Compilation of agreed common methods among existing IPM networks

Deliverable D2.2

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An EU-wide farm network demonstrating and promoting cost-effective IPM strategies

Coordination and Support Action (CSA)

01 October 2020 – 30 September 2024 (48 months)

Deliverable D2.2

Compilation of agreed common methods among existing IPM networks

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Lead partner: JKI

Authors list: Silke Dachbrodt-Saaydeh (JKI)

Thomas Rottstock (JKI)

Annett Gummert (JKI)

Jan Helbig (JKI)

Sandie Masson (Agroscope)

Callum Bennett (LEAF)

Marleen Riemens (WR)

Geert Kessel (WR)

Reviewed by: Calypso Picaud (APCA/CRAO), Mette Sønderskov (AU) and Nicolas Munier-Jolain (INRAE)

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☐	**CO**	Confidential, only for members of the consortium (including the Commission Services)

Abstract

The deliverable aims to identify and bring together best practices of existing and previous demo-farm networks, which promote IPM in Europe, in order to develop advice for existing and newly established IPM demo-farm networks. The information was gathered via a qualitative survey comprising a questionnaire and interviews with the organisers of the demo-farm networks. The respondents represent five European demo-farm networks, engaged in testing and dissemination of IPM strategies: DEPHY-France, DIPS-Germany, GROEN-AoZ-Netherlands, LEAF–United Kingdom and PestiRed-Switzerland.

Despite obvious organisational differences among the demo-farm networks, a variety of recommendations on best practices was identified. The general findings suggest that it is important for IPM demo-farm networks to comprise at least farmers, advisors and researchers. For the long-term transformation of practices, a value driven motivation of farmers' is essential. It is advisable to clearly define roles, activities and criteria for data collection from the beginning. The demo-farm networks suggest ideally implementing IPM on whole farms. To reduce initial difficulties, the farmers can begin the process with practices, which are known to be easily adopted. Establishment of farmer groups ensure peer-to-peer learning, while facilitators guarantee freedom of choice for the farmers. Field visits and associated face-to-face communication are crucial for the success of demo-farm networks. The publication of results from demo-farm networks can form the basis for improving the IPM advice for farmers and especially, to plan their cropping systems and IPM measures with a long-term perspective.

Preventive measures like diverse crop rotations and cultivation of more resistant varieties are crucial in IPM. This is also the case for well-organized field monitoring, which in combination with thresholds and ideally decision support systems are the basis for decisions for plant protection measures. Mechanical and thermal weed control can be a suitable alternative to herbicides. There is a demand for more biological control measures as alternative to conventional plant protection products (PPP). Moreover, farmers desire better information on selective, more target-specific PPP. The experience of the demo-farm networks shows that IPM measures have potential to reduce the use of PPP. Resistance development can for instance be avoided by the use of preventive measures, use of mechanical methods as well as change and mixture of different mode of actions of pesticides. It is recommended to conduct annual planning and evaluation of performance on farm and network level.

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Contents

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION' HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT N. 101000339

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION' HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT N. 101000339

1. Introduction

Deliverable 2.2 (D2.2) is part of IPM*WORKS* Task2.1 (Coordination of participation of existing networks), which is coordinated by the Julius Kühn-Institute in Germany. The project IPM*WORKS* was set up to foster exchange of experience on IPM strategies across Europe. There is already a number of demo-farm networks established in Europe, which are engaged in testing and promoting IPM strategies and new networks are initiated within IPM*WORKS*. However, so far there is very little exchange between the established networks[1], located in different European countries or with the upcoming new networks. In order to bring together and make the knowledge and experiences of existing and previous European demo-farm networks available, "LEAF" (UK), "GROEN-AoZ" (NL), "PestiRed" (CH), "DIPS" (DE) and "DEPHY" in France (Figure 1) were brought together in the project. We exchanged on the structure, core elements and methods and discussed experiences in order to identify common approaches among five respective networks.

Figure 1: The demo-farm networks, their location and the respective IPM*WORKS* main partner organisations representing networks

[1] Final Report EU-Workshop Demonstration Farms on Integrated Pest Management 24 and 25 May 2016, Bonn, Germany. https://www.nap-pflanzenschutz.de/fileadmin/SITE_MASTER/content/IPS/Integrierter_Pflanzenschutz/Modell-_und_Demonstrationsvorhaben_IPS/160623_Final_report_workshop_DEMO_farms-1.pdf

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2. Objective

D2.2 aims to identify and bring together best practices and challenges of European demo-farm networks, which promote IPM, in order to develop a shared set of best practices for existing and newly established IPM demo-farm networks.

3. Methodology

The data collection for this deliverable was conducted in two ways. The qualitative survey started with a questionnaire, which was followed by structured stakeholder interviews. The respondents of the survey are representatives of demo-farm networks, which are promoting IPM in Europe. After data collection, the obtained information was structured in a database and comparatively analysed.

3.1. Questionnaire survey

The questionnaire (Annex 1) was answered by five demo-farm networks, which are engaged in testing and dissemination of IPM strategies (DEPHY- France, DIPS-Germany, GROEN-AoZ-Netherlands, LEAF-United Kingdom and PestiRed-Switzerland). This initial survey was mainly on organisational aspects of the demo-farm networks (e.g. structure, knowledge exchange, publication of results, data management) but also on success stories and challenges.

3.2. Interview survey

The structured interviews were conducted with representatives from four European demo-farm networks (DEPHY, DIPS, LEAF, PestiRed). This part of the survey contained more specific questions about the experiences on IPM implementation and disseminations. Thus, an interview guide was developed (Annex 2), based on the questionnaire data.

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4. General findings

4.1. Network organization

This chapter focuses on the comparison of organisational aspects in the five demo-farm networks. Regarding the coordinating institutions, we found fundamental differences between the five demo-farm networks. DEPHY in France is coordinated by national ministries (agriculture and environment), the demo-farm networks in Germany and the Netherlands are coordinated by research institutions, PestiRed in Switzerland is managed by a consortium of governmental and non-governmental institutions and LEAF in the United Kingdom is a nongovernmental organization (Table 1). Unlike LEAF in the UK, DEPHY, DIPS and PESTIRED are funded by the government. The Dutch GROEN-AoZ network is funded through a combination of cooperating short-term projects.

Table 1. The demo-farm networks

Network	DEPHY	DIPS	GROEN-AoZ	LEAF	PESTIRED
Country	France	Germany	Netherlands	United Kingdom	Switzerland
Duration	since 2010	2011-2018	2017-2020	since 1993	since 2019
Number of participating farms	3200	66	30	38	68
Coordinator	Ministry for Agriculture & Ministry for Environment	Julius Kühn-Institut	Wageningen University and Research	Linking Environment & Farming (LEAF)	IP Suisse and cantonal agricultural offices of Solothurn, Vaud, Geneva
Production sectors	Arable crops, orchards, tropical crops, horticulture, vegetables, vine	Arable crops, horticulture, apple, vine, hops	Arable crops	Arable crops, horticulture, livestock	Arable crops

4.1.1. Objectives of the individual demo-farm networks

Although all five demo-farm networks were created to support practical Integrated Pest Management, research and knowledge exchange, the objectives of the demo-farm networks differed.

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GROEN-AoZ (Netherlands)

The overall objective of the GROEN-AOZ network is to develop, validate and communicate on sustainable methods for pest, disease and weed control in arable crops based on Integrated Crop Management (ICM). The questions and activities of the Dutch demo-farm network focus on five main topics (figure 2).

