D5.10: Practice Abstracts reporting period 2

WP5 – Knowledge Management

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Abstract

The current Deliverable contains the resume and the contents of the 103 practice abstracts developed under the project's activity. It constitutes an updated of the already submitted D5.9. The developed practice abstracts are categorized to different topics and are related to significant project outputs. The practice abstracts will be also published in the EIP-AGRI database. The developed practice abstracts aim to provide ready to use knowledge for end-users in an easy understandable and direct way.

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1 Introduction

The European Innovation Partnership for Agriculture Productivity and Sustainability (EIP-AGRI) was created in 2012, as one of the main innovation partnerships between the European Commission and the EU member states[1]. EIP-AGRI promotes the idea of producing "more with less", in order to make the Agro-forestry sector more adaptable, sustainable and competitive, by narrowing the gap between research and practice[2]. As a result, Agro-forestry products may become more attractive with less volatile market prices, while current challenges imposed by the ongoing climate change can also be faced.

Thematic Networks (TN), are a very popular type of multi-actor projects promoted by EIP-AGRI and funded by EU's Horizon 2020 programme. SmartProtect, as a TN, collected existing scientific knowledge and best practices regarding Integrated Pest Management (IPM) in vegetable production. Consequently, the aforementioned collected knowledge was translated into easily understandable and user-friendly material, so that information can be disseminated and made available to all interested parties such as producers, stakeholders, researchers and policy-makers involved in the vegetable chain production.

In the context of Rural Renaissance Horizon 2020 (RUR-15 TN) projects, projects' results are included in the EIP-AGRI repository. EIP-AGRI has a standard format to collect information derived by the project[3]. More specifically, information collected is summarized, and "Practice Abstracts" (PAs) are produced as projects' outcomes. PA contain all outcomes/recommendations that are ready for practice. They describe the main information that can serve/assist the end-users in the implementation of their daily agricultural practices.

A PA is a short summary of around 1,000-1,500 characters, accompanied by a brief title of up to 150 characters. Abstracts are placed on the EIP-AGRI repository, both in native and English languages, in order to achieve engagement with a broader audience.

During the SmartProtect project lifetime, 103 PAs were developed by the project's partners for the dissemination and communication of the project to the end-users. 41 PAs were developed during the first project period and 62 during the second period of the project implementation. The aforementioned abstracts will be uploaded on the EIP-AGRI repository, while in the current deliverable, a summary and description of their content is included.

All PAs are available in English, as well as in the language of the project partner that produced the respective PA. All national language PAs' versions are included in the ANNEX of the current deliverable. The number of PAs developed by each partner is depicted in **Figure 1** below.

[1] Home | EIP-AGRI (europa.eu)
[2] eip-agri_achievements_report_7_years_of_innovation_2020.pdf (ead.gr)
[3] EIP-AGRI common format | EIP-AGRI (europa.eu)

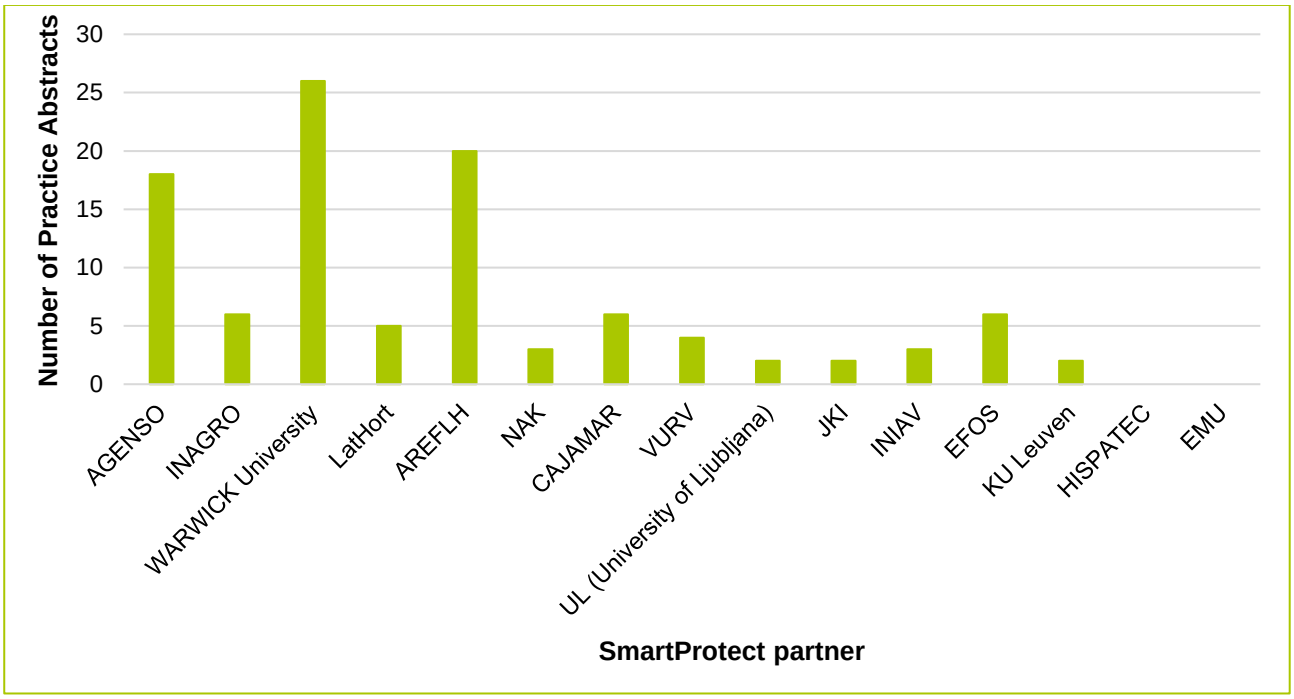

Figure 1. *Number of Practice Abstracts developed per SmartProtect partner*

The 103 developed PAs are scattered in the following categories which align with the main technique types of the SmartProtect Platform (https://platform.smartprotect-h2020.eu/):

- Application techniques
- Decision Support Systems
- Detection and Diagnosis techniques
- Monitoring techniques
- Other general

In **Figure 2**, the percentage of PAs per category is presented.

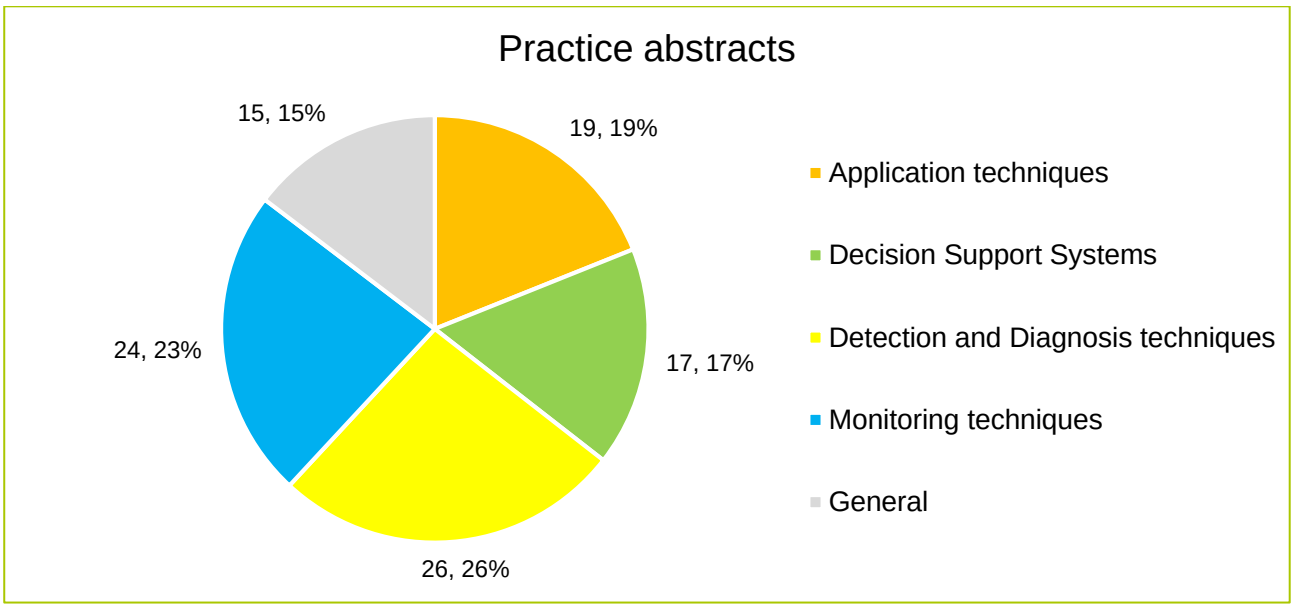

Figure 2. *Percentage of Practice Abstracts per topic category*

2 Summary of Practice Abstracts

The 103 PAs developed, aim to inform end-users regarding the actions of the SmartProtect, the significance of IPM technologies, the demand for modern IPM solutions, as well as the available application techniques, the Decision Support Systems (DSSs), the diagnostic, detection and monitoring techniques used in IPM. Additionally, the developed PAs, aim to inform about the UV applications, the diagnostic and detection techniques such as the smart traps used in vegetable crop production, together with the distribution of beneficials. On the table below (**Table 1**), the titles, the languages and the corresponding partner of each PA are summarized.

***Table 1**. Summary table of Practice Abstracts*

P.A. Number	Partner	Language	Title
1	AGENSO	English Greek	SmartProtect: everything you need to know about the project
2		English Greek	Official launch of SmartProtect website: access to innovation
3		English Greek	Official launch of SmartProtect platform: innovative IPM with “a click”
4		English Greek	Innovative IPM technologies: towards a sustainable and environmental-friendly future
5		English Greek	Demand and significance of modern IPM
6		English Greek	Official SmartProtect social media pages
7		English Greek	Application range for efficient IPM
8		English Greek	SmartProtect visual identity and materials
9		English Greek	Application techniques in innovative IPM systems
10		English Greek	Decision Support Systems in innovative IPM systems
11		English Greek	Diagnostics and detection techniques as part of modern IPM
12		English Greek	Monitoring techniques as proactive tool in modern IPM

13		English Greek	Detection of fungal spores in vegetable production
14		English Greek	Diagnostic tests to detect bacterial blight, Phytophthora, Ralstonia bacteria and potato Y virus
15		English Greek	Distribution of beneficial insects with air systems from the ground
16		English Greek	Distribution of beneficial insects with drone systems from the air
17		English Greek	EffiSpray, a smart tool for optimum spaying application
18		English Greek	OPTIMA DSS for Alternaria detection in carrots
19	INAGRO	English Dutch	UV-application in vegetable crops
20		English Dutch	UV-B and UV-C most interesting for crop protection
21		English Dutch	UV lamps: watch out for skin and eyes
22		English Dutch	UV systems – things to consider
23		English Dutch	UVC – How to assess the dose applied
24		English Dutch	How big should a UV system be to suit my needs?
25	WARWICK	English English	Testing different types of SMART trap
26		English English	Forecasting damage by root-feeding fly pests of brassica and onion
27		English English	Monitoring bean seed flies
28		English English	PATS-C & PATS-X – The use of drones for greenhouse pest monitoring and eradication

29	English English	Remote greenhouse crop monitoring for pest and disease risks and alerts (OKO digital, Greenpatrol robot, prospera)
30	English English	Greenhouse mapping applications for pest and disease scouting management (IPM scoutek, CropScanner app, Farmapp)
31	English English	Mobile pest and disease diagnosis in tomato cultivation
32	English English	Mobile pest and disease diagnosis in pepper cultivation
33	English English	Mobile pest and disease diagnosis in cucumber cultivation
34	English English	Mobile pest and disease diagnosis in onion cultivation
35	English English	Mobile pest and disease diagnosis in brassica cultivation
36	English English	Image based selective mechanical weeding for field vegetables (Garford Robocrop and Naoi – Dino)
37	English English	Decision support systems for pest and disease management in tomato cultivation
38	English English	Decision support systems for pest and disease management in pepper cultivation
39	English English	Decision support systems for pest and disease management in cucumber cultivation
40	English English	Decision support systems for pest and disease management in onion cultivation
41	English English	Decision support systems for pest and disease management in carrot cultivation
42	English English	Decision support systems for pest and disease management in brassica cultivation
43	English English	Decision support systems for pest and disease management in lettuce cultivation
44	English English	Plant pathogen detection in tomato crop by immunoassay-based techniques (ELISA & lateral flow devices)

45		English English	Plant pathogen detection in pepper crop by immunoassay-based techniques (ELISA & lateral flow devices)
46		English English	Plant pathogen detection in cucumber crop by immunoassay-based techniques (ELISA & lateral flow devices)
47		English English	Plant pathogen detection in onion crop by immunoassay-based techniques (ELISA & lateral flow devices)
48		English English	Plant pathogen detection in carrot crop by immunoassay-based techniques (ELISA & lateral flow devices)
49		English English	Plant pathogen detection in brassica crops by immunoassay-based techniques (ELISA & lateral flow devices)
50		English English	Plant pathogen detection in lettuce crop by immunoassay-based techniques (ELISA & lateral flow devices)
51	LatHort	English Latvian	Plant pathogen diagnostic using DNA/RNA based technologies
52		English Latvian	Plant pathogen diagnostic using ELISA based technologies
53		English Latvian	Molecular tools for on-site rapid detection of pathogens
54		English Latvian	Disorder detection technologies for vegetables
55		English Latvian	Decision support systems, an example Dacom
56	AREFLH	English French	How SmartProtect's work falls within broader EU Objectives – the sustainable use of pesticides directive
57		English French	Organic farming and EU Policy
58		English French	Detection of virus in plant disease identification
59		English French	Distribution systems for beneficials – Application Trichogramma dropper
60		English French	Aerial technologies for biological pest control

61		English French	Diagnostic and detection techniques – Application Agrorobotica SpyFly
62		English French	Diagnostic and detection techniques – Agrobase application
63		English French	Decision support technique – Futurcrop application
64		English French	Agrivi Farm Management Software
65		English French	eBEE AG – The Advanced Agriculture Drone
66		English French	Dino -Lite digital microscope– Diagnostics and detection techniques
67		English French	DJI Drone Agras series – Application techniques
68		English French	The FaunaPhotonics APS – Light sensor
69		English French	The Scoutbox high-efficiency pest management
70		English French	Natutec Scout App – Digital IPM management system
71		English French	Thrips- Lure - monitor thrips in low population
72		English French	SMAPPLAB Smart Trap Solutions
73		English French	M8A pro spraying drone - Application techniques
74		English French	BEECAM – Pest Monitoring
75		English French	BIOCAPTUR S50 - Application technique
76	NAK	English Hungarian	The application of agricultural drones as an IPM method from the perspective of Hungarian farmers
77		English	Trapping of insect pests in corn production

		Hungarian	
78		English Hungarian	Trapping of noctuids in vegetable production
79	Cajamar	English Spanish	Prevention techniques are your best partner
80		English Spanish	Smart IPM helps for horticulture adaptation to the new climate change challenges
81		English Spanish	Functional Biodiversity management as a tool in modern IPM programs
82		English Spanish	Biological control and biodiversity are not synonymous!
83		English Spanish	The insect monitoring as a preventive pest control method
84		English Spanish	The European Night of Researchers, Women and men who do science for you
85	VURV	English Czech	Smart approaches in integrated pest management (IPM)
86		English Czech	Plant viruses' identification: smart approaches
87		English Czech	SmartProtect technology to cope with climate change
88		English Czech	Sampling and preparation of vegetable samples for analysis of the presence of pathogens
89	UL	English Slovenian	Smart applications in vegetable and field crops production
90		English Slovenian	Identification of pests / diseases on vegetables with the help of smart applications
91	JKI	English German	Non-destructive mobile pest and disease detection technologies for crop protection
92		English German	Decision support technologies without sensor accompanying vegetable crop health
93	INIAV	English Portuguese	Real-time detection of the crop status

94		English Portuguese	How to prevent the Downy mildew disease
95		English Portuguese	Innovative strategies used in the control of downy mildew
96	EFOS	English Slovenian	Monitoring of pests: trap housing decision
97		English Slovenian	Pest monitoring: chemical lures
98		English Slovenian	Pest monitoring: visual lures
99		English Slovenian	Pest monitoring: installation of traps in the field
100		English Slovenian	Pest monitoring: rules for lure handling
101		English Slovenian	Pest monitoring: main difference between conventional and automated monitoring systems
102	KU Leuven	English Dutch	Wingbeat signals for insect monitoring
103		English Dutch	Insect monitoring using Artificial intelligence

3 Description of Practice Abstracts

The aforementioned Practice Abstracts that were summarized in Table 1, are described below.

3.1 SmartProtect: everything you need to know about the project

SmartProtect project started aiming to bridge knowledge transfer between researchers and technological providers on the one hand and agricultural producers on the other hand. SmartProtect is a thematic network targeting to give access to the producers, to innovative Integrated Pest Management (IPM) solutions, methodologies and technologies. IPM is defined as a broad-based approach that incorporates all existing practices for viable pest control. In a period, where IPM is considered to be one of the main pillars of modern agriculture, innovative technologies are expected to play a crucial role in the development of agriculture in the future, which will be characterised by sustainability. The main target of SmartProtect is to stimulate knowledge flow in a multi-actor and system approach in the regional Agricultural Knowledge and Innovation Systems (AKISs) and connect all these in an EU wide-level AKIS in order to enhance the innovative potential of advanced methodologies for IPM in vegetable production in Europe, mainly orienting to the end-user groups, farmers and their advisors. This action is predicted to modernize the agricultural sector, while attempt to minimize the environmental effect of pest management applications. SmartProtect will deliver a platform providing all the interested parties with available innovative knowledge on pest management, pointing to the improvement of pest management.

3.2 Official launch of SmartProtect website: access to innovation

The official website of SmartProtect project has already been launched and is accessible since the 21st of May 2020. The website is user-friendly, while its clear structure allows providing all interested parties and stakeholders with the updated information about the project. The new website (www.smartprotect-h2020.eu) can also provide useful information about the 15 partners of the project around Europe. In the website of the project, links of diverse EU projects related to IPM can also be found. As the website constitutes one of the main tools for dissemination and communication of the results and the progress of the project, its frequent and continuous improvement gives access to updated information regarding the actions of the project. Users have the ability to contact the Coordinator and the Dissemination manager of the project directly through the website of the project, which simplifies the communication with the project consortium. The website also provides a link allowing redirection to the platform developed, where everyone interested can find information about innovative technologies, methodologies as well as solutions and practices concerning IPM applications.

3.3 Official launch of SmartProtect platform: innovative IPM with “a click”

SmartProtect project aims to facilitate farmers, technicians, stakeholders and advisors in the agricultural sector by providing easily accessible information on IPM technologies, methodologies and techniques. The aforementioned information concerns the sustainable application of pest

management strategies in vegetable production, integrating precision farming technologies and data analytics. In the framework of the current project, an online data sharing platform is developed in order to connect and communicate the available technologies and distribute the corresponding information and knowledge related to support systems. The online platform (https://platform.smartprotect-h2020.eu/) is already launched and operational since March 2021. The introduced sustainable platform allows an interactive and constant knowledge transfer, with a focus on detection of beneficials, pests and pathogens, innovative monitoring techniques, prediction models, decision support systems and innovative biological control techniques. Understandable material, guidelines and articles are available through the online platform. The platform will be available both in English and in 12 different local languages (English, French, German, Estonian, Slovenian, Portuguese, Czech, Spanish, Latvian, Hungarian, Greek, Dutch), in order to provide all the interested parties with the available knowledge and information.

3.4 Innovative IPM technologies: towards a sustainable and environmental-friendly future

IPM strategies are nowadays characterised by a constant force for implementation of new innovative technologies aiming to deliver agricultural solutions worldwide. As technological progress is moving on a fast pace during the last years, smart technologies find application in more and more agricultural practices and fields. With time, prevention, detection and control activities tend to support more the treatment/application. In time and prompt diagnosis of plant pathogens and pests can significantly contribute to their cost-effective, successful and efficient management. Already developed novel monitoring, sensing and detecting techniques highlight the need to accelerate the adoption of precision approaches in agricultural systems. Additionally, existing smart techniques for applying pesticides, can remarkably reduce the inflow of chemical substances in the food chain production and their overflow in the environment, as well as surface water, and especially the aquifer. Apart from this, the effect of pest management applications on non-target organisms such as pollinators, can also be minimized by new innovative pest management strategies. Use of predictive models and Decision Support Systems (DSSs) may lead to reduction of the number of applications, while increasing their efficiency. In general, adoption of new technologies can conform pest management application into a very environmental-friendly practice.

3.5 Demand and significance of modern IPM

Modern Integrated Pest Management (IPM) systems include innovative methods, technologies and methodologies in order to achieve optimum management and profit for the producers. Prevention, proactivity, detection and control of pests using smart tools can remarkably increase the economical income of the producers. Management of pests before they have already caused significant damage to the cultivation and the product is very important. The perception that only chemical application can eliminate pest occurrence and the symptoms produced by its infestation/infection, has been proven incorrect and has partially been replaced by a holistic new approach. This holistic approach takes into account the significance of proactivity in order to lead to less product damage, while being more environmental-friendly. Producers have been ascertained regarding the practical benefits of innovative IPM systems and anticipate the establishment of such systems. Producers' economical profit by the establishment and application of new IPM systems can be attributed to the management before the occurrence of the damage by the pests, to the on time point management with severely less quantity of Plant Protection Products (PPPs), to the proper customized treatment and to the

introduction of novel monitoring techniques for the early detection of any further possible infection. In conclusion, pest management is a complex issue and should be faced with a multi-actor approach defined by environmental sustainability and methods for achieving optimum productivity for qualitative and quantitative yield.

3.6 Official SmartProtect social media pages

LinkedIn, Facebook and Twitter are some of the most famous online media platforms for interactive social networking, business networking and microblogging with a total number of users for 2020 approximately around 3.2 billion. Users have the ability to create an account and connect with each other in order to stay updated and create a network. SmartProtect LinkedIn, Facebook and Twitter account pages are launched and are operating since January 2020 and provide news about the project and generally about innovative pest control management. Already more than 1240 followers use the pages of the project to have access to useful information related to the project's activities and real time updates. Potentially interested followers can connect with the social media pages of the project at the links below, https://www.linkedin.com/company/smartprotecth2020, https://www.facebook.com/SmartProtectIPM, https://twitter.com/SmartprotectIPM and be part of the SmartProtect community. The management of social media accounts of the project is run by Work Package 5 – Knowledge management, in the framework of dissemination and communication activities and exploitation of the results.

3.7 Application range for efficient IPM

Plant cultivations are often threatened by infections caused by plant pathogens and attacks by plant pests. Plant pathogens may be fungi, bacteria or viruses, while plant pests may be insects, mites or nematodes. As a result, intensive farming requires frequent application of plant protection products, either biological ones, or chemical ones, and beneficial microorganisms and insects. The obsolete perception that the higher the dose is, the better the result will be, has been proved to be incorrect many years ago. In modern pest management systems, utilization of the proper dose is of paramount importance in order to achieve efficient plant pest or pathogen management, while avoiding the development of resistance. Possible resistance development may eventually lead to incapacitation of registered and applied plant protection products. Resistance development may also cause alternation in the natural balance between population of different endemic species such as pests and beneficials, which possibly reduces the efficiency of beneficials. Application of recommended dosage is very critical and significant to the conservation of biodiversity and management of harmful plant pests and pathogens, and should be taken into careful consideration in modern IPM systems' development and implementation.

3.8 SmartProtect visual identity and materials

Since the early beginning of SmartProtect project, a visual identity has been created to ensure the uniformity, homogeneity of the project's content and wide recognition of the project, while subsequently facilitate its acceptance by a broad audience. The visual identity covers the official logo and trademark of the project, as well as the official image used for background in all materials and tools, with specific colours and fonts. Incorporation of the project's visual identity in templates for documents and presentations, offers wide recognisability throughout the dissemination and communication activities and tools of the project (website, social media, newsletter, brochures, posters, banner, and of course events). Project's visual identity and communication and

dissemination materials and tools are available on the website of the project. The generation of the visual identity and communication and dissemination materials and tools is a task managed by WP5 - Communication and Dissemination. The establishment of visual identity allows the association and connection of the project's results with the project consortium, providing all partners with the ability to acquaint the progress of their actions and activities.

3.9 Application techniques in innovative IPM system

In the modern agricultural systems, the implementation of agricultural practices is supported by innovative machinery and tools to a certain extent, aiming to achieve higher yield, accompanied by constant improvement of product quality, while reducing the fatigue of the producers and the cost of production. The demand for sufficient production of high quality products inclines with the imperative need for ensuring food safety, towards solving lack of food. The ultimate goal is maintaining the balance by mitigating risk and shaping a rewarding farming throughout incorporation of innovative technologies. During such a period of uncertainty, farmers confront climate change, plant pathogens and pest, along with global market fluctuation and instability. However, tools related to enhancement of agricultural applications, such as innovative spraying systems, maps, smart tools for weed detection, smart monitoring and detection tools, drones, etc., offer to the producers the ability to modernize the established standard farming practices and procedures, and play a significant role in the digitalization of modern life. By leveraging simple, affordable techniques and technologies, a sustainable financial system can be activated, providing farmers with easy access to modern agricultural innovations that constitute an investment to the future.

3.10 Decision Support Systems in innovative IPM systems

As the constantly ongoing climate change and agronomic practices affect plant pathogens and pests, sustainable solutions are presented, in order to control the increased pest population and disease pressure to crops, while reducing the chemical inflow in the food production chain. Decision Support Systems (DSSs), programs that support determinations, judgments, and courses of action, by analysing data and collecting comprehensive information, appear to be very useful tools in modern agriculture. Such IoT solutions provide accurate and precise forecasts, predicting a possible outbreak of a pest or/and a disease, enabling an early proactive response by the producer, that will ensure crop safety. Data sources employed may vary depending on the species of pests/pathogens. However, a very common combination, is the exploitation of meteorological data and precedent infection data or pest occurrence data. In this way, a correlation of current meteorological data and the optimum growing conditions of pest can provide an elaborate risk index. The risk index is used to warn producers regarding possible infections/attacks. As contemporary agricultural systems mostly rely on prediction, rather than on counteraction for controlling crop diseases, the role of DSSs is expected to be more crucial in the future, as they have already been established and implemented in many occasions.

3.11 Diagnostics and detection techniques as part of modern IPM

Occurrence of emerging plant pests and pathogens, and possible changes of dynamics of existing populations, impose the need for accurate and on time detection. Early detection allows a precise diagnosis, which is a perquisite for an efficient management of the infection or infestation. In modern

agricultural systems, diagnostic and detection techniques, have been supported and reinforced by the development and application of innovative digital tools. Nowadays, producers have access to a broad range of techniques/tools for the detection and diagnosis of pests and pathogens. A variety of assays such as ELISA, rapid test strips, DNA traps, PCR, and lateral flow strip tests is available, as well as monitoring systems such as real-time monitoring systems, digitalized traps, drones, sensors (e.g., leaf wetness sensors) and satellite imagery services, in order to be used as supportive tools for sustainable farming. Proper detection and diagnosis significantly reduce the unreasonable application of plant protection products, allowing the reduction chemical inflow in food chain production and the reduction of resistance occurrence. Diagnostics and detection techniques should be considered as a main pillar of modern IPM development and implementation.

3.12 Monitoring techniques as proactive tool in modern IPM

Monitoring techniques serve nowadays as an integral part of modern IPM systems. They find application in control strategies for several plant pathogens and pests, as well as weed control. Monitoring of populations provide a very useful asset in implementing pest management strategies, especially regarding management of pests characterised by rapid reproduction or growth, and weeds that their management requires herbicides application. Moreover, monitoring data can be utilized in the development of Decision Support Systems for assisting producers in sustainable farming. Hyper-spectral imaging combined with drones have played a significant role in innovative monitoring of pest and disease population pressure. Pheromones which are also widely used in insect monitoring, in addition with novel traps, also constitute a powerful tool. Subsequently, upon existence of internet tools, monitoring data become remotely available, facilitating the action of shaping plant protection systems. In this way, farmers can have access to monitoring data for their orchards/fields, from distance and accelerate their response and plant protection applications, agricultural practices, or further investigate on the spot a specific part of the cultivation. All the aforementioned benefits may reduce plant protection applications and reduce fatigue of farmer, as well as the cost of production.

3.13 Detection of fungal spores in vegetable production

In modern vegetable production systems, the in time detection of phytopathogenic microorganisms is particularly important for the effective treatment, in order to avoid damage to production. Early detection can be followed by application of agricultural practices and applications of plant protection products in the case of fungi, while in the case of viruses and bacteria only by removal of the infected plant. With this into consideration, FungiAlert has designed the Sporsenz system, which detects fungal spores in the field. It is a small device that is placed on the soil of the crop or field that is destined to be controlled. The spores of the soil borne fungi are transferred to the special surface of the device, and then the device is sent to the laboratories of FungiAlert, where the spores are analyzed and the fungal population is identified. It is thus possible to study population variation but also to detect harmful fungi for crops. The Sporsenz system can offer detection in both hydroponic systems and irrigation systems. The results are sent to the producer via email, in order to organize the necessary actions and the proper disease management to ensure its production.

3.14 Diagnostic tests to detect bacterial blight, Phytophthora, Ralstonia bacteria and potato Y virus

Some of the most serious diseases affecting crops of the Solanaceae family, such as tomatoes and peppers, are the bacterial fire blight caused by the bacterium *Erwinia amylovora*, infection by bacteria of Ralstonia genus, such as *Ralstonia solanacearum*, several Phytophthora species such as *Phytophthora infestans*, as well as the Potato Virus Y (PVY). For the early diagnosis of the aforementioned diseases, the company Pocket Diagnostic has developed Rapid Test Kits that provide results in less than ten minutes. Their cost is relatively low and their significant advantage is that they are portable allowing use in the field or in the greenhouse. These Strip tests are simple to use, and offer a qualitative preliminary investigation and analysis of the plant material, in order to detect pathogens. They are available in different packaging sizes, i.e., of 1, 4 or 50 pieces per pack, depending on the pathogen detected. They are considered to be a very useful tool in the hands of the producer, and can be used prior to laboratory analysis, as a simple measure to prevent or confirm the infection in cases of symptoms' onset. They significantly contribute to the reduction of plant protection products' inflow in the production chain, as the indication of contamination absence can lead to a reduction of plant protection applications.

3.15 Distribution of beneficial insects with air systems from the ground

The protection of crops from pests in integrated management systems (IPM) includes, apart from the chemical treatment, the application/ release of insects that are beneficial predators for control the population of crop pests. Beneficial predators significantly reduce the population of pests, offering significant benefits to the producer, such as ensuring production and reducing the application of plant protection products. A way to apply/ distribute them is by using air systems that cause an air vortex in the environment, and with the appropriate push they release the respective insects. It is mainly applied as a method in greenhouses.

Their main advantages are that they can be used for a variety of different beneficial insects, that they offer precision and uniformity in the release covering the required area, and as they are easy to use, they significantly reduce the producer's effort and fatigue. Such machinery is available in manual versions and in trailer versions that are adapted to agricultural vehicles and tractors. Examples of such trailed machinery are the Koppert's "Natutec Drive" and Royal Brinkman's "UniMite bio-distribution system", while examples of manual systems are the Koppert's "Koppert Airbug" and Royal Brinkman's "Biospreader". Products of both categories can be a very useful tool in the hands of the producer that is interested in applying beneficials.

3.16 Distribution of beneficial insects with drone systems from the air

The protection of crops from pests in integrated management systems (IPM) includes, apart from the chemical treatment, the application/ release of insects that are beneficial predators for control the population of crop pests. Beneficial predators significantly reduce the population of pests, offering significant benefits to the producer, such as ensuring production and reducing the application of plant protection products. A way to apply/ distribute them is by using modern unmanned drones which can fly over the crop and release the beneficial insects in the appropriate part of the field. They are mainly used in outdoor crops and find application in a variety of crops, such as arboreal, vineyards, ornamental, strawberry and maize. They reduce the application time by up to 10 times, while their weight, size and flight time may vary by model. They facilitate the application in inaccessible and wet

soils, while having the ability to function even at a distance of a few kilometers, they can significantly reduce the producer's fatigue and simplify the application procedure. Finally, they offer the particularly important advantage that the application has great accuracy regarding reaching the target point. Examples of such systems are the “UAV-IQ” by UAV-IQ which is not yet available in Europe, the “Trichogramma dropper” by Range Rotors, the Koppert's “Natutec Drone” and the “Parabug” by Parabug solutions.

3.17 EffiSpray, a smart tool for optimum spaying application

Spaying application under the optimum environmental conditions allows achieving an effective result, while simultaneously, diminishing the environmental effects of spraying applications, such as off-target spray drift. EffiSpray, developed by AGENSO, is an innovative system for efficient spraying applications which helps farmers to optimize the application of Plant Protection Products (PPPs), by reducing the spread of spray drift in orchards and vineyards. With EffiSpray, the user will be able to use a variable rate spray system, which can be applied to all sprayers and can calculate the optimal spray dose for each application. At the same time, EffiSpray has a user-friendly application for the Android operating system, from where the user can receive forecasts and tips for the upcoming weather and “spray friendly” days so that applications are made under optimal conditions. Finally, the user will be provided with a spray dose calculator for the preparation of the spray liquid and during the application, the tractor operator will be informed about the proposed speed of the tractor in real time, for better application of PPPs. Effispray is freely available in https://www.effispray.gr/ and in Google Play in https://play.google.com/store/apps/details?id=gr.agenso.effispray&hl=el&gl=US

3.18 OPTIMA DSS for Alternaria detection in carrots

In the framework of OPTIMA H2020 project, a freely accessible DSS has been developed and is accessible in http://dss.optima-h2020.eu/. Pathogens incorporated into the tool are the following, Alternaria leaf blight for carrots, Downy mildew for vineyards, and Apple scab for apple orchards in Spain (Aragon region), France (Bordeaux region), Italy (Piemonte region) and Greece (Thessaly, Evia and Attica regions). The DSS provides users with a 5-day prediction, in an escalation step of 3 hours, of disease outbreak based on meteorological data, which is presented in a coloured interactive map, based on the risk level: Green for no risk (0%), Yellow for low risk, Orange for medium risk, and Red for maximum risk (~100%).

Thus, producers and other stakeholders operating in the agricultural production sector and carrot production can freely access this early prediction system, and consequently organize the agricultural applications such as spraying applications for their cultivations. This tool enables fast decision-taking that leads to reduced qualitative and quantitative product degradation and yield loss that may derive by severe disease outburst. The additional benefits are the reduced and more cost-effective use of PPPs, the lower residues and the reduced environmental and human health impacts that derive from the over-use of PPPs during spraying applications that may not be needed or/and effective.

3.19 UV-application in vegetable crops

For outdoor UV application, our market research showed three devices for open-air horticulture, namely the rear mounted implement from the company Cleanlight, a self-propelled machine from Saga Robotics (Thorvald) and the self-propelled machine developed by an American group, called

the Dragon UV array. For greenhouse application, the following companies offer smart UV solutions: Belgian company Octinion (Lumion), Cleanlight (in cooperation with Micothon) from the Netherlands and Saga Robotics from Norway. A home-made device is cheaper, but you cannot rely on technical support. Robots are of course expensive to buy and require some training for proper use.

Cleanlight's device is rear mounted on the tractor and consists of three parts, including a fixed part behind the tractor and two parts that can be folded down. The lamps are arranged in a series of four in vertical planes. The unit can treat about twelve rows of leeks against rust. Cleanlight also manufactures other customized devices.

The Dragon is a laterally supported implement with a hood shape in which several lamps are mounted. This set-up is specifically designed for single ridges such as in zucchini cultivation. Saga Robotics also offers a hood-shaped unit for such ridges, but as an autonomous driving machine.

Octinion, Cleanlight and Saga Robotics all have a self-propelled machine on the market for protected cultivation on which UV lamps are mounted. The great advantage of this is that no operator is needed to operate the machine. Treatment schedules can be set using software and night-time treatment can be organized very conveniently. Specific zones in a greenhouse can be given priority treatment.

3.20 UV-B and UV-C most interesting for crop protection

Research has shown that powdery mildew fungi are particularly sensitive to UV light and that these fungi cannot recover from this at night in the absence of blue light. The first successes within a crop protection context have already been achieved in sheltered crops such as strawberry, lettuce, tomato and cucumber. UV treatment seems to be an interesting control method within an IPM context. Such a physical treatment could, if sufficiently effective, contribute to a reduced use of chemical crop protection agents.

Because of their properties, UV-B and UV-C light are the most interesting forms for crop protection applications. Ultraviolet light (UV) is a form of radiation that falls just outside the detectable spectrum of the human eye. Its wavelength is between 100 and 400 nanometers and is thus shorter than that of visible light, in contrast to infrared light with longer wavelengths.

UV light can be divided into UV-A (315-400 nm), UV-B (280-315 nm) and UV-C (100-280 nm). UV-A is the cause of skin aging and UV-B leads to sunburn. UV-C is even more dangerous for the skin and causes wounds within a short time.

