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AGRICULTURE & INNOVATION

Focus Group SOIL-BORNE DISEASES

Mini-paper - *Transfer IPM Systems*

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Introduction

The year 2015 has been declared the International Year of Soils (IYS) by the 68th UN General Assembly. Amongst other topics it will contribute to promoting sustainable use of agricultural inputs for soil health and ecosystems management. The first pillar of action is "Promote sustainable management of soil resources for soil protection, conservation and sustainable productivity". Soil health and crop health are strongly connected as soil conditions play an important part in plant disease development affecting the survival of pathogens and nematodes, the movement through the soil to a potential host (crop) or the interaction with natural or applied antagonists (bio-control agents). Several climate change scenarios project increased host range and impact of soil-borne diseases on crop health and yield due to global warming. The range of agronomic adoptions within this context is considered limited compared to above-ground diseases. This means that increased efforts are needed by science, politics and practise to address yield losses due to soil-borne diseases and nematodes (SBD).

Grower involvement and training, including decision making processes of the growers, adaption of technologies, and tools/accessibility where identified as main drivers for IPM implementation (Pre-Workshop Survey, OECD Workshop on Integrated Pest Management, 2011). The most important driver recognized in this survey was the market and food retail industry. The first ERA-net C-IPM workshop in Berlin, October 2014 came to several conclusions about the role of research and knowledge transfer in IPM. For the long-term, instead of focusing on specific crop-pest-time-relationships, IPM implementation would benefit more from a broader system approach in research. It was stated that broadening the scope and putting IPM in resilient and sustainable systems would be beneficial. In addition, the EASAC report no. 24 (Feb. 2014) recommends better use of research advances in support of innovation and the translation of knowledge to practical applications.

For many crops substantial knowledge about SBD is already available. Nevertheless, introduction of overall research into integrated system guidelines focusing on sustainable and resilient farm systems is often missing. Adequate control measures are also known for many SBD, but their successful implementation into IPM systems and a consequent knowledge transfer into practise is lacking.

High losses by soil-borne diseases and nematodes are frequently the result of several factors affecting the 'living system soil' over a longer period of time. The soil loses what is considered its natural antagonistic potential to keep pathogens at an economic tolerable level. This decidedly dynamic set of factors needs to be addressed in integrated strategies against SBD, resulting in very complex and long-term IPM systems to be transferred into practice. Current IPM systems against above-ground diseases are preferably based on "*reaction*" (i. e. monitoring, thresholds) rather on preventive "*action*". Due to their longer term built-up – and cure - most SBD need

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control measures which *foresee* possibilities for prevention in crop land soils[1]. The transfer of IPM systems against SBD therefore needs to include such preventive, long-term actions via intensive collaboration of all stakeholders involved. Timely feedback (farm-extension-research-retail-policy) is essential for ecologic and economic reliability of such IPM systems. At this point, feasibility becomes important as methodologies are more challenging compared to above-ground diseases. Monitoring of SBD, and especially factors affecting them, is very time and money consuming. Initially, this speaks against individual farm activities, based for example on online decision support systems well known for leaf pathogens. To facilitate transfer of IPM systems against SBD, community-based approaches can be considered more successful than individual farm activities. Individual farm activities are presumably more successful when they are a linking part in the overall IPM scheme reducing costs and efforts.

Communities of practice (CoP)

CoP evolve because of the members' common interest in a particular task (i. e. SBD). They can be created specifically with the goal of gaining knowledge related to a specific problem. Through the process of sharing information and experiences members learn from each other, and have an opportunity for active involvement. The "participatory" model values both farm and scientific inputs, effectively integrating them to yield appropriate management decisions. The set-up of functional production units for a crop or set of crops can be a positive economic side-effect of CoP when addressing large retailers or markets in general. Such CoP would not tackle every SBD problem, but they can be considered a vehicle for acceptance when implementing IPM strategies using a common approach. CoP can tackle one or more aspects along the production chain: from agronomic questions such as market demands and crop selection to market access and retail. IPM systems would contribute to all aspects.