- Pest, disease and weed suppressive rotations and crop sequences
- Resilient varieties and green manure crops (including host status)
- Soil conservation methods as regards to e.g. the impact of crop residues on soil borne population dynamics of pests, diseases and weeds
- Monitoring and evaluation using damage thresholds, action thresholds and DSS systems
- Direct control methods using physical, biological and (preferably low impact) chemical control measures

www.wur.nl/akkerbouwopzand

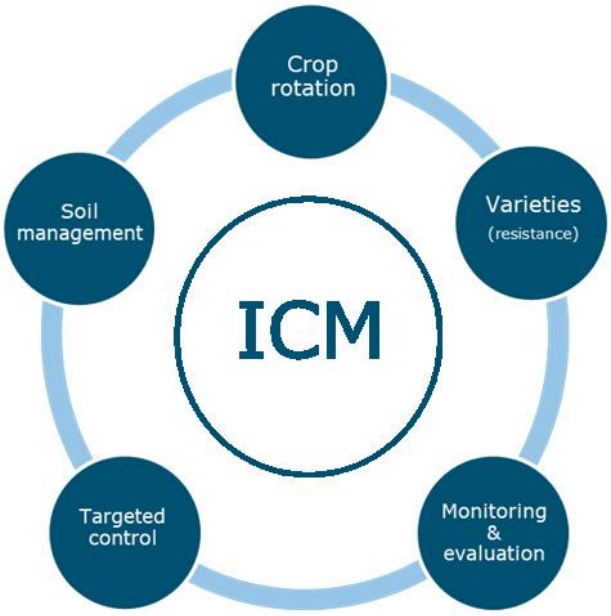

Figure 2: The structure of the Dutch demo-farm network

LEAF (United Kingdom)

Linking Environment And Farming (LEAF) demonstration farms are working, commercial farms practicing Integrated Farm Management (IFM). The 38 LEAF Demonstration Farmers communicate, discuss and demonstrate IFM best practice amongst other farmers and play a critical role in promoting sustainable farming to wider groups such as politicians, industry and students. LEAF Innovation Centres are research organizations, whose work supports the research, evidence, development and promotion of Integrated Farm Management.

https://LEAF.eco/farming/LEAF-network

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PestiRed (Switzerland)

The project aims to reduce the use of plant protection products by 75%, combining various measures over an entire crop rotation of 6 years. The application of plant protection products on one innovative plot in each of the 68 participating farms (on which IPM practises have been implemented) is on average 75% lower when compared to:

- a typical application level in the region at the beginning of the project
- a control plot grown in parallel in each of the 68 farms with the farmer's usual agricultural practices before entering the project

This should be achieved, while a reduction in economic yield of up to 10% is maintained. The project pursues a participatory approach in which farmers, value chains, consulting and research work together from the beginning. It covers the entire duration of a crop rotation and the full suite of measures implemented during this period. The new knowledge will benefit not only the project actors directly concerned (farmers, researchers and extension workers), but also all the agricultural actors in other parts of Switzerland. In addition, the project will identify the possibilities and barriers of non-chemical plant protection in practice and provide the basis for future agricultural policy (legal requirements and incentive system) in the area of plant protection.

https://pestired.ch/

DIPS (Germany)

The objective of the project was to establish, support and analyse a network of demonstration farms, which implemented and demonstrated IPM in the best possible way to other farmers, consultants and the public. The network demonstrated the possibilities and identified barriers of IPM under farming conditions. The 66 farms demonstrated "best practice" in IPM and innovations that contributed in particular to limiting the use of chemical pesticides to the necessary minimum. The aim was to optimize the implementation of IPM by adapting preventive measures such as crop rotation, the choice of variety, the effects of sowing dates on pesticide use. Non-chemical and alternative methods were demonstrated and tested, as well as the enhancing in-field monitoring and the use of decision support systems.

https://demo-ips.julius-kuehn.de/

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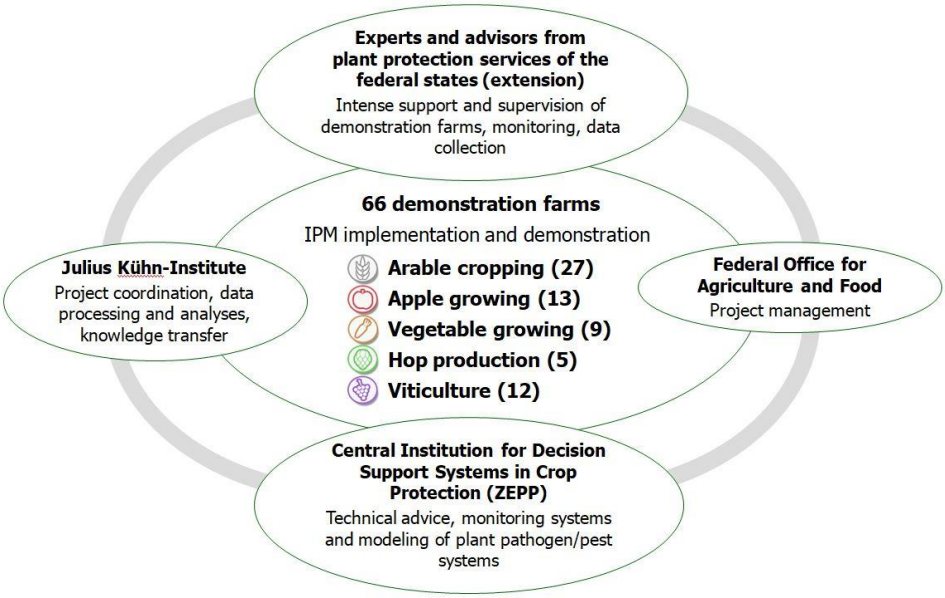

Figure 3: The structure of the German network of demonstration farms (DIPS)

DEPHY (France)

DEPHY stands for Demonstrate, Evaluate and produce references on agricultural systems with low use of PHYtosanitory products. This network aims to test, evaluate and disseminate agricultural techniques and systems reducing the use of pesticides while maintaining economic, social and environmental farm performance. This national network covers diverse production systems and involves research and many advisory services, agricultural schools, agricultural institutes. Over 3.000 farmers are engaged voluntarily in the project, working on adapting IPM practices to their production and context, in order to reduce pesticide use. Linked to research projects that go further in testing and evaluating IPM measures, DEPHY aims at demonstrating through demonstration events and multiple publications multiple paths to reduce pesticide use in real farm conditions, therefore requiring economical as well as environmental sustainability. Farmer groups gather from 10 to 15 farmers, develop a group project, both identifying individual and collective goals. The DEPHY network works with farmers on their change of practices, using the classification of Efficiency, Substitution and Re-design[2] to understand the extent of changes the agricultural systems have gone through. DEPHY emphasises demonstration and dissemination of experiences. Launched in 2010, the network has worked for more than 10 years to exchange on IPM principles, disseminating both specific methods to support farmers collectively in finding their own site-specific IPM strategy, as well as communicating on tested IPM solutions.

https://ecophytopic.fr/dephy/carte-interactive-dephy

[2] Hill and Macrae, 1996

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4.1.2. Considerations for the project objectives

Whole farm approach vs. stepwise approach

Three out of five demo-farm networks (LEAF, DEPHY and GROEN-AoZ) were established with the objective of promoting a whole farm approach for IPM implementation. In contrast, IPM practices were limited to a number of fields and/or crops of the demo-farms in the other two networks (stepwise approach). Although using a stepwise implementation of IPM, the experience of PestiRed shows that it is easier for farmers to adjust the entire cropping system from the beginning, rather than testing individual IPM measures on field level. IPM measures usually depend on or affect each other and/or specific methods also require for changes in the crop rotation. The adjustment can only be made on the whole farm approach. Moreover, ecological and economic benefits might only occur if the entire farm management is adapted. This suggests that networks focusing on the implementation of IPM should prefer a whole farm approach rather than an implementation of IPM on selected fields / crops.

Taking stock of experiences and easily implemented practices

The implementation of IPM is the common ground of the demo-farm networks. The experience shows that synergies with secondary objectives such as the development of alternative marketing strategies or long-lasting partnerships will occur in the course of the project collaboration. Existing structures and practices should be identified on the individual demo-farms to build up on. The demo-farm networks confirmed that some IPM practices are easier implemented by farmers than others. Generally, it is beneficial if farmers start with IPM practices, which are known to be more easily adopted. This can ease the transition and generate confidence in the starting phase. Examples for IPM practices in arable crops, which are easily adopted by farmers, are changes of sowing dates, false seedbed and cultivation of more tolerant/resistant varieties. Thus, positive effects of IPM occur already early in the transition without high additional costs and risks. This contributes to farmers' confidence and supports a conversion to a more holistic IPM approach. More complex practices are changes in crop-rotation or crop sequence, changes in cultural practices (e.g. till/no-till), and implementation of flower strips and setting up semi-natural habitats.

4.1.3. Network members

Experiences show that it is beneficial if demo-farm networks at least include farmers, advisors and researches as participants. In order to provide farmers, as main target group of IPM demo-farm networks, with tailor-made advice and information they are best grouped by production sectors (e.g. figure 3) or annual or perennial crops. Because arable crop farmers are many in number and cultivate large areas of farmland, all five demo-farm networks covered this production sector. Moreover, in view to achieve pesticide use reduction, the networks recommend involving arable crops as they have comparably high potential to contribute to a reduction in pesticide use.