Operator's safety should always be paramount when using UV light. This can be done by avoiding direct contact with the radiation through shielding of the lamps. If direct contact is still possible, then glasses, face shield and protective clothing (long sleeves, long pants) are recommended. Also wear protective gloves. Remember that the eyes are the most vulnerable to exposure.

3.21 UV lamps: watch out for skin and eyes

This fact sheet points out the dangers to skin and eyes of UV radiation. Such radiation has seen an increased application in agriculture as pest and disease control measure or plant enhancer. UV lamps emit a combination of visible light and invisible ultraviolet radiation. The danger with UV radiation is that you cannot see it and therefore cannot directly determine exposure. The UV radiation with the most energy content is UVC, followed by UBV and UVA.

Acute overexposure leads to an eye infection similar to snow blindness or welding eyes. Symptoms appear in 30 minutes to several days after exposure. The consequences of chronic exposure are the development of cataract, permanent damage to the retina, lesions to cornea and conjunctiva.

Overexposure to the skin leads to red swelling or burning, depending on the dose. Chronic exposure contributes to accelerated skin ageing, reduced immunity and development of cancer. In general, UVC radiation is less penetrating but all the more quickly harmful due to its higher energy content.

Protect yourself by wearing covering clothing and gloves and, in particular, UV protective face shields whether or not in combination with safety glasses. You can recognise suitable glasses by the marking on the lens according to CE user standard EN166FT. This is indicated by the code number 2 or 3 for UV filtering.

3.22 UV systems - things to consider

If you want to make your own UV device for research, there are a few things to take into consideration. One of the first things will be the choice of lamps and fittings. Several types of lamps are available on the market. The cheapest are of the TL-D T8 type, these are very similar to the fluorescent lamps of old. These lamps have a G13 socket (2x2 pins) and require a suitable fixture with ballast and ballast. A newer type of fluorescent lamp is the T5 type with a G5 socket with 2x2 pins. This type is sometimes referred to as mini TL.

The fluorescent lamps T8 and T5 usually make connection in the fixture at the front and back of the lamp with pins. A T5 with type 4P SE connection, like the type PL-L lamp, has a more practical connection, as this lamp connects to the socket on one side with 4 pins. Type HNS sockets are also made so that the lamp connects into the socket on one side. The most powerful UVC lamps known to the SmartProtect consortium are those from the company Cleanlight with an output of 160W, but only fit in the corresponding fittings.

The lamps used here are low-pressure mercury lamps. This mercury in the lamps poses risks to human and environmental safety. If a lamp breaks, always follow the instructions provided. In general, leave and ventilate the room and do not clear the glass until half an hour later. Also take care, because mercury vapour is heavier than air and sinks.

To meet these risks, LEDs seem a good alternative. However, LED technology for UV C applications is not yet market-ready. Currently, the energy efficiency is not yet high enough. Heat generation is also a problem for the technology to break through. The covid crisis did accelerate development and some solutions are available on the market, but vigilance is needed against misinformation. There have been cases of scams using so-called uv C LEDs that do not actually emit useful radiation at wavelength 254 nm.

Besides the lamps themselves, the suspension system is also a technical issue to solve. Depending on the crop, a suspension at the front, rear or side of a tractor will be an appropriate mounting. The simplest is to use a standard triangular suspension. The structure must be made strong to handle lateral, upward and downward forces. This can be done with the necessary reinforcement cables or beams. In a greenhouse, one might consider deploying the system similar to the spraying technique used. In a heated greenhouse, on the other hand, the obvious choice is to make the system compatible with the heating rails.

3.23 UVC - How to assess the dose applied

When you want to perform a UVC application, the dose is the most important parameter to take into account. On the one hand, it is important to be able to determine the effective dose for the pathogen to be treated without damaging plants and beneficials. On the other hand, there is also the technical part of being able to calculate and measure the radiation dose. We can express the dose in Joules per square meter. The irradiance is the power per unit area in Watts per square meter.

Research into the effectiveness of UVC treatments is still in full development. As a rule of thumb, fungi already die at lower doses than plants and animals. For daytime treatments, the effective dose is almost always much higher than for treatments followed by a longer dark period. This is due to enzymatic processes in the fungus that can repair DNA damage using blue light as a co-factor. This fact makes treatments after sundown the most preferable.

As a grower, it is best to do a small preliminary test if you are unsure about the dose. Many crop/disease combinations are not publicly available, so it is best to get assistance from the distributor. For cucumber, according to research, a dose of 70 J/m² every four nights is effective on powdery mildew, for strawberry 170 J/m² every two nights. Generally, the order of magnitude is somewhere in the range of 50 to 200 J/m² every 2-3 nights.

To calculate the theoretical irradiation, consider a quadratic decrease in dose with distance to the treated surface. Treating a surface 4 times further than the surface just under the lamp has an irradiation power on that surface 16 times smaller. Furthermore, the dose can be calculated as power/ (treatment width x travel speed). Using a reflector optimizes radiation to the surface to be treated.

Besides a theoretical calculation, you can also measure the effective radiation with a radiation meter or radiometer, after all, measuring is knowing. These range from simple handhelds to more expensive high-end spectroradiometers. Make sure the device has a sufficient bandwidth. There are also indicator cards on the market that change colour when exposed to a certain dose of UVC 254 nm. You can use these as overdose protection or to monitor treatment success.

3.24 How big should a UV system be to suit my needs?

As UV systems are mostly tailor-made at the moment, this is a difficult question to answer. Given UV has mostly a contact action in the intended use here, the answer could be similar as deciding how big a spraying system should be to be able to effectively and timely spray your crops when needed.

Consider a horizontal sprayer driving in a straight direction. Driving speed, nozzle flow rate (decided by type and operating pressure), nozzle spacing and boom width are the factors affecting what acreage a farmer will be able to spray within a given timeframe. Fixing some to the requirements of the sprayed products like doses and water volume to attain a good crop coverage and efficacy will give an outcome on how big the spraying system should be.

In a UV-system the dose can be influenced by the driving speed and power (W) per meter of the system. By choosing the type of lamps and/or the amount of lamps, the total wattage can be altered. In difference with chemical products, the effective dose is sometimes not known for UV treatments. This is an issue to resolve as the minimal effective dose also has a big influence on the acreage you can treat in a certain timeframe. The lower the effective dose, the faster you can go over the crop.

UV applications are mainly performed after sundown, so the treatment window is shorter than during daytime. The frequency is also rather high with a treatment around every three nights. As a consequence a farmer needs to work out how to cope with the more unconventional working hours.

3.25 Testing different types of SMART trap

Monitoring pest insects within crops can be very informative but also very time consuming, particularly if the crops are distributed over a wide area. SMART traps are generally traps that can be observed remotely, so that field visits are minimised. To date, the traps that are on the market use cameras, powered by solar cells, to take images of trapping surfaces and send them to a website where they can be viewed at any time. The trapping surfaces are usually sticky traps and insects are attracted to the traps by smell (usually pheromone) or vision (coloured trap). The systems are improving all the time in terms of image quality, identification and recording of the insects captured, and management of the trapping surface (e.g. automatic replacement). There is great potential for insect identification through machine learning and methods are being developed to identify insects through their wingbeat frequency. SMART traps are particularly useful for monitoring pest insects whose pattern of activity is unpredictable such as the moths *Plutella xylostella* and *Autographa gamma* which are migrants to, and within, Europe. Both species can be monitored effectively with SMART pheromone traps.

3.26 Forecasting damage by root-feeding fly pests of brassica and onion

Forecasting systems to improve the management of root-feeding fly pests of brassica and onion crops were reviewed in an ERA-NET C-IPM project called FlyIPM Insects | Free Full-Text | The Potential for Decision Support Tools to Improve the Management of Root-Feeding Fly Pests of Vegetables in Western Europe (mdpi.com). Forecasting systems have been developed for *Delia radicum*, *D. floralis*, *D. platura* and *D. antiqua*. All but one of the systems predict phenology rather than abundance; a forecast developed in Norway for *D. floralis* is based on a damage threshold. Degree-day forecasts have been developed in North America for *D. radicum*, *D. platura*, and *D. antiqua*, are presented on several advisory web sites in North America, and are available for use elsewhere. Simulation models have been developed for *D. radicum* in the UK and Germany, and there is a preliminary German model for *D. antiqua*. A Norwegian degree-day model has been developed for *D. radicum* based on spring emergence and the oviposition period. A comparable degree-day model is available in Denmark and this can use local soil temperatures for individual postal code areas. All the models require current weather data and the degree-day models mainly use air temperature records. Both air and soil temperatures are used in the UK and German simulation models. The models or their outputs are disseminated in a number of ways.

3.27 Monitoring bean seed flies

The bean seed fly (BSF) (*Delia platura* & *Delia florilega*) is a pest of over 40 crop species, causing the greatest problems in legumes and alliums. It usually causes the most crop damage early in the year. Crop yields are reduced when BSF larvae feed on developing seedlings, often killing them. Discussions with growers indicated that they would like to know when BSF are going to lay eggs in susceptible crops. BSF can be monitored using coloured water traps or sticky traps. The colours blue and white are particularly attractive to BSF and are also relatively less attractive than, for

example, yellow traps, to cabbage root flies (*Delia radicum*). Cabbage root flies look similar but are slightly larger than BSF and it can be difficult to separate the two species without detailed examination (using a microscope). Sticky traps that are oriented vertically capture more BSF than horizontal traps. It is possible to buy trapping systems for BSF that include an attractive lure. Use of a lure generally increases the numbers of bean seed flies captured compared with a similar trap with no lure. It is possible to monitor BSF using some of the SMART trapping systems available on the market. However, identification of BSF from an image can be difficult; not every individual can be identified with certainty. However, SMART traps are useful to monitor for sudden changes in fly abundance.

3.28 PATS-C & PATS-X – The use of drones for greenhouse pest monitoring and eradication

PATS produce intelligent autonomous systems in greenhouses that can monitor (PATS-C) and eradicate (PATS-X) flying pests. PATS-C tracks flying pest insects in the greenhouse 24/7 using AI image recognition from a mounted automated scanner. Its high frequency monitoring helps users to gain crucial insights into their IPM programme daily, allowing them to act on pests immediately, sometimes up to 5 weeks earlier. This helps them to prevent the spread of the next generation of offspring whilst saving time on scouting rounds. This reduces unnecessary crop losses and the use of costly resources. The service focuses mainly on moth pests (*Lepidoptera*) of which the caterpillars can cause considerable crop damage very quickly. It can also monitor beneficials in the greenhouse such as *Bombus terrestris* and *Macrolophus pygmaeus*. PATS-X is an extension on the monitoring technology which upon identification of flying pests, acts to eradicate them by flying into them using the spinning blades of micro drones. The technology therefore controls pests without the need for any chemical application. PATS-C is available globally and its list of pests and beneficials that it identifies is regularly updated online: https://www.pats-drones.com/pats-c. PATS-X is available from early 2023.

3.29 Remote greenhouse crop monitoring for pest and disease risks and alerts (OKO digital, Greenpatrol robot, prospera)

Regular and accurate crop scouting is an essential component in an effective integrated pest management (IPM) protocol. Scouting reports allow growers to make timely, informed decisions to protect their vegetable crops from pest and disease. This however can be a time consuming and laborious process, especially in larger greenhouses. Technologies such as Oko Digital, Gearsense, Prospera and GreenPatrol robot allow for remote scouting of crops in greenhouses in different ways. OKO immersive provides growers and consultants with the ability to take virtual, 8K visibility walks inside the greenhouse, using the OKO platform which runs along pipe rails, to see what is happening in near real-time. The GreenPatrol robot, designed for tomatoes and peppers can operate autonomously using satellite navigation to detect and map several pests and diseases. Growers can access an online application to see the robot's status and a map of healthy and infected zones, with recommended actions. Prospera is an autonomous camera system that once set up in the greenhouse ceiling can monitor the crops 24/7 with AI image recognition of crop issues. Prospera analyses tens of thousands of images to locate problems and can inform on the extent and spread percentage of an infestation (e.g., late blight in tomato crop). These technologies offer great potential in reducing the amount of labour needed in a greenhouse scouting regime.

3.30 Greenhouse mapping applications for pest and disease scouting management (IPM scoutek, CropScanner app, Farmapp)

Scouting apps have been developed to make the capture and utilisation of scouting data more efficient and easier to manage for greenhouse growers. The apps IPM scoutek, CropScanner app and Farmapp all offer the user fast and direct entry of scouting information such as pests, diseases, traps and beneficials into the app. These entries are geolocated into a greenhouse map and the software then allows real time visualisation of important information such as pest pressure hotspots & trends and beneficial insect population build up. This allows for tailored IPM application programmes to be built, targeting exactly where attention is needed as well as allowing the power to track application efficacy, to evaluate how well it is working and how much it is costing. Farmapp also has a feature that allows for optimal spraying routes to be visualized and tracked on the app and uses personal sensor data for timely pest and disease prediction alerts. These applications offer greenhouse growers a powerful and efficient tool for collecting and structuring scouting data in a visual mapped format. They help produce real time tailored IPM strategies that can be tracked, evaluated and used to inform future management decisions.

3.31 Mobile pest and disease diagnosis in tomato cultivation

Smartphone apps can now take advantage of high-resolution phone cameras with the aim of diagnosing and detecting pests and diseases in crops. In tomato cultivation the applications Xarvio scouting, Plantix and Agrio can be used for the detection of many pests and disease such as Bacterial Spot and Speck, Bacterial wilt, Early blight, Fusarium Wilt, Grey mould, Late blight, Leaf curl of Tomato, Powdery mildew, Tomato Leafminer, Whitefly, aphids and many more. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to them every day. Instead of AI image recognition, the application CropDiagnosis uses a smart reasoning machine (AI) questionnaire, it uses the crop's details and the threat's characteristics input from the user to guide them to the most likely diagnosis and treatment options. After diagnosis, each application will offer advice and treatment recommendations. Xarvio scouting, Plantix and Agrio also provide pest and disease alerts for if any have been detected in the local area of the user. Although currently not 100% accurate these technologies provide huge potential in enabling scouting operations to become more accessible and efficient in tomato cultivation.

3.32 Mobile pest and disease diagnosis in pepper cultivation

Smartphone apps can now take advantage of high-resolution cameras found in modern mobile phones with the aim of diagnosing and detecting pests and diseases in crops. In pepper cultivation the applications Xarvio scouting, Plantix and Agrio can be used for the detection of many pests and disease such as Alfalfa mosaic virus, Anthracnose of Pepper, Bacterial Spot, Cucumber mosaic virus, Early blight, Fusarium Wilt, Grey mould, Powdery mildew of pepper, Sooty mold, Tobacco Mosaic Virus, Tomato spotted wilt virus, Tomato yellow leaf curl virus, Wet rot and many more. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to every day. After diagnosis, each application will offer advice and treatment recommendations. They also provide pest and disease alerts for if any have been detected in the local area. Instead of AI image recognition, the application CropDiagnosis uses a smart reasoning machine (AI) questionnaire combined with the crop's details and the threat's characteristics input

from the user to guide them to the most likely diagnosis and treatment options. Although currently not 100% accurate these technologies provide huge potential in making scouting operations more accessible and efficient in pepper cultivation.

3.33 Mobile pest and disease diagnosis in cucumber cultivation

Smartphone apps can now take advantage of high-resolution phone cameras with the aim of diagnosing and detecting pests and diseases in crops. In cucumber cultivation the applications Xarvio scouting, Plantix and Agrio can be used for the detection of many pests and disease. Xarvio scouting allows for the detection of Cucumber green mottle mosaic virus, Cucumber mosaic virus, Downy mildew, Powdery mildew, Gummy stem blight, Anthracnose of curcubits, Angluar leaf spot disease, Tobacco Mosaic Virus, Spider mite, Thrips, Whitefly, Cucumber beetle, Aphids and Red Pumpkin Beetle. Plantix can detect many of the pests and disease mentioned as well as Leaf blight of Curcubits, Cucumber scab, Bacterial wilt and many more. Agrio also has a vast library including leafminers, mealybugs and more. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to them every day. After diagnosis, each application will offer advice and treatment recommendations. They also provide pest and disease alerts for if any have been detected in the local area of the user. Although currently they are not 100% accurate, these technologies provide huge potential in making scouting operations more accessible and efficient in cucumber cultivation.

3.34 Mobile pest and disease diagnosis in onion cultivation

Smartphone apps can now take advantage of high-resolution phone cameras with the aim of diagnosing and detecting pests and diseases in crops. In onion cultivation the applications Xarvio scouting and Plantix can be used for the detection of many pests and disease. Xarvio scouting can be used for image recognition of diseases such as Botrytis Leaf Blight, Downy Mildew, Stemphylium Leaf Blight of Onion and pest damage from Leaf-miner flies and Thrips. Plantix can be used in the recognition of OYDV, Aster yellow phytoplasma, Fusarium wilt, Powdery Mildew, White rot, Black mold, leaf blight of onion, white rot, purple blotch, Downy mildew, Botrytis leaf blight, leek rust as well as pest damage from Onion maggots, aphids, leaf-miners and many more. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to them every day. After diagnosis, each application will offer advice and treatment recommendations. They also provide pest and disease alerts for if any have been detected in the local area of the user. Although currently not 100% accurate these technologies provide huge potential in enabling scouting operations to become more accessible and efficient in onion cultivation.

3.35 Mobile pest and disease diagnosis in brassica cultivation

Smartphone apps can now take advantage of high-resolution phone cameras with the aim of diagnosing and detecting pests and diseases in crops. In brassica cultivation the applications Xarvio scouting, Plantix and Agrio can be used for the detection of many pests and disease. Xarvio scouting can be used for image recognition of Cabbage & Cauliflower diseases such as Alternaria leaf spot, Black rot and pest damage from Aphids, Cabbage White Butterfly, Cotton leafworm, Leaf-miner flies and Whitefly. Plantix can be used in the recognition of ring spot, bacterial rot of cabbage and pest damage of cabbage moth, cabbage webworm and many more. Agrio also has a large library that is constantly updated. These applications use machine learning algorithms and AI that learn from huge

data sets of images that are uploaded to them every day. After diagnosis, each application will offer advice and treatment recommendations. They also provide pest and disease alerts for if any have been detected in the local area of the user. Although currently not 100% accurate these technologies provide huge potential in making scouting operations more accessible and efficient in brassica cultivation.

3.36 Image based selective mechanical weeding for field vegetables (Garford Robocrop and Naoi – Dino)

Mechanical weeding can be an important non-chemical aspect of weed management in an effective IPM protocol. Many systems exist for mechanical weeding between rows but within rows (intra row) has limited options and so the tasks are often done separately. Garford's Robocrop InRow Weeder tractor attachment does both inter and intra row weeding using a digital video camera to capture images of the crop ahead of the toolbar. The information is then utilized for lateral steering of the hoe and individual synchronization of the InRow weeder discs which are constantly adjusted in speed to suit the variation in plant spacing. It was originally developed for use on transplanted crops such as lettuce, cabbage, celery etc. However, it can be used on many crops provided they have regular plant and row spacing with clearly separated foliage. Another technology utilizing image based selective mechanical weeding, but for only between row weeding, is Naoi technologies – Dino. The Dino is an autonomous robot that combines information from RTK GPS and other sensors with a precision range of 2cm to detect crop rows and adjust weeding as close to the plants as possible. This allows the robot to perform high quality, efficient weeding, saving the farmer time and reducing the need for chemical input. The Dino works on various vegetables such as lettuce, onions, carrots, parsnips, cabbage, leeks, cauliflower, various herbs and much more.

3.37 Decision support systems for pest and disease management in tomato cultivation

Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In tomato cultivation, disease prediction models using personal climate monitoring station and sensor data are available through iMETOS, Dacom farm disease management, WiseCrop and EVJA: OPI support system. iMETOS offers disease models for Late blight - *Phytophthora infestans*, Early blight - *Alternaria solani*, Powdery Mildew (three pathogens), Grey mould - *Botrytis cinerea*, Leaf spot - *Septoria lycopersici*, Anthracnose fruit rot – *Colletotrichum spp.*, Leaf mould - *Fulvia fulva* and *Phytophthora* blight - *Phytophthora capasci*. Dacom can predict Late blight, Grey mould and Early blight. These services utilize both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free tomato field or greenhouse. A DSS that can help in the pest management of tomato crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Tuta absoluta*, *Helicoverpa armigera*, *Bemisia tabaci*, *Aphis nasturtii*, *Myzus persicae*, *Aulacorthum solani*, *Frankliniella occidentalis*, *Frankliniella fusca*, *Thrips tabaci*, *Tetranychus urticae* and many more. These technologies offer great decision support for growers and agronomists in the pest and disease management of tomato crop. They can provide savings on crop losses, treatment applications and ultimately contribute towards more sustainable pest and disease management.

3.38 Decision support systems for pest and disease management in pepper cultivation

Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In pepper cultivation, disease prediction models using personal climate monitoring station and sensor data are available through iMETOS, Dacom farm disease management, and EVJA: OPI support system. iMETOS offers disease models for *Alternaria,* Powdery mildew – *Leveillula taurica*, Grey mould - *Botrytis cinerea* and Phytophthora blight - *Phytophthora capsici*. Dacom can predict *Alternaria*, Powdery mildew and Grey mould. These services utilise both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free pepper field or greenhouse. A DSS that can help in the pest management of pepper crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Bemisia tabaci*, *Thrips tabaci*, *Frankliniella fusca*, *Frankliniella occidentalis*, *Spodoptera exigua*, *Helicoverpa armigera*, *Agrotis ipsilon*, *Aphis nasturtii*, *Myzus persicae*, *Aulacorthum solani*, *Tuta absoluta*, *Meloidogyne incognita*, *Meloidogyne javanica*, *Plutella xylostella* and many more. These technologies offer great support for pepper cultivation, providing savings on treatment applications, crop losses and ultimately contributing towards more sustainable pest and disease management.

3.39 Decision support systems for pest and disease management in cucumber cultivation

Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In cucumber cultivation, disease prediction models using personal climate monitoring station and sensor data are available through iMETOS, EVJA: OPI support system and Agrivi Farm Management. iMETOS can offer disease models for powdery mildew of cucurbits, *Alternaria solani* and *Phytophthora infestans*. These services are based on scientific research and offer important decision support, utilising both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free cucumber field or greenhouse. A DSS that can help in the pest management of pepper crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Liriomyza sativae*, *Thrips palmi*, *Trialeurodes vaporariorum*, *Anasa tristis*, *Aphis nasturtii*, *Myzus persicae*, *Aulacorthum solani*, *Aphis gossypii*, *Frankliniella occidentalis*, *Frankliniella fusca*, *Thrips tabaci, Tetranychus urticae* and many more. These technologies offer great support for cucumber cultivation, providing savings on treatment applications, crop losses and ultimately contributing towards more sustainable pest and disease management.

3.40 Decision support systems for pest and disease management in onion cultivation

Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce

the chance of yield losses and the amount of application needed. In onion cultivation, disease prediction models using personal weather station and sensor data are available through iMETOS, Dacom farm disease management, Agronet and Agrivi farm management. iMETOS can help predict the development of Downy mildew, *Botrytis* Leaf Blight, *Botrytis* Leaf Spot, *Stemphylium* Leaf Blight and Purple Blotch. Dacom can predict Downy mildew, *Botrytis* Leaf Blight, Neck rot, Purple Blotch, White tip and Leaf spot. These services are based on scientific research and offer important decision support, utilising both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free onion field. A DSS that can help in the pest management of onion crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Acrolepiopsis assectella*, *Agrotis ipsilon, Delia platura*, *Thrips tabaci*, *Tetranychus urticae*, *Aphis nasturtii*, *Myzus persicae*, *Aulacorthum solani* and many more. These technologies offer great support for onion cultivation, providing savings on treatment applications, crop losses and ultimately contribute towards more sustainable pest and disease management.

3.41 Decision support systems for pest and disease management in carrot cultivation

Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In carrot cultivation, disease prediction models using personal weather station and sensor data are available through iMETOS and Dacom farm disease management. iMETOS offers Tomcast *Alternaria dauci* Model for carrots (leaf blight) and *Cercospora* Leaf Spot (leaf spot). Dacom can predict *Alternaria* leaf blight, *Cercospora* Leaf Spot, *Sclerotinia* disease and Powdery mildew. These services are based on scientific research utilising both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free carrot field, providing savings on crop losses and treatment application. OPTIMA IPM is a freely accessible DSS that offers 5-day prediction of disease outbreak and application guidance, based on meteorological data, for carrot leaf blight in certain European countries (available in http://dss.optima-h2020.eu/). A DSS that could help in the pest management of carrot crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Myzus persicae*, Aphis gossypii, *Agrotis ipsilon, Agrotis ipsilon* and many more. These technologies offer great support for growers and agronomists in carrot cultivation, with the potential to provide savings on treatment applications, crop losses and ultimately contributing towards more sustainable pest and disease management.

3.42 Decision support systems for pest and disease management in brassica cultivation

Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In brassica cultivation, disease prediction models using personal weather station and sensor data are available through Dacom farm disease management. Dacom can predict ringspot, *Alternaria* Leaf Spot, White rust/blister and Powdery mildew in cabbage. In broccoli it can predict Headrot, Downy mildew and Whiterust. This disease management service is based on scientific research, demonstrating savings of more than

40% in practice by offering important decision support, utilising both monitored and forecasted data to optimise the correct crop protection management strategy. A DSS tool that can help in the pest management of brassica crops is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as Cabbage aphid (*Brevicoryne brassicae*), Swede midge (*Contarinia nasturtii*), Cabbage root fly *(Delia radicum*), Peach-potato aphid (*Myzus persicae*), Cabbage white butterfly (*Pieris rapae*), Diamondback moth (*Plutella xylostella*), bean seed fly (*Delia platura*) and many more. These technologies offer great support for growers and agronomists in brassica cultivation, with the potential to provide savings on treatment applications, crop losses and ultimately contributing towards more sustainable pest and disease management.

3.43 Decision support systems for pest and disease management in lettuce cultivation

Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In lettuce cultivation, disease prediction models using personal weather station and sensor data are available through iMETOS and Dacom farm disease management. iMETOS can offers an Infection model for Lettuce Downy mildew- *Bremia lactucae*, infection model for Lettuce Anthracnose – *Microdochium panattonianumis* and a disease model for Lettuce grey mould – *Botrytis cinerea*. Dacom can predict Downy mildew and White mould - *Sclerotinia sclerotiorum*. The service itself has demonstrated savings of up to 40% in practice. Both of these services are based on scientific research and offer important decision support, utilising both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free lettuce field or greenhouse. FuturCrop uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of lettuce pests such as aphids (*Myzus persicae*, *Aphis nasturtii*, *Aulacorthum solani*), turnip moth (*Agrotis ipsilon*), beet armyworm (*Spodoptera exigua*), Cotton bollworm (Helicoverpa armigera), Cotton leafworm (*Spodoptera littoralis*), and many more. These technologies can offer great support for growers and agronomists in lettuce cultivation with the potential to provide savings on treatment applications, crop losses and ultimately contribute towards more sustainable pest and disease management.

3.44 Plant pathogen detection in tomato crop by immunoassay-based techniques (ELISA & lateral flow devices)

Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques, utilising the antigen-antibody reaction that can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment and some level of training. They allow for the detection of Cucumber mosaic virus - CMV, Tomato mosaic virus – ToMV, Tomato mottle mosaic virus - ToMMV, Tomato brown rugose fruit virus - ToBRFV, Tomato black ring virus - TBRV, Tomato bushy stunt virus – TBSV, Tomato Chlorotic Spot Virus - TCSV, Tobacco mosaic virus - TMV, Tomato spotted wilt virus - TSWV, Tomato ringspot virus - ToRSV, Tomato yellow leaf curl virus - TYLCV, Tomato Yellow Ring Virus - TYRV, *Clavibacter michiganensis subsp. michiganensis*, *Ralstonia solanacearum*, *Xanthomonas campestris pv. vesicatoria* and many more in Tomato crops. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE and AGDIA. Complete kits

contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. BIOREBA, Agdia and LOEWE all provide LFDs for many diseases relevant to the tomato crop. Examples test kits include ToBRFV, ToMV, ToRSV, TSV Pepino mosaic virus – PepMV, TSWV, many of the bacteria/ fungal diseases mentioned above and more. Both methods offer a powerful tool in the early detection of disease in tomato crops, ELISA for their accuracy, and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.

3.45 Plant pathogen detection in pepper crop by immunoassay-based techniques (ELISA & lateral flow devices)

Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques, utilising the antigen-antibody reaction that can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment and some level of training. They allow for the detection of Alfalfa mosaic virus – AMV, Cucumber mosaic virus - CMV, Pepper Mild Mottle Tobamovirus - PMMoV, Pepper Mottle Potyvirus - PepMoV, Pepper Veinal Mottle Potyvirus – PVMV, Potato virus Y - PVY, Tomato mosaic virus – ToMV, Tobacco mosaic virus - TMV, Tomato spotted wilt virus - TSWV, Tomato yellow leaf curl virus - TYLCV, , *Clavibacter michiganensis subsp. michiganensis*, *Ralstonia solanacearum*, *Xanthomonas campestris pv. vesicatoria* and many more in pepper crops. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE and AGDIA. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. The same companies provide LFDs for many diseases relevant to the pepper crop as well. Example LFD test kits include CMV, PepMV, PVY, PepMoV, PMMoV, TMV, TSWV, ToBRFV, ToMV, ToRSV, TSV Pepino mosaic virus – PepMV, TSWV, many of the bacteria/ fungal diseases mentioned above and more. Both methods offer a powerful tool in the early detection of disease in pepper crops, ELISA for their accuracy, and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.

3.46 Plant pathogen detection in cucumber crop by immunoassay-based techniques (ELISA & lateral flow devices)

Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) and some level of training. They allow for the detection of Cucumber Mosaic Virus - CMV, Cucumber Green Mottle Mosaic Virus – CGMMV, Cucurbit yellow stunting disorder virus – CYSDV, Tobacco mosaic virus – TMV, Zucchini yellow mosaic virus – ZYMV, Watermelon Mosaic virus – WMV, *Pseudomonas syringae pv lachrymans*, *Ralstonia solanacearum*, *Xanthomonas campestris*, *Verticillium spp*., *Rhizoctonia solani* in cucumber crops. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE, and AGDIA. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually

interpreted in the same way as the rapid covid-19 tests. BIOREBA, Agdia and LOEWE provide lateral flow test kits for some of the diseases relevant to the cucumber crop such as CMV, CGMMV, ZYMV, Zucchini Green Mottle Mosaic – ZGMMV, TMV, *Acidovorax avenae subsp. Citrulli*, *Ralstonia solanacearum*, *Xanthomonas* genus level, *Rhizoctonia solani, Botryitis cinerea* and many more. Both methods offer a powerful tool in the early detection of disease in cucumber crops, ELISA for their accuracy and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.

3.47 Plant pathogen detection in onion crop by immunoassay-based techniques (ELISA & lateral flow devices)

Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) as well as some level of training. They allow for the detection of Onion yellow dwarf virus - OYDV, Tomato spotted wilt virus - TSWV, Garlic common latent virus - GCLV, Iris yellow spot virus - IYSV, Leek yellow stripe virus - LYSV, POTY group test, *Phytophthora* spp., *Pythium spp*. and *Rhizoctonia solani*. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE, and AGDIA. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. The company Agdia provide these rapid one test strips for IYSV, TSWV, *Xanthomonas* - Genus level and POTY – group level. Both methods offer a powerful tool in the early detection of disease in onion crops, ELISA for their accuracy and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.

3.48 Plant pathogen detection in carrot crop by immunoassay-based techniques (ELISA & lateral flow devices)

Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) as well as some level of training. Tests available for purchase from the Leibniz-Institut DSMZ GmbH Shop allow for the detection of Carrot virus Y -CarVY, Carrot necrotic dieback virus – CNDV and Carrot thin leaf virus - CTLV. Creative diagnostics supplies complete test kits for CTLV. Other kits from Bioreba, Loewe and Agdia can be used for Alfalfa mosaic virus - AMV, Cucumber mosaic virus - CMV, *Phytophthora spp*., *Pythium spp*. and *Rhizoctonia solani*. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. Less tests exist for LFDs, especially for carrot diseases, however some relevant tests from the company Agdia can detect AMV, CMV, POTY group test, *Xanthomonas* genus level, *Rhizoctonia solani* and *Phytophthora* genus level. LOEWE® FAST lateral flow kits are available for CMV and *Botrytis cinerea*. Both methods offer a powerful tool in the early detection of disease in carrot crops, ELISA for their accuracy and availability of specific carrot virus tests, LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.

3.49 Plant pathogen detection in brassica crops by immunoassay-based techniques (ELISA & lateral flow devices)

Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) and some level of training. They allow for the detection of Brocoli Necrotic yellow virus - BNYV, Cauliflower mosaic virus - CaMV, Cucumber mosaic virus - CMV, Turnip mosaic virus - TuMV, Turnip yellow mosaic virus - TYMV, POTY group, *Xanthomonas campestris pv. campestris*, *Rhizoctonia solani*, *Phytophthora spp*., *Botrytis cinerea*. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE and Agdia. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. LOEWE®FAST Lateral Flow Kits can be provided for the detection of CMV and *Botrytis cinerea.* BIOREBA – Agristrip and Agdia ImmunoStrip® Tests can be used for the detection of CMV and the latter also provides test kits for *Xanthomonas* - Genus level, *Phytophtora spp*., *Rhizoctonia solani*. Both methods offer a powerful tool in the early detection of disease in brassica crops, ELISA for their accuracy and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.

3.50 Plant pathogen detection in lettuce crop by immunoassay-based techniques (ELISA & lateral flow devices)

Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) and some level of training. They allow for the detection of Brocoli Necrotic yellow virus - BNYV, Cauliflower mosaic virus - CaMV, Cucumber mosaic virus - CMV, Turnip mosaic virus - TuMV, Turnip yellow mosaic virus - TYMV, POTY group, *Xanthomonas campestris pv. campestris*, *Rhizoctonia solani*, *Phytophthora spp*., *Botrytis cinerea*. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE and Agdia. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. LOEWE®FAST Lateral Flow Kits can be provided for the detection of CMV and *Botrytis cinerea.* BIOREBA – Agristrip and Agdia ImmunoStrip® Tests can be used for the detection of CMV and the latter also provides test kits for *Xanthomonas* - Genus level, *Phytophtora spp*., *Rhizoctonia solani*. Both methods offer a powerful tool in the early detection of disease in brassica crops, ELISA for their accuracy and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.

3.51 Plant pathogen diagnostic using DNA/RNA based technologies

Plant pathogens are identified in very different ways - visually, based on expert experience and knowledge, and in the laboratory - by performing morphological analyses of the pest, or using biotechnological tools, more often used for fungal and bacterial pathogens, but possible also for

pests. The simplest and oldest laboratory method is to cultivate the pathogen on the medium, followed by microscopic analysis of the medium and identification of the pathogen by its morphological characteristics. In recent decades, with the development of biotechnology, molecular methods have been introduced in the diagnosis of plant pathogens. Nucleic acid (NA) analysis methods are the most accurate and fastest. They are most often based on polymerase chain reaction (PCR), a highly sensitive technology where DNA detection is possible even from a few pathogen spores. During the PCR, specific fragments of the sample genome unique to the pathogen are amplified. Visualization of molecular reactions is performed using electrophoresis to separate DNA fragments on an agarose gel, followed by DNA luminescence and comparison with specific markers. This method is usually the most accurate and relatively fast, but its technological complexity makes it expensive due to the need to use advanced laboratory equipment as well as expensive reagents. In addition, these analyses require specific knowledge and experience.

3.52 Plant pathogen diagnostic using ELISA based technologies

Plant pathogens are identified in very different ways - visually, based on expert experience and knowledge, and in the laboratory - by performing morphological research of the pest, or using biotechnological methods. Enzyme-linked immunosorbent assay (ELISA), a technology based on the detection of antibodies in the organism, or immunodiagnostics, is convenient and effective pathogen diagnostic method. Antibodies are molecules that are produced by the immune system of living organisms to help identify the pathogen that cause infection or damage. Antibodies that recognize specific antigens associated with a particular plant pathogen can be used as a basis for a diagnostic tool. The primary purpose of an immunoassay test is to determine the binding of a diagnostic antibody to a target antigen. There are several ways to determine antibody / antigen binding, but these often involve binding the antibody to an enzyme that causes discoloration by adding a test sample. Color changes indicate specific antibody / antigen binding. The enzyme-linked immunosorbent assay (ELISA), a technology developed in the 1970s, is the most commonly used diagnostic method using antibodies. ELISA analyses are performed in a laboratory. Immune system diagnostic technology is also used in rapid express tests.

