmental impact. Our estimated impact is based on data collected in Northern Italy. Our worst case data show that farmers treat 22 times (with TFI=43) per season against powdery and downy mildews, grey mould, black dead arm, berry moth, *Scaphoideus titanus*, mites, and thrips. Our best case data yield 18 applications (TFI=29). To these baseline data, we need to add 2 to 3 herbicide applications on the rows. *[TFI here only includes chemical compounds].*
HOW	IPM solutions to control berry moth and *Scaphoideus titanus* with pheromone and vibrational mating disruption in combination with microbial control agents, adapted agronomic practices and mechanical weed control will reduce the number of applications down to 6 (TFI=8), reducing emissions by a factor of 3. A recent French study also calculates that IPM solutions could reduce total TFI from above 20 to below 10. Finding alternatives to copper against downy mildew will stop copper accumulation in the soil and will benefit soil micro and macro-fauna and flora. Specific approaches could be provided to complete the IPM solutions portfolio: by the use of downy and powdery mildew resistant/tolerant *Vitis* hybrids or cultivars and the implementation of cultural techniques against Botrytis (Germany), the combination of new microbial control agents and natural products with different mechanism of action (induced resistance, competition, antibiosis) against downy, powdery mildews, grey mould (Italy, Germany), the combination of mathematical models, monitoring and sanitation methods (Italy), the use of decision support system to reduce fungicidal spraying against downy and powdery mildews

	(France and Italy), the use of cover cropping as an alternative to herbicides (France).
SOURCES	► On the ENDURE website: Deliverables: DR 1.23 (Pesticide use in viticulture and available data on current practices and innovations, bottlenecks) ► On the ENDURE Information Centre: Keywords: crop > European grape ► On the PURE website: http://www.pure-ipm.eu/taxonomy/term/31

TOOLS 18	IPM solutions for protected vegetables
	Systems

Date (01/02/2012)

WHAT IS...	The importance of protected cultivation or **Controlled Environment Agriculture (CEA)** systems have increased tenfold in the last 25 years thanks to significant scientific and technical breakthroughs. These systems are very attractive to investors while allowing the regular supply of fresh vegetables, fruits and ornamentals to many populations living in all the different world climates. Production strategies, driven by both local opportunities and constraints (energy availability vs. natural climatic advantages…), have led to contrasting CEA options within Europe. Currently, high-tech systems have been mostly developed in Northern Europe. In contrast, Mediterranean regions have favored the low-tech systems. As the cost of fossil energies is becoming an increasing constraint, the Mediterranean area becomes attractive for all CEA systems. A key issue is now to find the type of technology that can best reconcile a cost-effective investment with the implementation of satisfying IPM solutions. The objectives are to design IPM solutions adapted for different levels of greenhouse technology (based on a combination of strategic options and tactic components) that reduce reliance on pesticides and risks to human health while providing cost-effective investment and ensure that these solutions satisfy the needs of concerned stakeholders.
WHY	In the world of crop protection, the common perception is that greenhouses are farming system types where IPM and biological control in particular have been very successful. Yet, the reality is that the total area under biological and integrated control in greenhouses is still marginal in many areas: in 2007 it was estimated to represent at most 5% of the total greenhouse world area. The vast majority of greenhouses are therefore under conventional chemical pest control which in many greenhouse crops can mean 40 pesticide treatments per year. However, recent evolution in pepper cultivation in Southern Spain under retailer pressure has demonstrated the real potential for increasing BioContol Agents use even in low/medium tech CEA. Based on past experience with IPM in ornamentals, the IPM solutions will provide the basis to

	generate a 90% reduction in the frequency of chemical applications.
HOW	A major concern in designing IPM solutions for protected crops is to ensure the robustness of the proposed new systems towards current and future major system disturbances: the consequences of cutting back fossil energy input and the risk of exotic pest invasions. Thus, the first step is to select candidate greenhouse designs, i.e. those which include the structure, internal equipment for climate control and subsequent crop conditions, fitting new economic, environmental, social and sanitary requirements. The second step is to select tactical packages, including some emerging technologies, pest control tools and "If Then Else" or "Do that" rules. Examples of candidate emerging technologies are: physical pest control (e.g. insect-proof screens) or nanofiltration systems for disinfestations of recycled water. Examples of pest control tactics are the use of climate precision monitoring, new biopesticides, combinations of natural enemies and plant activators, or push-pull approach exploiting semiochemicals to repel pests from the crop ('push') and to attract them into traps ('pull') (development of biodegradable dispensers of pheromones).
SOURCES	► On the **ENDURE** website: Deliverables: DR 1.10 (Map of EU tomato growing areas), DR 1.11 (Tools for diagnosis) ► On the **ENDURE Information Centre**: Keywords: crop > tomato ► On the **PURE** website: http://www.pure-ipm.eu/taxonomy/term/32