Advisors play an important role within a demo-farm network. Farmers benefit from their broad expertise and access to advanced technical knowledge as well as their experiences. Advisors have or can bring specific expertise to the network via experts. In some cases, advisors also recommend new market opportunities or help linking to and understanding the supply chain

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partners. One important finding is that the advisors must be independent, acting without economic interest, and their role needs to be clearly defined from the beginning. It is important that the advisors provide knowledge and guide decisions but the farmer takes the final decision. This way, farmers maintain their responsibility and gain confidence in the course of different discussions or exchanges but can open also new opportunities.

The involvement of researchers supports the development of new strategies. From a more general point of view, they allow the scientific evaluation of the implementation of new practices. Thus, the dissemination on a larger scale and to larger groups of farmers, advisors or decision makers is facilitated.

In general, the composition of participants always depends on the objective and the planned activities of the network. All roles and activities should be clearly defined before the beginning of a project. The successful implementation of IPM depends also on conditions of the production framework outside the network and related challenges.

4.1.4. Challenges in the implementation of IPM

The demo-farm networks have mentioned they have experienced a range of organisational and technical difficulties. These challenges can hinder or impede the implementation of IPM. In particular, the organisational and technical challenges can be mitigated through transparency as regards explanation of expectations and continuous exchange and advice throughout the project.

Organisational challenges

- frequent change of facilitators in the network
- insufficient project duration (e.g. Germany and the Netherlands, 4-5 years/farm are not sufficient to be able to test and demonstrate fundamental changes)

Technical challenges on farm level

- lack of evidence for effectiveness of IPM
- lack of advice
- risk averse as regards to potential yield losses / sensitive high risk perception
- lack of capacity (financial, time)
- economic pressure for the farm business

Market challenges

- market requirements (e.g. zero defect standards for agricultural products)
- lack of supply chains for products (e.g. lack of local buyers, situation on global markets)

4.1.5. Farmer groups

Three out of the five demo-farm networks organize their member farms in groups (DEPHY, DIPS, PestiRed). The networks build mainly on advantages in organizing farmers in groups. Farmer groups motivate peer-to-peer learning (sharing of experience) and especially fosters hub formation. Once participants trust each other, hub formation is a long lasting process. The

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concern, that IPM decisions at group level may not benefit each farm to the same extent can be resolved. The group will discuss solutions but the implementation will be adapted to needs of each individual farm.

Motivation of farmers to join a demo-farm network

When recruiting farmers for a demo-farm network, the personal interest and motivation of the farmers is fundamental. Thus, their individual questions and issues should be addressed when developing IPM strategies inside the network. For most farmers, and especially for young farmers, the motivation is rather value driven aiming at the reduction of environmental and health risks and not so much depending on the financial compensation of their efforts within the network. It is also indicated by Sharma (2011) that young farmers or farmers with limited experience are more likely to implement new IPM measures on their farm, whereas more experienced farmers tend to rely more on their own experiences. In many cases, the risk of alternatives appears high and they seek to maximize the economic return for each crop, rather than assessing their success based on the long-term economic return of the entire cropping system.

The incentives for participating farmers are benchmarking, free advice / coaching as well as exchange of experiences and communication with other farmers of the network. In all demo-farm networks, they benefit from the support of advisory services and additionally, from the access to resources such as information materials, specific trainings, discussions and solutions for their individual problems. In addition, two out of five demo-farm networks (DIPS and PestiRed) offer financial compensation for farmers for innovative methods, which entail additional efforts, costs or even yield losses. Consistency of motivation and engagement of farmers can be a challenge and requires permanent engagement and continuous exchange between all project participants.

Role of the facilitators

In the demo-farm networks, internal advisors (or supervisors, or facilitators) participate to support the demo-farms. Facilitators play an important role as they continuously guide the farmers. They support farmers in different ways. For example, they organize exchanges between the farmers of the group and invite external farmers and experts to encourage pear-to-pear learning. Furthermore, they support through face-to-face advice and the provision of information material (e.g. flyers and videos). Facilitators ensure the buy-in of the farmers to the network goals, to develop and exchange on solutions themselves and to gain confidence based on each other experiences. Facilitators who created a relationship of trust can build on the existing practices and past experiences, and give recommendations for testing innovations. However, in any case they leave the final decision to farmers. Three out of five demo-farm networks offer initial training for their facilitators. Initial trainings for facilitators are beneficial to ensure a coherent approach for the project activities and implementation of new IPM methods. A frequent turnover of facilitators/advisors or supervisors needs to be avoided as it might disrupt the trust building processes and thus, might entail delays in knowledge transfer.

Participation of organic farms

Organic farms are only involved in the DEPHY network and LEAF. Although initially it might be difficult to find objectives or subjects of interest for both organic and conventional farmers,

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most of the networks succeed in finding common interests. The exchange between the production types is beneficial and important, as knowledge of established organic farmers provides input mainly on preventive methods on conventional farms. Furthermore, e.g. in Switzerland, the participation of organic farmers contributed to the transition of farms from conventional to organic farming.

4.2. Knowledge exchange and communication

4.2.1. Taking-stock of experienced networks

The lifespan of the European demo-farm networks differs greatly (Table 1). LEAF in the UK has a long-term experience since 1993 and is the oldest demo-farm network. In contrast, the demo-farm networks in the Netherlands and Switzerland have started recently. Thus, it can be assumed that younger networks can benefit from the experience including success, lessons learned and failures of the older networks. In addition, the recently established hubs in IPM*WORKS* will ultimately benefit from those experiences and from practices, which have been tested. The intention is to share those experiences and make them widely available online (e.g. websites and social media), or via publications and reports beyond the network. IPM*WORKS* meetings also offer good opportunities for sharing experience.

4.2.2. Demo-events and dissemination

All demo-farm networks use field days to share experiences and results. The adoption of new practices often depends on established experiences and sound test results. Thus, collective field visits and face-to-face communication are probably the most important element in demo-farm networks. For conducting demonstration events, the demo-farm networks recommend to focus on particular aspects of IPM and to demonstrate methods which farmers are particularly interested in. Events should preferably take place on farms/fields where a combination of methods is presented. The demo-farm networks mentioned a range of methods, which are particularly well suited such as:

- demonstration of innovative machinery, in particular for mechanical weed control (e.g. combination of hoes with row-sprayers)
- cultivation of more resistant/tolerant cultivars regarding their effects on fungicide savings
- intercropping with legumes (e.g. peas in sugar beet or barley, maize and clover)
- spray-windows in order to assess pest severity and/or control of success.

Other dissemination methods include webinars, manuals, videos and workshops. Virtual meetings with farmers have less impact and are rated less effective. Interviewees from all four networks agree that online events are insufficient to replace practical farm visits /field days because there is less exchange during online events compared to face-to-face events.

During the second meeting of the pre-existing national networks (April 21, 2021), it was agreed to produce leaflets presenting IPM-based success stories in those networks, based on a common layout inspired by the DEPHY network in France and finalised by IPMWORKS WP6,

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and also used by new hubs of demo farms launched within IPMWORKS (including presentation of the IPM strategy at the farming/cropping system level, focus on specifics methods for pest control, testimonies of farmers, figures demonstrating cost-efficiency, etc.). For PestiRed and GROEN-AoZ, the most recent national networks, it will be possible only at the end of the project to have enough years of experience to be presented. For DIPS, it might also be difficult to do, as the network stopped activities in 2018.

4.2.3. Information channels

The internet offers good opportunities for communication. Thus, farmers in the group or between the groups use for instance "WhatsApp" or other social media to communicate. Moreover, single hubs gain more visibility and can increase the exchange between hubs if they present their activities and initiatives on the joint project website. There is an emphasis among demo-farm networks regarding the high importance of a project website for the presentation of the network in the respective national language.

The content of information material, leaflets, etc., focuses ideally on entire cropping systems, the combination and synergies of individual measures and the optimal integration of innovative methods. Additional information about ecological impacts or benefits and the explanation of limitations of the methods especially contributes to the choice of most effective changes in the system.