3.53 Molecular tools for on-site rapid detection of pathogens

Molecular analyses are performed in broad range of scientific and commercial analytical laboratories to obtain reliable and precise results on pathogen diagnostic. During last couple of decades several technologies of molecular analyses are developed to perform in laboratory conditions where hi-tech premises and range of chemical reagents are necessary, as well as skills and knowledge of personnel is highly important to obtain reliable results. To simplify and develop fast and user-friendly technology the research on the molecular analysis has been continued. Several molecular technologies are developed in diagnostic. The recombinase polymerase amplification (RPA) method is between them. It is remarkable due to its simplicity, high sensitivity, selectivity, compatibility with multiplexing, extremely rapid amplification, as well as its operation at a low and constant temperature, without the need for an initial denaturation step or the use of multiple primers. Overall, RPA positions itself very favourably for widespread exploitation in kits and assays for use at the point-of-care or point-of-need, as well as in affordable, sensitive, specific, user friendly, rapid, robust, equipment-free and delivered (ASSURED) devices, in low-resource settings. Such technology is offered by Agdia’s AmplifyRP® testing platform, which enables highly specific and sensitive DNA or RNA analysis of plant pathogens in any type of testing environment. Crude sample extracts can be

prepared using a simple extraction buffer and can be tested directly. This makes the testing process very simple and saves the valuable time of end-user. Currently in vegetable plants testing of Tomato brown rugose fruit virus (ToBRFV) and Tomato chlorotic dwarf viroid (TCDVd) is offered by the platform.

3.54 Disorder detection technologies for vegetables

A complex approach to the day-to-day crop management is very important for farmers, and especially in horticultural farms. The need and sequence of works often is determined by weather conditions and their consequences - the spread of pests and diseases, lack of moisture, and disorders in plant nutrition and consequently plant fertilization needs. These disorders usually are detected visually according to the experience of farmer upon their appearance on the plants, as well as confirmed by soil and plant analyses. A complex evaluation of all factors and timely performed actions are very important for obtaining high quality products and economical, environmentally friendly use of resources. Recently, a number of digital solutions have been developed connected with meteorological stations and data processing platforms. Data processing platforms are based on artificial intelligence technologies, where data sets with thousands of images of a specific plant disease or pest damage are created, and used to acquire an algorithm for recognizing various diseases and pests in the process of machine learning. By linking this information to meteorological data sets, the algorithms generate forecasts and recommendations for the use of plant protection products and fertilizers, or perform the irrigation. Several such platforms of varying complexity and solutions have been created - for example, Agrio app, Cropwise, Plantix and others. These products are user friendly and easy understandable.

3.55 Decision support systems, an example Dacom

Decision support systems (DSS) are developed in order to help farmers to take decision for the agronomic measures needed to be performed in their crops in precise timing and in optimum amounts taking in to account plant development speed and weather data, as well as other agroecological factors influencing development of fungal diseases. Decision support systems usually are connected with automated metrological stations located directly in the farm. With Dacom Disease Management you can view where, when and with what amount you need to apply fungicide. It determines whether present conditions favour an outbreak of disease. If this is the case, it provides you with information regarding the optimum moment to spray. It also indicates which type of fungicide to use. Dacom Disease Management is available for various crops by means of a web application and mobile applications. The advice is calculated based on your crop recording, weather forecast and weather data.

3.56 How SmartProtect's work falls within broader EU Objectives – the sustainable use of pesticides directive

DIRECTIVE 2009/128/EC, or The Sustainable use of Pesticides Directive (SUD), was adopted in 2009 with the aim of reducing the most hazardous chemical pesticides' use and their negative impacts. The Farm to Fork Strategy includes a target of reducing the use of the most hazardous pesticides by 50% by 2030. The Directive's first impact assessment concludes that it has had little effect on the most hazardous pesticides' use. Some reasons for this are:

- Inconsistencies between EU Member States regarding the SUD's transposition and monitoring, often lacking clear targets at the respective states' level.
- The lack of EU-level obligations for Member States to document integrated pest management actions, hence the Member States' inability to accurately report their adoption.
- Limited availability of alternatives to hazardous chemical pesticides and information on integrated pest management solutions or non-chemical and less hazardous products.

The public consultation ran from January to April 2021. The resulting feedback will help formulate policy options to better implement the Directive and progress towards the above target, probably including:

- Legally binding targets (at EU & Member State level) to reduce the use of synthetic chemical pesticides and their associated risks.
- Better monitoring of the SUD by Member States through explicitly defined rules on official controls and greater Commission oversight through audits.
- Specific restrictions on the use of chemical pesticides and additional record-keeping requirements on the use of pesticides and testing of pesticide application equipment.

SmartProtect & its partners' work can fit in well with these objectives, as well as implement the policy options used to enforce the directive.

3.57 Organic farming and EU Policy

Organic farming is an agricultural method aimed at producing food with natural substances and processes. It generally involves shorter supply chains and provides opportunities for small farmers, thanks to the strengthening of the new provisions introduced by Regulation 2018/848 on organic production. This regulation aims to modernise the sector and harmonise standards, providing a stable regulatory framework.

Key benefits:

- Organically farmed land has about 30% more biodiversity than conventionally farmed land.
- Organic farming is beneficial for pollinators.
- Organic farmers cannot use synthetic fertilisers and can only use a limited range of chemical pesticides.
- The use of GMOs and ionising radiation is prohibited, and the use of antibiotics is severely restricted.

The area devoted to organic farming has increased by almost 66% in the last 10 years. It now accounts for 8.5% of the EU's total "utilised agricultural area". The share of agricultural land devoted to organic farming varies from a minimum of 0.5 % to a maximum of more than 25 % - it is crucial that each Member State develops its national organic farming strategy as soon as possible, based on a comprehensive analysis of the sector and including actions, incentives, clear deadlines and national targets.

The organic production action plan will contribute significantly to the achievement of other targets in the Biodiversity Strategy and the Farm to Fork Strategy, such as the pesticide reduction target and the nutrient surplus reduction target, while helping to drive the EU towards its zero-pollution ambition for a non-toxic environment. In this context, the work of SmartProtect and partners can fit well into the overall goals of pesticide reduction.

3.58 Detection of virus in plant disease identification

Accurate identification and diagnosis require knowledge of the symptoms induced and often a confirmatory lab test. Farmers or other non-specialist agriculturalists often lack in-depth knowledge of symptoms induced and often a confirmatory lab test. Small holder Farmers or other non-specialist agriculturalist often lack in-depth knowledge of symptoms and access to literature or expert opinion. For the early diagnosis of the aforementioned diseases, Buntata App is an Android application designed to help the users identify plant diseases with no a-priori knowledge. Buntata provides a visual key for the identification of diseases by displaying exemplar images of symptoms and offers solutions to aid identification of the causes. A user visually selects the part of the plant (e.g., affected leaf) that is affected and Buntata displays images with recorded symptoms. Picking the image that most closely, background information, diagnostics and control methods to help deal with the cause. Buntata displays diseases with similar symptoms together allowing easy comparison and help users to identify the correct one. Once the cause is identified, users can keep a record of this – tagged with the current location, notes and images stored locally on the device – for future reference.

3.59 Distribution systems for beneficials – Application Trichogramma dropper

The organic method is therefore the best way to combat the European corn borer. The European corn borer is one of the most important pests in maize cultivation worldwide. Around 4% of the annual harvest is destroyed by the small caterpillars of the moth, which are about 3 cm in size. The female moth lays up to 500 eggs, which then attach themselves to the underside of the maize leaves. After 7-14 days, the small caterpillars hatch and start feeding through the pith inside the maize stalks. The stalks often break as the plant loses stability due to the lack of pith.

The application of Trichogramma droppers offers farmers and service providers the ideal tool for fast, efficient and cost-effective biological pest control in maize. Thanks to its high-precision GPS, the Agrica drone distributes the Trichogramma capsules precisely and is therefore more effective than hand application.

Trichogramma is released in capsule form via a container attached to our multicopters. This is not only gentle on the soil, but is also a very economical method of application.

In capsule form, Trichogramma is distributed over the wheat fields with a content of around 1000 eggs per capsule. In addition, the application can be used for large areas and small areas. For large areas using machine operation, the Agrica turns automatically at the field border and continues its flight path. For irregular or very small pieces of field, manual operation can be switched over during operation, giving the pilot full control and being maneuverable manually.

3.60 Aerial technologies for biological pest control

Biological control of diseases and pests has attracted increasing attention due to an urgent need for environmental protection. However, traditional operating methods do not integrate well with biological control technology. With the advantages of simple operation, low operational cost, high operational efficiency and a wide range of applications, the use of multi-rotor unmanned aerial vehicles (UAVs) in biological control is of great importance. One such application is Natutec Drone, which has a long track record of producing biological products, with extensive R&D knowledge and field experience, to produce a high-tech dispersal mechanism that transports vulnerable beneficial organisms to disperse them precisely where they are needed. It is a unique dispersion mechanism that can transport a wide range of biological products and disperse them with great precision and efficiency over 8 hectares in the space of one hour. Aerial dispersion shortens the time it takes for beneficial organisms to establish themselves in the ecosystem and do their work in the crop. The Natutec drone can reach areas that may be difficult to reach on the ground - such as elevated areas or wet soil conditions. Aerial dispersal shortens the time it takes for beneficial organisms to establish themselves in the ecosystem and do their work in the crop.

3.61 Diagnostic and detection techniques – Application Agrorobotica SpyFly

Continuous technological progress has made it possible to have more and more sophisticated machinery is efficient but the risk remains, weather events, plant pathogens, parasitic diseases damage the crop every year causing huge losses. Climate change is further worsening the situation by disrupting the life cycles of known pests and allowing you alien pests to reproduce pandemically. Management is impossible without control, but something is changing Agrorobotica with SpyFly brings artificial intelligence to the field to support the farmer. With SpyFly, it is possible to monitor the presence of pests in crops in real time through a simple smartphone and to act promptly if needed. Equipped with a practical and durable modular casing, SpyFly is able to attract harmful insects by exploiting the combined action of color attraction and pheromones, allowing them to be captured on a sticky surface. At intervals, SpyFly photographs the sticky paper, transferring the images to a cloud platform, where they are processed and analyzed by algorithms, thus identifying harmful insects. SpyFly also measures weather-climate parameters, which are useful for developing predictive models on the spread of pests. The app monitors images of captured insects every moment, thus decreasing crop losses, hours of field manning, and the amount of treatments. SpyFly is an indispensable tool for farmers who wish to manage or convert their production to organic.

3.62 Diagnostic and detection techniques – Agrobase application

Climate change and rising atmospheric temperatures have already affected the length of the growing season in large areas of Europe. Changes in temperatures and growing seasons could also affect the proliferation and spread of certain species, such as insects, or weeds and diseases, severely affecting agricultural production. The Agrobase application easily identifies diseases, insects or pests in the field. Agrobase includes an agronomic knowledge database with a catalog of pests, weeds and diseases and all pesticides, insecticides and herbicides registered in a particular country. Correct identification of specific weeds, diseases or pests is the first step to effective control. Agrobase offers a rich and continually updated database of weeds, diseases, pests and insects,

which also includes descriptions of pesticide products with links-to choose the right solution to a specific problem. It also provides information on the registration and expiration date of plant protection products and, most importantly, the effectiveness of different problems. The application helps you identify weeds, pests, insects or diseases by searching for their common name, Latin name, category or crop. The application is designed to be practical and easy to use in the field by crop consultants, gardeners, trainee agronomists and agricultural students.

3.63 Decision support technique - Futurcrop application

The use of more suitable farming techniques can decrease the environmental impact of agriculture. In particular, optimizing the use of new technologies are necessary to combat ongoing desertification. By making the most of new technologies, it allows you to use ad hoc methods of cultivation and plant care according to the characteristics of the soils and areas where they are located, optimizing consumption energy consumption, rationalizing the use of water and fertilizer even according to real-time weather conditions. Futurcrop is the new technology for pest control. Using artificial intelligence model search techniques, data clustering and phenological patterns, the software can reduce crop scouting time and improve treatment results. Futurcrop predicts the biological development of 179 pests and then calculates the best time to treat them. This platform allows fewer but more effective treatments to be carried out precisely when the pests are most vulnerable. In addition, research, captures, and treatments can be recorded with a cell phone. Futurcrop collects daily data from 85,000 weather stations around the world and performs calculations that determine the development status of potential pests in its users' crops. If the user has his own weather station, he can configure access to data specific to his location. In addition, Futurcrop calculates future pest development dates 10 days in advance, allowing for sampling and treatment planning.

3.64 Agrivi Farm Management Software

Agrivi is driven by helping the agriculture industry by digitalizing agriculture and changing the way food is produced. Agrivi digital agriculture solutions help producers produce healthy safe and nutritious food in an efficient and sustainable way. Digital agriculture technologies offer a simpler and smarter way of doing work. Information straight from the field is available in just a few clicks. Making data-driven decisions and securing complete traceability for the food standards was never so easy. From planting the harvesting. From food processing to retail. Agrivi solutions support companies across the entire food value chain in implementing digital transformation projects. Agrivi farm management software helps you plan, monitor and analyze all activities on your farm easily. Tillage, planting, crop protection, fertilization, irrigation, harvesting and all other activities are managed with a few clicks. Plus, you can track input usage quantities, costs and work hours for every activity. With a knowledge-based of best practice processes for over 100 crops, start improving your productivity now.

3.65 eBEE AG - The Advanced Agriculture Drone

eBee AG is a new drone for agriculture that easily and safely fits into the daily routine, and gives more information about precision management, while it is fully compatible with the farm management systems. Agriculture professionals face many challenges today and it’s not always easy to overcome those challenges. The eBee AG is the new drone solution for agriculture by senseFLY SA. This technology is designed to help professionals operating in agriculture, producers, agronomists,

service providers to overcome the many challenges they face in the fields. eBee AG helps to save time in the field and helps to make better decisions regarding crop planning and crop health.

The eBee Ag with its fixed Duet M multispectral/RGB camera, automated flight and vast coverage, delivers accurate and timely plant health insights for making better decisions to improve crop yields, save on inputs, allocate resources and achieve greater profit potential. The multispectral sensor achieves higher data accuracy than using a modified NIR sensor. This technology can be used in all types of crops and in the big scale and in small scale farms.

eBee Ag with its endurance battery can fly and cover up to 200 ha for numerous crops' monitoring. For more information you can visit the following link https://www.sensefly.com/drones/ebee-ag/.

3.66 Dino-Lite digital microscope - Diagnostics and detection techniques

The detection techniques permit to the farmer to control the nutrients in the soil, and mainly monitor the occurrence of weeds, pests and diseases on a micro-management level and ultimately provides the optimal condition. Dino-Lite microscopes help farmers and experts to efficiently identify insects easily and quickly and in allows to take the right measures. Dino-Lite are easy-to use and portable, providing powerful magnification features on-the-go for insect identification. The Dino-Lite Wi-Fi streamer provides quick wireless accessibility streaming the live view of the Dino-Lite to Wi-Fi portable devices. Devices include Android iPhone and tablets. The Dino-Lite includes feature-rich computer software that allows for viewing image and video capture, measuring of other advanced features for compatible models on supported platforms and video capture. The digital microscope provides a powerful, portable and feature-rich solution for microscopic inspection at up to 900x magnification and 5-megapixel resolution. The Dino-lite can be used in all type of crops and in small and big scale farms as well in the greenhouses. For more information you can visit the following link: https://www.dino-lite.eu/index.php/en/products/microscopes.

3.67 DJI Drone Agras series - Application techniques

How to take agricultural innovation to the next level with highly efficient, reliable and intelligent tools. DJI Agri ste 16 was designed from the ground up, and it features six rotors, an RTK dual redundancy system and an avionic resin sea system. It has a payload of up to 16 liters a spray rate of up to four point eight liters per minute and eight sprinklers work perfectly with the downward airflow resulting in an impressive spraying effect it has a spray with of 6.5 meters which can cover an area of 10 hectares per hour. The multi aircraft control mode functions with the camera as well of an HD video transmission system with a range of up to 3 kilometers ensuring flight safety and boosting spraying efficiency thanks to the all-new modular design of the 16 both spray tank and batteries are easily swappable which significantly improves operational. Efficiency its core module has rating of ip67 making it easy for maintenance the foldable aircraft. The T20 will automatically fly to and spray the areas. It uses radar to fly at the set height above the crop and adjusts its flow rate based on speed. DJI Drone can be used in corn, fruits tress and potatoes corps as well is possible to use in a range of crops. This drone is possible to be used in the big scale and in the open field.

3.68 The FaunaPhotonics APS - Light sensor

The FaunaPhotonics APS is a technology that individual sensors on the spray boom make a real-time spray decision individually. The signal is then collected on the network and transmitted to the spray controller in the cab. The flash of a light is the function signal, following the connection to the 4640 and turning on the actual sprays which will allow to spray more when there are more harmful insects and spry less, when there are fewer insects or when there are beneficial insects' insides. When see the light flash the insects are detected by the sensors. The advantages of this self-propelled sprayer are the high efficiency and the possibility of catching insects' events over high crops. The stationary sensors are efficient in catching the first influx of the insects in the field so they can act as an early warming detection system so by mounting these sensors into a tractor is possible to find the hot spots or high densities of insects in the field. Using the sensor, it creates heat maps showing these high-density spots visually. The heat map is generated based on the number of insects per minute we see in the field and the reason to compose it is that the tractor may not be in each area of the field for the same amount of time. If you treat them as a monoculture and thus as a completely uniform space then what you miss is that there are actual differences in insect activity within a specific field so if you know exactly where the insects are or when they're coming in then all of a sudden, you can precisely target those insects using precision agriculture.

3.69 The Scoutbox high-efficiency pest management

The Scout box enables horticultural growers to scout pests in greenhouses by just pushing one button. The Scoutbox revolutionizes insect scouting by combining image recognition and sophisticated machine learning algorithms.

The Scoutbox is a portable semi-automatic device that scouts when making the rounds and traversals in the greenhouse. Now, scouting personnel no longer has to take a manual count, as the Scoutbox photographs each insect track and send pictures to the central crop watch server special software, which identifies in counts for both pests such as white flies trip seas leaf miner, and their natural enemies. Thus, growers have immediate access to the online data collected by Scoutbox, allowing performing highly efficient pest management. The Scoutbox has great benefits for greenhouse growers, as automated insect counting is faster and more objective and accurate than manually counting traps. A wealth of traps can be counted per greenhouse at the same time resulting in much more accurate reports taking snapshots, that growers can access the result for their crops, even while scouting. The Scoutbox is easy to use and fits in well with the highly automated and computerized production methods used in greenhouse production during pest management.

The Scoutbox can be used in big and small-scale farms as well as in greenhouses. For more information, you can visit the following link: https://www.agrocares.com/insectcares/

3.70 Natutec Scout App - Digital IPM management system

Natutec Scout is a platform that quickly and easily provides insight into the pest status of a given greenhouses. The Natutec scout app is a tool that makes the scouting process more efficient, simpler and more efficient. It functions by registering observations with the mobile app for reducing labour needed. Scanning of a given pest like the white fly allows its counting in an automatic way. A smartphone camera needs to be used. . Uploading of the scouting data can be performed quickly and easily to the Natutec scout dashboard. The app dashboard gives an insight and extensive

analysis. The Natutec scout can be used for optimal and intensive remote service for quicker and efficient scouting, while it also provides smart and extensive options for analysis and alerts. This, enables proper application of good agricultural practices and application of biocontrol solutions for ensuring crop health and consequently high yield. The central data storage is accessible everywhere and fully customizable with threshold alerts' creation. Compared to conventional scouting, it offers a 10-time faster result, with 94% accuracy for specific pests. For more information you can visit the following link: https://www.youtube.com/watch?v=nm7jBBggekw

3.71 Thrips-Lure - monitor thrips in low population

Thrips-Lure is a controlled release dispenser of potent attractant to attract thrips close to a blue or yellow sticky card. Use it to monitor thrips in low-population situations or early before thrips population increases significantly. Thrips-Lure has the potential to massively trap thrips and keep populations low in crops. Thrips-Lure caught an average of 3 times more than untreated cards. The Thrips-Lure attracted significantly more flower thrips (*F. tritici*) and Western flower thrips (*F. occidentalis*) than other commercial lure products. Other university trials have shown that this Thrips-Lure increases capture by 1.8-8 times on sticky cards or water traps.

Thrips-Lure is also compatible with existing commercial traps. There is a need for at least one lure per tree and 2-4 lures for larger trees. Use at least 1 lure per 500 sq. ft. in greenhouses. Replace the lure every 3-4 weeks depending on temperature. The Thrips-Lure can be used on the big and the small farm scale and in greenhouses, while can be used for the range of crops.

For more information please visit: http://www.agbio-inc.com/thrips-lure.html

3.72 SMAPPLAB Smart Trap Solutions

SMAPP LAB is a decision support for effective plant protection is able to provide much more precise pest control assistance than previous trap systems. The smart trap solution has a self-cleaning function and continue the operation during the whole season. The trap can take pictures automatically. In the same time collect the local meteorological data from the fields. The farmers can monitor online the forecast data and can protect the crops in the right time.

Traps have on-board camera and sensors, traps automatically collect daily catch count, identify pest species and measure local environment parameters. The pictures are sent to the servers where species identification and catch counting is automatically performed by algorithms, then we evaluate catch and meteorological data. Farmers can track flight season curves on a personal online dashboard as well as receive suggestions on ideal defence times to maximize efficiency. The SMAPPLAB can be used big and small farm scale and in the open filed. Can be used in the maize crops.

Higher yield and used less pesticides for more sustainable agriculture with Smart plant the protection is possible.

For more information you can visit the following link: https://platform.smartprotect-h2020.eu/en/view/ipm/306

3.73 M8A pro spraying drone - Application techniques

The M8A pro spraying drone, has as its main feature its ability to spray plant protection products or fumigate and quickly through an easy change of device transform itself into a drone for sowing or fertilizing. M8A has eight motors that generate the necessary propulsive force its measurement between the axes is one meter and sixty-three centimeters its modern, state-of-the-art design allows it to fly in adverse weather conditions. In addition, it guarantees efficient performance in agricultural work and the loading capacity of this drone is 20 kilos in 15 minutes it can cover up to 2 hectares. The vertical take-off and landing is what makes it easy to operate and the flight height for sowing or spraying is between one and three meters from the top of the plane. It currently operates automatically after establishing a willow plane between a starting point and a landing point. The drone can be operated in three different modes, which provides flexibility and facilitates the execution of any spraying job. All modes offer automatic terrain tracking (if equipped) and manual or fully automatic spraying functionality. The M8A can be used in the big scale farm, in open field that is corn crops.

For more information please visit: https://platform.smartprotect-h2020.eu/en/view/ipm/188

3.74 BEECAM – Pest Monitoring

The BEECAM ecosystem is the biodiversity inventory. The BEECAM is the innovative technology for dealing with biocontrol strategies that include the best natural enemies within the categories. The purpose of these new services is to create alternative methods for Integrated Pest Management (IPM) techniques and to gather knowledge on open-field pollinating insect colonies, hive activity, phenotypes, etc. The ecosystem was initiated by the CTIF in France, which developed a couple of tools to understand how insect populations cooperate with large-scale crops, as part of their mission to define new strategies for sustainable agriculture and integrated pest management. The BEECAM's built-in autonomy, long-lasting batteries and long-range communication distance make them particularly suitable for large-scale film collection. In a harsh environment, it has considerable internal processing power and great autonomy with very low power consumption, supported by wake-up and sleep strategies. The BEECAM allows for greater mobility, for example in response to pesticide reduction legislation. A special tool verifies the sprayer's performance: leaf coverage is expressed as a percentage of active product over the entire sampling and a histogram of droplet size is provided. It automatically sends a warning to the technician when the accumulated number of flies has been reached or when a large amount of test has been pasted in a short time the insect colonies are taken up and reports are published no instrumentation is required. For more information you can visit the following link: https://platform.smartprotect-h2020.eu/en/view/ipm/169

3.75 BIOCAPTUR S50 - Application technique

BIOCAPTUR S50 is an innovative and environmentally friendly solution for pest control in intensive agriculture. It is a high-tech industrial piece of equipment that is designed to solve the major problem of *Tuta absoluta* and other pests in intensive agriculture in a totally ecological manner. These pests develop in the course of multiple electromagnetic specifications emitted by its powerful LED diodes, which act as an irresistible stimulus for the pests, bringing them closer to the equipment where they are sucked up. The incorporation of the BIOCAPTUR rotar and 360-degree reversible rotation system greatly increases the capture efficiency of BIOCAPTURE S50 such that a single piece of equipment is capable of controlling pests in an area of 5,000 square metres. The control of *Tuta*

absoluta is one of the main conditions for achieving the expected profitability in the cultivation of tomato, pepper, aubergine and courgette. Until now, there was no biological control protocol that had proved sufficiently effective. BIOCAPTUR S50 is a 100% environmentally friendly product. The device activates its LED lights at peak activity to exert a powerful attraction on these and similar insects when the device approaches a suction airflow sucks in the insects and can be adjusted in height to follow the phenological development of the plant.

For more information please visit: https://platform.smartprotect-h2020.eu/en/view/ipm/292

3.76 The application of agricultural drones as an IPM method from the perspective of Hungarian farmers

Based on the opinion of experts and farmers in Hungary, the use of agricultural drones in plant protection can reduce the environmental load and the ecological footprint, decrease the trampling damage, eliminate the inaccessible areas, simplify the nutrient management, support fast data collection and decision support, as well as allow savings of up to 90% in pesticides. In their view, monitoring and spraying drones will be an essential tool in the process of controlling systems in precision farming, but it is important that suitable and appropriate pesticides are available for this technology. Currently, farmers consider the use of agricultural drones as an IPM solution to be the third most important area of drones' applications. Agricultural drones are most commonly used for nutrient replenishment or pre-plant protection decision support. The most significant obstacles to the widespread use of drones as IPM tools are considered to be the uncertain legal background, the lack of adequate state support and the lack of expertise and competences. In addition, agricultural stakeholders would have a need for the possibility of using drones for spraying. Legalization of spraying drones requires three basic elements: the qualification of the drones to verify that the equipment is working properly and does not cause unacceptable environmental pressures, the authorization of aerial application of pesticides, and providing of the necessary legal background. In Hungary, the regulation of agricultural drone use is currently in progress.

3.77 Trapping of insect pests in corn production

Insect pests are considered major problems and important constraints to vegetable production. The difficulty in identifying and treating insect pests in the cornfield stems from the diversity of insects and the complex interplay of conditions that affect them. Integrated pest management is based on insect pest monitoring to support pest control and the selection of the adequate control methods. The classic approach to monitoring insect pests is relies on placing a series of traps in the infested areas to locate, identify, and rank the severity of pest infestations. Cap2020 offers traps designed for trapping different kinds of pests. The CapTrap Creep is an ideal tool for monitoring populations of corn pests such as corn seedling maggots (Atherigona oryzae), european corn borer (Ostrinia nubilalis) and the corn earworm (Helicoverpa armigera). The trap has for several years proven its worth in mass trapping of this pest. This trap works with a specific pheromone. The use of the trap and the associated CapTrap account allow real-time monitoring of the presence of the pest and supports the selection of the optimal interventions.

3.78 Trapping of noctuids in vegetable production

Insect pests are considered major problems and important constraints to vegetable production. Effective management of these pests are essential for profitable production of vegetable crops. The

classic approach to monitoring insect pests is relies on placing a series of traps in the infested areas to locate, identify, and rank the severity of pest infestations. Cap2020 offers traps designed for trapping different kinds of pests. The CapTrap Funnel is suitable for trapping noctuids including the heliothis moth (*Helicoverpa armigera*) or the gamma moth (*Autographa gamma*), but also other pests such as the boxwood borer (*Cydalima perspectalis*). Thanks to the attractiveness of the pheromone and the analysis of the movement of the insect in the trap, only the target insect is counted during the monitoring. The use of the trap and the associated CapTrap account allow real-time monitoring of the presence of the pest and supports the selection of the optimal interventions. The CapTrap Funnel is mostly applied in brussel sprouts, cauliflower and head cabbage production, but also suitable for a wide range of corps.

3.79 Prevention techniques are your best partner

One of the key points in the implementation of IPM is prevention, which can be the farmer's best ally in crop protection. Starting production activity in the best possible sanitary conditions is fundamental. It is therefore important to implement cultural and preventive measures to reduce the incidence of pests and diseases. Among the most important measures are the following:

1. Sanitary guarantee of plant material.
2. Correct management of plant debris that can become sources of pests and diseases.
3. Adaptation of planting/transplanting dates, choosing the ideal date for each crop in each place.
4. Definition of a strategy for monitoring and follow-up of pests and diseases.
5. Choice of appropriate planting densities and/or planting frames.
6. Use of cultivars/patterns tolerant to the main pests and diseases.
7. Thorough knowledge of the crop.
8. Pre-planting cleaning and sanitation of structure, soil, tools, etc.
9. Rational irrigation, avoiding waterlogging, root asphyxia, water stress and proliferation of soil fungus.
10. Early elimination of plants affected by viruses.
11. Carry out crop rotations. Establish biodiversity over a long period of time.
12. Encouragement of biological control techniques, by conservation and/or flooding, and favoring the conditions for the correct establishment and functioning of natural enemies.
13. Use of floating covers, physical barriers, double roofs, tunnels to keep our crops protected.

3.80 Smart IPM helps for horticulture adaptation to the new climate change challenges

Today's agriculture faces a difficult future due to the effects that climate change will have on pest incidence. An increase in pest pressure can be expected, both in the number of pest species and in the pressure exerted by pests now present. It is observed that most pests are already significantly

more active in winter. This means that phytosanitary measures will be needed for longer periods, which is likely to accelerate the development of resistance to pesticides.

In this scenario, integrated production seems the most reasonable way forward. However, the execution of coherent pest control strategies is a very complex task that requires the implementation of all the tools at our disposal. It requires the integration of knowledge generated in many fields, from the biology and ecology of the pest and its natural enemies, the sensitivity of the crop to pests and diseases according to varieties or production systems, as well as the effect of the different existing biotechnological measures. It is worthy to consider that in IPM programs biological control, based on the use of natural enemies, should be the basis of the phytosanitary strategy in our crops. Awareness-raising and dissemination of these practices, as well as technical advice to all producers, is therefore fundamental.

3.81 Functional Biodiversity management as a tool in modern IPM programs

With the growing awareness that agriculture benefits from the health of ecosystems, it is essential to value the pest regulation services that biodiversity can offer as a key tool in integrated management programmes. The "reconstruction" of suitable habitats for the conservation of natural enemies, through the establishment of different ecological infrastructures, can be key to adapting our agroecosystems to the needs of auxiliary fauna and improving their control capacity. The integration between production and sustainability is the objective and conservation biological control is emerging as a new tool that can contribute to slowing down the free dispersal of pests. Several studies show that beneficial insects increase their longevity or fecundity with access to nectar and pollen. However, these resources are often scarce in agricultural systems. Thus, the establishment of non-productive elements on the farm, such as stone margins, hedges, ground covers, flowering strips or nests for birds and bats, will allow us to find numerous allies in nature that serve as real phytosanitary barriers. The aim is to favour the presence of native natural enemies to ensure a biological control in the background, but it also makes the release of natural enemies more sustainable by providing them with food and shelter when there is no crop or a sufficient level of pest (prey/host), so the use of these ecological infrastructures should be seen as a necessary strategy for the release of auxiliary fauna.

3.82 Biological control and biodiversity are not synonymous!

Biodiversity is an ally in pest control, but it is not a matter of increasing biodiversity per se, but of doing so in such a way as to primarily enhance the presence of species that are useful to us, providing them with all the resources they need to establish themselves, food (pollen, nectar, or alternative prey), shelter or mating sites. When introducing this functional biodiversity, however, it must be borne in mind that not all plants contribute in the same way to achieving this objective. In general, knowledge of which plant materials are mainly exploited by most of small predators and parasitoids is scarce. In this sense, for the proper management of natural vegetation and biological control, it is essential to analyse the specificity of each natural enemy with the plant resources that each of them exploits. In line with this work, it should be noted that DiseñEN (www.diseñen.es), an interactive web tool, has recently been presented in Spain. Its aim is to support decision-making by anyone interested in implementing conservation biological control strategies, and it is intended to be a learning tool capable of offering tailor-made solutions for crops in the Mediterranean basin. This

tool is the result of more than 10 years of joint research between Fundación Cajamar and IFAPA to adapt Mediterranean agroecosystems to the needs of native beneficial auxiliary fauna. DiseñEN is the evolution of PlantEN, which is a mobile APP presented in 2018 to publicise the results of various projects developed and which helps to identify the most interesting plants for designing hedgerows that promote the presence of beneficial auxiliary fauna.

3.83 The insect monitoring as a preventive pest control method

The increase of pests in production systems generates large economic losses due to decreased crop productivity. In IPM, prevention and early detection of pests through insect monitoring is important, for which a good tool is the use of chromotropic plates, traps and sexual confusion diffusers. Traps can be traditional, such as those offered by TRÉCÉ with its two product lines, PHEROCON and STORGARD. Or traps can be automatic, such as TRAPVIEW, developed by the company EFOS, or SNAPTRAP, developed by the company SNAPTRAP. TRAPVIEW is a trap with an automated pest control system that can be used for any type of insect. It is energy independent as it has a solar panel to send the images of the captures to a platform where they can be viewed, processed and archived securely, providing an overview of the situation in real time, and predicting a future pest situation. EFOS has developed a mobile application (TRAPVIEW app) where the information is available at all times.

3.84 The European Night of Researchers, Women and men who do science for you

Scientific dissemination event, organised in Almería by the University of Almería, Fundación Descubre, Junta de Andalucía, Almería City Council and Cajamar. Held on September 24, 2021.

The 2021 edition was dedicated to the EU Green Deal and more than 500 researchers participated in 115 activities.

Fundación Cajamar participated in the agriculture category, presenting different projects related to sustainability, pest and disease management. Seven researchers from the Recherche Centre were present at the event, where the objectives of the SMARTPROTECT project were explained and with the project's QR code, attendees could access the project's website. An electronic trap, Trapview (Efos, Slovenia), for efficient pest monitoring was also on display.

3.85 Smart approaches in integrated pest management (IPM)

Farming is the major source for of food in the world. Farmers aims to maximize yield and protect their vegetables. As the consumption is increasing, effective approaches in vegetable protection are needed. Along with increasing general knowledge the future farming is moving towards the smarter technologies in order to increase the productivity within a short time. Nowadays, Integrated Pest Management (IPM) is used as an effective and environmentally sensitive approach to manage pests. IPM relies on a combination of common-sense practices. The most economical means are used with the least possible hazard to people, animals, and the environment. IPM was introduced in 2009 under the Sustainable Use Directive and implementation of IPM practices has become an obligation for EU farmers.

Recently, Green Deal has been defined as a part of EU policy calling for climate neutrality and environmental stability. While EU consumers call for available and safe food, in case of vegetables

particular, farmers forecast weaker yields, with lower quality, and hence lower incomes, as a result of the new green policies of the EU. At the heart of their concerns is the significant reduction in the use of pesticides and fertilizers by 2030.

As a consequence, new effective approaches have been developed to predict, identify and monitor and the pest occurrence. Currently trapviews that are weather resistant and used pheromones to lure the pests, send automatically the info to remote devices. Drones, collecting data based on spectral analysis represents further steps forward being expectedly accompanied by robots. The devices along with prediction models will allow for effective pest management in vegetables. Smart farming represents thus the future of IPM approaches.

3.86 Plant viruses identification: smart approaches

Viruses are ranked the second most important plant pathogens following fungi. Viruses are tiny particles, which cause economic losses that have been estimated to be more than several billion dollars per year worldwide. As well vegetables suffer many viral diseases being vector transmitted (insect) soil or seed borne as well. Symptoms of viral diseases are visually difficult to be recognized with symptoms like crinkling, browning of leaf tissues, mosaic, and necrosis. Sometimes no symptoms are visually observed.

The diagnosis is the basis to manage the viral disease. Diagnostic approaches are used to control phytosanitary measures, to certify health status of seeds and seedlings being marketed domestically or internationally and to predict e.g., the crop losses.

A lot of methods have been developed to detect plant viruses, such as microscopical observation, serological techniques or molecular methods. Microscopical methods are demanding, serological methods (e.g., ELISA) are sensitive, but they are not usually very specific. However, the principle is used for SMART field diagnostic similar to pregnancy or COVID 19 tests. Molecular techniques that need well equipped laboratories are reliable, featuring high specificity, but are rather expensive and they are suited for official controls and certification. SMART solutions aim to use cheap equivalent of molecular techniques suited for small private laboratories and farmers.

3.87 SmartProtect technology to cope with climate change

During the last ten decades scientinst have being warning about global warming. Indeed, global climate change has already had observable effects on the environment. Without a quick response from humanity, the situation will worsen. Thus, temperatures can be expected to rise, frost-free season will lingthen accompanied by extremely heat periods or changes in humidity patterns and rains. Shortage of water has been already reported. Agriculture is highly exposed to climate change, as farming activities directly depend on climatic conditions.