Examples of CoP are pilot projects such as demonstration farms. Several European countries (e.g. Germany, Denmark, France) established networks of IPM demonstration farms as part of their National Action Plans to reduce the risks of pesticide use and to foster IPM implementation (Germany: National Action Plan on Sustainable Use of Plant Protection Products). New and innovative IPM methods are implemented on farm level accompanied with far-reaching support by official extension services. Nevertheless, this type of successful IPM implementation also needs to actively address soil-borne diseases and nematodes within the scope of IPM. There are limits to this type of knowledge transfer, mainly of financial nature. Farmers have to take economic risks for changing growing patterns when implementing diseases control. Those risks are comparably high for SBD which limits acceptance in knowledge transfer systems.

Transfer of IPM systems: acceptance

Among other factors, farmer's acceptance is crucial to adoption of IPM systems against SBD. IPM systems can affect the most important, almost unchangeable production factor of a (soil-based) farm: its crop land. They lead to long-term, not immediately foreseeable, ecologic and economic consequences which need to be addressed before an IPM system becomes established.

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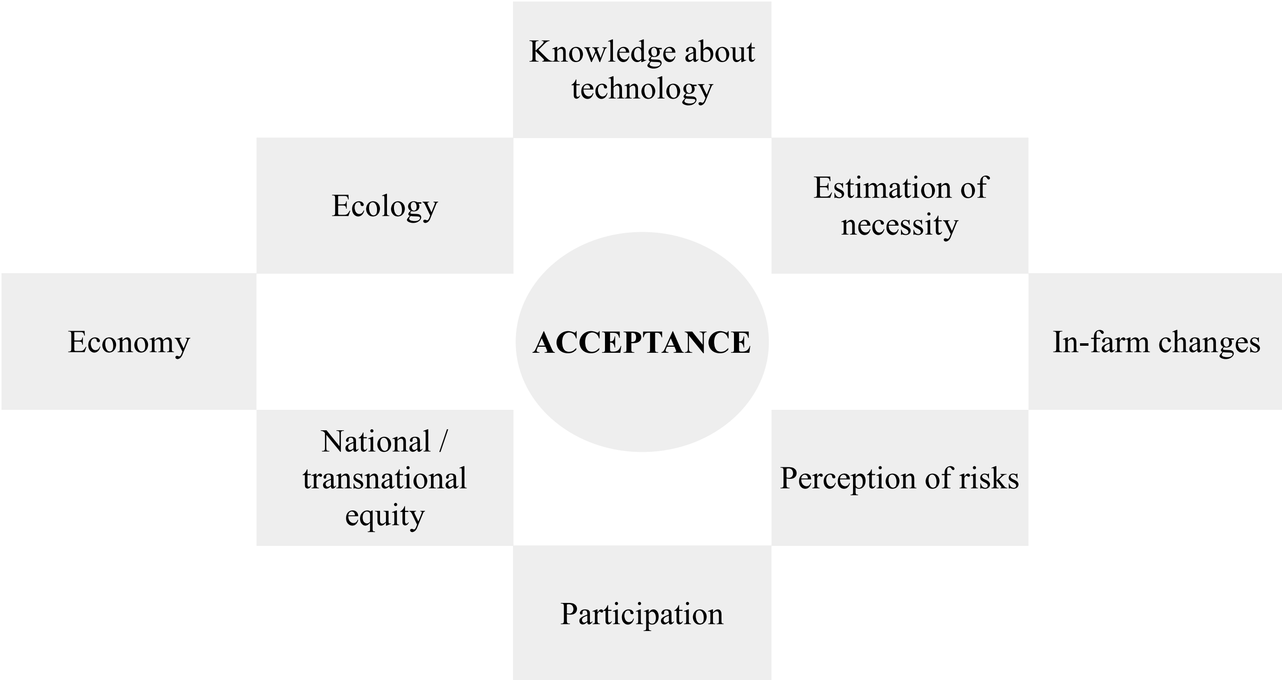
1 Does not apply to farm operations using potting soils or soil-less cropping.



Retail or market-oriented crop rotations temporarily neglect agronomic requirements regarding soil health. It is a risk a farmer actively decides to take based on an estimation of necessity (income). If the risk cannot be taken any longer, agronomic changes within the farm operation are the consequence, i. e. changing the crop rotation or types of soil cultivation. Those in-farm changes have direct economic effects which relate to the farm's ability to compete within the market (national/transnational equity). Because of their process duration, IPM systems for SBD especially require substantial knowledge of technology and innovation, and active participation of farmers. For the most part, the process does not follow a prognosis-based "threshold and spray"scheme, included in several IPM systems using combinations of chemical and non-chemical measures against above-ground diseases. Within this context, innovative types of knowledge transfer and participation are needed to successfully transfer IPM systems against SBD. In most instances, this will require substantial financial input, in areas such as affordable and industry independent extension services, soil analysis, crop breeding, monitoring and DSS (decision support systems). In regards to bio-control agents against SBD, legislation needs to provide for fast, effective, and uncomplicated registration procedures. This will allow for speedy practical implementation and timely feedback from farmers on effectiveness.