4.3. Research in demo-farm networks

In contrast to the other demo-farm networks, "LEAF", "GROEN-AoZ" and "DEPHY" comprise research farms as well as commercial farms. The combination of applied research and on-farm approaches is beneficial for a number of reasons.

Example from the Netherlands:

In the Netherlands, research is mostly carried out by e.g. Wageningen Research (WR), input suppliers, advisory companies, pesticide producers and breeding companies. The results can be used for on-farm demonstrations. The purpose of on-farm demonstrations is not research but instead they focus on established IPM measures in combination with research results. Another example are two large scale IPM/ICM system trials (by WR), where complete ICM/holistic IPM strategies are implemented and may experiment with higher risk non-established IPM measures until they are ready for use on commercial farms. These trials also serve as inspirational platforms for group members and on-farm demonstrations. In turn, the IPM/ICM system trials offer the opportunity to carry out "small scale satellite IPM trials" where experimental individual IPM measures can be evaluated prior to potential adoption in the system trials.

4.3.1. Benefits from the participation of research farms

- Specific applied research questions can be addressed in experiments with intense monitoring and accurate experimental layout under on-farm conditions.

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- Research farms are most suitable for developing, adapting and validating new technologies proposed by farmers.
- More risky methods and practices are tested and the outcomes presented to farmers.
- Scientific evidence on the efficiency of IPM measures encourages farmers to adopt IPM.
- Farmers benefit from intensive monitoring and analysis of demonstration trials.
- Events on research farms serve the widespread dissemination of demonstration results.
- Research farms add scientific expertise and credibility to the network.
- With research support, IPM strategies can be tested by farmers with reduced risk.
- Farmers benefit from resources, information and advice.
- Farmers can give feedback and measures can be readapted according to farmers needs.

4.3.2. Limitations

Although research is an important element of demo-farm networks, we need to make sure that the focus of research addresses the requirements of the participating farms. The scientifically sound experiments require large efforts by farmers. Therefore, in most cases the participating farms can only test, demonstrate and compare different strategies. However, it is difficult to set up on-farm experimental settings if farmers are not compensated because it entails large efforts for the farmers. Moreover, concerning the testing of new solutions farmers might be risk averse. Thus, discussions of the solutions or technologies based on the experience of other farmers in peer-to-peer learning or demonstrations help to overcome the barriers. Also testing of methods on small plots or on several farms can be beneficial to convince farmers. Consequently, the demonstration of experiences on tested and pre-validated IPM measures on demo-farm networks contributes to ease the limitations.

4.4. Data collection

The demo-farm networks collect data to analyse and verify the success of IPM measures within the network and for the dissemination of results outside of the network. Farmers, facilitators and/or researchers collect the data. Qualitative information from case studies is important and provides insights to evaluate farmers' attitudes, satisfaction, experiences, expectations, challenges, preconceptions and perception of new measures. However, quantitative data is preferably collected and analysed in demo-farm networks. The IPMworks deliverable D1.1 (Good practices for learning and adoption of IPM in hubs and networks) contains more detailed information regarding the data collection in demo-farm networks.

- GROEN-AoZ for instance, collects information on timing, cultivation practices, fertilization as well as weed, pest and disease control. The gathered information is mainly used within the network but also for publication of results. Moreover, relevant data is used to develop DSS.
- In LEAF data is collected to assess sustainable practices for a continued improvement on farms.
- In PestiRed data is e.g. collected on cultural methods, varieties, monitoring, pesticide

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use, decision-making, yields and costs. The data evaluation provides information on the efficacy and progress of IPM practices.

- DEPHY for instance, collects data on the cropping systems, farm structure and technical interventions. The data is used to show progress and results.
- In DIPS the purpose of the data collection was to gain scientific evidence on the performance and impacts of the IPM measures. Data e.g. on agronomy, crop variety, monitoring, treatment intensity and yield were collected. The data was used to generate results for dissemination as well as for recommendations.

Depending on the size and aim of the network, the use of digital systems for data collection and management is a big advantage. It eases the data collection and handling and allows for the time efficient analyses of large data sets. The data is analysed either by the coordinating organization of the demo-farm network or by a partner institution, responsible for the scientific support. The data is mainly used to:

- provide information on the crop-specific use of pesticides
- identify a potential reduction of pesticide use by IPM implementation
- measure effects of methods on yields and economics
- show progress and to publish results
- understand the levers of changing practices
- benchmarking among farmers
- set targets for the future
- support political decisions

The demo-farm networks faced also difficulties linked to the data collection despite the acknowledged advantages of a detailed analysis of the data:

- suitable indicators should be defined according to the objectives at the beginning of the project
- it was mentioned that it is time consuming to collect data
- farmers are not very fond of long questionnaires
- farmers are worried about data privacy issues if data is collected in a database because they are not able to control the access to their farm data.

4.5. Key findings

Organisational issues

- There are obvious organisational differences between European demo-farm networks depending on their objectives, target groups and methodologies.
- All project participants should define and agree on their roles and activities before or at the beginning of a project.
- From the beginning of the project, IPM implementation at the whole farm level is most beneficial, although starting with well-known practices can overcome initial scepticism and ensure confidence.
- At least, farmers, advisors and researchers need to be participants of a demo-farm network. Other partners such as providers of decision support systems, the retail chain or consumers or policy makers also could join the network if they contribute to achieving the project objectives.

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- Independent advisors (without economic interest) are essential providing neutral advice to the demo-farmers.
- The selection of sectors and crops should consider the crops with large potential for IPM methods and/or the need to develop sustainable cost-efficient IPM solutions.
- The organization of farmers in groups helps to ensure peer-to-peer learning.
- Effective incentives for farmers to join a network can be benchmarking, free advice / coaching, access to additional knowledge resources as well as exchange and communication with other farmers.

Demo-events and knowledge exchange

- The combination of research and practical farming support the uptake of new methods by farmers.
- Knowledge exchange with organic farmers contributes to the enrichment and adoption of preventive methods.
- The demonstration of methods and approaches of IPM leads to further development of farming practices.
- On-farm events are most suitable and especially if a combination of methods is demonstrated.
- For information material and other resources, it is recommended to cover an entire cropping system rather than focusing on single IPM techniques.

Data management

- Digital systems support the collection and processing of data collected in demo-farm networks.
- It is recommended to define the indicators for data collection in the objectives at the beginning of the project.
- In addition to quantitative data, qualitative data (e.g. farmers' attitudes, satisfaction, experiences, expectations, challenges, preconceptions and perception of new measures) can also be important to assess the progress made in demo farm networks.

Facilitation

- It is advisable for facilitators to give only recommendations and leave the final decisions to the farmers.
- Initial training for the facilitators of the demo-farm network ensures a coherent approach for project activities within a network.

Communication

- Field visits and face-to-face advice on specific subjects as well as permanent communication between all participants are crucial for a successful demo-farm network.
- A diversity of communication channels is most important for the communication inside and the dissemination of results.
- The dissemination of experiences from established demo-farm networks provide information and guidance to other networks and farmers.
- The use of the internet (e.g. network websites) offers good opportunities to present demo-farm networks.

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5. General principles of IPM

This chapter is dedicated to the technical details of the IPM strategies, which are applied in the demo-farm networks. We follow the logical structure of the General principles of Integrated Pest Management (IPM) of the Directive on the Sustainable use of pesticides (EC 2009, Barzman et al. 2015).