Pests can change habitats, and the occurrence of pests that were typically reported in the southern areas, are already also reported in northern areas. This is already the case for fungi (e.g. *Fusarium*), but also for pests. Therefore, it is necessary to apply smart technologies for monitoring and identification of pests, improve information systems and share information as much as possible. To ensure this task, use of functional monitoring technologies is needed (e.g., internet-related traps, camera equipped drones with a selected suitable spectrum). For the identification of individual plant pathogen strains, molecular methods are suggested, due to the selectivity and robustness of methods such as Polymerase Chain Reaction (PCR). Based on appropriate data, predictive models

can provide a good view of the spread of pests and plant pathogens. It may be recommended that every farmer should consider using these tools.

3.88 Sampling and preparation of vegetable samples for analysis of the presence of pathogens

Plant pathogens cause losses in the quality of the final product and yields. Normally, the farmer with sufficient experience can detect their presence with the naked eye, but often the symptoms of individual pathogens (fungi, bacteria and viruses) cannot be diferentiated. In such a case, molecular diagnosis should be sought. A similar procedure can be used in the early stages of infection, when, for example, vector carriers appear in the field. The presence of the pathogen must then be determined by PCR or a similar technique.

For the analysis of samples, it is necessary to contact the laboratories that deal with the detection of the phytopathogen and are best accredited for such activities according to national and international standards (e.g. ISO EN 17025: 2018). Such laboratories are reliable and have procedures in place to ensure the confidentiality of the information obtained. Upon agreement, it is necessary to deliver an order to the laboratory, i.e. to request the analysis with an indication of which types of pathogens the farmer wants to determine. Furthermore, it is necessary to provide the laboratory with incriminated samples – i.e. parts of plants, usually parts of leaves, but analyzes can be performed, for example, from water cleaned roots.

In the case of nucleic acid analyzes, the laboratory will advise whether it is a pathogen with DNA (all fungi, bacteria) or, for some viruses, only RNA.

Sterile scissors, tweezers, foil pieces or plastic sealable containers, markers and sachets should be prepared for sampling for nucleic acid analysis. According to the agreement with the laboratory, the leaf blades are usually taken as duplicates. The leaves are inserted into a container or foil, described well and transported to the laboratory, preferably chilled. A container with a stabilizing agent solution ("RNA lafterTM") usually supplied by the laboratory is used for RNA analyzes.

The farmer then adjusts field treatment and cultivation procedure according to the laboratory results.

3.89 Smart applications in vegetable and field crops production

One of the fundamental steps in integrated plant protection is the proper detection and correct identification of pests, diseases and weeds. In order to be able to choose the appropriate plant protection technique in time, we can use various applications that can be easily downloaded to a smartphone. One of these is Xarvio ™, with which we can help ourselves in the detection of weeds, diseases and pests. However, it can be also used to quickly identify pests on yellow sticky boards. The mentioned electronic tool can also help us to detect the nitrogen content in the plant and damage extent to the leaves. The application is useful in identifying harmful organisms in the production of vegetables (beans, peppers, cabbage, cucumbers, eggplant, leeks, onions, etc.) and field crops (corn, potatoes, soybeans, sugar beets, etc.). Its use is easy, as the mentioned tool works with the help of imaging with a smartphone. The set of the mentioned application includes more than 400 species of harmful organisms (diseases, pests) on more than 50 host plants. With the help of specific algorithms, the application can also properly identify nutrient deficiencies in plants, thus enabling us to more easily monitor plant nutrition.

3.90 Identification of pests / diseases on vegetables with the help of smart applications

By using apps that can be downloaded to a smartphone can make it easier for us to grow food and feed at all levels. In addition to the fact, that there are applications that can help us in the determination of pests, diseases and weeds, some applications can also help us in choosing the appropriate product for controlling harmful organisms. Among the more important applications in the group of the latter is CampoGest, which can greatly facilitate communication between agricultural advisors and farmers involved in food production. By using the mentioned application, we can facilitate the identification of pests and diseases on various species of vegetables (leeks, lettuce, cauliflower, onions, tomatoes, cabbage, Brussels sprouts, cucumber, etc.). By determining the harmful organism, it is also possible to select the appropriate plant protection product (insecticides / fungicides) as well as the beneficial organisms for suppression of harmful organisms. At the same time, the most effective concentration is indicated next to the proposed plant protection product. The use of the CampoGest application, which is suitable for growing vegetables in greenhouses and outdoors, is not yet free and is available only in Spanish.

3.91 Non-destructive mobile pest and disease detection technologies for crop protection

Efficient and fast interventions with no or minimal impact on beneficial insects are important to a successful vegetable crop protection and pest and diseases monitoring. In the last decade smart technologies based on smart images and algorithms have been integrated in smart applications that are free available and under subscription for smartphones. Many of the smart application like *Plantix App* and *Agri Tech App* are available in English, Spanish, and French and rarely in German version as for *Cropalyzer App*. *Plantix App* is a free application and currently widely used that identifies pest and disease with photographs from affected part of the plants. *Cropalyzer App* is a free application that identifies major pest, disease and disorder in vegetable crop. *Agri Tech App* detects crop fungal disease at primary stage and proposes appropriate treatments. Although the applications are free; however, when used with a premium subscription the user can have more possibilities in the identification of crop fungal diseases from a photograph. Non-destructive mobile disorder detection are technologies that support pest and disease monitoring in crop vegetable protection. Albeit these technologies need a special subscription, they are affordable and may support efficiently to small farmer vegetable at open field and greenhouse scale.

3.92 Decision support technologies without sensor accompanying vegetable crop health

For an effective pest and disease monitoring and application of control to reduce the damage it is a necessity today to use practical tools/technologies. There are weather stations that through data loggers and thermocouples can follow up plant behavior against the attack of pests and damage of fungus. Nevertheless, these climatic and modern large devices need the assistance and operation of people with knowledge. Today, there are software applications designed to run in mobile device that do not need sensor, and with only photographs support and can recognize pest and disease and indicate possible IPM strategies. Likewise, the smart application (Apps) can advise what to do and what type of pesticide can be used to control pest and diseases. *Xarvio App* and *Scouting App*

identifies pest and diseases for bell pepper, tomato and leek. *Agrio Technology App* identifies pest and diseases and provide an overview of crop situation. *Bioline App* can identify pest and diseases and provide IPM, particularly for vegetable crops in greenhouse. The smart applications are free available with fewer options in the moment of image recognition. However, with an affordable premium subscription the user can get more options for monitoring in the moment of use and identification of pest and disease. *Agrio Technology App* and *Bioline App* are available in many languages, but do not include German version, while *Xarvio Scouting App* is available in German as well.

3.93 Real-time detection of the crop status

Monitoring the plants in the field is expensive, intensive labouring and real time-consuming. In order to facilitate this observation, the drones, small unmanned aerial vehicles (UAVs), equipped with several sensors (for remote evaluation) simplify the monitoring procedures, reduce costs, reduce data collection time, and produce critical and practical information. The detection system using drones makes it possible to collect spectral data for the phytosanitary states of crops. Early detection, with the elimination of infected plants, is essential for an effective control of the spread of diseases, in the field or the greenhouse. Intelligent techniques, using UAV and remote sensing allow the producers to constantly monitor the health status of the crops and detect the disease in plants at an early stage. In addition, vegetation indices, such as the Normalized Difference Vegetation Index (NDVI), calculated from the acquisition of images with a multispectral camera coupled to the drone, are simple and effective parameters for the qualitative and quantitative assessment of plant vigour, colour, vegetation cover and growth dynamics.

3.94 How to prevent the Downy mildew disease

Downy mildew is a very common foliar disease, frequent in temperate climatic regions in the autumn-winter period. It is responsible for high damage in several horticultural crops, in field and greenhouse, especially when there is a combination of mild temperature and abundant dew deposition on the leaves. Avoiding the deposition of a film of water on the vegetation cover is important to limit the spread of the downy mildew disease, since it is essential for the germination of the conidia that infect the leaves and in pathogen sporulation induction. The disease is caused by an obligate parasite of oomycete class and can be diagnosed visually, in the case of brassicas belong from the Hyaloperonospora genus. The infection starts in young plants in nurseries and in the adult phase is expressed by the appearance of chlorosis on older leaves, accompanied by abundant whitish sporulation on the underside of the leaves.

The application of chemicals should be the last action for the phytosanitary protection of plants. In the short-cycle crops, such as radish (*Raphanus sativus*) and wild rocket (*Diplotaxis tenuifolia*), it is not possible to apply synthetic products, as this requires their application close to the harvest time. Early detection of the disease and the adoption of cultural measures that avoid environmental conditions favourable to the development of downy mildew are strategies followed in Integrated Pest Management (IPM). Intense aeration, the use of localized irrigation systems, avoiding irrigation at the end of the day, and crop rotation reduce the risk of epidemic attacks. The use of downy mildew resistant varieties is also highlighted, increasing the sustainability of production, with a greater and better food production, with reduced inputs and less waste production.

3.95 Innovative strategies used in the control of downy mildew

There are currently several innovative technologies to support farmers for optimizing crop protection. They are an important investment for a modern agriculture. The use of diagnostic and detection tools that allow to remotely detect and confirm the presence of the disease at an early stage, such as molecular tests (ELISA, DNA, RNA tests) and the mobile phone applications, increase the efficiency of application of pesticides. It is also important to monitor the crops, pests and diseases using drones or satellite images, and using smart traps like those for recording the aerial presence of downy mildew spores. The reduction in inoculum multiplication will make infection more difficult and decrease the number of infected plants. There are several decision support tools, with and without the use of sensors, such as the installation of climatic stations that allow an early farmer's response to the occurrence of favourable conditions of spread of the disease, as well as, the use of sensors to register the leaf moisture at surface. When the application of plant protection products is necessary, the use of innovative techniques, such as more efficient spraying systems and spraying drones for localized treatments, are effective tools in the application of recommended doses, with a direct implication in increasing farmers' profit.

3.96 Monitoring of pests: trap housing decision

When introducing new monitoring techniques, like automated monitoring or simply when monitoring a new pest, it is important to choose the most appropriate monitoring tool, because one size does not fit all. An understanding of the insect pests' characteristics is essential for determining the most suitable trap to use and how to use it effectively. Both the design and sometimes colour are principal factors that determine how well a trap functions. There may be more than one suitable trap for several insect pests and many users have a personal preference based upon experience. Sometimes the only way to determine the most suitable housing is the experimental way – try few different traps designs to define which work best for your pest.

Automatic traps are different in shape when comparing with conventional monitoring tools (mainly because of different add-ons and other essential parts), but the way they lure pests into the housings are similar - they usually mimic well established conventional methods (entrances and proportions of the monitoring spaces are very alike). In general, for monitoring of smaller Lepidoptera pests, delta or wing traps are most often in use, but for larger sized moths funnel or cone-net shaped traps works better. In order to select the right monitoring tool it is best to choose the trap, which is shaped most similar to the one used in conventional monitoring.

For moths colour of the trap is usually not important, because they are being active at night, it is important only in terms that it should not attract beneficial insects. Moreover, specific colours are attractive to some of the day-flying pest insects – choosing the right trap colour can be an important decision when monitoring different flies, aphids or thrips.

3.97 Pest monitoring: chemical lures

Taps are made in the way that they lure and retain pests in the trap. Many chemical and visual lures attract insects and are an essential component of active monitoring. Alternatively, some traps combine different lures for best performance.

Much of an insect's behaviour is mediated by semiochemicals in its environment. Semiochemicals facilitate communication between the members of a single species (e.g., pheromones) or between

members of different species (e.g., allelochemicals). Pheromones are semiochemicals that are produced and received by members of the same species. A range of behaviours and biological processes are influenced by pheromones, but pest management programs most often use compounds which are produced by female to attract a mate (sex pheromones). Pheromone traps are very sensitive, meaning they attract insects present at very low densities. Even though pheromones are species specific, traps do sometimes catch other insects either passively or actively because of a close similarity in some species pheromones, but their numbers are usually lower than the target pest. Sensitivity and specificity make pheromone-baited traps efficient, labour-saving tools.

Semiochemicals come in various forms: rubber septa, hollow fibers, flakes, tape, laminated plastics, and membranes over reservoirs, polyethylene vials... The lure design should deliver the pheromone into the environment in a manner that mimics natural release rates and concentrations of the target insects. Lures vary in duration of effectiveness and distance of attraction due to differences in pheromone load and release rates. A controlled-release lure will allow the pheromone to be released in a concentration small enough to attract the pest into the trap, but strong enough to reach out and pull them in over a useful distance.

3.98 Pest monitoring: visual lures

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Colour can serve as a strong attractant. Insects may use a specific colour to locate host fruit or plant material, with both hue and intensity affecting insect response. Contrasts between light and dark can also play a role, with either the trap in contrast with the background colour or through the use of lines with insects orienting to an edge between a light and dark area on a trap. Yellow is the most common attractant colour for Hemiptera and Diptera species.

A great number of insect species are attracted to the light of various wavelength. The major downside to light traps is that they are not selective and numerous species of moths, beetles, flies, and other insects, most of which are not pests, are attracted to the light, so they require well trained labour for verification of trap catches, but on the other hand they are catching individuals of both sexes, so we get more complete information about the population abundancy. They are a good tool for determining moth diversity across different habitats. Radius of attraction of low powered light traps for moths is smaller than with pheromone traps. They are even less effective near bright artificial lights and in the period of bright moonlight.

3.99 Pest monitoring: installation of traps in the field

Trap positioning and density can be determined by an insect's dispersal ability and flight behaviour, therefore the recommendations differ for different pest species.

- Traps should be placed in the field before the pest becomes active or immigration events occur. Knowing the pest history as well as the weather conditions in the infested area assist in predicting the insect occurrence and pressure.
- Traps should be placed within the crop area at crop height where the activity of monitoring pest is greatest, not simply in the area easiest to access. In field crops traps should be placed on posts with the trap opening just above the plant canopy, but in orchards the recommended height is usually in the upper third of the canopy.
- An area where moth catches from previous seasons were high, or a "hot spot", is a good place to locate a trap. Avoid placing traps on the perimeter row. Instead place traps within the interior of the orchard/vineyard block, unless recommended differently.
- Put the traps at least 40m apart and if you are trapping for more than one kind of insect, use separate traps for each kind of lure (if you put different chemical attractant in the same trap, contamination might occur causing lure failure).
- The entrance of the trap must be easily accessible to the insects.
- Set the trap parallel to the prevailing wind direction for optimal pheromone plume distribution.
- Label your traps with the name of the species you are trapping, especially if you are monitoring for different insect species at the same site or if you are maintaining a network of traps for two or more pests.
- Once the trap is in place, hang bright, coloured flagging tape to mark the position so you can find the traps again as the season progresses and to increase their visibility to farm workers.
- Keep away from high dust areas. Dust can severely reduce efficacy of sticky traps.
- Avoid hanging pheromone traps in areas with high bird or animal activity to reduce the chance of them being accidentally trapped.
- Place the traps where they will not be knocked over by farm machinery.

3.100 Pest monitoring: rules for lure handling

Lures should always be stored according to the manufacturer's instructions. The conditions depend on the lure properties. Pheromone lures should usually be stored in dry place, possibly without large temperature changes, away from direct sunlight. Never leave lures in vehicle or in any area where they may be exposed to unusually high temperatures as this will cause lure failure. Lures should be left in their sealed packages until they are used in the field. Lure must be installed just before the expected pest emergence.

Pheromone blends are species-specific and insects are sensitive to minute quantities of pheromones. When handling semiochemical lures always wear disposable gloves to avoid cross-contamination with other products. Even if you are handling only one kind of lure, use disposable gloves or disposable forceps not to contaminate the lure, otherwise it will be less effective than it should be.

Remove the lure packaging from the field, because even the most minute amount of pheromone may compete with your bait.

If a trap is to be used over multiple seasons you should avoid re-using the trap with a lure for another species.

3.101 Pest monitoring: main difference between conventional and automated monitoring systems

The main function of any active monitoring is luring and retaining the pests in the trap. Due to their specifics, in automated monitoring devices must meet at least two additional needs:

Power supply: Traps will only work with charged batteries, what can be provided with large powerful batteries or with the charging system. When batteries are charged through the solar panel, it must be mounted above the foliage in the way that it is exposed to the south on the northern hemisphere and to the north on the southern hemisphere and it must not be shaded – all the foliage around the panel should be regularly removed.

Connectivity: Device must establish the network connection in order to be operational. Device will not work in the areas with very low or no coverage. Connectivity can be affected by selection of appropriate SIM card (which defines the operator) modem (which defines the type of network) or with powerful antenna (which can amplify the signal strength).

Automated monitoring systems record the data automatically. Accurately recorded monitoring results and control actions undertaken are essential for reviewing the effectiveness of control measures and for better decision-making in the following years. Comparison of monitoring results over multiple years can indicate critical changes in population dynamics and pest behaviour. Advanced systems already offer various statistics, smart reporting and reliable forecasting of the pest situation in the field.

3.102 Wingbeat signals for insect monitoring

Insect monitoring is an essential aspect of integrated pest management, and identifying insect species is critical to ensure effective control measures. Wingbeat signals are a unique feature of flying insects that can be used to differentiate between species.

These signals are generated by the beating of insect wings and are typically measured using acoustic, optical or other specialized sensors. For example, optical sensors can track an insect's wing movement during flight by using a light emitter and receiver placed opposite each other. The insect obstructs the emitted light, producing a pattern of light intensity measurements representing its wingbeat. Recent research has focused on using Artificial Intelligence (AI) models to identify insect species based on their wingbeat signals. By analyzing the wingbeat signal directly or extracting its frequency or time-frequency, convolutional neural networks (CNNs) can distinguish between different insect species with high accuracy.

For instance, an acoustic sensor (microphone) can record the buzzing sound of a mosquito, which can then be analyzed by AI models to not only distinguish it from the sound of a bee but also point out to the specific mosquito species that the sound belongs to. Furthermore, recent studies have demonstrated that CNNs can effectively categorize the wingbeats of insects, even when their flight patterns are highly similar. For example, Kalfas et al. (2022) successfully classified wingbeat signals from two closely related fruitfly species of the *Drosophila* genus (*melanogaster* and *suzukii*) using a model named "InceptionFly." This model achieved a high level of accuracy, with a balanced accuracy of 92.1% on their test set and 91.7% on an independent dataset that simulated real-world, in-field conditions. These findings suggest that this approach could enable early and automated detection of *D. suzukii* infestation in fruit orchards, offering a promising solution to this economically significant pest problem.

The application of such techniques in insect monitoring has emerged as an efficient method for detecting the emergence of invasive pests at an early stage and minimizing their impact on crop production. With the development of new technologies like optical sensors and machine learning models, insect monitoring has become more accessible, providing farmers with valuable insights into their pest populations.

3.103 Insect monitoring using Artificial intelligence

Insect monitoring is a crucial aspect of modern agriculture, as pests can cause significant damage to crops, leading to substantial economic losses. Traditional methods of insect monitoring involve manual observation and trapping, which can be time-consuming and labor-intensive. However, the advent of automation and Artificial Intelligence (AI) presents new opportunities to improve the efficiency and effectiveness of insect monitoring.

One potential application of automation in insect monitoring is the use of sensors to detect the presence of insects in fields. These sensors can be placed at strategic locations in the field, embedded in smart traps, and programmed to detect characteristic patterns of insect movement or behavior. For example, some sensors can detect the sound of insect wings flapping, while others may use vibrations or light to detect insect movement. Other technologies involve remote sensing approach by employing radar or satellite data that can give indication of insect presence based on the crops' health. The data collected from these traps can be used to create pest distribution maps, which can be shared with farmers to aid in decision making.

Complex sensor data can be analyzed using AI algorithms to identify specific pests and estimate their population density. AI can help automate the processing of sensor data and provide near real-time information about the presence and behavior of insects in the field. By utilizing this information, farmers can effectively implement targeted pest control measures, which can significantly reduce the reliance on broad-spectrum insecticides. This approach can help safeguard beneficial insects

and prevent the development of pesticide resistance, ultimately promoting a more sustainable and eco-friendly agricultural practice. Additionally, AI-powered models can predict the potential future threat of pests based on historical data (e.g., seasonal trends), helping farmers to prevent infestations before they occur.

Overall, the use of automation and artificial intelligence in insect monitoring has the potential to increase the efficiency and accuracy of pest detection and management. By reducing the need for manual labor and providing farmers with real-time information about insect behavior, this technology can help improve crop yields and reduce the economic impact of insect damage on agriculture.

4 Conclusions

In the current deliverable, the SmartProtect's Practice Abstracts were presented. Topics related to the project's outcomes were described, providing all interested parties with useful information related to the project and its results. The document constitutes summarizes knowledge collected and presented in an easily digestible way aiming to facilitate producers, stakeholders and people involved in the chain production of vegetables.

5 ANNEX

The current ANNEX contains the developed PAs in the national language of each SmartProtect partner that developed the corresponding PA. The aforementioned are available in the following table (**Table 2**). The order (numbers) follow the same ordering of the PAs previously described.

Table 2. *SmartProtect PAs in the local language of the corresponding project partners*

PA number	Partner/ Native language	Native language title	Practice abstract
1	AGENSO/ Greek	SmartProtect: όσα χρειάζεται να ξέρετε για το έργο	Το έργο SmartProtect ξεκίνησε με στόχο τη γεφύρωση και τη μεταφορά γνώσεων μεταξύ αφενός ερευνητών, παρόχων τεχνολογίας και αφετέρου γεωργικών παραγωγών. Το SmartProtect είναι ένα θεματικό δίκτυο που στοχεύει στην παροχή πρόσβασης σε καινοτόμες λύσεις, μεθοδολογίες και τεχνολογίες ολοκληρωμένης διαχείρισης επιβλαβών οργανισμών (IPM) για τους παραγωγούς. Ως IPM ορίζεται μια ευρεία προσέγγιση που ενσωματώνει όλες τις υπάρχουσες πρακτικές για βιώσιμο έλεγχο των παρασίτων. Σε μια περίοδο, όπου τα IPM θεωρούνται ένας από τους κύριους πυλώνες της σύγχρονης γεωργίας, οι καινοτόμες τεχνολογίες αναμένεται να διαδραματίσουν καθοριστικό ρόλο στην ανάπτυξη της γεωργίας στο μέλλον, η οποία θα χαρακτηρίζεται από βιωσιμότητα. Ο κύριος στόχος του SmartProtect είναι να ενθαρρύνει τη ροή γνώσεων σε μια προσέγγιση πολλαπλών παραγόντων και συστημάτων στα περιφερειακά Συστήματα Γεωργικής Γνώσης και Καινοτομίας (AKIS) και να τα συνδέσει όλα αυτά σε ένα AKIS σε Ευρωπαϊκό επίπεδο, προκειμένου να ενισχύσει το δυναμικό των καινοτόμων προηγμένων μεθοδολογιών IPM στην παραγωγή κηπευτικών στην Ευρώπη, με κύριο προσανατολισμό προς τις ομάδες τελικών χρηστών, παραγωγών και γεωργικών συμβούλων. Αυτή η δράση προβλέπεται να εκσυγχρονίσει τον γεωργικό τομέα, ενώ επιχειρεί να ελαχιστοποιήσει τις περιβαλλοντικές επιπτώσεις των εφαρμογών διαχείρισης επιβλαβών οργανισμών. Το SmartProtect θα προσφέρει μια πλατφόρμα που θα παρέχει σε όλα τα ενδιαφερόμενα μέρη διαθέσιμες καινοτόμες πληροφορίες για τη διαχείριση των παρασίτων, στοχεύοντας στη βελτίωση της διαχείρισης των παρασίτων.
2		Επίσημη έναρξη για την ιστοσελίδα του SmartProtect: πρόσβαση στην καινοτομία	Η επίσημη ιστοσελίδα του έργου SmartProtect έχει ήδη ξεκινήσει να λειτουργεί και είναι προσβάσιμη από τις 21 Μαΐου 2020. Η ιστοσελίδα είναι φιλικά διαμορφωμένη προς τον χρήστη, ενώ η σαφής δομή της επιτρέπει την παροχή πληροφοριών σχετικά με το έργο προς όλα τα ενδιαφερόμενα μέρη και τους ενδιαφερόμενους φορείς. Η νέα ιστοσελίδα (www.smartprotect-h2020.eu) μπορεί επίσης να παρέχει χρήσιμες πληροφορίες για τους 16 εταίρους του έργου ανά την Ευρώπη. Στην ιστοσελίδα του έργου, υπάρχουν επίσης σύνδεσμοι διαφόρων Ευρωπαϊκών έργων σχετικών με IPM. Καθώς η ιστοσελίδα αποτελεί ένα από τα κυριότερα εργαλεία για τη διάδοση και την επικοινωνία των

		αποτελεσμάτων και της προόδου του έργου, οι συχνές και συνεχείς βελτιώσεις της ιστοσελίδας παρέχουν πρόσβαση σε ενημερωμένες πληροφορίες σχετικά με τις δράσεις του έργου. Οι χρήστες έχουν τη δυνατότητα να επικοινωνήσουν απευθείας με τον συντονιστή του έργου και τον διαχειριστή διάδοσης του έργου μέσω της ιστοσελίδας του έργου, γεγονός που απλοποιεί την επικοινωνία με τους εταίρους του έργου. Η ιστοσελίδα παρέχει επίσης έναν σύνδεσμο για την μετάβαση στην πλατφόρμα που αναπτύχθηκε, όπου όλοι οι ενδιαφερόμενοι μπορούν να βρουν πληροφορίες σχετικά με καινοτόμες τεχνολογίες, μεθοδολογίες, καθώς και λύσεις και πρακτικές σχετικά με τις εφαρμογές IPM.
3	Επίσημη έναρξη για την πλατφόρμα του SmartProtect	Το έργο SmartProtect στοχεύει στη διευκόλυνση των αγροτών, των τεχνικών, των συμβούλων και όλων των ενδιαφερομένων που δραστηριοποιούνται στον γεωργικό τομέα, παρέχοντας εύκολα προσβάσιμες πληροφορίες σε τεχνολογίες, μεθοδολογίες και τεχνικές. Οι προαναφερθείσες πληροφορίες αφορούν τη βιώσιμη εφαρμογή στρατηγικών διαχείρισης επιβλαβών οργανισμών στην παραγωγή λαχανικών, ενσωματώνοντας τεχνολογίες ακριβείας και αναλύσεις δεδομένων. Στο πλαίσιο του παρόντος έργου, αναπτύσσεται μια διαδικτυακή πλατφόρμα ανταλλαγής δεδομένων με σκοπό τη σύνδεση και την γνωστοποίηση των διαθέσιμων τεχνολογιών και τη διανομή των αντίστοιχων πληροφοριών και γνώσεων που σχετίζονται με συστήματα υποστήριξης. Η διαδικτυακή πλατφόρμα (https://platform.smartprotect-h2020.eu/) έχει ήδη ξεκινήσει και λειτουργεί από τον Μάρτιο του 2021. Η προτεινόμενη βιώσιμη πλατφόρμα επιτρέπει μια διαδραστική και συνεχή μεταφορά γνώσης, με έμφαση στην ανίχνευση ωφέλιμων οργανισμών, παρασίτων και παθογόνων, καινοτόμων τεχνικών παρακολούθησης, μοντέλων πρόβλεψης, συστημάτων υποστήριξης λήψης αποφάσεων και καινοτόμες τεχνικές βιολογικής αντιμετώπισης. Έτσι, εύκολα κατανοητό υλικό, οδηγίες και άρθρα διατίθενται μέσω της διαδικτυακής πλατφόρμας. Η πλατφόρμα θα είναι διαθέσιμη τόσο στα αγγλικά όσο και σε 12 διαφορετικές τοπικές γλώσσες (Αγγλικά, Γαλλικά, Γερμανικά, Εσθονικά, Σλοβένικα, Πορτογαλικά, Τσέχικα, Ισπανικά, Λετονικά, Ουγγρικά, Ελληνικά, Ολλανδικά), προκειμένου να παρέχονται οι διαθέσιμες γνώσεις και πληροφορίες σε όλους τους ενδιαφερόμενους.
4	Καινοτόμες τεχνολογίες IPM: προς ένα μέλλον βιώσιμο και φιλικό προς το περιβάλλον	Οι στρατηγικές IPM χαρακτηρίζονται πλέον σήμερα από έναν σταθερά αυξανόμενο ρυθμό υιοθέτησης της εφαρμογής νέων καινοτόμων τεχνολογιών με στόχο την παροχή γεωργικών λύσεων παγκοσμίως. Καθώς η τεχνολογική πρόοδος κινείται με ταχύτατους ρυθμούς τα τελευταία χρόνια, οι έξυπνες τεχνολογίες βρίσκουν εφαρμογή σε όλο και περισσότερους γεωργικούς τομείς. Με το χρόνο, οι δραστηριότητες πρόληψης, ανίχνευσης και ελέγχου τείνουν να υποστηρίζουν περισσότερο την εφαρμογή θεραπείας. Η έγκαιρη διάγνωση παθογόνων και

		επιβλαβών οργανισμών των φυτών μπορεί να συμβάλει σημαντικά στην οικονομικά αποδοτική, επιτυχημένη και αποτελεσματική διαχείρισή τους. Οι τεχνικές παρακολούθησης, ανίχνευσης και ανίχνευσης που έχουν ήδη αναπτυχθεί υπογραμμίζουν την ανάγκη επιτάχυνσης της υιοθέτησης προσεγγίσεων ακριβείας στα γεωργικά συστήματα. Επιπλέον, οι υπάρχουσες έξυπνες τεχνικές για την εφαρμογή φυτοφαρμάκων, μπορούν να μειώσουν αξιοσημείωτα την εισροή χημικών ουσιών στην πρωτογενή παραγωγή και την τροφική αλυσίδα, αλλά και την συσσώρευσή τους στο περιβάλλον, τα επιφανειακά ύδατα, και ιδίως τον υδροφόρο ορίζοντα. Εκτός από αυτό, η επίδραση των εφαρμογών διαχείρισης παρασίτων σε οργανισμούς μη-στόχους, όπως οι επικονιαστές, μπορεί επίσης να ελαχιστοποιηθεί με νέες καινοτόμες στρατηγικές διαχείρισης επιβλαβών οργανισμών. Η χρήση προγνωστικών μοντέλων και συστημάτων υποστήριξης αποφάσεων (DSS) μπορεί να οδηγήσει σε μείωση του αριθμού των εφαρμογών, ενώ παράλληλα αυξάνει την αποτελεσματικότητά τους. Γενικά, η υιοθέτηση νέων τεχνολογιών μπορεί να διαμορφώσει την εφαρμογή διαχείρισης επιβλαβών οργανισμών σε μια πολύ φιλική προς το περιβάλλον πρακτική.
5	Ζήτηση και σημασία των σύγχρονων IPM	Τα σύγχρονα συστήματα ολοκληρωμένης διαχείρισης επιβλαβών οργανισμών (IPM) περιλαμβάνουν καινοτόμες μεθόδους, τεχνολογίες και μεθοδολογίες προκειμένου να επιτευχθεί η βέλτιστη διαχείριση αλλά και το αντίστοιχο κέρδος για τους παραγωγούς. Η πρόληψη, η ανίχνευση και ο έλεγχος των παρασίτων με τη χρήση έξυπνων εργαλείων μπορεί να αυξήσει σημαντικά το οικονομικό εισόδημα των παραγωγών. Η διαχείριση των παρασίτων πριν προκαλέσουν σημαντική ζημιά στην καλλιέργεια και το προϊόν, είναι ιδιαιτέρως σημαντική. Η αντίληψη ότι μόνο η χημική εφαρμογή μπορεί να εξαλείψει την εμφάνιση παρασίτων και τα συμπτώματα που προκαλούνται από αυτά, έχει αποδειχθεί εσφαλμένη και έχει εν μέρει αντικατασταθεί από μια ολιστική νέα προσέγγιση. Αυτή η ολιστική προσέγγιση λαμβάνει υπόψη τη σημασία της πρόληψης, προκειμένου να οδηγήσει σε λιγότερη ζημιά στο προϊόν, ενώ είναι πιο φιλική προς το περιβάλλον. Οι παραγωγοί έχουν διαπιστώσει τα πρακτικά οφέλη των καινοτόμων συστημάτων IPM και προβλέπουν στη δημιουργία και εφαρμογή τέτοιων συστημάτων. Το οικονομικό κέρδος των παραγωγών από την αξιοποίηση και εφαρμογή νέων συστημάτων IPM μπορεί να αποδοθεί στη διαχείριση πριν από την εμφάνιση ζημιών από τα παράσιτα, την έγκαιρη σημειακή διαχείριση με πολύ λιγότερη ποσότητα φυτοπροστατευτικών προϊόντων (ΦΠ), την κατάλληλη προσαρμοσμένη επεξεργασία και την εισαγωγή νέων τεχνικών παρακολούθησης για την έγκαιρη ανίχνευση τυχόν περαιτέρω πιθανής μόλυνσης. Συμπερασματικά, η διαχείριση παρασίτων είναι ένα πολύπλοκο ζήτημα και πρέπει να αντιμετωπιστεί με μια πολυπαραγοντική

		προσέγγιση που χαρακτηρίζεται από την περιβαλλοντική βιωσιμότητα και μεθόδους για την επίτευξη της βέλτιστης παραγωγικότητας για ποιοτική και ποσοτική απόδοση.
6	Επίσημοι λογαριασμοί του SmartProtect στα μέσα κοινωνικής δικτύωσης	Το LinkedIn, το Facebook και το Twitter είναι μερικές από τις πιο γνωστές διαδικτυακές πλατφόρμες πολυμέσων για διαδραστική κοινωνική δικτύωση, επιχειρηματική δικτύωση και micro-blogging με συνολικό αριθμό χρηστών για το 2020 περίπου στα 3,2 δισεκατομμύρια. Οι χρήστες έχουν τη δυνατότητα να δημιουργήσουν έναν λογαριασμό και να συνδεθούν μεταξύ τους προκειμένου να παραμένουν ενημερωμένοι και να δημιουργήσουν ένα δίκτυο. Οι σελίδες λογαριασμού SmartProtect στο LinkedIn, στο Facebook και στο Twitter έχουν ξεκινήσει να λειτουργούν από τον Ιανουάριο του 2020 και παρέχουν νέα για το έργο και γενικά για την καινοτόμο διαχείριση επιβλαβών οργανισμών. Ήδη περισσότεροι από 1240 ακόλουθοι χρησιμοποιούν τις σελίδες του έργου για να έχουν πρόσβαση σε χρήσιμες πληροφορίες που σχετίζονται με τις δραστηριότητες του έργου και να λαμβάνουν ενημερώσεις σε πραγματικό χρόνο. Οι δυνητικά ενδιαφερόμενοι ακόλουθοι μπορούν να συνδεθούν με τις σελίδες κοινωνικών μέσων του έργου στους παρακάτω συνδέσμους, https://www.linkedin.com/company/smartprotecth2020, https://www.facebook.com/SmartProtectIPM, https://twitter.com/SmartprotectIPM και να γίνουν μέλη της κοινότητας του SmartProtect. Η διαχείριση των λογαριασμών των μέσων κοινωνικής δικτύωσης του έργου διευθύνεται από το Πακέτο Εργασίας 5 - Διαχείριση γνώσεων, στο πλαίσιο δραστηριοτήτων διάδοσης και επικοινωνίας, καθώς και αξιοποίησης των αποτελεσμάτων.
7	Δόσεις εφαρμογής για αποτελεσματική διαχείριση	Οι φυτικές καλλιέργειες απειλούνται συχνά από μολύνσεις που προκαλούνται από φυτοπαθογόνους μικροοργανισμούς και από επιθέσεις από επιβλαβείς εντομολογικούς εχθρούς. Οι φυτοπαθογόνοι μικροοργανισμοί μπορεί να είναι μύκητες, βακτήρια ή ιοί, ενώ οι φυτικοί εχθροί μπορεί να είναι έντομα, νηματώδεις ή και ακάρεα. Ως αποτέλεσμα, η εντατική γεωργική καλλιέργεια απαιτεί συχνή εφαρμογή φυτοπροστατευτικών προϊόντων, είτε βιολογικών, είτε χημικών, αλλά και ωφέλιμων μικροοργανισμών και εντόμων. Η ξεπερασμένη αντίληψη ότι όσο υψηλότερη είναι η δόση, τόσο καλύτερο θα είναι το αποτέλεσμα, έχει αποδειχθεί λανθασμένη πριν από πολλά χρόνια. Στα σύγχρονα συστήματα διαχείρισης επιβλαβών οργανισμών, η χρήση της κατάλληλης δόσης είναι ιδιαίτερης σημασίας προκειμένου να επιτευχθεί αποτελεσματική διαχείριση ασθενειών και εχθρών των φυτών, αποφεύγοντας παράλληλα την ανάπτυξη ανθεκτικότητας. Η πιθανή ανάπτυξη ανθεκτικότητας μπορεί τελικά να οδηγήσει σε απώλεια της αποτελεσματικότητας των εφαρμοζόμενων φυτοπροστατευτικών προϊόντων. Η ανάπτυξη ανθεκτικότητας μπορεί επίσης να προκαλέσει διατάραξη στη φυσική ισορροπία μεταξύ του πληθυσμού