Methods in IPM against SBD and their current use

The EIP-focus group on IPM practices for SBD discussed promising non-chemical techniques for high-value crops (vegetables and ornamentals in greenhouses) and open field crops:

Greenhouse crops	Open field crops
Solarisation	Bio-fumigation
Grafting/resistance	Resistant varieties
Biological control agents (BCA)	Catch crops
Soilless systems	Green manure
Anaerobic soil disinfection	Intercropping

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In contrast to many open field crops the use of pesticides against SBD is held more established in high value crops (greenhouses). Access to permitted pesticides, timely application, less dependence on weather and climate, and reduced impact on non-target organisms are advantages missing in open-field crop production. Important SBD such as *Plasmodiophora brassicae* or cyst-nematodes (*Heterodera* spp.) affect many open-field crops and cannot be chemically controlled due to lack of pesticides or ecological concerns. Several of the above mentioned non-chemical methods have a long history in agriculture and crop protection. Some evolved over millenia and some are already an integral part of farm business. Nevertheless, practical information is still missing on how to use promising non-chemical techniques together as a tool box. For example, breeding for resistant crop varieties addressing leave diseases (i.e. mildew) rarely consider the crops' ability to tolerate SBD, and vice versa. Crops planted for green manure to improve soil health may inadvertently serve as hosts for other diseases above or below soil within the crop rotation. As mentioned in the previous chapter, this may become visible after several years at the earliest as the soil acts as a buffer system covering adverse effects for longer periods of time.

Questionnaire among EIP focus-group members

A short questionnaire[2] among EIP focus-group members on the use of available IPM-systems revealed some interesting tendencies. Some of the oldest techniques to reduce SBD (crop rotation, grafting, organic amendments) seem to play a minor part in knowledge transfer systems. Interestingly, by way of comparison newer techniques such as monitoring systems and decision support system (DDS) are also missing in knowledge transfer systems, probably due to the difficult ecological characteristics of many important SBD. In regards to above-ground diseases those techniques are established in IPM systems, and actively adopted by farmers. The development and knowledge-transfer of monitoring and decision support systems specific for SBD in combination with innovative types of knowledge transfer and farmer participation are in demand.

[2] Not representative

Types of IPM-methods currently used at your facility to address soil-borne diseases/nematodes and their current transfer into practice.

Transfer method **IPM method: the use of ...**	Farmer schools (multi-day)	Seminar off season	Seminar in season	Webinar	Demonstration on farms (institution)	Demonstration on farms (farmers)	**SUM**
1 Composts	1	4	4		4	3	**16**
2 Bio-fumigation		3	3		4	1	**11**
3 Organic amendments		2	2		2	1	**7**
4 Resistant varieties		3	3		3	3	**12**
5 Green manure	1	2	2	1	2	2	**10**
6 Crop rotation	1	3	2	1	1	1	**9**
7 Monitoring systems		2	2				**4**
8 DSS (Decision support system)		1					**1**
9 Solarisation		2	3		3	2	**10**
10 Grafting		2	2		2	2	**8**
11 Biological control agents (BCA)		6	3		4	3	**16**
12 Soilless cropping		2	2		2	1	**7**
SUM	**3**	**32**	**28**	**2**	**27**	**19**	

References:

EASAC Report 24 - Risks to Plant Health: EU Priorities for Tackling Emerging Plant Pests and Diseases. http://www.easac.eu/home/reports-and-statements/detail-view/article/risks-to-pla.html

OECD Workshop on Integrated Pest Management; Pre-workshop survey (2011): Strategies for the adoption and implementation of IPM in agriculture contributing to the sustainable use of pesticides and to pesticide risk reduction. Berlin, Germany

Report and presentations from the C-IPM workshop "Future challenges for IPM in a changing agriculture" (8 October, 2014), http://c-ipm.org/publications/

National Action Plan on Sustainable Use of Plant Protection Products, Germany. http://www.nap-pflanzenschutz.de/en/nap-germany/