5.1. Prevention

Preventive measures are considered as very important by the demo-farm networks. The most often mentioned IPM strategies for prevention are:

- Diverse crop rotations are promoted in all the demo-farm networks. This includes not only the length of the crop rotation but also the choice of crops and the crop sequence. Well-planned crop sequences can interrupt transmission pathways or green bridges in the crop rotation. Examples are cultivation breaks, e.g. rotation between grains and other crops, rotation between summer and winter crops. Utilize the trap crop function where the trap crops attract pest organisms of other crops (e.g. green manure crops are hosts for nematodes). Thus, the choice of functional pre- crops is important. However, the experiences of the demo-farm networks show that changes in crop rotation require long-term efforts and are difficult to achieve.
- An adaptation of the tillage systems is used in some demo-farm networks (PestiRed, DIPS) to control the important site-specific pests. Both, regular plowing as well as no-till systems have advantages. Plowing can suppress weeds and diseases, which is particularly important between similar crops in a crop rotation. Thus, plowing can contribute to savings in agrochemicals and subsequently contribute to environmental conservation. No-till systems on the other hand are beneficial for soil conservation, as they reduce soil erosion, reduce nutrient losses thanks to longer catch crops, and favor soil biodiversity (earthworms, fungi, arthropods, etc.). Changes in soil tillage can contribute to the described benefits but require investment for machinery.
- False or stale seedbed is used in most demo-farm networks (DIPS, PestiRed, GROEN-AoZ) to reduce the pressure through weeds (e.g. problematic monocotyledonous weeds). This method was mentioned to be easily implemented.
- Cover crops are used in most demo-farm networks (DIPS, GROEN-AoZ, PestiRed) for weed suppression and in the case of legumes additionally for nitrogen fixation (e.g. Vicia faba L.; small-grained legumes, vetch mixtures).
- Intercropping is applied in all five demo-farm networks. For intercropping, either mixtures of different crop species or mixtures of different varieties are used. Cover crop mixtures, for example have positive effects in the suppression of weeds (e.g. peas and beans suppress weeds in winter oilseed rape, peas and barley). Relay intercropping or companion crops generate better soil cover for longer periods of time. The following crop can be established before the first crop is harvested (e.g. sowing of cereals or maize directly into a clover cover). In some cases, the relay crops provide nitrogen (legumes). However, finding suitable crops fitting with regional conditions requires some effort. It would be helpful to have an overview for intercropping which covers different crop varieties.

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- Cultivation of more resistant or tolerant varieties is also promoted by all the demo-farm networks. It is important that these varieties are also accepted by the market. Sometimes mixtures of varieties with different characteristics can help to fulfil market requirements. Publications of results from comparative variety tests can support farmers' decisions.
- An optimized seeding (e.g. adapted date, lower density, higher distance, use of GPS) can help to save in the use of agrochemicals (PestiRed, GROEN-AoZ). Later sowing dates can for instance enable a reduction of herbicides, fungicides, insecticides and fertilizers in some arable crops.
- Soil fertility management can also act as preventive measure (DEPHY). For instance, green manure crops contribute to the organic matter management. There is an interaction of fertilization and soil management with disease and herbicide management.
- Crop residue management is in the focus of several demo-farm networks (GROEN-AoZ, PestiRed, DIPS), as crop residues have impact on the population dynamics of weeds, pests and diseases. Multiple stubble cultivation can act preventively.
- Ecological infrastructures are explicitly promoted by four out of five demo-farm networks (LEAF, PestiRed, DIPS, DEPHY). Basically, this is done to support beneficial organisms by providing habitats inside the fields or at their edges, e.g. by flower strips and hedge rows to maximize abundance and diversity of beneficial organisms. Associated IPM measures were rated difficult to implement, as they are associated with reduction of cultivated land and the evidence of efficiency for pest regulation are scarce.
- The push-pull strategy was used in PestiRed farms as a further preventive method. As an example: A strip of *Brassica rapa subsp. oleifera* is sown along the rapeseed plot. This strip flowers before the oilseed rape and therefore attracts the pollen beetles during the sensitive stage of the rape. This is the "pull" effect. The "push" is the application of a bio-control product based on 95% Kaolin at the same time, which disturbs the pollen beetles and drives them away from the plot.

5.2. Monitoring

Field monitoring is an important basis for the decision-making on crop treatment and thus essential for IPM. Within the demo-farm networks, both farmers and advisors conduct the field monitoring. An effective monitoring is based on regular field observation according to the monitoring guidelines of the particular pest, diseases and weeds in order to determine the threshold values. Trainings with advisors and researchers help to support the monitoring. This contributes to better knowledge on thresholds, pest and beneficial species. The traits of varietal resistance should be considered when using the thresholds values and reflected in the management tactics.

Examples:

- Arable crops: winter wheat and winter barley (e.g. rust, mildew, septoria), oilseed rape (e.g. slugs, cabbage-stem flea beetle, pollen beetle with yellow traps) (DIPS)
- Action thresholds for Alternaria solani in potatoes at the end of the growing season. The action and damage thresholds are not yet known (ongoing research) but what we envisage is e.g. a weekly check of the field or a check after conducive weather conditions. Alternaria solani lesions can be quantified. If we find numbers over the

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action threshold, we can decide to take action. If the numbers are below the action threshold, we can wait until the next check. (GROEN-AoZ)

- Orchards: Apple (e.g. Panonychus ulmi, Aculus schlechtendali, V. inaequalis,…) with pheromone traps, color traps and further methods (DIPS)
- Vegetable: carrots and cabbage (insects, fungal diseases, mice, weeds, beneficial organisms) (DIPS)
- Thrips (e.g. in onion) can be counted and the results compared to action/damage thresholds
- Hops (e.g. fungal diseases, insects, damage through roe deer) (DIPS)
- Vineyards: (e.g. Drosophila suzukii, Eupoecilia ambiguella, Lobesia botrana,…) (DIPS)

Benefits

Farmers benefit from their monitoring efforts in multiple ways. The monitoring records visualise the development of the infestation or occurrence of pests, diseases and weeds. Based on their development and thresholds they can make sound decisions on the right timing and proper choice of PPP or even omit treatments if the infestation is below threshold. The documentation of monitoring results can also be used for comparison with other fields and seasons. Farmers of the demo-farm networks benefit from field monitoring in various ways:

- farmers improve their knowledge on pests, weeds and diseases, which is crucial in IPM
- support of the decision-making on plant protection measures
- opportunity for farmers to track the progress and measure the efficiency of measures
- financially (lower cost for pesticides due to early detection)
- opportunity to evaluate the efficiency of preventive and alternative methods
- can contribute to a reduced pesticide use
- farmers can see effects of their pesticide use on beneficial insects

Challenges

It was mentioned that it is difficult to increase monitoring efforts among farmers. The farmers in the demo-farm networks face several challenges as regards to monitoring:

- lack of knowledge on monitoring of different pests, diseases, weeds
- sticking to habitual decision making can hinder the implementation of monitoring
- monitoring is very time consuming (but time can be saved by partial treatment (application of limited parts of the fields)
- higher costs due to labour involved in monitoring
- lack of action thresholds linked to specific control measures (this varies between the groups of pests, diseases and weeds)
- difficulties for farmers to keep up the monitoring intensity after the end of the project (a stronger governmental advisory service on monitoring could be a solution)

5.3. Decision making

In all interviewed demo-farm networks the pest, weed and disease management decisions were based on continuous field monitoring and use of thresholds. Additionally, there are

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farmers in all demo-farm networks using decision support systems (DSS) and forecasting tools and their use increased during the project period. All demo-farm networks see potential to increase farmer's awareness on DSS. The experience shows that it is challenging to convince farmers to rely on threshold and the DSS, as it in some cases means to tolerate more unwanted organisms in their fields. It is argued that many current DSS's primarily determine spray timing based on the weather conditions. Thus, other important information is neglected. The DSS's for instance do not include the effect of IPM measures on the timing of direct measures (e.g. to account for the disease pressure from the top soil in the field). One of the ways forward is to include more knowledge on the pathogen in DSS's (e.g. is it present, disease pressure, which genotypes/variants). DSS are available and used especially for economically important pests and diseases, for example:

- Agro meteo (all crops and pests) Agrometeo - Agrometeo (PestiRed)
- PhytoPre (potatoes diseases) PhytoPRE+2000 (PestiRed)
- Fusaprog (fusarium in wheat) www.fusaprog.ch (PestiRed)
- ScleroPro (Sclerotinia in oilseed raps) (DIPS)
- Farm maps BlightApp (control of late blight and early blight in potatoes and tomatoes) www.farmmaps.eu (GROEN AoZ)

5.4. Non-chemical methods

The non-chemical methods include biological measures as well as physical and mechanical methods for plant protection.

5.4.1. Biological control measures

There is a variety of biological control measures used by farmers in all interviewed demo-farm networks. On the one hand, there are biological plant protection products (Table 2) and on the other hand, there are beneficial organisms, which can be used to support the crops. There is an obvious demand and potential for more- and for more effective measures (particularly for weeds).