		διαφορετικών ενδημικών ειδών όπως οι εχθροί και οι ωφέλιμοι οργανισμοί, η οποία πιθανώς μειώνει την αποτελεσματικότητα των ωφέλιμων. Η εφαρμογή της συνιστώμενης δοσολογίας είναι πολύ κρίσιμη και σημαντική για τη διατήρηση της βιοποικιλότητας και την ορθή διαχείριση επιβλαβών εχθρών και ασθενειών των φυτών, και πρέπει να λαμβάνεται προσεκτικά υπόψη κατά την ανάπτυξη και εφαρμογή των σύγχρονων συστημάτων IPM.
8	Οπτική ταυτότητα του SmartProtect και ενημερωτικό υλικό	Από την αρχή του έργου SmartProtect, έχει δημιουργηθεί μια οπτική ταυτότητα για να διασφαλιστεί η ομοιομορφία και η ομοιογένεια του περιεχομένου του έργου και η ευρεία αναγνώριση του έργου ώστε να διευκολύνεται η αποδοχή του από ένα ευρύ κοινό. Η οπτική ταυτότητα καλύπτει το επίσημο λογότυπο και το εμπορικό σήμα του έργου, καθώς και την επίσημη εικόνα που χρησιμοποιείται για φόντο σε όλα τα υλικά και εργαλεία, με συγκεκριμένα χρώματα και γραμματοσειρές. Η ενσωμάτωση της οπτικής ταυτότητας του έργου σε πρότυπα για έγγραφα και παρουσιάσεις, προσφέρει ευρεία αναγνωρισιμότητα σε όλες τις δραστηριότητες διάδοσης και επικοινωνίας αλλά και εργαλεία του έργου (ιστότοπος, κοινωνικά μέσα, ενημερωτικό δελτίο, φυλλάδια, αφίσες, banner και φυσικά εκδηλώσεις). Υλικά και εργαλεία οπτικής ταυτότητας και επικοινωνίας και διάδοσης του έργου είναι διαθέσιμα στον ιστότοπο του έργου. Η δημιουργία της οπτικής ταυτότητας και των υλικών και των εργαλείων επικοινωνίας και διάδοσης είναι μια εργασία που διαχειρίζεται το WP5 - Επικοινωνία και Διάδοση. Η καθιέρωση οπτικής ταυτότητας επιτρέπει τη σύνδεση των αποτελεσμάτων του έργου με τους εταίρους του έργου, παρέχοντάς τους τη δυνατότητα να κοινοποιούν και να γνωστοποιούν την πρόοδο των δράσεων και των δραστηριοτήτων τους.
9	Τεχνικές εφαρμογής σε καινοτόμα συστήματα IPM	Στα σύγχρονα γεωργικά συστήματα, η εφαρμογή των γεωργικών πρακτικών υποστηρίζεται σε ορισμένο βαθμό από καινοτόμα συστήματα και εργαλεία, με στόχο την επίτευξη υψηλότερης απόδοσης, που συνοδεύεται από συνεχή βελτίωση της ποιότητας των προϊόντων, μειώνοντας παράλληλα την κόπωση για τους παραγωγούς και το κόστος παραγωγής. Η ζήτηση για επάρκεια προϊόντων υψηλής ποιότητας συμβαδίζει με την επιτακτική ανάγκη για διασφάλιση της ασφάλειας των τροφίμων, προς επίλυση της έλλειψης τροφίμων. Απώτερος στόχος είναι η διατήρηση της ισορροπίας και του περιορισμού του κινδύνου με γνώμονα τη διαμόρφωση μιας σύγχρονης γεωργίας με την ενσωμάτωση καινοτόμων τεχνολογιών. Σε μια τέτοια περίοδο αβεβαιότητας, οι παραγωγοί αντιμετωπίζουν την κλιματική αλλαγή, τους εχθρούς και τις ασθένειες των φυτών, καθώς και τη διακύμανση και την αστάθεια της παγκόσμιας αγοράς. Παρόλα αυτά, εργαλεία που σχετίζονται με την ενίσχυση των γεωργικών εφαρμογών, όπως καινοτόμα συστήματα ψεκασμού, χάρτες, έξυπνα εργαλεία για την ανίχνευση ζιζανίων, έξυπνα συστήματα

		παρακολούθησης και ανίχνευσης, drones κ.λπ., προσφέρουν στους παραγωγούς τη δυνατότητα εκσυγχρονισμού των καθιερωμένων τυπικών πρακτικών και διαδικασιών καλλιέργειας και διαδραματίζουν σημαντικό ρόλο στον εκσυγχρονισμό της σύγχρονης ζωής. Αξιοποιώντας απλές, προσιτές και οικονομικές τεχνικές και τεχνολογίες, μπορεί να ενεργοποιηθεί ένα βιώσιμο χρηματοοικονομικό σύστημα, παρέχοντας στους αγρότες εύκολη πρόσβαση σε γεωργικές καινοτομίες που αποτελούν επένδυση στο μέλλον.
10	Συστήματα υποβοήθησης λήψεως αποφάσεων σε καινοτόμα συστήματα IPM	Καθώς οι διαρκείς κλιματικές αλλαγές και οι εφαρμοζόμενες αγρονομικές πρακτικές επηρεάζουν τους φυτοπαθογόνους μικροοργανισμούς και τους εχθρούς των καλλιεργειών, παρουσιάζονται βιώσιμες λύσεις, προκειμένου να ελεγχθεί η αύξηση του πληθυσμού των εχθρών και η πίεση των ασθενειών στις καλλιέργειες, μειώνοντας παράλληλα τη εισροή χημικών στην αλυσίδα παραγωγής τροφίμων. Τα Συστήματα Υποστήριξης Αποφάσεων (DSS), προγράμματα που υποστηρίζουν προσδιορισμό καταστάσεων και κρίσεων, αλλά και του τρόπου και της πορείας δράσης, αναλύοντας δεδομένα και συλλέγοντας ολοκληρωμένες πληροφορίες, παρουσιάζονται ως πολύ χρήσιμα εργαλεία στη σύγχρονη γεωργία. Τέτοιες IoT λύσεις μπορούν να παρέχουν ακριβείς προβλέψεις, προβλέποντας πιθανή έξαρση εχθρού ή / και ασθένειας, επιτρέποντας την έγκαιρη προληπτική δράση από τον παραγωγό, που θα διασφαλίσει την ασφάλεια των καλλιεργειών. Οι πηγές δεδομένων που αξιοποιούνται μπορεί να διαφέρουν ανάλογα με το είδος του εκάστοτε εχθρού ή παθογόνου. Ωστόσο, ένας πολύ συνηθισμένος συνδυασμός, είναι η αξιοποίηση μετεωρολογικών δεδομένων και δεδομένων προηγουμένων μολύνσεων ή δεδομένων περιστατικών ανίχνευσης εχθρών. Με αυτόν τον τρόπο, μια συσχέτιση των τρεχόντων μετεωρολογικών δεδομένων και των βέλτιστων συνθηκών επώασης, ανάπτυξης και προσβολής των εχθρών μπορεί να παρέχει έναν εξειδικευμένο δείκτη κινδύνου. Ο δείκτης κινδύνου χρησιμοποιείται για να προειδοποιεί τους παραγωγούς σχετικά με πιθανές προσβολές. Δεδομένου ότι τα σύγχρονα γεωργικά συστήματα βασίζονται κυρίως στην δράση/πρόληψη και όχι στην αντίδραση κατόπιν της εμφάνισης του προβλήματος για τον έλεγχο των ασθενειών των καλλιεργειών, ο ρόλος των DSSs αναμένεται να είναι ιδιαίτερα κρίσιμος στο μέλλον, καθώς έχουν ήδη εφαρμόζονται σε πολλές περιπτώσεις.
11	Τεχνικές διάγνωσης και ανίχνευσης ως μέρος των σύγχρονων IPM	Η εμφάνιση νέων αναδυόμενων φυτοπαθογόνων μικροοργανισμών και εχθρών, αλλά και πιθανές αλλαγές του δυναμικού των υπαρχόντων πληθυσμών, καθιστούν αναγκαία την ακριβή και έγκαιρη ανίχνευση. Η έγκαιρη ανίχνευση επιτρέπει μια ακριβή διάγνωση, η οποία αποτελεί απαραίτητη προϋπόθεση για την αποτελεσματική διαχείριση της μόλυνσης ή της προσβολής. Στα σύγχρονα γεωργικά συστήματα, οι τεχνικές διάγνωσης και ανίχνευσης, έχουν

		ενισχυθεί σημαντικά από την ανάπτυξη και εφαρμογή καινοτόμων ψηφιακών εργαλείων. Σήμερα, οι παραγωγοί έχουν πρόσβαση σε ένα ευρύ φάσμα τεχνικών / εργαλείων για την ανίχνευση και διάγνωση εχθρών και φυτοπαθογόνων. Υπάρχει μια ποικιλία δοκιμασιών όπως ELISA, γρήγορες ταινίες δοκιμής, παγίδες DNA, PCR και δοκιμές πλευρικής ροής, καθώς και συστημάτων παρακολούθησης όπως συστήματα παρακολούθησης σε πραγματικό χρόνο, ψηφιακές παγίδες, drones, αισθητήρες (π.χ. αισθητήρες υγρασίας φυλλώματος) και υπηρεσίες δορυφορικών εικόνων, προκειμένου να χρησιμοποιούνται ως υποστηρικτικά εργαλεία για τη διασφάλιση της βιωσιμότητας της γεωργία. Η ορθή ανίχνευση και διάγνωση μειώνει σημαντικά την αλόγιστη εφαρμογή φυτοπροστατευτικών προϊόντων, επιτρέποντας τη μείωση της εισροής χημικών στην αλυσίδα της τροφικής παραγωγής και τη μείωση της εμφάνισης περιπτώσεων ανθεκτικότητας. Οι τεχνικές διάγνωσης και ανίχνευσης πρέπει να θεωρούνται ως ένας από τους βασικούς πυλώνες κατά την ανάπτυξη και εφαρμογή σύγχρονων IPM.
12	Οι τεχνικές παρακολούθησης ως εργαλείο πρόληψης στα σύγχρονα IPM	Οι τεχνικές παρακολούθησης χρησιμοποιούνται πλέον ως αναπόσπαστο μέρος των σύγχρονων συστημάτων IPM. Βρίσκουν εφαρμογή για τον έλεγχο πολλών φυτοπαθογόνων μικροοργανισμών και εχθρών, καθώς και για τον έλεγχο ζιζανίων. Η παρακολούθηση των πληθυσμών των εχθρών παρέχει ένα πολύ χρήσιμο πλεονέκτημα για την εφαρμογή στρατηγικών διαχείρισης επιβλαβών οργανισμών, ειδικά όσον αφορά τη διαχείριση των παρασίτων που χαρακτηρίζονται από ταχεία αναπαραγωγή ή ρυθμό ανάπτυξης και ζιζανίων που η διαχείρισή τους απαιτεί εφαρμογή ζιζανιοκτόνων. Επιπλέον, τα δεδομένα παρακολούθησης μπορούν να χρησιμοποιηθούν για την ανάπτυξη Συστημάτων Υποστήριξης Λήψεως Αποφάσεων (DSSs) για να βοηθήσουν τους παραγωγούς στη διαμόρφωση μιας βιώσιμης γεωργίας. Η υπερ-φασματική απεικόνιση σε συνδυασμό με τη χρήση drones έχουν επίσης παίξει σημαντικό ρόλο στην καινοτόμο παρακολούθηση της πίεσης του πληθυσμού των παρασίτων και των ασθενειών. Οι φερομόνες που χρησιμοποιούνται επίσης ευρέως στην παρακολούθηση των εντόμων, εκτός από τις σύγχρονες παγίδες, αποτελούν επίσης ένα ισχυρό εργαλείο. Κατά συνέπεια, με την ύπαρξη διαδικτυακών εργαλείων, τα δεδομένα παρακολούθησης καθίστανται διαθέσιμα από απομακρυσμένες τοποθεσίες, διευκολύνοντας τη δράση της διαμόρφωσης των φυτοπροστατευτικών συστημάτων. Με αυτόν τον τρόπο, οι αγρότες μπορούν να έχουν πρόσβαση σε δεδομένα παρακολούθησης από τους οπωρώνες και χωράφια τους, από απόσταση και δρουν έγκαιρα για τις εφαρμογές φυτοπροστασίας, τις γεωργικές πρακτικές ή να έχουν την δυνατότητα να διερευνήσουν περαιτέρω επιτόπου ένα συγκεκριμένο τμήμα της καλλιέργειας για πιθανή προσβολή. Όλα τα προαναφερθέντα οφέλη μπορεί να μειώσουν τον αριθμό των εφαρμογών φυτοπροστατευτικών

		προϊόντων και να μειώσουν την κόπωση του αγρότη αλλά και το κόστος παραγωγής.
13	Ανίχνευση σπορίων μυκήτων σε καλλιέργειας κηπευτικών	Στα σύγχρονα συστήματα παραγωγής κηπευτικών, η έγκαιρη ανίχνευση φυτοπαθογόνων μικροοργανισμών είναι ιδιαίτερα σημαντική στην αποτελεσματική αντιμετώπιση, με σκοπό την αποφυγή ζημιάς στην παραγωγή. Ο έγκαιρος εντοπισμός μπορεί να ακολουθηθεί από εφαρμογή καλλιεργητικών πρακτικών και εφαρμογών φυτοπροστατευτικών προϊόντων στη περίπτωση των μυκήτων, ενώ στη περίπτωση των ιών και των βακτηρίων μόνο από απομάκρυνση του μολυσμένου φυτού. Με αυτό το γνώμονα, η εταιρεία FungiAlert, έχει σχεδιάσει το σύστημα Sporsenz, το οποίο εντοπίζει σπόρια μυκήτων στον αγρό. Πρόκειται για μία μικρή συσκευή που τοποθετείται στο έδαφος της καλλιέργειας ή του αγρού που είναι προς έλεγχο. Τα σπόρια των εδαφογενών μυκήτων μεταφέρονται στην ειδική επιφάνεια της συσκευής και στη συνέχεια αυτή αποστέλλεται στα εργαστήρια της FungiAlert, όπου πραγματοποιείται ανάλυση των σπορίων και στη συνέχεια αναγνώριση του πληθυσμού των μυκήτων. Είναι δυνατή έτσι η μελέτη της πληθυσμιακής διακύμανσης αλλά και η ανίχνευση επιβλαβών μυκήτων για τις καλλιέργειες. Το σύστημα Sporsenz μπορεί να προσφέρει ανίχνευση και σε υδροπονικά συστήματα αλλά και αρδευτικά συστήματα. Τα αποτελέσματα στέλνονται στον παραγωγό μέσω email, ώστε να οργανώσει τις απαραίτητες ενέργειες και τη διαχείριση της ασθένειας για την διασφάλιση της παραγωγής του.
14	Διαγνωστικά τεστ για ανίχνευση του βακτηριακού καψίματος, φυτόφθορας, βακτηρίων του γένους Ralstonia και του ιού Υ της πατάτας	Μερικές από τις σοβαρότερες ασθένειες που πλήττουν καλλιέργειες της οικογένειας Solanaceae, όπως για παράδειγμα η τομάτα και η πιπεριά, είναι το βακτηριακό κάψιμο που προκαλείται από το βακτήριο *Erwinia amylovora*, η προσβολή από βακτήρια των γενών Ralstonia, όπως για παράδειγμα τα βακτήρια του είδους Ralstonia solanacearum, φυτόφθορες του γένους Phytophthora όπως Phytophthora infestans, καθώς και ο ιός Υ της πατάτας (PVY). Για την έγκαιρη διάγνωση των προαναφερθέντων ασθενειών, η εταιρεία Pocket Diagnostic έχει αναπτύξει Test Kits ταχείας χρήσης που δίνουν αποτέλεσμα σε διάστημα μικρότερο των δέκα λεπτών. Το κόστος τους είναι σχετικά χαμηλό και το σημαντικό πλεονέκτημά τους είναι ότι είναι φορητά και επιτρέπουν τη χρήση στον αγρό ή και το θερμοκήπιο. Πρόκειται για Strip tests που είναι απλά στη χρήση, και προσφέρουν ένα ποιοτικό προκαταρκτικό έλεγχο του φυτικού υλικού, με σκοπό την ανίχνευση των παθογόνων. Διατίθενται σε διάφορες συσκευασίες του 1, των 4 ή των 50 τεμαχίων ανά συσκευασία, ανάλογα με το παθογόνο ανίχνευσης. Αποτελούν ένα ιδιαίτερα χρήσιμο εργαλείο στα χέρια του παραγωγού, και μπορούν να χρησιμοποιηθούν πριν τον εργαστηριακό έλεγχο ως ένα απλό μέτρο πρόληψης ή και επιβεβαίωσης της προσβολής σε περιπτώσεις εντοπισμού συμπτωμάτων. Συμβάλλουν

		σημαντικά στη μείωση των εισροών φυτοπροστατευτικών προϊόντων, καθώς η ένδειξη απουσίας μολύσματος, μπορεί να οδηγήσει σε μείωση των εφαρμογών φυτοπροστασίας.
15	Απελευθέρωση ωφέλιμων εντόμων με συστήματα αέρα από εδάφους	Η προστασία των καλλιεργειών από εντομολογικούς εχθρούς στις περιπτώσεις ολοκληρωμένης προσέγγισης δηλαδή σε συστήματα ολοκληρωμένης διαχείρισης (IPM) περιλαμβάνει πέραν της χημικής αντιμετώπισης, και την εφαρμογή/ απελευθέρωση εντόμων που είναι ωφέλιμοι θηρευτές των εντόμων εχθρών των καλλιεργειών. Οι ωφέλιμοι θηρευτές μειώνουν σημαντικά τον πληθυσμό των εχθρών, προσφέροντας σημαντικά οφέλη στον παραγωγό, όπως η διασφάλιση της παραγωγής και η μείωση της χρήσης φυτοπροστατευτικών προϊόντων. Ένας από τους τρόπους εφαρμογής/ απελευθέρωσής τους είναι με συστήματα αέρα που προκαλούν έναν στροβιλισμό του αέρα στο περιβάλλον, και με την κατάλληλη ώθηση απελευθερώνουν τα εκάστοτε έντομα. Σαν μέθοδος ενδείκνυται κυρίως για χρήση σε θερμοκήπια. Τα πλεονεκτήματά τους είναι πως μπορούν να χρησιμοποιηθούν για πληθώρα διαφορετικών ωφέλιμων εντόμων, προσφέρουν ακρίβεια και ομοιομορφία στην απελευθέρωση, καλύπτοντας την απαιτούμενη περιοχή, και καθώς είναι εύκολα στη χρήση, μειώνουν σημαντικά τον κόπο του παραγωγού. Διατίθενται σε χειροκίνητες εκδόσεις και σε ρυμουλκούμενες εκδόσεις από γεωργικά οχήματα και ελκυστήρες. Παραδείγματα ρυμουλκούμενων τέτοιων συστημάτων είναι το «Natutec Drive» της Koppert και το «UniMite bio-distribution system» της Royal Brinkman, ενώ παραδείγματα χειροκίνητων συστημάτων είναι το «Koppert Airbug» της Koppert και το «Biospreader» της RoyalBrinkman. Και οι δύο κατηγορίες μπορούν να αποτελέσουν ιδιαίτερα χρήσιμα εργαλεία στα χέρια των παραγωγών που ενδιαφέρονται να εφαρμόσουν ωφέλιμους θηρευτές.
16	Απελευθέρωση ωφέλιμων εντόμων με συστήματα drones από αέρος	Η προστασία των καλλιεργειών από εντομολογικούς εχθρούς στις περιπτώσεις ολοκληρωμένης προσέγγισης δηλαδή σε συστήματα ολοκληρωμένης διαχείρισης (IPM) περιλαμβάνει πέραν της χημικής αντιμετώπισης, και την εφαρμογή/ απελευθέρωση εντόμων που είναι ωφέλιμοι θηρευτές των εντόμων εχθρών των καλλιεργειών. Οι ωφέλιμοι θηρευτές μειώνουν σημαντικά τον πληθυσμό των εχθρών, προσφέροντας σημαντικά οφέλη στον παραγωγό, όπως η διασφάλιση της παραγωγής και η μείωση της χρήσης φυτοπροστατευτικών προϊόντων. Ένας από τους τρόπους εφαρμογής/ απελευθέρωσής τους είναι με τη χρήση σύγχρονων μη επανδρωμένων drones τα οποία πετάνε πάνω από την καλλιέργεια και απελευθερώνουν στα απαραίτητα σημεία τα ωφέλιμα έντομα. Χρησιμοποιούνται κατά κύριο λόγο σε υπαίθριες καλλιέργειες και βρίσκουν εφαρμογή σε πληθώρα καλλιεργειών, όπως δενδρώδεις, αμπέλια, καλλωπιστικά, φράουλα και αραβόσιτο. Μειώνουν κατά έως και 10 φορές το χρόνο εφαρμογής, ενώ το βάρος,

		το μέγεθος και ο χρόνος πτήσης τους ποικίλουν ανά μοντέλο. Διευκολύνουν την εφαρμογή σε δύσβατα και βρεγμένα εδάφη και έχοντας την ικανότητα εφαρμογής ακόμα και σε απόσταση μερικών χιλιομέτρων, μπορούν να μειώσουν σημαντικά τη κούραση του παραγωγού και να απλοποιήσουν την εφαρμογή/ απελευθέρωση. Τέλος, προσφέρουν το ιδιαίτερα σημαντικό πλεονέκτημα ότι η εφαρμογή έχει μεγάλη ακρίβεια ως προς την επίτευξη του σημείου απελευθέρωσης. Παραδείγματα τέτοιων συστημάτων είναι το «UAV-IQ» της εταιρείας UAV-IQ που δεν είναι ακόμα διαθέσιμο στην Ευρώπη, το «Trichogramma dropper» της Range Rotors, το «Natutec Drone» της Koppert και το «Parabug» της Parabug solutions.
17	EffiSpray, ένα έξυπνο εργαλείο για βέλτιστη εφαρμογή ψεκασμού	Η εφαρμογή ψεκασμού υπό τις βέλτιστες περιβαλλοντικές συνθήκες επιτρέπει την επίτευξη ενός αποτελεσματικού αποτελέσματος, ενώ ταυτόχρονα μειώνει τις περιβαλλοντικές επιπτώσεις των εφαρμογών του ψεκασμού, όπως η μετατόπιση του ψεκαστικού νέφους εκτός στόχου. Το EffiSpray, που αναπτύχθηκε από την AGENSO, αποτελεί ένα καινοτόμο σύστημα για εφαρμογές αποδοτικού ψεκασμού, το οποίο βοηθά τους αγρότες να βελτιστοποιήσουν την εφαρμογή φυτοπροστατευτικών προϊόντων (ΦΠΠ), μειώνοντας παράλληλα τη διασπορά ψεκαστικού νέφους σε οπωρώνες και αμπελώνες. Με το Effispray, ο χρήστης θα έχει τη δυνατότητα να χρησιμοποιεί σύστημα ψεκασμού μεταβλητού ρυθμού, το οποίο μπορεί να εφαρμοστεί σε όλους τους ψεκαστήρες και μπορεί να υπολογίσει τη βέλτιστη δόση ψεκασμού για κάθε εφαρμογή. Παράλληλα, το EffiSpray διαθέτει μια εφαρμογή για λειτουργικό σύστημα Android φιλική προς το χρήστη, απ' όπου ο χρήστης μπορεί να λαμβάνει προβλέψεις και συμβουλές για τις επερχόμενες καιρικές συνθήκες και τις «φιλικές προς ψεκασμό» ημέρες, ώστε οι εφαρμογές να γίνονται κάτω από βέλτιστες συνθήκες. Τέλος, θα παρέχεται στο χρήστη ένας υπολογιστής δόσης ψεκασμού για την παρασκευή του ψεκαστικού υγρού ενώ κατά την εφαρμογή ο χειριστής του τρακτέρ θα μπορεί να ενημερωθεί για την προτεινόμενη ταχύτητα κίνησης του τρακτέρ σε πραγματικό χρόνο, προκειμένου να επιτύχει καλύτερη εφαρμογή ΦΠΠ. Το Effispray διατίθεται δωρεάν στο https://www.effispray.gr/ και στο Google Play στο https://play.google.com/store/apps/details?id=gr.agenso.effispray&hl=el&gl=US
18	OPTIMA DSS για ανίχνευση Αλτερνάριας σε καρότα	Στο πλαίσιο του έργου OPTIMA H2020, έχει αναπτυχθεί ένα ελεύθερα διαθέσιμο DSS και είναι προσβάσιμο στη διεύθυνση http://dss.optima-h2020.eu/. Τα παθογόνα που ενσωματώνονται στο εργαλείο είναι τα ακόλουθα, αλτερνάρια για καρότα, περονόσπορος για αμπελώνες και φουζικλάδιο για μήλα στην Ισπανία (περιοχή Aragon), Γαλλία (περιοχή Bordeaux), Ιταλία (περιοχή Piemonte) και Ελλάδα (Θεσσαλία, Εύβοια και Αττική). Το DSS παρέχει στους χρήστες μια πρόβλεψη 5 ημερών, σε επίπεδο 3ώρου,

			για την εκδήλωση της ασθένειας βάσει μετεωρολογικών δεδομένων, η οποία παρουσιάζεται σε έναν έγχρωμο διαδραστικό χάρτη, με βάση το επίπεδο κινδύνου: πράσινο για έλλειψη κινδύνου (0%), κίτρινο για χαμηλό κίνδυνο, πορτοκαλί για μεσαίο κίνδυνο και κόκκινο για μέγιστο κίνδυνο (~100%). Έτσι, οι παραγωγοί που δραστηριοποιούνται στον τομέα της γεωργικής παραγωγής και της παραγωγής καρότου μπορούν να έχουν δωρεάν πρόσβαση σε αυτό το σύστημα έγκαιρης πρόβλεψης, και κατά συνέπεια να οργανώσουν τις γεωργικές εφαρμογές όπως οι εφαρμογές ψεκασμού για τις καλλιέργειές τους. Αυτό το εργαλείο επιτρέπει τη γρήγορη λήψη αποφάσεων που οδηγεί σε μειωμένη ποιοτική και ποσοτική υποβάθμιση του προϊόντος και απώλεια απόδοσης που μπορεί να προκληθεί από σοβαρή μόλυνση. Τα πρόσθετα οφέλη είναι η μειωμένη και πιο οικονομική χρήση των ΦΠΠ, τα χαμηλότερα υπολείμματα και οι μειωμένες επιπτώσεις στο περιβάλλον και στην ανθρώπινη υγεία που προκύπτουν από την υπερβολική χρήση ΦΠΠ κατά τη διάρκεια εφαρμογών ψεκασμού που μπορεί να μην χρειάζονται ή/και να μην είναι αποτελεσματικές.
19	INAGRO/ Dutch	UV-toepassingen in groenteteelt	Voor UV-toepassing in openlucht toonde ons marktonderzoek drie toestellen voor de open lucht groenteteelt, namelijk het gedragen toestel van de firma Cleanlight, een zelfrijdende machine van Saga Robotics (Thorvald) en de zelfbouwmachine ontwikkeld door een Amerikaanse groep, genaamd de Dragon UV array. Onder afdekking bieden de volgende firma's slimme UV-oplossingen aan: het Belgische Octinion (Lumion), Cleanlight (in samenwerking met Micothon) uit Nederland en Saga Robotics uit Noorwegen. Een zelfgemaakt toestel is goedkoper, maar je kan niet terugvallen op technische ondersteuning. Robots zijn natuurlijk duur in aankoop en vergen wel enige opleiding voor goed gebruik. Het toestel van Cleanlight is achterop gedragen en bestaat uit drie delen, waaronder een vast deel achter de tractor en twee neer te klappen delen. De lampen zijn hierbij in een reeks van vier in een verticaal vlak opgesteld. Het toestel kan ongeveer twaalf rijen prei behandelen tegen roest. Cleanlight maakt ook andere op maat gemaakte toestellen. De Dragon is een zijdelings gedragen opstelling met een kapvorm waarin meerdere lampen zijn gemonteerd. Deze opstelling is specifiek ontworpen voor enkelvoudige ruggen zoals in de courgetteteelt. Ook Saga Robotics biedt een kapvormig toestel aan voor dergelijke ruggen, maar dan als autonoom rijdende machine. Zowel Octinion, Cleanlight als Saga Robotics hebben voor beschutte teelten een zelfrijdend toestel op de markt waarop UV-lampen zijn gemonteerd. Het grote voordeel hieraan is dat er geen operator bij het toestel hoeft te staan. Met software kunnen behandelingsschema's worden ingesteld

		en is ’s nachts behandelen praktisch goed te organiseren. Specifieke zones in een serre kunnen prioritair behandeling krijgen.
20	UV-B en UV-C interessantst voor gewasbescherming	Uit onderzoek is gebleken dat echte meeldauwschimmels bijzonder gevoelig zijn voor UV-licht en dat deze schimmels hiervan ‘s nachts niet kunnen herstellen bij gebrek aan blauw licht. De eerste successen binnen een gewasbeschermingscontext zijn al behaald in beschutte teelten zoals aardbei, sla, tomaat en komkommer. UV-behandeling lijkt binnen een IPM-context een interessante beheersingsmethode. Zo’n fysische behandeling zou mits voldoende effectiviteit kunnen bijdragen aan een verlaagde inzet van chemische gewasbeschermingsmiddelen. Door hun eigenschappen zijn UV-B en UV-C-licht de meest interessante vormen voor gewasbeschermingstoepassingen. Ultraviolet licht (UV) is een vorm van straling die net buiten het waarneembare spectrum van het menselijk oog valt. De golflengte ligt tussen 100 en 400 nanometer en is daarmee korter dan die van zichtbaar licht, dit in tegenstelling tot infrarood licht met langere golflengte. UV-licht kunnen we onderverdelen in UV-A (315-400 nm), UV-B (280–315 nm) en UV-C (100–280 nm). UV-A is de oorzaak van huidveroudering en UV-B leidt tot zonnebrand. UV-C is nog veel gevaarlijker voor de huid en veroorzaakt binnen korte tijd wonden. De veiligheid van de operator moet steeds voorop staan bij de toepassing van UV-licht. Dat kan door rechtstreeks contact met de straling te vermijden via afscherming van de lampen. Als er toch direct contact mogelijk is, dan is een bril, gezichtsscherm en beschermende kledij (lange mouwen, lange broek) aangewezen. Draag ook beschermende handschoenen. Onthoud dat de ogen het meest kwetsbaar zijn aan blootstelling.
21	UV-lampen: pas op voor huid en ogen	In deze fiche wordt op de gevaren voor huid en ogen van UV straling gewezen. Dergelijke straling kent steeds meer toepassing in de landbouw als beheersing van plagen en ziekten of plantenversterker. UV-lampen stralen een combinatie uit van zichtbaar licht en onzichtbare ultraviolette straling. Het gevaar aan UV straling is dat je deze niet zien en dus de blootstelling niet direct kan vaststellen. De UV straling met de meeste energie-inhoud is UVC, gevolgd door UBV en UVA. Acute overmatige blootstelling leidt tot een oogontsteking vergelijkbaar met sneeuwblindheid of lasogen. De symptomen treden in 30 minuten tot enkele dagen na blootstelling. De gevolgen van chronische blootstelling zijn de ontwikkeling van staar, blijvende beschadigingen aan het netvlies, letsels aan hoorn- en bindvlies.

			Overmatige blootstelling aan de huid leidt tot rode zwelling of ergere verbranding, afhankelijk van de dosis. Chronische blootstelling draagt bij aan een versnelde huidveroudering, verminderde immuniteit en ontwikkeling van kanker. In het algemeen is de UVC straling minder penetrant, maar des te sneller schadelijk door de hogere energie-inhoud. Bescherm jezelf door het dragen van bedekkende kledij en handschoenen en in het bijzonder UV beschermende gelaatschermen al dan niet in combinatie met een veiligheidsbril. Een geschikte bril herken je aan de markering op de lens volgens CE gebruiksnorm EN166FT. Dit aan het codenummer 2 of 3 voor UV filtering.
	22	Uv-techniek – zaken om in beschouwing te nemen	Wil je voor onderzoek zelf een uv-toestel maken, dan zijn er enkele zaken in beschouwing te nemen. Een van de eerste zaken zal de keuze van de lampen en armaturen zijn. Op de markt zijn verscheidene type lampen beschikbaar. De goedkoopste zijn van het type TL-D T8 en zijn zeer vergelijkbaar met de TL lampen van vroeger. Deze lampen hebben een G13 socket (2x2 pinnen) en vereisen een gepaste armatuur met voorschakelapparaat en ballast. Een nieuwer type TL lamp is het T5 type met een G5 socket met 2x2 pinnen. Naar dit type wordt soms verwezen als mini TL. De TL- lampen T8 en T5 maken meestal connectie in de armatuur voor en achteraan de lamp met pinnen. Een T5 met type 4P SE aansluiting heeft net als het type PL-L lamp een meer praktische aansluiting, want deze lamp connecteert in de socket aan één kant met 4 pinnen. De type HNS aansluitingen zijn ook zo gemaakt dat de lamp aan één kant in de socket zit. De krachtigste UVC-lampen gekend bij het SmartProtect consortium zijn deze van de firma Cleanlight met een vermogen van 160W, maar passen enkel in de bijhorende armaturen. De gebruikte lampen zijn lage druk kwiklampen. Dit kwik in de lampen brengt risico's mee op de veiligheid van mens en milieu. Als een lamp breekt, volg dan steeds de voorziene instructies. Algemeen geldt: verlaat en verlucht de ruimte en ruim het glas pas een half uurtje later. Let ook op, want kwikdamp is zwaarder dan lucht en zakt naar beneden. Om aan deze risico's tegemoet te komen, lijken LED's een goed alternatief. LED technologie voor uv C toepassingen is evenwel nog niet marktklaar. Momenteel is de energie-efficiëntie nog niet hoog genoeg. De warmteontwikkeling is ook een probleem voor de technologie om door te breken. Door de covidcrisis is de ontwikkeling wel versneld en zijn er enkele oplossingen op de markt beschikbaar, maar er is waakzaamheid geboden voor onjuiste informatie. Er zijn gevallen van oplichting bekend met zogezegde uv C LED's die eigenlijk geen nuttige straling uitzenden op golflengte 254 nm.

		Naast de lampen zelf is het ophangsysteem ook een technisch vraagstuk om op te lossen. Afhankelijk van de teelt zal een ophanging vooraan, achteraan of zijdelings van een trekker een gepaste montage zijn. Het meest eenvoudig is om gebruik te maken van een standaard driehoeksophanging. De constructie moet sterk gemaakt worden om zijwaartse, op- en neergaande krachten te ondervangen. Dit kan met de nodige verstevigingskabels of balken. Bij een serre kan gedacht worden om het systeem in te zetten gelijkaardig aan de gebruikte spuittechniek. In een verwarmde kas ligt daarentegen de keuze voor de hand om het systeem compatibel met de verwarmingsrails te maken.
23	Uv C – Hoe bepaal ik de dosis?	Wanneer je een uv C toepassing wil plaatsen is de dosis de belangrijkste parameter. Enerzijds is het belangrijk de effectieve dosis te kunnen bepalen voor de te behandelen pathogeen zonder schade aan plant en nuttigen. Anderzijds is er ook het technische luik om de stralingsdosis te kunnen berekenen en meten. De dosis kunnen we uitdrukken in Joule per vierkante meter. De bestralingssterkte is het vermogen per oppervlakte eenheid in Watt per vierkante meter. Het onderzoek naar de effectiviteit van uv C behandelingen is nog in volle ontwikkeling. Schimmels sterven in regel reeds aan lagere dosissen dan planten en dieren. Bij behandelingen overdag is de effectieve dosis zo goed als altijd veel hoger dan bij behandelingen gevolgd door een langere donkere periode. Dit door enzymatische processen in de schimmel die DNA-schade kan herstellen met behulp van blauw licht. De voorkeur gaat hierdoor uit naar avondbehandeling. Als teler kan je best een kleine voorproef doen als je onzeker bent over de te nemen dosis. Veel gewas/ziekte combinaties zijn niet publiek beschikbaar, dus laat je je best bijstaan door de verdeler. Voor komkommer is volgens onderzoek een dosis van 70 J/m² elke vier nachten effectief op witziekte, voor aardbei 170 J/m² elke twee nachten. De grootteorde ligt ergens in de lijn van 50 tot 200 J/m² elke 2-3 nachten. Om de theoretische bestraling te berekenen moet je rekening houden met een kwadratische afname van de dosis met de afstand tot het behandeld oppervlak. Een vlak behandelen op 4 maal verder dan het vlak net onder de lamp heeft een bestralingsvermogen op dat vlak 16 keer kleiner. Verder is de dosis te berekenen als vermogen/(behandelingsbreedte x rijsnelheid). Het gebruik van een reflector zorgt voor een optimalisering van de straling naar het te behandelen oppervlak. Naast een theoretische berekening kan je ook de effectieve straling meten met een stralingsmeter of radiometer, meten is immers weten. Deze gaan van eenvoudige handhelds tot duurdere high end spectroradiometers. Zorg er voor dat het

			toestel een voldoende bandbreedte heeft. Verder zijn er ook indicatorkaartjes op de markt die verkleuren bij blootstelling aan een bepaalde dosis uv C 254 nm. Deze kan je gebruiken als overdosisbescherming of ter controle van een behandeling.
24		Hoe groot moet een uv-systeem zijn om aan de bedrijfseisen te voldoen	Aangezien UV-systemen meestal op maat worden gemaakt, is deze vraag moeilijk te beantwoorden. Omdat UV vooral een contactwerking heeft in de beoogde toepassing, kan het antwoord vergelijkbaar zijn met de vraag hoe groot een spuitsysteem moet zijn om uw gewassen effectief en tijdig te kunnen behandelen wanneer nodig. Beschouw een horizontale sproeier die in een rechte richting rijdt. De rijsnelheid, het debiet van de spuitdoppen (bepaald door het type en de werkdruk), de dopafstand en de breedte van de spuitboom zijn de factoren die bepalen welk areaal een landbouwer binnen een bepaald tijdsbestek kan behandelen. Als een aantal factoren zoals de dosering en het watervolume van de courante toepassingen gekend zijn om een goede bedekking van het gewas en een goede werkzaamheid te bereiken, kan worden bepaald hoe groot het spuitsysteem moet zijn. In een UV-systeem kan de dosis worden beïnvloed door de rijsnelheid en het vermogen (W) per meter van het systeem. Door de keuze van het type en/of het aantal lampen kan het totale wattage worden gewijzigd. In tegenstelling tot chemische producten is de effectieve dosis bij UV-behandelingen soms niet bekend. Dit is een probleem dat moet worden opgelost omdat de minimale effectieve dosis ook een grote invloed heeft op het areaal dat u in een bepaald tijdsbestek kunt behandelen. Hoe lager de effectieve dosis, hoe sneller u over het gewas kunt gaan. UV-toepassingen worden voornamelijk na zonsondergang uitgevoerd, dus het behandelingsvenster is korter dan overdag. De frequentie is ook vrij hoog, met een behandeling om de drie nachten. Bijgevolg moet een landbouwer uitzoeken hoe hij met de meer onconventionele werktijden kan omgaan.
25	WARWICK/ English	Testing different types of SMART trap	Monitoring pest insects within crops can be very informative but also very time consuming, particularly if the crops are distributed over a wide area. SMART traps are generally traps that can be observed remotely, so that field visits are minimised. To date, the traps that are on the market use cameras, powered by solar cells, to take images of trapping surfaces and send them to a website where they can be viewed at any time. The trapping surfaces are usually sticky traps and insects are attracted to the traps by smell (usually pheromone) or vision (coloured trap). The systems are improving all the time in terms of image quality, identification and recording of the insects captured, and management of the trapping surface (e.g. automatic replacement). There is

		great potential for insect identification through machine learning and methods are being developed to identify insects through their wingbeat frequency. SMART traps are particularly useful for monitoring pest insects whose pattern of activity is unpredictable such as the moths *Plutella xylostella* and *Autographa gamma* which are migrants to, and within, Europe. Both species can be monitored effectively with SMART pheromone traps.
26	Forecasting damage by root-feeding fly pests of brassica and onion	Forecasting systems to improve the management of root-feeding fly pests of brassica and onion crops were reviewed in an ERA-NET C-IPM project called FlyIPM Insects | Free Full-Text | The Potential for Decision Support Tools to Improve the Management of Root-Feeding Fly Pests of Vegetables in Western Europe (mdpi.com). Forecasting systems have been developed for *Delia radicum*, *D. floralis*, *D. platura* and *D. antiqua*. All but one of the systems predict phenology rather than abundance; a forecast developed in Norway for *D. floralis* is based on a damage threshold. Degree-day forecasts have been developed in North America for *D. radicum*, *D. platura*, and *D. antiqua*, are presented on several advisory web sites in North America, and are available for use elsewhere. Simulation models have been developed for *D. radicum* in the UK and Germany, and there is a preliminary German model for *D. antiqua*. A Norwegian degree-day model has been developed for *D. radicum* based on spring emergence and the oviposition period. A comparable degree-day model is available in Denmark and this can use local soil temperatures for individual postal code areas. All the models require current weather data and the degree-day models mainly use air temperature records. Both air and soil temperatures are used in the UK and German simulation models. The models or their outputs are disseminated in a number of ways.
27	Monitoring bean seed flies	The bean seed fly (BSF) (*Delia platura* & *Delia florilega*) is a pest of over 40 crop species, causing the greatest problems in legumes and alliums. It usually causes the most crop damage early in the year. Crop yields are reduced when BSF larvae feed on developing seedlings, often killing them. Discussions with growers indicated that they would like to know when BSF are going to lay eggs in susceptible crops. BSF can be monitored using coloured water traps or sticky traps. The colours blue and white are particularly attractive to BSF and are also relatively less attractive than, for example, yellow traps, to cabbage root flies (*Delia radicum*). Cabbage root flies look similar but are slightly larger than BSF and it can be difficult to separate the two species without detailed examination (using a microscope). Sticky traps that are oriented vertically capture more BSF than

			horizontal traps. It is possible to buy trapping systems for BSF that include an attractive lure. Use of a lure generally increases the numbers of bean seed flies captured compared with a similar trap with no lure. It is possible to monitor BSF using some of the SMART trapping systems available on the market. However, identification of BSF from an image can be difficult; not every individual can be identified with certainty. However, SMART traps are useful to monitor for sudden changes in fly abundance.
28		PATS-C & PATS-X – The use of drones for greenhouse pest monitoring and eradication	PATS produce intelligent autonomous systems in greenhouses that can monitor (PATS-C) and eradicate (PATS-X) flying pests. PATS-C tracks flying pest insects in the greenhouse 24/7 using AI image recognition from a mounted automated scanner. Its high frequency monitoring helps users to gain crucial insights into their IPM programme daily, allowing them to act on pests immediately, sometimes up to 5 weeks earlier. This helps them to prevent the spread of the next generation of offspring whilst saving time on scouting rounds. This reduces unnecessary crop losses and the use of costly resources. The service focuses mainly on moth pests (*Lepidoptera*) of which the caterpillars can cause considerable crop damage very quickly. It can also monitor beneficials in the greenhouse such as *Bombus terrestris* and *Macrolophus pygmaeus*. PATS-X is an extension on the monitoring technology which upon identification of flying pests, acts to eradicate them by flying into them using the spinning blades of micro drones. The technology therefore controls pests without the need for any chemical application. PATS-C is available globally and its list of pests and beneficials that it identifies is regularly updated online: https://www.pats-drones.com/pats-c. PATS-X is available from early 2023.
29		Remote greenhouse crop monitoring for pest and disease risks and alerts (OKO digital, Greenpatrol robot, prospera)	Regular and accurate crop scouting is an essential component in an effective integrated pest management (IPM) protocol. Scouting reports allow growers to make timely, informed decisions to protect their vegetable crops from pest and disease. This however can be a time consuming and laborious process, especially in larger greenhouses. Technologies such as Oko Digital, Gearsense, Prospera and GreenPatrol robot allow for remote scouting of crops in greenhouses in different ways. OKO immersive provides growers and consultants with the ability to take virtual, 8K visibility walks inside the greenhouse, using the OKO platform which runs along pipe rails, to see what is happening in near real-time. The GreenPatrol robot, designed for tomatoes and peppers can operate autonomously using satellite navigation to detect and map several pests and diseases. Growers can access an online application to see the robot's status and a map of

			healthy and infected zones, with recommended actions. Prospera is an autonomous camera system that once set up in the greenhouse ceiling can monitor the crops 24/7 with AI image recognition of crop issues. Prospera analyses tens of thousands of images to locate problems and can inform on the extent and spread percentage of an infestation (e.g., late blight in tomato crop). These technologies offer great potential in reducing the amount of labour needed in a greenhouse scouting regime.
	30	Greenhouse mapping applications for pest and disease scouting management (IPM scoutek, CropScanner app, Farmapp)	Scouting apps have been developed to make the capture and utilisation of scouting data more efficient and easier to manage for greenhouse growers. The apps IPM scoutek, CropScanner app and Farmapp all offer the user fast and direct entry of scouting information such as pests, diseases, traps and beneficials into the app. These entries are geolocated into a greenhouse map and the software then allows real time visualisation of important information such as pest pressure hotspots & trends and beneficial insect population build up. This allows for tailored IPM application programmes to be built, targeting exactly where attention is needed as well as allowing the power to track application efficacy, to evaluate how well it is working and how much it is costing. Farmapp also has a feature that allows for optimal spraying routes to be visualized and tracked on the app and uses personal sensor data for timely pest and disease prediction alerts. These applications offer greenhouse growers a powerful and efficient tool for collecting and structuring scouting data in a visual mapped format. They help produce real time tailored IPM strategies that can be tracked, evaluated and used to inform future management decisions.
	31	Mobile pest and disease diagnosis in tomato cultivation	Smartphone apps can now take advantage of high-resolution phone cameras with the aim of diagnosing and detecting pests and diseases in crops. In tomato cultivation the applications Xarvio scouting, Plantix and Agrio can be used for the detection of many pests and disease such as Bacterial Spot and Speck, Bacterial wilt, Early blight, Fusarium Wilt, Grey mould, Late blight, Leaf curl of Tomato, Powdery mildew, Tomato Leafminer, Whitefly, aphids and many more. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to them every day. Instead of AI image recognition, the application CropDiagnosis uses a smart reasoning machine (AI) questionnaire, it uses the crop's details and the threat's characteristics input from the user to guide them to the most likely diagnosis and treatment options. After diagnosis, each application will offer advice and treatment recommendations. Xarvio scouting, Plantix and Agrio also provide pest and disease alerts for if any have

			been detected in the local area of the user. Although currently not 100% accurate these technologies provide huge potential in enabling scouting operations to become more accessible and efficient in tomato cultivation.
32		Mobile pest and disease diagnosis in pepper cultivation	Smartphone apps can now take advantage of high-resolution cameras found in modern mobile phones with the aim of diagnosing and detecting pests and diseases in crops. In pepper cultivation the applications Xarvio scouting, Plantix and Agrio can be used for the detection of many pests and disease such as Alfalfa mosaic virus, Anthracnose of Pepper, Bacterial Spot, Cucumber mosaic virus, Early blight, Fusarium Wilt, Grey mould, Powdery mildew of pepper, Sooty mold, Tobacco Mosaic Virus, Tomato spotted wilt virus, Tomato yellow leaf curl virus, Wet rot and many more. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to every day. After diagnosis, each application will offer advice and treatment recommendations. They also provide pest and disease alerts for if any have been detected in the local area. Instead of AI image recognition, the application CropDiagnosis uses a smart reasoning machine (AI) questionnaire combined with the crop's details and the threat's characteristics input from the user to guide them to the most likely diagnosis and treatment options. Although currently not 100% accurate these technologies provide huge potential in making scouting operations more accessible and efficient in pepper cultivation.
33		Mobile pest and disease diagnosis in cucumber cultivation	Smartphone apps can now take advantage of high-resolution phone cameras with the aim of diagnosing and detecting pests and diseases in crops. In cucumber cultivation the applications Xarvio scouting, Plantix and Agrio can be used for the detection of many pests and disease. Xarvio scouting allows for the detection of Cucumber green mottle mosaic virus, Cucumber mosaic virus, Downy mildew, Powdery mildew, Gummy stem blight, Anthracnose of curcubits, Angluar leaf spot disease, Tobacco Mosaic Virus, Spider mite, Thrips, Whitefly, Cucumber beetle, Aphids and Red Pumpkin Beetle. Plantix can detect many of the pests and disease mentioned as well as Leaf blight of Curcubits, Cucumber scab, Bacterial wilt and many more. Agrio also has a vast library including leafminers, mealybugs and more. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to them every day. After diagnosis, each application will offer advice and treatment recommendations. They also provide pest and disease alerts for if any have been detected in the local area of the user. Although currently they are not 100% accurate, these technologies provide huge potential in making

		scouting operations more accessible and efficient in cucumber cultivation.
34	Mobile pest and disease diagnosis in onion cultivation	Smartphone apps can now take advantage of high-resolution phone cameras with the aim of diagnosing and detecting pests and diseases in crops. In onion cultivation the applications Xarvio scouting and Plantix can be used for the detection of many pests and disease. Xarvio scouting can be used for image recognition of diseases such as Botrytis Leaf Blight, Downy Mildew, Stemphylium Leaf Blight of Onion and pest damage from Leaf-miner flies and Thrips. Plantix can be used in the recognition of OYDV, Aster yellow phytoplasma, Fusarium wilt, Powdery Mildew, White rot, Black mold, leaf blight of onion, white rot, purple blotch, Downy mildew, Botrytis leaf blight, leek rust as well as pest damage from Onion maggots, aphids, leaf-miners and many more. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to them every day. After diagnosis, each application will offer advice and treatment recommendations. They also provide pest and disease alerts for if any have been detected in the local area of the user. Although currently not 100% accurate these technologies provide huge potential in enabling scouting operations to become more accessible and efficient in onion cultivation.
35	Mobile pest and disease diagnosis in brassica cultivation	Smartphone apps can now take advantage of high-resolution phone cameras with the aim of diagnosing and detecting pests and diseases in crops. In brassica cultivation the applications Xarvio scouting, Plantix and Agrio can be used for the detection of many pests and disease. Xarvio scouting can be used for image recognition of Cabbage & Cauliflower diseases such as Alternaria leaf spot, Black rot and pest damage from Aphids, Cabbage White Butterfly, Cotton leafworm, Leaf-miner flies and Whitefly. Plantix can be used in the recognition of ring spot, bacterial rot of cabbage and pest damage of cabbage moth, cabbage webworm and many more. Agrio also has a large library that is constantly updated. These applications use machine learning algorithms and AI that learn from huge data sets of images that are uploaded to them every day. After diagnosis, each application will offer advice and treatment recommendations. They also provide pest and disease alerts for if any have been detected in the local area of the user. Although currently not 100% accurate these technologies provide huge potential in making scouting operations more accessible and efficient in brassica cultivation.

36	Image based selective mechanical weeding for field vegetables (Garford Robocrop and Naoi – Dino)	Mechanical weeding can be an important non-chemical aspect of weed management in an effective IPM protocol. Many systems exist for mechanical weeding between rows but within rows (intra row) has limited options and so the tasks are often done separately. Garford's Robocrop InRow Weeder tractor attachment does both inter and intra row weeding using a digital video camera to capture images of the crop ahead of the toolbar. The information is then utilized for lateral steering of the hoe and individual synchronization of the InRow weeder discs which are constantly adjusted in speed to suit the variation in plant spacing. It was originally developed for use on transplanted crops such as lettuce, cabbage, celery etc. However, it can be used on many crops provided they have regular plant and row spacing with clearly separated foliage. Another technology utilizing image based selective mechanical weeding, but for only between row weeding, is Naoi technologies – Dino. The Dino is an autonomous robot that combines information from RTK GPS and other sensors with a precision range of 2cm to detect crop rows and adjust weeding as close to the plants as possible. This allows the robot to perform high quality, efficient weeding, saving the farmer time and reducing the need for chemical input. The Dino works on various vegetables such as lettuce, onions, carrots, parsnips, cabbage, leeks, cauliflower, various herbs and much more.
37	Decision support systems for pest and disease management in tomato cultivation	Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In tomato cultivation, disease prediction models using personal climate monitoring station and sensor data are available through iMETOS, Dacom farm disease management, WiseCrop and EVJA: OPI support system. iMETOS offers disease models for Late blight - *Phytophthora infestans*, Early blight - *Alternaria solani*, Powdery Mildew (three pathogens), Grey mould - *Botrytis cinerea*, Leaf spot - *Septoria lycopersici*, Anthracnose fruit rot – *Colletotrichum spp*., Leaf mould - *Fulvia fulva* and *Phytophthora* blight - *Phytophthora capasci*. Dacom can predict Late blight, Grey mould and Early blight. These services utilize both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free tomato field or greenhouse. A DSS that can help in the pest management of tomato crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Tuta absoluta*, *Helicoverpa armigera*, *Bemisia tabaci*, *Aphis nasturtii*, *Myzus persicae*, *Aulacorthum solani*, *Frankliniella occidentalis*, *Frankliniella fusca*, *Thrips tabaci*, *Tetranychus*

			urticae and many more. These technologies offer great decision support for growers and agronomists in the pest and disease management of tomato crop. They can provide savings on crop losses, treatment applications and ultimately contribute towards more sustainable pest and disease management.
38		Decision support systems for pest and disease management in pepper cultivation	Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In pepper cultivation, disease prediction models using personal climate monitoring station and sensor data are available through iMETOS, Dacom farm disease management, and EVJA: OPI support system. iMETOS offers disease models for *Alternaria,* Powdery mildew – *Leveillula taurica*, Grey mould - *Botrytis cinerea* and Phytophthora blight - *Phytophthora capsici*. Dacom can predict *Alternaria*, Powdery mildew and Grey mould. These services utilise both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free pepper field or greenhouse. A DSS that can help in the pest management of pepper crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as Bemisia tabaci, Thrips tabaci, Frankliniella fusca, Frankliniella occidentalis, Spodoptera exigua, Helicoverpa armigera, Agrotis ipsilon, Aphis nasturtii, Myzus persicae, Aulacorthum solani, Tuta absoluta, Meloidogyne incognita, Meloidogyne javanica, Plutella xylostella and many more. These technologies offer great support for pepper cultivation, providing savings on treatment applications, crop losses and ultimately contributing towards more sustainable pest and disease management.
39		Decision support systems for pest and disease management in cucumber cultivation	Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In cucumber cultivation, disease prediction models using personal climate monitoring station and sensor data are available through iMETOS, EVJA: OPI support system and Agrivi Farm Management. iMETOS can offer disease models for powdery mildew of cucurbits, *Alternaria solani* and *Phytophthora infestans*. These services are based on scientific research and offer important decision support, utilising both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free cucumber field or greenhouse. A DSS that can help in the pest management

			of pepper crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Liriomyza sativae*, *Thrips palmi*, *Trialeurodes vaporariorum*, *Anasa tristis*, *Aphis nasturtii*, *Myzus persicae*, *Aulacorthum solani*, *Aphis gossypii*, *Frankliniella occidentalis*, *Frankliniella fusca*, *Thrips tabaci, Tetranychus urticae* and many more. These technologies offer great support for cucumber cultivation, providing savings on treatment applications, crop losses and ultimately contributing towards more sustainable pest and disease management.
	40	Decision support systems for pest and disease management in onion cultivation	Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In onion cultivation, disease prediction models using personal weather station and sensor data are available through iMETOS, Dacom farm disease management, Agronet and Agrivi farm management. iMETOS can help predict the development of Downy mildew, *Botrytis* Leaf Blight, *Botrytis* Leaf Spot, *Stemphylium* Leaf Blight and Purple Blotch. Dacom can predict Downy mildew, *Botrytis* Leaf Blight, Neck rot, Purple Blotch, White tip and Leaf spot. These services are based on scientific research and offer important decision support, utilising both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free onion field. A DSS that can help in the pest management of onion crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Acrolepiopsis assectella*, *Agrotis ipsilon, Delia platura*, *Thrips tabaci*, *Tetranychus urticae*, *Aphis nasturtii*, *Myzus persicae*, *Aulacorthum solani* and many more. These technologies offer great support for onion cultivation, providing savings on treatment applications, crop losses and ultimately contribute towards more sustainable pest and disease management.
	41	Decision support systems for pest and disease management in carrot cultivation	Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In carrot cultivation, disease prediction models using personal weather station and sensor data are available through iMETOS and Dacom farm disease management. iMETOS offers Tomcast *Alternaria dauci* Model for carrots (leaf blight) and *Cercospora* Leaf Spot (leaf spot). Dacom can predict *Alternaria* leaf blight,

		Cercospora Leaf Spot, *Sclerotinia* disease and Powdery mildew. These services are based on scientific research utilising both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free carrot field, providing savings on crop losses and treatment application. OPTIMA IPM is a freely accessible DSS that offers 5-day prediction of disease outbreak and application guidance, based on meteorological data, for carrot leaf blight in certain European countries (available in http://dss.optima-h2020.eu/). A DSS that could help in the pest management of carrot crop is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as *Myzus persicae*, Aphis gossypii, *Agrotis ipsilon, Agrotis ipsilon* and many more. These technologies offer great support for growers and agronomists in carrot cultivation, with the potential to provide savings on treatment applications, crop losses and ultimately contributing towards more sustainable pest and disease management.
42	Decision support systems for pest and disease management in brassica cultivation	Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In brassica cultivation, disease prediction models using personal weather station and sensor data are available through Dacom farm disease management. Dacom can predict ringspot, *Alternaria* Leaf Spot, White rust/blister and Powdery mildew in cabbage. In broccoli it can predict Headrot, Downy mildew and Whiterust. This disease management service is based on scientific research, demonstrating savings of more than 40% in practice by offering important decision support, utilising both monitored and forecasted data to optimise the correct crop protection management strategy. A DSS tool that can help in the pest management of brassica crops is FuturCrop. This service uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of pests such as Cabbage aphid (*Brevicoryne brassicae*), Swede midge (*Contarinia nasturtii*), Cabbage root fly *(Delia radicum*), Peach-potato aphid (*Myzus persicae*), Cabbage white butterfly (*Pieris rapae*), Diamondback moth (*Plutella xylostella*), bean seed fly (*Delia platura*) and many more. These technologies offer great support for growers and agronomists in brassica cultivation, with the potential to provide savings on treatment applications, crop losses and ultimately contributing towards more sustainable pest and disease management.

43	Decision support systems for pest and disease management in lettuce cultivation	Decision support systems (DSS) provide growers and agronomists with timely alarms of potential pest and disease occurrences. This allows for action to be taken at the right time which can reduce the chance of yield losses and the amount of application needed. In lettuce cultivation, disease prediction models using personal weather station and sensor data are available through iMETOS and Dacom farm disease management. iMETOS can offers an Infection model for Lettuce Downy mildew- *Bremia lactucae*, infection model for Lettuce Anthracnose – *Microdochium panattonianumis* and a disease model for Lettuce grey mould – *Botrytis cinerea*. Dacom can predict Downy mildew and White mould - *Sclerotinia sclerotiorum*. The service itself has demonstrated savings of up to 40% in practice. Both of these services are based on scientific research and offer important decision support, utilising both monitored and forecasted data to optimise the correct crop protection management strategy for a disease-free lettuce field or greenhouse. FuturCrop uses daily data from over 85,000 weather stations worldwide, or the users own weather station, to calculate the development status of lettuce pests such as aphids (*Myzus persicae*, *Aphis nasturtii*, *Aulacorthum solani*), turnip moth (*Agrotis ipsilon*), beet armyworm (*Spodoptera exigua*), Cotton bollworm (Helicoverpa armigera), Cotton leafworm (*Spodoptera littoralis*), and many more. These technologies can offer great support for growers and agronomists in lettuce cultivation with the potential to provide savings on treatment applications, crop losses and ultimately contribute towards more sustainable pest and disease management.
44	Plant pathogen detection in tomato crop by immunoassay -based techniques (ELISA & lateral flow devices)	Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques, utilising the antigen-antibody reaction that can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment and some level of training. They allow for the detection of Cucumber mosaic virus - CMV, Tomato mosaic virus – ToMV, Tomato mottle mosaic virus - ToMMV, Tomato brown rugose fruit virus - ToBRFV, Tomato black ring virus - TBRV, Tomato bushy stunt virus – TBSV, Tomato Chlorotic Spot Virus - TCSV, Tobacco mosaic virus - TMV, Tomato spotted wilt virus - TSWV, Tomato ringspot virus - ToRSV, Tomato yellow leaf curl virus - TYLCV, Tomato Yellow Ring Virus - TYRV, *Clavibacter michiganensis subsp. Michiganensis*, *Ralstonia solanacearum*, *Xanthomonas campestris pv. vesicatoria* and many more in Tomato crops. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE and AGDIA. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no

			special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. BIOREBA, Agdia and LOEWE all provide LFDs for many diseases relevant to the tomato crop. Examples test kits include ToBRFV, ToMV, ToRSV, TSV Pepino mosaic virus – PepMV, TSWV, many of the bacteria/ fungal diseases mentioned above and more. Both methods offer a powerful tool in the early detection of disease in tomato crops, ELISA for their accuracy, and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.
	45	Plant pathogen detection in pepper crop by immunoassay -based techniques (ELISA & lateral flow devices)	Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques, utilising the antigen-antibody reaction that can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment and some level of training. They allow for the detection of Alfalfa mosaic virus – AMV, Cucumber mosaic virus - CMV, Pepper Mild Mottle Tobamovirus - PMMoV, Pepper Mottle Potyvirus - PepMoV, Pepper Veinal Mottle Potyvirus – PVMV, Potato virus Y - PVY, Tomato mosaic virus – ToMV, Tobacco mosaic virus - TMV, Tomato spotted wilt virus - TSWV, Tomato yellow leaf curl virus - TYLCV, , *Clavibacter michiganensis subsp. michiganensis*, *Ralstonia solanacearum*, *Xanthomonas campestris pv. vesicatoria* and many more in pepper crops. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE and AGDIA. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. The same companies provide LFDs for many diseases relevant to the pepper crop as well. Example LFD test kits include CMV, PepMV, PVY, PepMoV, PMMoV, TMV, TSWV, ToBRFV, ToMV, ToRSV, TSV Pepino mosaic virus – PepMV, TSWV, many of the bacteria/ fungal diseases mentioned above and more. Both methods offer a powerful tool in the early detection of disease in pepper crops, ELISA for their accuracy, and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.
	46	Plant pathogen detection in cucumber crop by immunoassay -based	Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA

		techniques (ELISA & lateral flow devices)	spectrophotometer device for reading the ELISA plates) and some level of training. They allow for the detection of Cucumber Mosaic Virus - CMV, Cucumber Green Mottle Mosaic Virus – CGMMV, Cucurbit yellow stunting disorder virus – CYSDV, Tobacco mosaic virus – TMV, Zucchini yellow mosaic virus – ZYMV, Watermelon Mosaic virus – WMV, *Pseudomonas syringae pv lachrymans*, *Ralstonia solanacearum*, *Xanthomonas campestris*, *Verticillium spp*., *Rhizoctonia solani* in cucumber crops. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE, and AGDIA. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. BIOREBA, Agdia and LOEWE provide lateral flow test kits for some of the diseases relevant to the cucumber crop such as CMV, CGMMV, ZYMV, Zucchini Green Mottle Mosaic – ZGMMV, TMV, *Acidovorax avenae subsp. Citrulli*, *Ralstonia solanacearum*, *Xanthomonas* genus level, *Rhizoctonia solani, Botryitis cinerea* and many more. Both methods offer a powerful tool in the early detection of disease in cucumber crops, ELISA for their accuracy and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.
47		Plant pathogen detection in onion crop by immunoassay -based techniques (ELISA & lateral flow devices)	Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) as well as some level of training. They allow for the detection of Onion yellow dwarf virus - OYDV, Tomato spotted wilt virus - TSWV, Garlic common latent virus - GCLV, Iris yellow spot virus - IYSV, Leek yellow stripe virus - LYSV, POTY group test, *Phytophthora* spp., *Pythium spp*. and *Rhizoctonia solani*. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE, and AGDIA. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. The company Agdia provide these rapid one test strips for IYSV, TSWV, *Xanthomonas* - Genus level and POTY – group level. Both methods offer a powerful tool in the early detection of disease in onion crops, ELISA for their accuracy and LFDs for their rapid and easy

			to interpret results that can facilitate further testing and targeted management.
48		Plant pathogen detection in carrot crop by immunoassay -based techniques (ELISA & lateral flow devices)	Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) as well as some level of training. Tests available for purchase from the Leibniz-Institut DSMZ GmbH Shop allow for the detection of Carrot virus Y -CarVY, Carrot necrotic dieback virus – CNDV and Carrot thin leaf virus - CTLV. Creative diagnostics supplies complete test kits for CTLV. Other kits from Bioreba, Loewe and Agdia can be used for Alfalfa mosaic virus - AMV, Cucumber mosaic virus - CMV, *Phytophthora spp*., *Pythium spp*. and *Rhizoctonia solani*. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. Their results can be visually interpreted in the same way as the rapid covid-19 tests. Less tests exist for LFDs, especially for carrot diseases, however some relevant tests from the company Agdia can detect AMV, CMV, POTY group test, *Xanthomonas* genus level, *Rhizoctonia solani* and *Phytophthora* genus level. LOEWE® FAST lateral flow kits are available for CMV and *Botrytis cinerea*. Both methods offer a powerful tool in the early detection of disease in carrot crops, ELISA for their accuracy and availability of specific carrot virus tests, LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.
49		Plant pathogen detection in brassica crops by immunoassay -based techniques (ELISA & lateral flow devices)	Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) and some level of training. They allow for the detection of Brocoli Necrotic yellow virus - BNYV, Cauliflower mosaic virus - CaMV, Cucumber mosaic virus - CMV, Turnip mosaic virus - TuMV, Turnip yellow mosaic virus - TYMV, POTY group, *Xanthomonas campestris pv. campestris*, *Rhizoctonia solani*, *Phytophthora spp*., *Botrytis cinerea*. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE and Agdia. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. LOEWE®FAST

			Lateral Flow Kits can be provided for the detection of CMV and *Botrytis cinerea.* BIOREBA – Agristrip and Agdia ImmunoStrip® Tests can be used for the detection of CMV and the latter also provides test kits for *Xanthomonas* - Genus level, *Phytophtora spp*., *Rhizoctonia solani*. Both methods offer a powerful tool in the early detection of disease in brassica crops, ELISA for their accuracy and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.
50		Plant pathogen detection in lettuce crop by immunoassay -based techniques (ELISA & lateral flow devices)	Both Enzyme-linked immunosorbent assay (ELISA) and lateral flow devices (LFDs) are immunoassay techniques that utilise the antigen-antibody reaction and can be used in the detection of plant disease. ELISA kits provide accurate and relatively fast (1-2 days) results. They are cost effective but often require laboratory equipment (ELISA spectrophotometer device for reading the ELISA plates) and some level of training. They allow for the detection of Brocoli Necrotic yellow virus - BNYV, Cauliflower mosaic virus - CaMV, Cucumber mosaic virus - CMV, Turnip mosaic virus - TuMV, Turnip yellow mosaic virus - TYMV, POTY group, *Xanthomonas campestris pv. campestris*, *Rhizoctonia solani*, *Phytophthora spp*., *Botrytis cinerea*. Such tools are provided by Creative diagnostics, BIOREBA, LOEWE and Agdia. Complete kits contain all the components required to perform an ELISA assay. Lateral flow devices require no special laboratory equipment or trained personnel and can obtain results in as fast as 10 minutes. LOEWE®FAST Lateral Flow Kits can be provided for the detection of CMV and *Botrytis cinerea.* BIOREBA – Agristrip and Agdia ImmunoStrip® Tests can be used for the detection of CMV and the latter also provides test kits for *Xanthomonas* - Genus level, *Phytophtora spp*., *Rhizoctonia solani*. Both methods offer a powerful tool in the early detection of disease in brassica crops, ELISA for their accuracy and LFDs for their rapid and easy to interpret results that can facilitate further testing and targeted management.
51	LatHort/ Latvian	Augu patogēnu diagnostika, izmantojot DNS/RNS tehnoloģijas	Augu patogēni tiek noteikti ļoti dažādi – vizuāli, balstoties uz eksperta pieredzi un zināšanām, laboratoriski – veicot kaitēkļa morfoloģisko izpēti, vai izmantojot biotehnoloģiskās metodes, kas biežāk tiek izmantotas sēņu un baktēriju ierosinātu slimību noteikšanai, bet iespējams izmantot arī kaitēkļu diagnostikai. Vienkāršākā un senākā laboratoriskā metode ir patogēna kultivēšana uz barotnes, kam seko barotnes mikroskopiskas analīzes un patogēna noteikšana pēc tā morfoloģiskajām pazīmēm. Pēdējās desmitgadēs, attīstoties biotehnoloģijām, augu patogēnu diagnostikā tiek ieviestas molekulārās metodes. Visprecīzākās un ātrākās ir nukleīnskābju (NS) analīzes metodes. Visbiežāk tās balstās uz polimerāzes ķēdes reakciju (PĶR), kas ir ļoti jutīga tehnoloģija, kad DNS noteikšana iespējama pat tikai no

		dažām patogēna sporām. PĶR gaitā tiek pavairoti parauga genoma specifiski fragmenti, kas raksturīgi tikai šim patogēnam. Molekulārā līmenī notikušo reakciju vizualizācija tiek veikta, izmantojot elektroforēzi DNS fragmentu sadalīšanai agarozes gēlā, kam seko DNS luminiscēšana un salīdzināšana ar specifiskiem marķieriem. Šī metode parasti ir visprecīzākā, un salīdzinoši ātra, tomēr tās tehnoloģiskā sarežģītība padara to dārgu, jo jāizmanto tehnoloģiski sarežģīts laboratoriju aprīkojums, kā arī dārgi reaģenti. Turklāt šo analīžu veikšanai nepieciešamas specifiskas zināšanas un pieredze.
52	Augu patogēnu diagnostika, izmantojot ELISA tehnoloģijas	Augu patogēni tiek noteikti ļoti dažādi – vizuāli, balstoties uz eksperta pieredzi un zināšanām, laboratoriski – veicot kaitēkļa morfoloģisko izpēti, vai izmantojot biotehnoloģiskās metodes. Ērta un pietiekoši efektīva ir Enzīmu imūnsistēmas tests (ELISA), tehnoloģija, kas balstīta uz antivielu noteikšanu organismā, jeb imūndiagnostiku. Antivielas ir molekulas, kuras ražo dzīvu organismu imūnsistēma, lai palīdzētu identificēt infekciju vai bojājumu radošo organismus. Antivielas, kas atpazīst specifiskus antigēnus, kas saistīti ar konkrētu augu patogēnu, var izmantot kā diagnostikas instrumenta pamatu. Imūndiagnostikas testa galvenais mērķis ir noteikt diagnosticējošās antivielas saistīšanos ar mērķa antigēnu. Ir vairāki antivielu / antigēnu saistīšanās noteikšanas veidi, taču bieži tie ietver antivielu saistīšanu ar fermentu, kas rada krāsas izmaiņas, pievienojot analīzes paraugu. Krāsas izmaiņas liecina par konkrēto antivielu / antigēnu saistīšanos. Enzīmu imūnsistēmas tests (ELISA), tehnoloģija, kas izstrādāta 1970. gados, ir visbiežāk izmantotā diagnostikas metode, kurā tiek izmantotas antivielas. ELISA analīzes veic laboratoriski. Imūnsistēmas diagnostikas tehnoloģija tiek izmantota arī ātrajos ekspertes testos.
53	Molekulārās metodes ātrai patogēnu noteikšanai uz vietas saimniecībā	Molekulārās analīzes plaši tiek veiktas zinātniskajās un komerciālās laboratorijās, ar mērķi iegūt ticamus un precīzus patogēnu diagnostikas rezultātus. Pēdējo pāris gadu desmitu laikā ir izstrādātas vairākas molekulāro analīžu tehnoloģijas, kas veicamas laboratorijas apstākļos, izmantojot augsto tehnoloģiju aprīkojumu un plašu ķīmisko reaģentu klāstu, kā arī personāla prasmes un zināšanas. Attīstoties tehnoloģijām, ir izveidots plašs molekulāro analīžu klāsts, starp kurām ir arī vienkāršotas un lietotājam draudzīgas tehnoloģijas. Patogēnu diagnostikā starp tām ir minama rekombinācijas polimerāzes amplifikācijas (RPA) metode. Tā raksturojas ar vienkāršību, augstu jutību, selektivitāti, ātru DNS vai RNS fragmentu pavairošanu, kā arī darbību salīdzinoši zemā un nemainīgā temperatūrā, tai nav nepieciešama sākotnējā denaturācija vai vairāku praimeru izmantošana. Kopumā RPA pozicionējas, kā piemērota tehnoloģija, ko izmantot testos, kas paredzēti lietošanai saimniecībā. Šī tehnoloģija ir viegli pieejama, jutīga, specifiska, lietotājam draudzīga, ātra, izturīga,