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Table 2. Examples of biological plant protection methods/products and their use

Product	Crop and pests	Network
ContansWG (***Coniothyrium minitans***)	Biological fungicide against *Sclerotinia diseases;* in vegetables (salads), arable crops (carrots, potatoes, beans, tobacco)	DEPHY, DIPS, GROEN-AoZ
NeemAzal **(Azadirachtin, Neem tree)**	Sucking and biting insects in arable crops (potato beetle), vegetables, orchards, vine yards (*Daktulosphaira vitifoliae, Melolontha*)	DEPHY, DIPS
Sluxx (Ferric phosphate)	Against slugs outside and in greenhouses; in vine yards, vegetables, orchards and arable crops (e.g. potatoes, oilseed rape)	DEPHY, PestiRed
Serenade & Taegro **(Bacillus amyloliquefaciens)**	Fungicide in vegetables, ornamental plants, vine yards, roses, oilseed rape, sugar beet	DEPHY, GROEN-AoZ
Surround **(95% Kaolin)**	Against flee beetle in oilseed rape, vine yards (*Empoasca vitis*), orchards (*Cacopsylla pyri, Rhagoletis completa, Drosophila suzukii*, sunburn in apple, olives)	DEPHY, PestiRed
BT products (***Bacillus thuringiensis***)	Against more than 30 kinds of pests (Lepidoptera., Orthoptera, Coleoptera, Diptera, Hymenoptera, Caterpillar) in arable crops, orchards, ornamental plants, vegetables	DEPHY, DIPS
Trichogramma **parasitic wasps (*Trichogrammabrassicae Bezdenko*)**	Trichogramma wasps are tiny parasites that attack the eggs of over 200 species of moths and caterpillars. E.g. against corn borers, Cabbageworm, Tomato Hornworm, Corn Earworm, Codling Moth, Cutworm, Armyworm, Webworm, Cabbage Looper, Fruit worms, and Cane Borers	DEPHY, DIPS, PestiRed
Pheromon traps **(female sex pheromones of pests insects)**	Against pests in crops like: apple (*Cydia pomonella, Synanthedon myopaeformis*), vine (*Eupoecilia ambiguella, Lobesia botrana*), plums *(Grapholita funebrana*)	DEPHY, DIPS

5.4.2. Physical /mechanical measures

There is a variety of physical and cultural measures used by farmers in the demo-farm networks. These measures are mechanical treatments, thermal treatments and UV treatments. Precision-farming improves especially the site-specific application of PPP, site-specific and needs-based application of growth regulators and fertilizers).

Examples of mechanical treatments

Mechanical weeding is applied in all demo-farm networks. There are diverse equipments

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available for mechanical weeding (e.g. finger weeding, torsion weeding). The implementation of mechanical weed management can be challenging because of different spacing among rows. The weeding between rows can be supported with camera guidance and combined with row spraying or thermal weeding.

Most common mechanical IPM measures are:

- harrowing, e.g. cereals, peas, spring crops in early age or before germination
- hoeing, e.g. in oilseed rape, maize, sugar beet
- hulling to suppress weeds in row cultures like potatoes (PestiRed)
- pruning prevent issues with fungus in apple, vine and hops (DIPS)
- nets can be used to protect crops against insects and thus have potential to reduce pesticides (DIPS e.g. vine and vegetable)
- trapping of mice (DIPS)

Physical barrier

- mulching (compost, paper pulp,...) to suppress weeds in e.g. arable onion cultivation, often combined with mechanical weeding (GROEN-AoZ)

Examples of thermal treatments

- hot water/air treatments of seeds
- flaming of weeds

Examples of UV treatments

- UV radiation in greenhouses; e.g. a company in the Netherlands (www.Cleanlight.nl) is building small carts that drive around in the greenhouse (at night) with UV-c lamps active. This is a form of surface sterilisation of the crop and the greenhouse.
- Soil solarisation is a method of using the sun's power to control pests such as bacteria, insects, and weeds in the soil. The process involves covering the ground with a tarp, usually a transparent polyethylene cover, to trap solar energy. The sun heats the soil to temperatures that kill bacteria, fungi, insects, nematodes, mites, weeds, and weed seeds. (GROEN-AoZ)

Example of water treatment

- Inundation is a practice where the field is flooded with water to kill soil borne pests and diseases. Farmers are experimenting with this technique in the Netherlands.

5.4.3. Pesticide selection

All five demo-farm networks inform their demo-farms about the toxicity of plant protection products. Thus, the networks can support the use of more selective pesticides by farmers. There is potential to increases farmers' awareness of selective plant protection products. In Switzerland for instance, the Plant Protection Products Action Plan lists products with a particular risk potential according to two criteria:

- the substance is a candidate for substitution according to the ordinance for plant protection products
- the active substance is persistent in the soil (DT50 > 6 months)

There is a need for a common method to evaluate the environmental impact of pesticide applications. Different tools are available to quantify the environmental impact of PPP

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application. For instance, in the Netherlands several different methods are available (e.g. www.milieumeetlat.nl) or in Germany the SYNOPS model is used.

5.5. Reduced pesticide use

In all interviewed demo-farm networks, farmers have strategies to reduce the amount of applied plant protection products. Further, the longer established demo-farm networks confirm that IPM measures have the potential to improve the efficiency of plant protection products or to reduce the application.

Especially the following methods were considered effective:

- application according to weather conditions (based on decision support tools)
- treatment according to the level of infestation
- mixtures of plant protection products to utilize synergistic effects between active ingredients and improve overall efficiency. This also addresses the need for resistance management
- modern spray nozzles with low-drift technique reduce unwanted losses and impacts
- precision farming (e.g. sensors/drone/satellite data to determine crop biomass/LAI[3] and adjust the spray volume to the LAI present: variable rate applications)
- application limited to areas where required (plant and row applications)
- unsprayed buffer strips to neighbouring areas reduce the treated area.

5.6. Anti-resistance strategies

Farmers of all interviewed demo-farm networks apply strategies to mitigate resistance towards plant protection products (PPP). Examples therefore are:

- diverse crop rotations (different families of plants) can reduce resistance development to PPP
- use of non-chemical measures in order to reduce weeds
- change of modes of action of active substances within the growing season and from year to year (e.g. anti-grass herbicides family [HRAC[4]] and fungal pathogens [FRAC[5]])

5.7. Evaluation

LEAF and PestiRed use an annual plan developed by the farmers with support of the advisor. Such an action plan can include the applied IPM practices, selection of plant protection products, dose, rates and timing. A record of achievements can be used to show the progress towards the set targets. The evaluation should take place annually, ideally right after the growing season. The DEPHY network practices a different approach where at first an individual

[3] LAI = Leaf Area Index

[4] HRAC = Herbicide Resistance Action Committee

[5] FRAC = Fungicide Resistance Action Committee

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interview takes place and then the farmers assess retrospectively the growing season in a collective meeting and are able to evaluate different aspects and challenges of the growing season.

The overall evaluation of the work in the demo-farm networks is measured in two ways. One method is the evaluation of performance at farm level. An evaluation at farm level for instance includes:

- reduction in pesticide use (record of plant protection product application)
- efficiency of measures
- farmers attitudes

In all interviewed networks, it is voluntary for the farmers to document and compare production costs. A cost-benefit-analysis is conducted in France and Switzerland. In Switzerland, the evaluation focuses primarily on crop level and not yet on the entire crop rotation but is planned for the entire crop rotation at the end of the project. In France, the evaluation is performed at the cropping system level, i.e. for a coherent set of fields, which is managed with the same overall strategy.

Another way to evaluate the success of a demo-farm network is to quantify indicators of outreach, e.g. number of people, who have been reached. This for instance includes participants on demo-events (e.g. field-days, workshops, online meetings). Generally, data on performance needs to be adjusted and collected according to the target groups.

Challenges to reach the set targets

Two demo-farm networks have experienced challenges to reach their set targets because of an already high level of IPM on the demo-farms. PestiRed, for instance, has difficulties to show progress through comparison of differently managed fields on the same farm and same year. On one hand the participating farmers are highly motivated, but on the other hand conducting two different forms of crop management in the same growing season entails a higher workload, which they avoid. Thus, the farmers here tend to apply the same practices everywhere and PestiRed cannot identify the difference between business as usual and new IPM strategies.

The experience from the German demo-farm network shows that it is rather difficult to achieve a considerable reduction of PPP in production sectors, where the level of IPM is already high. In Germany, this was the case for hops, vine, orchards and vegetables. Although there is a potential for improvement on IPM in the mentioned sectors pesticide use savings might be lower compared to other sectors (e.g. arable crops).