		lietojama bez sarežģīta aprīkojuma, neprasa daudz resursus. Šādu tehnoloģiju piedāvā Agdia AmplifyRP® testēšanas platforma, kas ļauj veikt ļoti specifisku un jutīgu augu patogēnu DNS vai RNS analīzi. Neapstrādātus paraugu ekstraktus var pagatavot, izmantojot vienkāršu ekstrakcijas buferšķīdumu, un to var analizēt uzreiz saimniecībā. Tas padara testēšanas procesu ļoti vienkāršu un ietaupa lietotāja laiku. Šobrīd dārzeņiem platforma piedāvā noteikt Tomato brown rugose fruit virus (ToBRFV) un Tomato chlorotic dwarf viroid (TCDVd).
54	Digitālie risinājumi dārzeņu bojājumu noteikšanai	Lauksaimniekiem, un īpaši dārzkopjiem, ir ļoti svarīga kompleksa pieeja augu audzēšanas ikdienas menedžmentā. Darbu nepieciešamību un secību bieži vien nosaka laika apstākļi un to radītās sekas – kaitēkļu un slimību izplatība, mitruma trūkums, augu barošanās īpatnības, kas regulējamas atkarībā no augu vizuālā izskata, kā arī augšņu un augu analīzēm. Komplekss visu faktoru izvērtējums un savlaicīgi veiktas darbības ir ļoti svarīgi kvalitatīvas produkcijas ieguvei un ekonomiskai, vidi saudzējošai resursu izmantošanai. Pēdējā laikā ir radītas vairāki digitālie risinājumi, kas darbojas kopā ar meteostacijām un datu apstrādes platformām. Datu apstrādes platformas ir veidotas balstoties uz mākslīgās inteliģences tehnoloģijām, kur veidotas datu kopas ar tūkstošiem kādas konkrētas augu slimības vai kaitēkļu bojājumu attēliem, kas mašīnmācības procesā iegūst algoritmu dažādu slimību un kaitēkļu atpazīšanai. Sasaistot šo informāciju ar meteoroloģisko datu kopām, algoritmi ģenerē prognozes un ieteikumus augu aizsardzības un mēslošanas līdzekļu lietošanai, vai laistīšanas nepieciešamībai. Šādas, dažādas komplicētības un piedāvāto risinājumu platformas ir izveidotas vairākas – piemēram Agrio app, Cropwise, Plantix un citas. Šīs aplikācijas ir veidotas lietotājam draudzīgas un viegli saprotamas.
55	Lēmumu atbalsta sistēmas, kā piemērs DACOM	Lēmumu atbalsta sistēmas ir izstrādātas, lai palīdzētu lauksaimniekiem precīzi noteiktajā laikā un optimālos apjomos pieņemt lēmumu par veicamajiem agrotehniskajiem pasākumiem atbilstošajos kultūraugu sējumos/stādījumos, ņemot vērā augu attīstības tempu, laikapstākļus, kā arī citus agroekoloģiskos faktorus, kas ietekmē slimību attīstību. Lēmumu atbalsta sistēmas parasti ir savienotas ar automatizētām metroloģiskajām stacijām, kas izvietotas tieši saimniecībā. Izmantojot Dacom Disease Management, varat apskatīt, kur, kad un kādā daudzumā fungicīds jāsmidzina. Sistēma nosaka, vai pašreizējie apstākļi veicina slimības attīstību. Ja tas tā ir, tā sniedz informāciju par optimālo augu aizsardzības līdzekļa izsmidzināšanas brīdi. Sistēma arī norāda, kāda veida fungicīdu izmantot. Dacom Disease Management ir izstrādāts dažādiem kultūraugiem, izmantojot tīmekļa lietojumprogrammu un mobilās lietojumprogrammas. Sistēma veido ieteikumus, pamatojoties uz jūsu veiktajiem

			agronomisko darbību un ražas prognožu ierakstu, laika prognozi un laikapstākļu datiem.
56	AREFLH/ French	Comment le travail de SmartProtect s'inscrit dans les objectifs plus larges de l'UE - la directive sur l'utilisation durable des pesticides	La DIRECTIVE 2009/128/CE, ou directive sur l'Utilisation Durable des Pesticides (UDP), a été adoptée en 2009 dans le but de réduire l'utilisation des pesticides chimiques les plus dangereux et leurs effets négatifs. La stratégie de la "Ferme à la Fourchette" comprend un objectif de réduction de 50% de l'utilisation des pesticides les plus dangereux d'ici 2030. La première évaluation d'impact de la Directive conclut qu'elle a eu peu d'effet sur l'utilisation des pesticides les plus dangereux. Cela s'explique notamment par les raisons suivantes : • Les incohérences entre les États membres de l'UE concernant la transposition et le suivi de la directive UDP, souvent sans objectifs clairs au niveau des États. • L'absence d'obligations au niveau de l'UE pour les États membres de documenter les actions de lutte intégrée contre les ravageurs, d'où l'incapacité des États membres à rendre compte avec précision de leur adaptions. • La disponibilité limitée d'alternatives aux pesticides chimiques dangereux et d'informations sur les solutions de lutte antiparasitaire ou sur les produits non chimiques et moins dangereux. La consultation publique s'est déroulée de janvier à avril 2020. Le retour d'information des parties prenantes qui en résultera aidera à formuler des options politiques pour mieux mettre en œuvre la directive et progresser vers l''objectif ci-dessus, incluant probablement : • Des objectifs juridiquement contraignants (au niveau de l'UE & des États membres) pour réduire l'utilisation des pesticides chimiques et leurs risques associés. • Un meilleur suivi par les États membres grâce à des règles explicitement définies sur les contrôles officiels et une plus grande surveillance de la Commission par le biais d'audits. • Des restrictions spécifiques sur l'utilisation des pesticides chimiques et des exigences supplémentaires en matière de tenue de registres sur l'utilisation des pesticides et les tests du matériel d'application des pesticides. Le travail de SmartProtect et de ses partenaires peut s'inscrire dans ces objectifs, et pourra également permettre de mettre en œuvre les options politiques utilisées pour faire appliquer la directive.
57		L'Agriculture biologique et la politique de l'UE	L'agriculture biologique est une méthode agricole visant à produire des aliments avec des substances et procédés naturels. Elle implique généralement des chaînes d'approvisionnement plus courtes et offre des opportunités aux petits agricultures, grâce au renforcement des nouvelles dispositions introduites par le règlement 2018/848 sur la

		production biologique. Ce règlement vise à moderniser le secteur et à harmoniser les normes, en fournissant un cadre réglementaire stable. *Principaux avantages:* • Les terres exploitées en agriculture biologique présentent une biodiversité supérieure d'environ 30% celle des terres exploitées en agriculture conventionnelle. • L'agriculture biologique est bénéfique pour les pollinisateurs. • Les agricultures biologiques ne peuvent pas utiliser d'engrais de synthèse et ne peuvent pas utiliser d'engrais de synthèse et ne peuvent utiliser qu'une gamme limitée de pesticides chimiques. • L'utilisation d'OGM et de rayonnements ionisants est interdite, et l'utilisation d'antibiotiques est sévèrement limitée. La superficie consacrée à l'agriculture biologique a augmenté de près de 66% au cours des dix dernières années. Elle représente désormais 8,5% de la "surface agricole utilisée" totale de l'UE. La part des terres agricoles consacrées à l'agriculture biologique varie d'un minimum de 0,5% à un maximum de plus de 25%. Il est crucial que chaque État membre élabore au plus vite sa stratégie nationale en matière d'agriculture biologique, sur la base d'une analyse complète du secteur et un prévoyant des actions, des mesures d'incitation, des délais précis et des objectifs nationaux. Le plan d'action en faveur de la production biologique contribuera de manière significative à la réalisation d'autres objectifs de la stratégie en faveur de la biodiversité et de la stratégie "de la ferme à la table", tels que l'objectif de réduction des pesticides et l'objectifs de réduction des excédents de nutriments, tout en aide l'UE à se rapprocher de son ambition de pollution zéro pour un environnement non toxique. Dans ce contexte, le travail de SmartProtect et de ses partenaires s'inscrit parfaitement dans les objectifs globaux de réduction des pesticides.
58	Détection de virus dans l'identification des maladies des plantes	L'identification des virus dans les maladies des plantes peut être complexe et difficile. Une identification précise et le diagnostic nécessitent une connaissance des symptômes induits et souvent un test de confirmation en laboratoire. Les agriculteurs ou autres cultivateurs non spécialisés manquent souvent de connaissances approfondies sur les symptômes induits et souvent d'un test de laboratoire de confirmation. Les agriculteurs agricoles ou d'autres cultivateurs non spécialisés manquent souvent de connaissances approfondies sur les symptômes et d'accès à la littérature ou à l'avis d'experts. Pour le diagnostic précoce des maladies susmentionnées, *Buntata App* c'est une application intelligente pour aider les utilisateurs à identifier les maladies des plantes sans connaissance a-

		priori. *Buntata* fournit une clé visuelle pour l'identification des maladies en affichant des images exemplaires des symptômes et propose des solutions pour aider à identifier les causes. L'utilisateur sélectionne visuellement la partie de la plante qui est affectée et *Buntata* affiche des images de symptômes enregistrés. En choisissant l'image qui se rapproche le plus, on obtient des informations de base, des diagnostics et des méthodes de contrôle pour aider à traiter la cause. *Buntata* affiche les maladies avec des symptômes similaires ensemble permettant une comparaison facile pour aider les utilisateurs à identifier la bonne. Une fois la cause identifiée, les utilisateurs peuvent en garder une trace - étiquetée avec l'emplacement actuel, des notes et des images stockées localement sur l'appareil - pour une consultation ultérieure.
59	Systèmes de distribution pour les auxiliaires - Application Trichogramma dropper	La méthode biologique est donc le meilleur moyen de lutter contre la pyrale du maïs. La pyrale du maïs est l'un des plus importants ravageurs de la culture du maïs dans le monde. Environ 4 % de la récolte annuelle est détruite par les petites chenilles de la pyrale, qui mesurent environ 3 cm. La femelle pond jusqu'à 500 œufs, qui se fixent ensuite sur la face inférieure des feuilles de maïs. Après 7 à 14 jours, les petites chenilles éclosent et commencent à se nourrir de la moelle des tiges de maïs. Les tiges se cassent souvent car la plante perd sa stabilité en raison du manque de moelle. L'application de compte-gouttes Trichogramma offre aux agriculteurs et aux prestataires de services l'outil idéal pour une lutte biologique rapide, efficace et rentable contre les ravageurs du maïs. Grâce à son GPS de haute précision, le drone Agrica distribue les capsules de Trichogrammes avec précision et est donc plus efficace que l'application manuelle. Les trichogrammes sont libérés sous forme de capsules via un conteneur fixé à nos multicoptères. Cette méthode est non seulement douce pour le sol, mais aussi très économique. Sous forme de capsule, Trichogramma est réparti sur les champs de blé avec une teneur d'environ 1000 œufs par capsule. En outre, l'application peut être utilisée pour les grandes surfaces et les petites surfaces. Pour les grandes surfaces utilisant une machine, l'Agrica tourne automatiquement à la limite du champ et poursuit sa trajectoire de vol. Pour les parcelles irrégulières ou de très petite taille, il est possible de passer en mode manuel pendant le fonctionnement, ce qui donne au pilote un contrôle total et permet de manœuvrer manuellement.
60	Technologies aériennes pour la lutte biologique	La lutte biologique contre les maladies et les ravageurs suscite une attention croissante en raison du besoin urgent de protection de l'environnement. Cependant, les méthodes d'exploitation traditionnelles ne s'intègrent pas bien à la technologie de contrôle biologique. Avec les avantages d'un

	contre les parasites	fonctionnement simple, d'un faible coût opérationnel, d'une grande efficacité opérationnelle et d'un large éventail d'applications, l'utilisation de drones multirotors dans la lutte biologique revêt une grande importance. L'une de ces applications est Natutec Drone, qui a une longue expérience de la production de produits biologiques, avec des connaissances approfondies en R&D et une expérience de terrain, pour produire un mécanisme de dispersion de haute technologie qui transporte des organismes bénéfiques vulnérables pour les disperser précisément là où ils sont nécessaires. Il s'agit d'un mécanisme de dispersion unique qui peut transporter une large gamme de produits biologiques et les disperser avec une grande précision et efficacité sur 8 hectares en l'espace d'une heure. La dispersion aérienne réduit le temps nécessaire aux organismes bénéfiques pour s'établir dans l'écosystème et faire leur travail dans la culture. Le drone Natutec peut atteindre des zones qui peuvent être difficiles à atteindre au sol - comme les zones surélevées ou les sols humides. La dispersion aérienne raccourcit le temps nécessaire aux organismes utiles pour s'établir dans l'écosystème et faire leur travail dans la culture
61	Techniques de diagnostic et de détection - Application Agrorobotica SpyFly	Les progrès technologiques constants ont permis de disposer de machines de plus en plus sophistiquées et efficaces, mais le risque demeure. Les événements climatiques, les maladies des plantes et les parasites endommagent la récolte chaque année, causant d'énormes pertes. Le changement climatique aggrave encore la situation en perturbant les cycles de vie des ravageurs connus et en permettant aux ravageurs exotiques de se reproduire de manière pandémique. La gestion est impossible sans contrôle, mais quelque chose est en train de changer. Avec Spyfly, Agrorobotica apporte l'intelligence artificielle dans les champs pour aider l'agriculteur. Avec SpyFly, il est possible de surveiller en temps réel la présence de nuisibles dans les cultures via un simple smartphone et d'agir rapidement si nécessaire. Doté d'un boîtier modulaire pratique et durable, SpyFly est capable d'attirer les insectes nuisibles, en exploitant l'action combinée de l'attraction des couleurs et des phéromones, ce qui permet de les capturer sur une surface collante. À intervalles réguliers, SpyFly photographie le papier collant, transférant les images vers une plateforme en nuage, où elles sont traitées et analysées par des algorithmes, identifiant ainsi les insectes nuisibles. SpyFly mesure également les paramètres météorologiques et climatiques, qui sont utiles pour développer des modèles prédictifs sur la propagation des parasites. L'application contrôle à chaque instant les images des insectes capturés, ce qui permet de réduire les pertes de récolte, les heures de travail sur le terrain et la quantité de traitements. Spyfly est un outil

		indispensable pour les agriculteurs qui souhaitent gérer ou convertir leur production à l'agriculture biologique.
62	Techniques de diagnostic et de détection - Application Agrobase	Le changement climatique et la hausse des températures atmosphériques ont déjà affecté la durée de la saison de croissance dans de vastes régions d'Europe. L'évolution des températures et des saisons de croissance pourrait également avoir une incidence sur la prolifération et la propagation de certaines espèces, comme les insectes, ou des mauvaises herbes et des maladies, ce qui affecterait gravement la production agricole. L'application Agrobase permet d'identifier facilement les maladies, les insectes ou les ravageurs sur le terrain. Agrobase comprend une base de données de connaissances agronomiques avec un catalogue de ravageurs, de mauvaises herbes et de maladies ainsi que tous les pesticides, insecticides et herbicides enregistrés dans un pays donné. L'identification correcte des mauvaises herbes, maladies ou ravageurs spécifiques est la première étape d'une lutte efficace. Agrobase offre une base de données riche et continuellement mise à jour sur les mauvaises herbes, les maladies, les ravageurs et les insectes, qui comprend également des descriptions de produits pesticides avec des liens permettant de choisir la bonne solution à un problème spécifique. Elle fournit également des informations sur l'enregistrement et la date d'expiration des produits phytosanitaires et, surtout, sur l'efficacité des différents problèmes. L'application vous aide à identifier les mauvaises herbes, les ravageurs, les insectes ou les maladies en recherchant leur nom commun, leur nom latin, leur catégorie ou leur culture. L'application est conçue pour être pratique et facile à utiliser sur le terrain par les conseillers agricoles, les jardiniers, les agronomes stagiaires et les étudiants en agriculture.
63	Technique d'aide à la décision – application Futurcrop	L'utilisation de techniques agricoles plus adaptées peut réduire l'impact environnemental de l'agriculture. En particulier, l'optimisation de l'utilisation des nouvelles technologies est nécessaire pour lutter contre la désertification en cours. En exploitant au mieux les nouvelles technologies, il est possible d'utiliser des méthodes de culture et de soin des plantes ad hoc en fonction des caractéristiques des sols et des zones où elles se trouvent, en optimisant la consommation d'énergie, en rationalisant l'utilisation de l'eau et des engrais, même en fonction des conditions météorologiques en temps réel. FuturCrop est la nouvelle technologie de lutte contre les parasites. Grâce aux techniques de recherche de modèles d'intelligence artificielle, au regroupement de données et aux modèles phénologiques, le logiciel peut réduire le temps de dépistage des cultures et améliorer les résultats des traitements. FuturCrop prédit le développement biologique de 179 parasites et calcule ensuite le meilleur moment pour les traiter. Cette plateforme permet d'effectuer des

		traitements moins nombreux mais plus efficaces, précisément au moment où les ravageurs sont les plus vulnérables. En outre, les recherches, les captures et les traitements peuvent être enregistrés à l'aide d'un téléphone portable. FuturCrop collecte quotidiennement les données de 85 000 stations météorologiques dans le monde et effectue des calculs qui déterminent l'état de développement des parasites potentiels dans les cultures de ses utilisateurs. Si l'utilisateur dispose de sa propre station météorologique, il peut configurer l'accès aux données spécifiques à son emplacement. En outre, FuturCrop calcule les futures dates de développement des parasites 10 jours à l'avance, ce qui permet de planifier l'échantillonnage et le traitement.
64	Gestion agricole Agrivi Software	Agrivi est motivé par l'aide à l'industrie agricole en numérisant l'agriculture et en changeant la façon dont les aliments sont produits. Les solutions d'agriculture numérique d'Agrivi aident les producteurs à produire des aliments sains, sûrs et nutritifs de manière efficace et durable. Les technologies agricoles numériques offrent une façon plus simple et plus intelligente de travailler. Les informations en provenance directe du champ sont disponibles en quelques clics. Il n'a jamais été aussi facile de prendre des décisions fondées sur des données et de garantir une traçabilité complète des normes alimentaires. De la plantation à la récolte. De la transformation des aliments à la vente au détail. Les solutions Agrivi accompagnent les entreprises de l'ensemble de la chaîne de valeur alimentaire dans la mise en œuvre de projets de transformation numérique. Le logiciel de gestion agricole Agrivi vous aide à planifier, surveiller et analyser facilement toutes les activités de votre exploitation. Le travail du sol, la plantation, la protection des cultures, la fertilisation, l'irrigation, la récolte et toutes les autres activités sont gérées en quelques clics. De plus, vous pouvez suivre les quantités d'intrants utilisées, les coûts et les heures de travail pour chaque activité. Avec une base de connaissances des processus de meilleures pratiques pour plus de 100 cultures, commencez à améliorer votre productivité dès maintenant. Obtenez un aperçu instantané des prévisions météorologiques à 7 jours ou de l'historique sur 3 ans pour chaque champ. Des algorithmes de détection avancés alertent les agriculteurs en cas de risque d'apparition d'un insecte nuisible ou d'une maladie dans leurs champs. Pour plus d'informations, vous pouvez consulter le lien suivant : https://www.agrivi.com/products/.
65	eBEE AG - L'agriculture avancée Drone	eBee AG est un nouveau drone pour l'agriculture, qui s'intègre facilement et en toute sécurité dans la routine quotidienne, et donne plus d'informations sur la gestion de précision, tout en étant entièrement compatible avec les systèmes de gestion agricole. Les professionnels de l'agriculture sont confrontés à de nombreux défis aujourd'hui

		et il n'est pas toujours facile de les surmonter. L'eBEE AG est la nouvelle solution de drone pour l'agriculture de senseFLY SA. Cette technologie est conçue pour aider les professionnels de l'agriculture, producteurs, agronomes, prestataires de services à surmonter les nombreux défis auxquels ils sont confrontés dans les champs. eBEE AG permet de gagner du temps sur le terrain et aide à prendre de meilleures décisions concernant la planification et la santé des cultures. L'eBee AG, avec sa caméra fixe Duet M multispectrale/RGB, son vol automatisé et sa vaste couverture, fournit des informations précises et opportunes sur la santé des plantes afin de prendre de meilleures décisions pour améliorer le rendement des cultures, économiser les intrants, allouer les ressources et réaliser un plus grand potentiel de profit. Le capteur multispectral permet d'obtenir des données plus précises qu'en utilisant un capteur NIR modifié. Cette technologie peut être utilisée pour tous les types de cultures, à grande et à petite échelle. eBEE Ag avec sa batterie d'endurance peut voler et couvrir jusqu'à 200 ha pour le suivi de nombreuses cultures. Pour plus d'informations, vous pouvez consulter le lien suivant : https://www.sensefly.com/drones/ebee-ag/.
66	Dino Lite digital microscope - Diagnostics et techniques de détection	Les techniques de détection permettent à l'agriculteur de contrôler les nutriments dans le sol, et surtout de surveiller l'apparition de mauvaises herbes, de parasites et de maladies à un niveau de micro-gestion et, en fin de compte, de fournir des conditions optimales. Les microscopes Dino-Lite aident les agriculteurs et les experts à identifier efficacement les insectes facilement et rapidement, ce qui permet de prendre les bonnes mesures. Les Dino-Lite sont faciles à utiliser et portables, offrant de puissantes fonctions de grossissement en déplacement pour l'identification des insectes. Le Dino-Lite wi-fi streamer permet une accessibilité sans fil rapide en diffusant la vue en direct du Dino-Lite sur des appareils portables Wi-Fi. Ces appareils comprennent les iphones et les tablettes Android. Le Dino-Lite comprend un logiciel informatique riche en fonctionnalités qui permet de visualiser la capture d'images et de vidéos, de mesurer d'autres fonctionnalités avancées pour les modèles compatibles sur les plateformes prises en charge et de capturer des vidéos. Le microscope numérique offre une solution puissante, portable et riche en fonctionnalités pour l'inspection microscopique avec un grossissement allant jusqu'à 900x et une résolution de 5 mégapixels. Le Dino-lite peut-être utiliser dans tous les types de cultures et dans les petites et grandes exploitations agricoles ainsi que dans les serres. Pour plus d'informations, vous pouvez consulter le lien suivant : https://www.dino-lite.eu/index.php/en/products/microscopes.

67	DJI Drone Agras series - Techniques d'application	Comment faire passer l'innovation agricole au niveau supérieur avec des outils hautement efficaces, fiables et intelligents. Le DIJ Agri ste 16 a été conçu de A à Z, et il est doté de six rotors, d'un système RTK à double redondance et d'un système de mer en résine avionique. Il dispose d'une charge utile allant jusqu'à 16 litres, d'un débit de pulvérisation allant jusqu'à quatre virgule huit litres par minute et de huit arroseurs fonctionnant parfaitement avec le flux d'air descendant, ce qui donne un effet de pulvérisation impressionnant; il a une portée de 6,5 mètres qui peut couvrir une surface de 10 hectares par heure. Le mode de contrôle multi-avions fonctionne avec la caméra fpv ainsi qu'un système de transmission vidéo HD avec une portée allant jusqu'à 3 kilomètres, assurant la sécurité du vol et augmentant l'efficacité de la pulvérisation grâce à la toute nouvelle conception modulaire du 16, le réservoir de pulvérisation et les batteries sont facilement interchangeables, ce qui améliore considérablement le fonctionnement. L'efficacité de son module central est classée ip67, ce qui facilite l'entretien de l'appareil pliable. Le T20 se dirige automatiquement vers les zones à traiter et les pulvérise. Il utilise un radar pour voler à la hauteur définie au-dessus de la culture et ajuste son débit en fonction de la vitesse. Le drone DJI peut être utilisé pour le maïs, les arbres fruitiers et les pommes de terre, ainsi que pour toute une gamme de cultures. Ce drone peut être utilisé à grande échelle et en plein champ.
68	L'APS de FaunaPhotonics - Capteur de lumière	L'APS de FaunaPhotonics est une technologie qui permet à des capteurs individuels situés sur la rampe de pulvérisation de prendre individuellement une décision de pulvérisation en temps réel. Le signal est ensuite collecté sur le réseau et transmis au contrôleur de pulvérisation dans la cabine. Le flash d'une lumière est le signal de fonction, suivant la connexion au 4640 et activant les pulvérisations réelles qui permettront de pulvériser plus lorsqu'il y a plus d'insectes nuisibles et de pulvériser moins, lorsqu'il y a moins d'insectes ou lorsqu'il y a des insectes bénéfiques à l'intérieur. En voyant le flash lumineux, les insectes sont détectés par les capteurs. Les avantages de ce pulvérisateur autopropulsé sont la grande efficacité et la possibilité d'attraper les événements des insectes sur des cultures élevées. Les capteurs stationnaires sont très efficaces pour capter le premier afflux d'insectes dans le champ, ils peuvent donc agir comme un système de détection précoce de réchauffement. En montant ces capteurs sur un tracteur, il est possible de trouver les points chauds ou les fortes densités d'insectes dans le champ. En utilisant le capteur, la date mobile crée des cartes de chaleur montrant visuellement ces points de haute densité. La carte de chaleur est générée sur la base du nombre d'insectes par minute que nous voyons dans le champ. La raison de la composer est que le tracteur peut ne pas être dans chaque zone du champ pendant la même durée. Si vous les traitez

		comme une monoculture et donc comme un espace complètement uniforme, vous ne voyez pas qu'il existe des différences réelles dans l'activité des insectes au sein d'un champ spécifique. Si vous savez exactement où se trouvent les insectes ou quand ils arrivent, vous pouvez tout à coup cibler précisément ces insectes en utilisant l'agriculture de précision.
69	La Scoutbox une lutte antiparasitaire très efficace	La Scoutbox permet aux horticulteurs de repérer les parasites dans les serres en appuyant simplement sur un bouton. La Scoutbox révolutionne le dépistage des insectes en combinant la reconnaissance d'images et des algorithmes sophistiqués d'apprentissage automatique. Le Scoutbox est un appareil portable semi-automatique qui effectue des repérages lors des rondes et des traversées dans la serre. Désormais, le personnel de dépistage n'a plus besoin de faire un comptage manuel, car le Scoutbox photographie chaque trace d'insecte et envoie les images au logiciel spécial du serveur central de surveillance des cultures, qui identifie dans les comptages à la fois les ravageurs tels que les mouches blanches triples et la mineuse des mers, et leurs ennemis naturels. Ainsi, les cultivateurs ont un accès immédiat aux données en ligne collectées par la Scoutbox, ce qui permet de réaliser une gestion très efficace des ravageurs. La Scoutbox présente de grands avantages pour les serristes, car le comptage automatisé des insectes est plus rapide et plus objectif et précis que le comptage manuel des pièges. Un grand nombre de pièges peuvent être comptés par serre en même temps, ce qui permet d'obtenir des rapports beaucoup plus précis et des instantanés qui permettent aux producteurs d'avoir accès aux résultats pour leurs cultures, même pendant le repérage. La Scoutbox est facile à utiliser et s'intègre parfaitement aux méthodes de production hautement automatisées et informatisées utilisées dans la production en serre lors de la lutte contre les parasites. La Scoutbox peut être utilisée dans les grandes et petites exploitations agricoles ainsi que dans les serres. Pour plus d'informations, vous pouvez consulter le lien suivant : https://www.agrocares.com/insectcares
70	Natutec Scout App - Gestion numérique de la lutte intégrée contre les parasites système	Natutec Scout est une plateforme qui permet de connaître rapidement et facilement le statut parasitaire d'une serre donnée. L'application Natutec scout est un outil qui rend le processus de repérage plus efficace, plus simple et plus performant. Elle fonctionne en enregistrant les observations avec l'application mobile pour réduire la main d'œuvre nécessaire. Le scannage d'un ravageur donné comme la mouche blanche permet son comptage de manière automatique. Il suffit d'utiliser l'appareil photo d'un smartphone. . Le téléchargement des données de repérage peut être effectué rapidement et facilement sur le tableau de bord de Natutec scout. Le tableau de bord de l'application donne un aperçu et une analyse approfondie. Le Natutec

		scout peut être utilisé pour un service à distance optimal et intensif pour un repérage plus rapide et efficace, tout en offrant des options intelligentes et étendues pour l'analyse et les alertes. Cela permet d'appliquer correctement les bonnes pratiques agricoles et les solutions de biocontrôle pour garantir la santé des cultures et donc un rendement élevé. Le stockage central des données est accessible partout et entièrement personnalisable avec la création de seuils d'alerte. Par rapport au dépistage conventionnel, il offre un résultat 10 fois plus rapide, avec une précision de 94 % pour des parasites spécifiques. Pour plus d'informations, vous pouvez consulter le lien suivant : https://www.youtube.com/watch?v=nm7jBBggekw
71	Thrips-Lure - surveiller les thrips à faible population	Thrips-Lure est un distributeur à libération contrôlée d'un puissant attractif pour attirer les thrips à proximité d'une carte collante bleue ou jaune. Utilisez-le pour surveiller les thrips dans les situations de faible population ou tôt avant que la population de thrips n'augmente de manière significative. Thrips-Lure a le potentiel de piéger massivement les thrips et de maintenir des populations faibles dans les cultures. Thrips-Lure a attrapé en moyenne 3 fois plus de thrips que les cartes non traitées. Le Thrips-Lure a attiré beaucoup plus de thrips des fleurs (F. tritici) et de thrips des fleurs occidentales (F. occidentalis) que d'autres produits d'appât commerciaux. D'autres essais universitaires ont montré que ce Thrips-Lure augmente la capture de 1,8 à 8 fois sur des cartes collantes ou des pièges à eau. Thrips-Lure est également compatible avec les pièges commerciaux existants. Il faut au moins un leurre par arbre et 2 à 4 leurres pour les grands arbres. Dans les serres, utilisez au moins un leurre par 500 pieds carrés. Remplacez le leurre toutes les 3 à 4 semaines selon la température. Le thrips-Lure peut être utilisé à l'échelle de la grande et de la petite exploitation agricole et les serres peuvent être utilisées pour toute une gamme de cultures. Pour plus d'informations, veuillez consulter le site : http://www.agbio-inc.com/thrips-lure.html
72	SMAPPLAB Solutions de pièges intelligents	SMAPP LAB est un outil d'aide à la décision pour une protection efficace des plantes. Il est capable de fournir une aide à la lutte antiparasitaire beaucoup plus précise que les systèmes de piégeage précédents. Le piège intelligent est doté d'une fonction d'auto-nettoyage et continue à fonctionner pendant toute la saison. Le piège peut prendre des photos automatiquement. Dans le même temps, il recueille les données météorologiques locales des champs. Les agriculteurs peuvent surveiller en ligne les données prévisionnelles et protéger les cultures au moment opportun. Les pièges sont dotés d'une caméra et de capteurs embarqués. Ils enregistrent automatiquement le nombre de captures quotidiennes, identifient les espèces nuisibles et

		mesurent les paramètres de l'environnement local. Les images sont envoyées aux serveurs où l'identification des espèces et le comptage des captures sont effectués automatiquement par des algorithmes, puis nous évaluons les captures et les données météorologiques. Les agriculteurs peuvent suivre les courbes de la saison de vol sur un tableau de bord personnel en ligne et recevoir des suggestions sur les périodes de défense idéales pour maximiser l'efficacité. Le SMAPPLAB peut être utilisé à l'échelle d'une petite ou d'une grande exploitation agricole, ainsi qu'en milieu ouvert. Il peut être utilisé pour les cultures de maïs. La protection des plantes intelligentes permet d'augmenter le rendement et de réduire l'utilisation de pesticides pour une agriculture plus durable. Pour plus d'informations, vous pouvez visiter le lien suivant : https://platform.smartprotect-h2020.eu/en/view/ipm/306
73	Drone de pulvérisation M8A pro - Techniques d'application	Le drone de pulvérisation M8A pro a pour principale caractéristique de pouvoir pulvériser des produits phytopharmaceutiques ou de faire de la fumigation et de se transformer rapidement, par un simple changement de dispositif, en drone de semis ou de fertilisation. Le M8A dispose de huit moteurs qui génèrent la force de propulsion nécessaire; sa distance entre les axes est d'un mètre et soixante-trois centimètres; sa conception moderne et ultramoderne lui permet de voler dans des conditions météorologiques défavorables. En outre, il garantit des performances efficaces dans les travaux agricoles et la capacité de chargement de ce drone est de 20 kilos en 15 minutes, ce qui lui permet de couvrir jusqu'à 2 hectares. Le décollage et l'atterrissage verticaux le rendent facile à utiliser et la hauteur de vol pour l'ensemencement ou la pulvérisation se situe entre un et trois mètres du haut de l'avion. Actuellement, il fonctionne automatiquement après avoir établi un plan de saule entre un point de départ et un point d'atterrissage. Le drone peut être utilisé dans trois modes différents, ce qui offre une grande flexibilité et facilite l'exécution de n'importe quel travail de pulvérisation. Tous les modes offrent un suivi automatique du terrain (si le drone en est équipé) et une fonctionnalité de pulvérisation manuelle ou entièrement automatique. Le M8A peut être utilisé dans les grandes exploitations agricoles, dans les champs ouverts de cultures de maïs. Pour plus d' informations, veuillez consulter: https://platform.smartprotect-h2020.eu/en/view/ipm/188
74	BEECAM - Surveillance des parasites	L'écosystème BEECAM est l'inventaire de la biodiversité. BEECAM est la technologie innovante pour traiter les stratégies de biocontrôle qui incluent les meilleurs ennemis naturels dans les catégories. L'objectif de ces nouveaux services est de créer des méthodes alternatives pour les techniques de lutte intégrée contre les ravageurs (IPM) et de rassembler des connaissances sur les colonies d'insectes pollinisateurs en plein champ, l'activité des ruches, les

		phénotypes, etc. L'écosystème a été initié par le CTIF en France, qui a développé quelques outils pour comprendre comment les populations d'insectes coopèrent avec les grandes cultures, dans le cadre de sa mission visant à définir de nouvelles stratégies pour l'agriculture durable et la lutte intégrée contre les ravageurs. L'autonomie intégrée, les batteries de longue durée et la distance de communication du BEECAM le rendent particulièrement adapté à la collecte de films à grande échelle. Dans un environnement difficile, il dispose d'une puissance de traitement interne considérable et d'une grande autonomie avec une très faible consommation d'énergie, grâce à des stratégies de réveil et de mise en veille. Le BEECAM permet une plus grande mobilité, par exemple en réponse à la législation sur la réduction des pesticides. Un outil spécial permet de vérifier les performances du pulvérisateur: la couverture des feuilles est exprimée en pourcentage de produit actif sur l'ensemble de l'échantillonnage et un histogramme de la taille des gouttelettes est fourni. Il envoie automatiquement un avertissement au technicien lorsque le nombre cumulé de mouches est atteint ou lorsqu'une grande quantité de test a été collée en peu de temps. Les colonies d'insectes sont relevées et des rapports sont publiés; aucune instrumentation n'est nécessaire. Pour plus d'informations, vous pouvez visiter le lien suivant : https://platform.smartprotect-h2020.eu/fr/view/ipm/169
75	BIOCAPTUR S50 - Technique d' application	BIOCAPTUR S50 est une solution innovante et respectueuse de l'environnement pour la lutte contre les parasites dans l'agriculture intensive. Il s'agit d'un équipement industriel de haute technologie conçu pour résoudre de manière totalement écologique le problème majeur de la "tuta absoluta" et d'autres parasites dans l'agriculture intensive. Ces parasites se développent au fil des multiples spécifications électromagnétiques émises par ses puissantes diodes LED, qui agissent comme un stimulus irrésistible pour les parasites, les rapprochant de l'équipement où ils sont aspirés. L'incorporation du rotar BIOCAPTUR et du système de rotation réversible à 360 degrés augmente considérablement l'efficacité de capture de BIOCAPTURE S50, de sorte qu'un seul équipement est capable de contrôler les nuisibles dans une zone de 5 000 mètres carrés. Le contrôle de Tuta absoluta est l'une des principales conditions pour atteindre la rentabilité attendue dans la culture de la tomate, du poivron, de l'aubergine et de la courgette. Jusqu'à présent, aucun protocole de contrôle biologique ne s'était avéré suffisamment efficace. BIOCAPTUR S50 est un produit 100% écologique. L'appareil active ses lumières LED en pleine activité pour exercer une puissante attraction sur ces insectes et d'autres similaires. A l'approche de l'appareil, un flux d'air aspirant aspire les insectes et peut être réglé en hauteur pour suivre le développement phénologique de la plante.