5.8. Success stories and key findings

The demo-farm networks achieved manifold success in the implementation of IPM. Despite the observation that the progress was not always as high as expected, the demo-farm networks noticed an increased awareness on IPM and implementation of respective strategies by farmers.

Prevention

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It is important that farmers plan their cropping systems with a long-term perspective and apply a variety of preventive measures. A diverse and well-planned crop rotation is crucial in IPM. In France, for instance, arable crop farmers have diversified their crop rotation and cattle farmers have reduced the maize fields and grow grasses and legumes instead to produce fodder. The use of more resistant crop varieties (e.g. potato, onion, carrots, barley and sugar beet) can reduce the need of chemical inputs (GROEN-AOZ). Similar varietal effects in arable crops were also noticed in the German demo-farm network. PestiRed noticed successes with earlier sowing dates and push-pull-technique in oilseed rape. Moreover, the mixture of a normal oilseed rape variety with an earlier flowering variety was successful.

Monitoring and Decision making

A well organized field monitoring is crucial, particularly when preventive IPM measures are not fully implemented. The awareness of field monitoring has increased in the demo-farm networks. There is evidence from the German DIPS network, that field monitoring has potential to reduce pesticide use in different crops (e.g. winter wheat and oilseed rape) (see DIPS project report). Decisions on plant protection measures are optimally based on monitoring, thresholds and possibly decision support systems (DSS). There is potential to increase farmer's awareness of DSS. GROEN-AOZ has had success with the adoption of DSS's to more effectively control potato late blight including resistant varieties.

Non-chemical methods

Regarding non-chemical methods, most success has been made through mechanical precision methods to control weeds in a variety of crops (GROEN-AOZ). Particularly in dry regions, mechanical weed management could help to reduce the herbicide use (DIPS). Although mechanical weed control can be effective, we have to be aware that it requires precise timing (weather conditions, growth stage of crops and weeds). Hoeing additionally requires a specific spacing of rows. There is an obvious demand and potential for more biological control measures like in particular biological plant protection products.

Pesticide selection, reduction and Anti-resistance strategies

More should also be done to inform farmers about the selective toxicity of pesticides. The demo-farm networks confirm that IPM measures have potential to reduce the use of plant protection products. In Germany, demo-farmers for instance gave up preventive spraying and adopted partial field treatments. The experience from the Netherlands shows that precision spraying techniques including row application and variable rate spraying have potential to reduce the use of PPP. Resistance towards plant protection products can be avoided/mitigated by diverse crop rotations, use of mechanical methods as well as change and mixture of agrochemicals.

Evaluation

Annual planning and evaluation of performance (on farm and network level) should be conducted after the growing season.

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6. Conclusion

Although we are aware that IPM is always site-specific and we cannot generally recommend farming practices, the deliverable (D2.2) brought together the experience of five European demo-farm networks. Their approaches and experiences show a diversity of methods and their combinations aiming to further implement IPM. The results of this survey reveal several common patterns among the diverse demo-farm networks in different countries of Europe. From the survey, we derived recommendations on how to organize and manage IPM networks, identified similar IPM strategies and associated challenges. This suggests that it is important to promote the transnational exchange among existing IPM demo-farm networks. Further, we agreed on best practices during intensive discussion among the demo-farm networks. These best practices provide inspiration for facilitators of newly established hubs in IPM*WORKS* (hub-coaches) as well as for coordinators of existing networks eager to improve their approaches for IPM. Further, the results of this survey contribute to a transnational cooperation on IPM in Europe.

In spite of differences across national networks of Demo farms arising from their specific history, the coordination within IPMWORKS will allow coordinated activities in the area of dissemination. National networks agreed to produce (as far as possible) some dissemination material sharing the same format as new IPMWORKS hubs, i.e. leaflets presenting details of success stories of IPM implementation.

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GROEN-AoZ

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Integrated Nematode Management: State-of-the-art and visions for the future (cabi.org)

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LEAF

Virtual Field Day 2020: https://www.youtube.com/watch?v=O_5i0jU4iG8

IPM in field vegetables from Riviera: https://www.youtube.com/watch?v=RHLFu0GtfbA

IPM strategies including variety selection for BYDV tolerance: video: https://youtu.be/xHs_GNz_ecw

LDF launch: https://www.youtube.com/watch?v=xmgx30g0sjk&t=145s

IPM specific video: https://leafuk.org/news-and-media/videos/integrated-pest-management-promoting-healthy-crop-growth-on-farm

Phytobac: https://leafuk.org/news-and-media/videos/phytobac

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LEAF Marque carrots, pots, onions: https://leafuk.org/news-and-media/videos/leaf-marque-potatoes-carrots-and-onions

Sweetcorn: https://leafuk.org/news-and-media/videos/leaf-marque-sweetcorn

Peas: https://leafuk.org/news-and-media/videos/leaf-marque-peas

Strawberries: https://leafuk.org/news-and-media/videos/leaf-marque-strawberries

Asparagus: https://leafuk.org/news-and-media/videos/leaf-marque-asparagus

Daffodils: https://leafuk.org/news-and-media/videos/leaf-marque-daffodils

Craig Livingstone IFM video: https://youtu.be/4U173DUtJc4

West Stoke Farm: https://youtu.be/w8tM36LPiVw

Riviera Produce: https://youtu.be/pyWtdH-tsIg

Church Farm: https://youtu.be/OUhzc3qm57k

PestiRed

Plant protection strategy – Field crop production (English subtitles):

www.youtube.com/watch?v=NrWQxLYax74

Plant protection strategy – Viticulture (English subtitles):

www.youtube.com/watch?v=JfhQzKd_2QI

Plant protection strategy – Fruit production (English subtitles):

www.youtube.com/watch?v=TYqSXIzmnsc

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Annex 1. Questionnaire

Questionnaire for a survey of existing demo-farm networks in Europe

IPM*WORKS* Task 2.1

1.	Organisation of your demo-farm network		
1.1	In which country is your demo-farm network located?		
1.2	What is the name of your demo-farm network?		
1.3	Please list the website(s) of your demo-farm network.		
1.4	Which organisation is coordinating the demo-farm network?		
1.5	How is your demo-farm network funded, and is the funding temporal limited?		
1.6	What is the annual budget of your demo-farm network?		
1.7	In which year did your demo-farm network start?		
1.8	Please give a brief description of the objectives of your demo-farm network.		
1.9	Are the demo farms commercial farms or research farms, or both? (please describe briefly)		
1.10	Which stakeholders are actively involved in your demo-farm network (e.g. farmers, advisors, researchers, policy makers, educators, suppliers, consumers, citizens)?		
1.11	How many demo-farms are involved in your network?		
1.12	Which crops or production sectors are part of the demo-farm network?	What is the total number of demo farms per crop or production sector?	How many organic demo-farms are involved per crop or production sector?
1.13	Are the demo-farms organised in (sub)groups / hubs within the network? If so, roughly how many farmers are part of a (sub)group / hub?		
1.14	Do the demo-farms receive project related financial support (e.g. compensation for yield losses; support for additional costs such as seeds, additional farm operations, machinery and field days; or reimbursement for other activities)?		

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2.	IPM in your demo-farm network		
2.1	Is the implementation of IPM the core objective of your demo-farm network? - Reduction of agrochemicals due to implementation of IPM		
2.2	Do you focus on particular issues in particular crops? (please describe briefly)		
2.3	What IPM methods (e.g. cultural practices, choice of varieties, crop rotation, intercropping, enhancement of biodiversity, pests control, decision making) are applied on the demo-farms in your network?		
	IPM practices	*Descriptions*	*Testing period (1, 3 or more than 3 years)*
2.4	Is IPM applied on the entire demo-farms or limited to certain fields / crops? (please describe briefly)		
2.5	Are innovative technologies (e.g. DSS, breeding, machinery, precision farming and optical detection) tested in your demo-farm network? (please give examples)		

3.	Collection of data in your demo-farm network
3.1	Which quantitative data (e.g. cultural methods, varieties, pest/disease incidents, monitoring effort, use of pesticides, decision-making, yields) is collected at the demo-farms? (please give examples of the type of data and the kind of data registration)
3.2	Which qualitative information (e.g. farmer attitudes, interaction within the network) do you collect on the demo-farms and in the network? (please give examples of the kind of information and data registration)
3.3	What is the purpose of the data collection? Do you use the information only inside the network (e.g.to monitor farmer activities, record infestation or pesticide use or measure impacts) or do you use the data also for other purposes? (please give examples)
3.4	Who collects which kind of data or information in your demo-farm network? (e.g. farmers – monitoring, pesticide use, yields; advisors – farm data, qualitative data)
3.5	Is there an interface for data transmission to an institution which assesses all data? If so, is this farmer, advisor, researcher or other?)
3.6	Is there a coordinator/ stakeholder inside the network/ institution responsible for the data analyses?
3.7	Are any particular systems (e.g. databases) used for data collection and/or analysis?(please give examples) - Oracle database used - Online input mask for the demonstration farms (developed by ISIP)
3.8	Do you currently assess or measure effects of IPM implementation on the demo-farms? (e.g. uptake of new technologies, pesticide use (TFI), economic and environmental performance, anecdotal evidence)
3.9	How do you measure the impact/success of the IPM demo-farm network?

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4.	Capacity building in your demo-farm network
4.1	Are the farmers supported by specific advisory activities (e.g. face to face-advice, webinars, online resources) for the implementation of particular IPM methods on their farms? If yes, please describe related project activities.
4.2	What is the role of the advisors (coordinators, facilitators, hub-coaches) in capacity building?
4.3	Please give examples of ways of demonstrating IPM practices (facilitation) that have been particular effective in your network.
4.4	How can you support the new demo-networks in the field of capacity building? (e.g. training materials)
4.5	How do you organize peer-to-peer knowledge exchange for advisors and how often? (e.g. seminars, farm tours, webinars)
4.6	How do you deliver initial training to advisors entering the network? (e.g. on technical aspects, social skills)

5.	Communication in your demo-farm network				
5.1	Please give examples of methods you use to share experiences and results within the demo-farm network (e.g. workshops, demonstration events and field days)?				
	Type of event	Sector/crops	Target audience	No. Participants	Frequency
5.2	Which communication channels do you use to share experiences and results outside the network? (please list the most important tools or methods)				
5.3	Please give any examples of knowledge exchange with organic farms your network has engaged in?				

6. Success-stories of your demo-farm network

6.1	Please give examples of IPM-practices and strategies which worked well, are easily adopted by farmers or exceeded expectations
6.2	Please give examples of IPM practices which your network has proved to be cost efficient.
6.3	What are additional positive ecological effects of the project?
6.4	Which sociological effects do you observe in the project? (e.g. increased awareness among farmers, policy makers, consumers; changes in advisory services)
6.5	Which organisational or institutional aspects of your demo-farm network can you clearly recommend to other networks?

7.	Challenges of your demo-farm network
7.1	How do you motivate / convince farmers to join the demo-farm network?
7.2	Please give examples of factors which hinder the implementation of IPM (holistic and/or single practices).
7.3	Please give examples of barriers to adoption of specific IPM practices by farmers.
7.4	Please give examples of IPM practices which turned out to be less effective than anticipated.
7.5	Please give examples of further research needs identified by your network.
7.6	Please give examples of organisational difficulties of your demo-farm network, which should be avoided by other networks.

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Annex 2. Interview guide

- **1. General questions**

1.1 Should IPM methods be tested on the entire farm from the beginning or do you think a stepwise approach is more suitable?

(*While 2 networks implement IPM on whole farms, IPM is limited to certain parts of the demo-farms in 3 networks*)

1.2 Should new demo-farm networks focus on arable crops?

(arable crops is the only production sector covered by all networks; 2 out of 5 networks focus alone on arable crops)

1.3 What core messages would you give the coordinators or organisers of new networks?

- **2. Prevention / Suppression**

2.1. Which preventive measures are most important to support a stable IPM cropping system? (e.g. crop rotation, habitat management to encourage beneficial organism, …)

2.2 Which of these practices have been tested in your network?

2.3 Which of these preventive measures are rather easily adapted by farmers?

2.4 What were successful changes and/or biggest challenges?

- **3. Monitoring**

3.1 Were the pest/disease/weed control strategies based on monitoring?

3.2 By whom (farmers, field scouts, advisors)?

3.3 What are the main difficulties for farmers as regards to monitoring? (e.g. time consuming, knowledge of the pests, risk averse)

3.4 How do farmers benefit from conducting regular field monitoring?

3.5 Could the project show effects of monitoring and applying thresholds as regards to a more effective pesticides use?

3.6 What is an effective field monitoring based on? (Please describe the procedure)

- **4. Long term strategy for decision making**

4.1 Which long-term strategies are used by the farms of your network for decision making?

(Please describe the procedure)

4.2 If you have a crop management plan, please describe the structure and application.

- **5. Use of Decision support systems/tools**

5.1 Were available DSS or other forecasting tools applied in the project?

5.2 Do farmers trust those tools?

5.3 Are the results of the tools reliable?

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- **6. Combination of non-chemical methods**

6.1 Which biological methods for crop protection are successfully used in your demo-farm network or were tested on individual farms? (Please describe the procedure and name the respective target species)

6.2 Which mechanical methods for crop protection are successfully used in your demo-farm network or were tested on individual farms?

(Please describe the procedure and name the respective target species)

6.3 Which physical methods for crop protection are successfully used in your demo-farm network or were tested on individual farms?

(Please describe the procedure and name the respective target species)

6.4 How do you support the farmers during the process of implementing new IPM methods?

6.5 Which IPM methods are well suited to be demonstrated on events?

6.7 Which IPM practices would you suggest to produce a leaflet on?

- **7. Selection of specific pesticides**

7.1 How do you increase the farmer's awareness on the avoidances of non-selective pesticides to save non-target (beneficial) species?

7.2 Please give examples regarding the effective application of selective pesticides.

- **8. Reduced pesticide use**

8.1 Which IPM methods could you prove to successfully reduce pesticides?

8.2 What do farmers of your network do to maximize the efficacy in pesticide application?

(e.g. appropriate timing, consideration of weather, modern machinery, application method)

8.3 Which bio-pesticides are successfully used by farmers in your network?

(Please give examples)

- **9. Anti-resistance strategies**

9.1 Which strategies do the farmers of your network successfully apply to mitigate resistance to pesticides? (Please describe)

(e.g. rotating between pesticides with different modes of action and application at different times, choosing varieties based on pest risk, advise from qualified agronomist,…)

- **10. Evaluation (record the performance of the applied measures)**

10.1 How do farmers of your network evaluate the performance of applied plant protection measures? (e.g. untreated spray windows, based on records of previous use, type and dosage of chemical, effects of pesticides, environmental factors, pests, numbers,…)

10.2 Did you assess/evaluate/estimate the (extra-) cost of newly implemented methods?

10.3 Do you have examples of adaptation of cost efficient IPM strategies?

10.4. Was a cost-benefit-analysis done based on individual crops or the crop rotation or –sequence?

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- **11. Data collection**

11.1 What are the advantages of combining research and practical farming?

11.2 How did you choose suitable indicators?

11.3 What is the advantage of qualitative and quantitative data?

11.4 What are they used for?

11.5 Which qualitative data should at least be collected in demo-farm networks?

(3 out of 5 demo-farm networks collect qualitative data)

11.6 Do we agree that each demo-farm network should have a digital system for data entry and transfer?

11.7 What are the advantages of the used database?

(3 out of 5 networks have digital solutions for data entry and transfer)

(4 out of 5 networks use databases for data collection)

- **12. Hub-setting**

12.1 What are the pros and cons of involving organic farms into a demo-farm network?

(organic farms are only involved in France; 2 out of 5 networks; exchange knowledge with organic farmers)

12.2 What are the pros and cons of having research farms within a demo-farm network?

(all networks have commercial farms, 2 networks [UK and France]in addition have research farms)

12.3 What are the pros and cons of organising farmers in groups?

(farmer groups exist in 3 out of 5 networks)

12.4 What should be the role of the internal facilitators of a demo-farm network?

(4 out of 5 networks have internal advisors to support the demo-farms)

- **13. Knowledge exchange / communication**

13.1 To what extend can info material and online events compensate farm visits and face to face advice?

(there is advisory support to farmers through information material and online events and on the other hand by farm visits and face to face communication)

13.2 How can more recent demo-farm networks benefit from the experience of longer established networks? Please give examples.

(UK has the oldest network; Netherlands and Switzerland have started recently; France and Germany have about 10 years experience)

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