			Pour plus d' informations, veuillez consulter: https://platform.smartprotect-h2020.eu/fr/view/ipm/292
76	NAK/ Hungarian	Agrárdrónok, mint IPM módszer alkalmazása a magyar gazdák szemszögéből	Magyarországon a szakértők és gazdálkodók véleménye alapján a mezőgazdasági drónok növényvédelemben való alkalmazásával elérhető a környezeti terhelés és a taposási kár csökkentése, a megközelíthetetlen területek megszűnése, az egyszerű tápanyaggazdálkodás, a gyors felvételezés, feldolgozás és döntéstámogatás, továbbá akár 90% feletti szermegtakarítás. Meglátásuk szerint a monitoring és permetező drónok lesznek a precíziós mezőgazdaság folyamatirányítási rendszerének alapvető eszközei, fontos azonban, hogy az erre a technológiára alkalmas és megfelelő növényvédő szerek álljanak rendelkezésre. Jelenleg a gazdálkodók az agrárdrónok, mint IPM megoldás használatát a drónok alkalmazásának harmadik legfontosabb területének tekintik. Leggyakrabban tápanyagutánpótlás vagy növényvédelmet megelőző döntéstámogatás céljából alkalmazzák a mezőgazdasági drónokat. A drónok, mint IPM eszközök széleskörű alkalmazásának legjelentősebb akadályozó tényezőjének a bizonytalan jogi hátteret, a megfelelő állami támogatás és szaktudás hiányát tartják. Ezenfelül a piaci szereplőknek igénye lenne a drónos permetezésre. A drónnal való permetezés legalizálásához három alapvető dologra van szükség, a drón típusminősítésére, melynek során ellenőrzik, hogy a permetezőgép megfelelően működik, szórásképe egyenletes és használata nem okoz elfogadhatatlan környezeti terhelést, a növényvédőszerek légi kijuttatásának engedélyezésére, valamint a biztonságos munkavégzést biztosító jogszabályi háttér megteremtésére. Magyarországon a mezőgazdasági drónhasználat szabályozása jelenleg folyamatban van.
77		Rovarkártevők befogása a kukoricatermesztésben	A rovarkártevők a kukoricatermesztés fő problémáinak számítanak. A kukoricatáblában a rovarkártevők azonosításának és kezelésének nehézségei a rovarok sokféleségéből és az őket érintő körülmények összetett kölcsönhatásából fakadnak. Az integrált növényvédelem alapja a kártevő-monitoring, amely támogatja a kártevők elleni védekezést és a megfelelő védekezési módszerek kiválasztását. A kártevők megfigyelésének klasszikus megközelítése a fertőzött területeken elhelyezett csapdasor alkalmazásán alapul, célja a kártevők azonosítása, helyének meghatározása, a fertőzöttség súlyosságának megállapítása. A Cap2020 különféle kártevők befogására tervezett csapdákat kínál. A CapTrap kúszócsapda, mely egy adott feromonnal működő csapda, ideális eszköz olyan kukorica kártevők populációinak megfigyelésére, mint a kukoricacsemete kukac (Atherigona oryzae), az európai kukoricabogár (Ostrinia nubilalis) és a gyapottok-bagolylepke (Helicoverpa armigera). A csapda alkalmazásának sikerességét a kártevők tömeges befogásában több éves pozitív tapasztalat bizonyítja. A csapda és a hozzá tartozó CapTrap fiók használata lehetővé

			teszi a kártevő jelenlétének valós idejű nyomon követését és az optimális beavatkozások kiválasztásának támogatását.
78		Lepkefélék csapdázása a zöldségtermesztésben	A rovarkártevők a zöldségtermesztés fő problémájának és fontos korlátjának számítanak. E kártevők hatékony kezelése elengedhetetlen a nyereséges zöldségtermesztéshez. A kártevők megfigyelésének klasszikus megközelítése a fertőzött területeken elhelyezett csapdasor alkalmazásán alapul, célja a kártevők azonosítása, helyének meghatározása, a fertőzöttség súlyosságának megállapítása. A Cap2020 különféle kártevők befogására tervezett csapdákat kínál. A CapTrap tölcsércsapda alkalmas lepkefélék befogására, úgymint a gyapottok-bagolylepke (Helicoverpa armigera), a gamma-bagolylepke (Autographa gamma) vagy a selyemfényű puszpángmoly (Cydalima perspectalis). A feromon speciális vonzereje és a csapdában lévő rovarok mozgásának elemzése biztosítja, hogy a monitorozás során csak a célrovar kerül megfigyelésre. A csapda és a hozzá tartozó CapTrap fiók használata lehetővé teszi a kártevő jelenlétének valós idejű nyomon követését és támogatja az optimális beavatkozások kiválasztását. A CapTrap tölcsércsapdát jellemzően a kelbimbó-, karfiol- és fejeskáposzta-termesztésben alkalmazzák, de széleskörűen használható egyéb termények esetében is.
79	Cajamar/ Spanish	La prevención es tu mejor aliado en la protección de tus cultivos	En la puesta en práctica de la GIP uno de los puntos clave es la prevención, que puede ser el mejor aliado del agricultor en la protección de los cultivos. Iniciar la actividad productiva en las mejores condiciones sanitarias posibles es fundamental. Por eso es importante poner en práctica medidas culturales y preventivas que reduzcan la incidencia de plagas y enfermedades. Entre las medidas más importantes destacan las siguientes: 1. Garantía sanitaria del material vegetal. 2. Gestión correcta de los restos vegetales que pueden convertirse en focos de plagas, enfermedades. 3. Adaptación de las fechas de plantación/trasplante, eligiendo la fecha idónea para cada cultivo en cada lugar. 4. Definición de una estrategia de monitoreo y seguimiento de plagas y enfermedades. 5. Elección de densidades y/o marcos de plantación adecuados. 6. Empleo de cultivares/patrones tolerantes a las principales plagas y enfermedades. 7. Conocimiento exhaustivo del cultivo. 8. Limpieza y sanidad previa a la plantación de la estructura, suelo, herramientas, etc. 9. Regar de forma racional, evitar encharcamientos, asfixia radicular, estrés hídrico y proliferación de hongos del suelo. 10. Eliminación temprana de las plantas afectadas por virosis.

		11. Realizar rotaciones de cultivo. Establecer biodiversidad prolongada en el tiempo. 12. Fomento de las técnicas de control biológico, por conservación y/o inundación, y favorecer las condiciones para un correcto establecimiento y funcionamiento de los enemigos naturales. Empleo de cubiertas flotantes, barreras físicas, dobles techos, tunelillos para mantener protegidos nuestros cultivos.
80	La GIP inteligente ayuda a la adaptación de la horticultura a los nuevos retos del cambio climático	La agricultura actual se enfrenta a un futuro difícil debido a los efectos que el cambio climático va a tener sobre la incidencia de plagas. Cabe esperar un aumento en la de presión de plagas, tanto en número de especies como en la presión ejercida por plagas ya presentes. Actualmente ya se observa que la mayoría de las plagas prolonga notablemente su actividad en invierno. Esto significa que se necesitarán medidas fitosanitarias durante periodos más prolongados, acelerando previsiblemente el desarrollo de resistencias a plaguicidas. En este escenario, la producción integrada parece el camino más razonable a seguir para evitar el incremento en el uso de productos fitosanitarios. Sin embargo, la puesta en práctica de estrategias coherentes para el control de las plagas es una tarea muy compleja que requiere de la implementación de todas aquellas herramientas de las que podamos disponer. Necesita la integración del conocimiento generado en muchos ámbitos, desde la biología y ecología de la plaga, y de sus enemigos naturales, de la sensibilidad del cultivo a plagas y enfermedades según variedades o los sistemas productivos, así como del efecto de las diferentes medidas biotecnológicas existentes, entre otras cosas. Entre todos los métodos de control, la principal herramienta a tener en cuenta debe ser el control biológico, que se basa en el empleo de los enemigos naturales, depredadores o parasitoides. Por lo que la concienciación y divulgación de estas prácticas, así como con el asesoramiento técnico a todos aquellos productores es fundamental.
81	La biodiversidad funcional como una herramienta más en los programas de GIP actuales	Ante la creciente conciencia de que la agricultura se beneficia de la salud de los ecosistemas, es fundamental poner en valor los servicios de regulación de plagas que puede ofrecer la biodiversidad como una herramienta clave en los programas de gestión integrada. La “reconstrucción” de hábitats adecuados para la conservación de enemigos naturales, mediante el establecimiento de diferentes infraestructuras ecológicas puede ser clave para adaptar nuestros agroecosistemas a las necesidades de la fauna auxiliar y mejorar su capacidad de control**.** La integración entre producción y sostenibilidad es el objetivo y el control biológico por conservación emerge como un nuevo instrumento que puede contribuir a frenar la libre dispersión de las plagas. Varios estudios demuestran que los insectos beneficiosos aumentan su longevidad o fecundidad con el

		acceso al néctar y al polen. Sin embargo, estos recursos suelen ser escasos en los sistemas agrícolas. Así, el establecimiento de elementos no productivos en la explotación como márgenes de piedra, setos, cubiertas vegetales, bandas floridas o nidos para pájaros y murciélagos, nos van a permitir encontrar en la naturaleza a numerosos aliados que sirvan de verdaderas barreras fitosanitarias. El objetivo es favorecer la presencia de enemigos naturales nativos que nos asegure un control biológico de fondo, pero también hace más sostenible la suelta de enemigos naturales al aportarles alimentos y refugios cuando no hay cultivo o un nivel suficiente de plaga (presa/huésped), por lo que el uso de estas infraestructuras ecológicas debería contemplarse como una estrategia necesaria para la liberación de la fauna auxiliar.
82	¡Control biológico y biodiversidad no son sinónimos!	La biodiversidad es una aliada en control de las plagas, pero, no se trata de incrementar la biodiversidad en sí misma, sino de hacerlo de manera que se potencie principalmente la presencia de especies que nos resulten útiles, aportándoles todos aquellos recursos que necesiten para establecerse, ya sea alimento (polen, néctar, o presa alternativa), refugio o lugares de apareamiento. A la hora de introducir esta biodiversidad funcional hay que tener en cuenta que, sin embargo, no todas las plantas contribuyen de igual manera en la consecución de este objetivo. En general es necesario el conocimiento de qué materiales vegetales son principalmente explotados por la mayoría de los pequeños depredadores y parasitoides es escaso. En este sentido, para el manejo adecuado de la vegetación natural y del control biológico, es fundamental analizar la especificidad de cada enemigo natural con los recursos vegetales que cada uno de ellos aprovecha. En la línea de estos trabajos, hay que señalar que en España se ha presentado recientemente, DiseñEN (www.diseñen.es) que es una herramienta web interactiva, cuyo objetivo apoyar en la toma de decisiones a cualquier persona interesada en poner en práctica estrategias de control biológico por conservación, pretende ser una herramienta que aprenda y que sea capaz de ofrecer soluciones a la carta en cultivos del arco mediterráneo. Esta herramienta es el resultado de más de 10 años de investigación conjunta entre Fundación Cajamar e IFAPA para adaptar los agroecosistemas mediterráneos a las necesidades de la fauna auxiliar beneficiosa autóctona. DiseñEN es la evolución de PlantEN, que es una APP para el móvil presentada en 2018 para dar a conocer los resultados de diversos proyectos desarrollados y que ayuda a conocer las plantas más interesantes para diseñar setos que fomenten la presencia de fauna auxiliar beneficiosa.
83	La monitorización de insectos	El aumento de las plagas en los sistemas productivos genera grandes pérdidas económicas al obtener una menor productividad de los cultivos. En la GIP es importante la

		como método de control preventivo de plagas	prevención y la detección precoz de las plagas mediante la monitorización de los insectos, para ello una buena herramienta es el uso de placas cromotrópicas, trampas y difusores de confuxión sexual. Las trampas pueden ser tradicionales, como las que ofrece TRÉCÉ con sus dos líneas de productos, PHEROCON y STORGARD. O pueden ser automáticas, como TRAPVIEW, desarrollada por la empresa EFOS, o SNAPTRAP desarrollado la compañía SNAPTRAP. TRAPVIEW es una trampa con un sistema automatizado de control de plagas que puede utilizarse para cualquier tipo de insecto. Cada trampa es independiente de la energía ya que dispone de un panel solar para enviar las imágenes de las capturas a una plataforma donde se pueden ver, procesar y archivar de forma segura, proporcionando una visión general de la situación en tiempo real, y prediciendo una situación futura de las plagas. Han desarrollado una aplicación móvil donde se dispone de esa información en cada momento.
84		La Noche Europea de l@s Investigador @s, Mujeres y hombres que hacen ciencia para ti	Evento de divulgación científica, organizado en Almería por la Universidad de Almería, Fundación Descubre, Junta de Andalucía, Ayuntamiento de Almería y Cajamar. Se realizó el 24 de septiembre de 2021. La edición de 2021 estuvo dedicada al Pacto Verde Europeo (EU Green Deal) y donde participaron más de 500 investigadores con 115 actividades. Fundación Cajamar ha participado en la categoría de agricultura, presentando diferentes proyectos relacionados con la sostenibilidad, con la la gestión de plagas y enfermedades. Siete investigadores del Centro Experimental estuvieron presentes en el evento, donde se explicaron los objetivos del proyecto SMARTPROTECT y con el código QR del proyecto, los asistentes accedían a la web del proyecto. También se exhibió una trampa electrónica, Trapview (Efos, Eslovenia), para monitorización eficiente de plagas.
85	VURV/ Czech	Chytré přístupy v integrované ochraně rostlin (IPM)	Zemědělství je hlavním zdrojem potravin na světě. Cílem farmářů je maximalizovat výnos a chránit jejich zeleninu. Jak se zvyšuje spotřeba, je zapotřebí účinných přístupů k ochraně zeleniny. Spolu s rostoucími obecnými, směřuje zemědělství využití k chytrých technologiím, aby mohlo krátké době zvýšit svoji produktivitu. V dnešní době se používá jako účinný a ekologicky citlivý přístup k ochraně proti škůd tzv integrovaná ochrana rostlin (IPM). IPM spoléhá na kombinaci postupů založených na racionálních přístupech. Používá nejekonomičtější prostředky s co nejmenším rizikem pro lidi, zvířata a životní prostředí. IPM byla zavedena v roce 2009 na základě směrnice o udržitelném používání a provádění postupů IPM a pro zemědělce v EU stalo povinností. V poslední době byl definován tzv. Green Deal jako součást politiky EU volající po klimatické neutralitě a stabilitě

		životního prostředí. Zatímco spotřebitelé v EU požadují dostupné a bezpečné potraviny, zejména v případě zelenin, zemědělci předpovídají slabší výnosy s nižší kvalitou a tedy nižšími příjmy v důsledku nových ekologických politik EU. Jádrem jejich obav je významné snížení používání pesticidů a hnojiv do roku 2030. V důsledku toho jsou vyvíjeny nové účinné přístupy k předvídání, identifikaci, monitorování a výskytu škůdců. V současné době jsou k dispozici pasti, které jsou odolné vůči povětrnostním vlivům a používají feromony k lákání škůdců a automaticky odesílají informace do vzdálených zařízení. Drony, sběr dat na základě spektrální analýzy představují další kroky vpřed, které jsou pravděpodobně doprovázeny roboty. Zařízení spolu s predikčními modely umožní efektivní ochranu proti škůdcům ma zeleninách. Inteligentní zemědělství tedy představuje budoucnost přístupů IPM.
86	Identifikace rostlinných virů: chytré přístupy	Viry představují po houbách druhé nejhorší rostlinné patogeny. Viry jsou drobné částice, ale způsobují vysoké ekonomické ztráty, což podle odhadů celosvětově činí více než několik miliard dolarů ročně. Stejně tak zelenina trpí mnoha virovými chorobami přenášenými vektory (hmyzem), půdou nebo semeny. Příznaky virových onemocnění, jako je zvrásnění, zhnědnutí listových tkání, mozaika a nekróza lze vizuálně obtížně rozpoznat. Někdy nejsou vizuálně pozorovány žádné příznaky. Diagnostika je základem pro zvládnutí virových onemocnění. Diagnostické přístupy se používají ke kontrole fytosanitárních opatření, osvědčování zdravotního stavu semen a sazenic uváděných na trh na domácím nebo mezinárodním trhu a k předpovědi např. Ztráty na výnosech. K detekci rostlinných virů byla vyvinuta řada metod, jako jsou mikroskopická pozorování, sérologické techniky nebo molekulární metody. Mikroskopické metody jsou náročné, sérologické metody (např. ELISA) jsou citlivé, ale obvykle nejsou příliš specifické. Princip metody se však používá pro SMART terénní diagnostiku podobnou těhotenským nebo COVID 19testům. Molekulární techniky, které vyžadují dobře vybavené laboratoře, jsou spolehlivé, vyznačují se vysokou specificitou, ale jsou poměrně drahé. Jsou vhodné pro úřední kontroly a certifikaci. Cílem řešení SMART je použít levný ekvivalent molekulárních technik vhodných pro malé soukromé laboratoře a zemědělce.
87	Technologie smartprotect pro řešení klimatické změny	Posledních deset let varují vědci před globálním oteplováním. Globální změna klimatu již skutečně měla pozorovatelné účinky na životní prostředí. Bez rychlé reakce lidstva se situace zhorší. Lze tedy očekávat, že teploty porostou, období bez mrazu se bude prodlužovat a bude doprovázeno extrémně horkými obdobími nebo změnami vlhkostních charakteristik a dešťů. Nedostatek vody již je hlášen. Zemědělství je velmi vystaveno změně klimatu,

		protože zemědělské činnosti přímo závisí na klimatických podmínkách. Škůdci mohou měnit stanoviště a výskyt škůdců, typických pro jižní oblast, je hlášen stále severněji. To již platí pro houby (např. *Fusarium*), ale také pro škůdce. Proto je nutné využívat inteligentní technologie pro monitorování a identifikaci škůdců, vylepšovat informační systémy a co nejvíce sdílet informace. Pro zabezpečení tohoto úkolu doporučujeme používat technologii pro monitorování (např. Pasti spojené s internetem, drony s kamerami vybavené kamerami s vybranými vhodnými spektry). Použijte, pokud potřebujete sledovat jednotlivé kmeny fytopatogenů, které mohou lišit svou agresivitu, pokud použijete molekulární metody, nejlépe typ jednoduchých stripů nebo složitějších PCR. Na základě vhodných údajů mohou prediktivní modely poskytnout dobrý pohled na šíření škůdců a fytopatogenů. Lze doporučit, aby každý zemědělec zvážil použití těchto nástrojů.
88	Odběr a příprava vzorků zelenin pro analýzy přítomnosti patogenů	Rostlinné patogeny způsobují ztráty na kvalitě koncového produktu i výnosech. Běžně může farmář jejich přítomnoist při dostatečných zkušenostech odhalit pouhým okem, ale často se nedají symptomy jednotlivých patogenů (houby, bakterie a viry) odhalit. V takovém případě je třeba sáhnout po molekulární diagnostice. Obdobný postup lze použít i v raných fázích infekce, kdy se na poli objeví např. přenašeči chorob. Pak je třeba stanovit přítomnost patogena pomocí PCR nebo obdobných metod. Pro analýzu vzorků je třeba oslovit laboratoře, které se stanovením daného fytopatogena zabývají a nejlépe jsou pro takovou činnost acreditováni podle národních a mezinárodníchj norem (např. ISO EN 17025:2018). Takové laboratoře jsou spolehlivé a mají postupy zaručující důvěrnost získaných informací. Po dohodě je třeba doručit do laborartoře objednávku, tj. zadání analýzy s uvedením, které typy patotgenů chce farmář stanovit. Dále je třeba poskytnout laboratoři inkriminované vzorky - tj. části rostlin, obvykle části listů, ale analýzy lze provádět např. i z očištěnýchnných kořenů. Pokud se jedná o analýzy nukleových kyselin, laboratoř poradí, zda se jedná o patogen s DNA (všechny houby, bakterie) nebo, u některých virů, pouze RNA. Pro odběr vzorků pro analýzu nukleových kyselin si je třeba přichystat sterilní nůžky, pinzety, kousky alobalu nebo plastové uzaviratelné nádobky, fix - popisovač a sáčky. Podle dohody s laboratoří se odebírají listové čepele obvykle jako duplikáty. Listy se vsunou do nádobky nebo alobalu, dobře popíšou a transportují do laboratoře nejlépe chlazerné. Pro RNA analýzy se využije nádobka s roztokem stabilizačního činidla („RNA lafterTM“) obvykle dodaného laboratoří.

			Farmář pak svůj pěstební postup upraví podle laboratorního výsledku.
89	UL/ Slovenian	Pametne aplikacije v pridelavi vrtnin in poljščin	Eden od temeljnih korakov integriranega varstva rastlin je ustrezna detekcija in pravilna identifikacija škodljivih organizmov. Da bi lahko pravočasno izbrali ustrezno tehniko zatiranja, si lahko pomagamo z različnimi aplikacijami, ki jih enostavno naložimo na pametni telefon. Ena od takšnih je Xarvio™, s katero si lahko pomagamo pri detekciji plevelov, bolezni in škodljivcev. Lahko pa z njo izvedemo hitro identifikacijo škodljivcev na rumenih lepljivih ploščah. Omenjeno elektronsko orodje pa nam lahko pomaga tudi pri zaznavanju vsebnosti dušika v rastlini in poškodb na listih. Aplikacija je uporabna pri prepoznavanju škodljivih organizmov v pridelavi zelenjadnic (fižol, paprika, zelje, kumare, jajčevec, por, čebula idr.) in poljščin (koruza, krompir, soja, sladkorna pesa idr.). Njena uporaba je enostavna, saj omenjeno orodje deluje s pomočjo slikanja s pametnim telefonom. V naboru omenjene aplikacije je več kot 400 vrst škodljivih organizmov (bolezni, škodljivci, pleveli) na več kot 50 gostiteljskih rastlinah. Aplikacija lahko s pomočjo specifičnih algoritmov ustrezno prepozna tudi pomankanje hranil v rastlinah in nam s tem omogoča enostavnejše spremljanje prehranjenosti rastlin.
90		Prepoznavanje škodljivcev/bolezni na zelenjadnicah s pomočjo pametnih aplikacij	Uporaba aplikacij, ki si jih lahko naložimo na pametni telefon, nam lahko pridelavo hrane in krme olajša na vseh nivojih. Poleg tega, da obstajajo aplikacije, ki nam lahko pomagajo pri determinaciji škodljivih organizmov, pa nam nekatere aplikacije lahko pomagajo tudi pri izbiri ustreznega pripravka za zatiranje škodljivih organizmov. Med pomembnejše aplikacije v skupini slednjih spada CampoGest, ki lahko zelo olajša komunikacijo med kmetijskimi svetovalci in kmetovalci, ki se ukvarjajo s pridelavo hrane. Z uporabo omenjene aplikacije si lahko olajšamo prepoznavanje škodljivcev in bolezni na različnih vrstah zelenjave (por, solata, cvetača, čebula, paradižnik, glavnato zelje, brstični ohrovt, kumare, idr.). Z determinacijo škodljivega organizma pa je omogočena tudi izbira ustreznega pripravka (insekticidi/fungicidi) kot tudi uporaba koristnih organizmov za zatiranje škodljivih organizmov. Obenem je ob predlaganem pripravku navedena tudi njegova najbolj učinkovita koncentracija. Uporaba aplikacije CampoGest, ki je ustrezna v pridelavi zelenjadnic v rastlinjakih in na prostem, zaenkrat še ni brezplačna, in je dostopna samo v španskem jeziku.
91	JKI/ German	Zerstörungsfreie mobile Schädlings- und Krankheitserkennungstechnologien für den	Effiziente und schnelle Eingriffe, die keine oder nur minimale Auswirkungen auf Nützlinge haben, sind wichtig für einen erfolgreichen Schutz von Gemüsekulturen und die Überwachung von Schädlingen und Krankheiten. In den letzten zehn Jahren wurden moderne Technologien, die auf intelligenten Bilderkennung und Algorithmen basieren, in Anwendungen integriert, die kostenlos oder im Abonnement für Smartphones erhältlich sind. Viele der intelligenten

	Pflanzenschutz	Anwendungen wie die *Plantix App* und die *Agri Tech App* sind in englischer, spanischer und französischer Sprache erhältlich, seltener in deutscher Sprache wie die *Cropalyzer App*. *Plantix App* ist eine kostenlose und derzeit weit verbreitete Anwendung zur Identifizierung von Schädlingen und Krankheiten anhand von Fotos der betroffenen Pflanzenteile. *Cropalyzer App* ist eine kostenlose Anwendung, die die wichtigsten Schädlinge, Krankheiten und andere Schadsymptome in Gemüsekulturen identifiziert. *Agri Tech App* erkennt Pilzkrankheiten im Anfangsstadium und schlägt geeignete Behandlungen vor. Obwohl die Anwendungen kostenlos sind, kann der Nutzer mit einem Premium-Abonnement mehr Möglichkeiten zur Identifizierung von Pilzkrankheiten anhand eines Fotos nutzen. Die zerstörungsfreie mobile Erkennung von Krankheiten ist eine Technologie, die die Überwachung von Schädlingen und Krankheiten im Pflanzenschutz unterstützt. Obwohl für bestimmte Anwendungen ein spezielles Abonnement erforderlich ist, sind sie erschwinglich und können Kleinbauern beim Gemüseanbau im Freiland und im Gewächshaus unterstützen.
92	Entscheidungsunterstützende Technologien ohne Sensor für die Pflanzengesundheit in Gemüsekulturen	Für eine wirksame Überwachung von Schädlingen und Krankheiten und die Anwendung von Bekämpfungsmaßnahmen zur Verringerung der Schäden ist es möglich und hilfreich, praktische Instrumente/Technologien einzusetzen. Es gibt Wetterstationen, die mit Hilfe von Datenloggern und Thermoelementen das Verhalten der Pflanzen gegenüber Schädlingsbefall und Pilzbefall verfolgen können. Diese modernen Klimamessgeräte bedürfen jedoch einer Bedienung von Menschen mit entsprechenden Kenntnissen. Heute gibt es Softwareanwendungen, die für den Einsatz auf mobilen Geräten entwickelt wurden und die ohne Sensoren und nur mit Hilfe von Fotos Schädlinge und Krankheiten erkennen und mögliche IPM-Strategien aufzeigen können. Ebenso kann eine intelligente Anwendung Hilfestellungen geben, was zu tun ist und welche Art von Maßnahme zur Bekämpfung von Schädlingen und Krankheiten eingesetzt werden kann. Die *Xarvio App* und die *Scouting App* erkennen Schädlinge und Krankheiten bei Paprika, Tomaten und Lauch. Agrio Technology App identifiziert Schädlinge und Krankheiten und gibt einen Überblick über die Situation der Kulturen. Die *Bioline App* kann Schädlinge und Krankheiten erkennen und empfiehlt IPS-Maßnahmen, insbesondere für Gemüsekulturen im Gewächshaus. Die intelligenten Anwendungen sind kostenlos erhältlich aber bieten dann nur wenige Optionen bei der Bilderkennung. Mit einem erschwinglichen Premium-Abonnement kann der Nutzer jedoch mehr Optionen für die Überwachung im Moment der Nutzung und die Identifizierung von Schädlingen und Krankheiten erhalten. Die Agrio Technology App und die *Bioline App* sind in vielen Sprachen verfügbar, jedoch nicht

			in Deutsch, während die *Xarvio Scouting App* auch in Deutsch verfügbar ist.
93		Deteção em tempo real do estado das culturas	A monitorização das plantas no campo é dispendiosa, trabalhosa e demorada. De forma a facilitar esta observação, os *drones*, pequenos veículos aéreos não tripulados (UAVs), equipados com diversos sensores (para avaliação remota) simplificam os procedimentos de monitorização, reduzem os custos, diminuem o tempo de recolha dos dados, e produzem informações críticas e práticas. O sistema de deteção com recurso a *drones* permite recolher dados espectrais que informam sobre o estado sanitário das culturas. A deteção precoce, com eliminação das plantas infetadas, é fundamental para um controlo eficaz da disseminação de pragas e doenças, no campo ou na estufa. As técnicas inteligentes, com recurso a UAV e avaliação remota, permitem assim que os produtores monitorizem, constantemente, o estado de saúde da cultura e detetem, precocemente, a doença nas plantas. Além disso, os índices de vegetação, como o Índice de Vegetação por Diferença Normalizada (NDVI), calculado a partir da aquisição de imagens com câmara multiespectral acoplada ao *drone*, são parâmetros simples e eficazes para a avaliação qualitativa e quantitativa do vigor das plantas, cor, cobertura vegetal e dinâmica do crescimento.
94	INIAV/ Portuguese	Como evitar A doença do míldio	O míldio é uma doença foliar muito comum, frequente nas regiões de clima temperado no período outono-inverno. É responsável por danos elevados em diversas culturas hortícolas, no campo e em estufa, especialmente quando há conjugação de temperatura amena e abundante deposição de orvalho nas folhas. Evitar a deposição de uma película de água no coberto vegetal é uma condição essencial para limitar a propagação da doença do míldio, uma vez que é imprescindível à germinação dos conídios que infetam as folhas e na indução da esporulação do agente patogénico. A doença pode ser diagnosticada visualmente e é causada por um parasita obrigatório da classe oomiceta e, no caso das brássicas, pertence ao género Hyaloperonospora. A infeção inicia-se nas plantas jovens nos viveiros e na fase adulta manifesta-se pelo aparecimento de cloroses nas folhas mais velhas, acompanhadas de esporulação abundante de cor esbranquiçada, na página inferior das folhas. A aplicação de químicos deve ser o último recurso para o controlo fitossanitário das plantas. Em culturas de ciclo curto, caso do rabanete (Raphanus sativus) e da rúcula selvagem (Diplotaxis tenuifolia), não é possível aplicar produtos químicos de síntese, uma vez que obrigaria a usar os pesticidas muito próximo da data de colheita. A deteção precoce da doença e a adoção de medidas culturais que evitem condições ambientais favoráveis ao desenvolvimento do míldio são estratégias seguidas na

			Proteção Integrada das culturas. O arejamento intenso, a utilização de sistemas de rega localizada evitando a rega ao final do dia, e a rotação cultural permitem reduzir os riscos de ataques epidémicos. Salienta-se também a importância do uso de variedades resistentes ao míldio, o que aumenta a sustentabilidade da produção com maior e melhor produção de alimentos, com diminuição de “inputs” e menor produção de resíduos.
95		Estratégias inovadoras usadas no controlo da doença do míldio	Existem atualmente diversas tecnologias inovadoras que apoiam os agricultores na otimização da proteção das culturas, e que são um investimento importante para a modernização da agricultura. A utilização de ferramentas de diagnóstico e deteção que permitem confirmar e detetar remotamente a presença da doença numa fase precoce, como os testes moleculares (testes ELISA, DNA, RNA) e as aplicações para telemóveis, aumentam a eficiência da aplicação dos produtos fitofarmacêuticos. Também é importante a monitorização da cultura, pragas e doenças com recurso a drones ou a imagens de satélite, e o uso de armadilhas inteligentes que no caso do míldio registam a presença aérea dos esporos. A redução da multiplicação do inóculo irá dificultar a infeção e diminuir o número de plantas infetadas. No apoio à decisão existem diversas ferramentas disponíveis, com e sem uso de sensores, como a instalação de estações climáticas que permitem uma resposta antecipada do agricultor perante a ocorrência de situações favoráveis à propagação da doença, assim como o uso de sensores que registam a humidade foliar. Quando há necessidade de aplicar produtos fitossanitários o recurso a sistemas de pulverização inovadores mais eficientes e drones de pulverização para tratamentos localizados são ferramentas eficazes na aplicação das doses recomendadas, com implicação direta no aumento do lucro dos agricultores.
96	EFOS/ Slovenian	Spremljanje škodljivcev: odločitev o izbiri modela pasti	Ob vpeljavi novih tehnik spremljanja pojava škodljivcev, kot na primer avtomatsko spremljanje pojava škodljivcev ali pri vpeljavi spremljanja pojava nove vrste škodljivcev, je vedno pomembno, da izberemo najustreznejši model pasti. Razumevanje obnašanja in lastnosti posameznega škodljivca je nujno za izbiro najučinkovitejše pasti. Oblika in včasih tudi barva pasti sta odločilna pri tem ali bo past delovala učinkovito ali ne. Včasih je za enega škodljivca učinkovitih več modelov pasti, takrat se pridelovalci odločijo na podlagi preteklih izkušenj spremljanja škodljivcev. Ko ne vemo kateri model pasti je za spremljanje škodljivca najučinkovitejši je najbolje, da poskusimo več različnih in se odločimo za tistega, ki nam najbolj ustreza. Avtomatske pasti se po obliki razlikujejo od klasičnih predvsem zaradi drugačnih sestavnih delov in dodatkov. Način privabljanja žuželk v ohišje pasti pa je podoben, vhodi v avtomatske pasti so narejene po zgledu vhodov klasičnih pasti prav tako pa so podobne ali enake tudi dimenzije

		opazovalnih površin. Za spremljanje pojava manjših škodljivcev iz redu Lepidoptera se največkrat uporablja delta ali wing past, za večje vešče pa so primernejše lijakaste ali cone-net pasti. Da bi izbrali najustreznejšo obliko avtomatske pasti je najbolje, da se zgledujemo po obliki klasične pasti, ki je najpogosteje v uporabi za spremljanje določenega škodljivca. Za privabljanje vešč barva po navadi ni pomemben dejavnik, ker so dejavne v mraku in temi, izbira barve teh pasti pa je pomembna, ker ne želimo privabljati koristnih organizmov. Izbira barve pa je zelo pomembna tudi pri privabljanju žuželk, ki so aktivne podnevi kot so na primer različne muhe, listne uši in resarji.
97	Spremljanje škodljivcev: kemična privabila	Pasti so ustvarjene tako, da privabijo žuželko v svojo notranjost in jo tam zadržijo. Obstaja veliko število kemičnih in vizualnih privabil, ki so ključna komponenta aktivnega spremljanja pojava škodljivcev. V nekaterih pasteh lahko uporabljamo celo kombinacije različnih privabil, da zagotovimo najboljše delovanje. Obnašanje žuželke večinoma uravnavajo semiokemikalije, ki so prisotne v njenem okolju. Semiokemikalije omogočajo boljšo komunikacijo med posameznimi osebki iste vrste (npr. feromoni) ali med osebki, ki pripadajo različnim vrstam (npr. alelokemikalije). Feromoni so semiokemikalije, ki jih oddajajo in sprejemajo osebki iste vrste in tako komunicirajo med seboj. S feromoni je uravnavana vrsta bioloških procesov, ki vplivajo na obnašanje osebka, za potrebe privabljanja škodljivcev v pasti pa so najpogosteje uporabljene spojine, ki jih oddajajo samice, da privabljajo samce (spolni feromoni). Feromonske pasti privabijo samce že pri nizki zastopanosti populacije v okolju in nam tako omogočajo zgodnjo detekcijo. Čeprav so feromoni spojine, ki so različne pri vsaki vrsti, se včasih v past ujamejo tudi osebki drugih vrst, včasih pasivno ali pa zaradi tega, ker različne vrste izločajo podobne feromone. Število ne ciljnih vrst v pasti je navadno nižje od števila vrst, ki jih želimo privabiti. Specifično in natančno privabljanje je velika prednost feromonskih pasti, ki nam zelo olajša spremljanje populacije škodljivcev. Privabila s semiokemikalijami so različnih oblik: gumijasti dispenzerji, votle membrane, feromonski kosmiči, feromonski trakovi, plastika prekrita s feromonom, feromonske membrane, feromonske kapsule… Oblika vabe naj bi zagotavljala oddajanje feromona v okolje na način, ki oponaša naravni način in koncentracije sproščanja tarčnih organizmov. Privabila se razlikujejo glede na trajanje učinkovitosti in razdaljo privabljanja žuželk, zaradi koncentracije feromona v privabilu in načina sproščanja feromona. Privabilo s kontroliranim sproščanjem feromona nam omogoča sproščanje nizke koncentracije feromona, ki

		privabi osebek v past a hkrati dovolj močne, da jih privabi tudi iz večje razdalje.
98	Spremljanje škodljivcev: vizualna privabila	Barva je lahko močno privabilo. Žuželke prepoznavajo odtenke in intenzivnost posamezne barve, da najdejo gostiteljsko sadje ali rastlino. Pomembno lahko vpliva tudi kontrast med svetlobo in temo, ali kontrast med barvo pasti in barvo v ozadju, ali uporaba črt po katerih se žuželke orientirajo na kontrastne robove med temnimi in svetlimi deli pasti. Za žuželke iz redu stenic in dvokrilcev je običajna rumena barvna vaba. Veliko vrst žuželk privablja tudi svetloba različnih valovnih dolžin. Slaba stran svetlobnih vab pa je, da niso selektivne in zato privabijo številne vrste vešč, hroščev, muh in ostalih žuželk, ki niso škodljivci. Za prepoznavo škodljivcev v svetlobni pasti potrebujemo več dela in izkušenj, ker pa lovimo osebke obeh spolov nam nudi celostno sliko zastopanosti populacije. Svetlobne vabe so odlično orodje za določanje raznolikosti vrst vešč v različnih habitatih. Radij privabljanja svetlobnih pasti z nižjo svetilnostjo je manjši od feromonskih pasti. Prisotnost močne umetne svetlobe (npr. ulična razsvetljava) ali v obdobjih močne mesečine svetlobna past ni učinkovita.
99	Spremljanje škodljivcev: namestitev pasti na teren	Način namestitve pasti in gostota pasti na terenu sta odvisna od sposobnosti razpršitve žuželk in njihovih letalskih sposobnosti, zato so priporočila za namestitev pasti vrstno specifična. • Past mora biti nameščena in funkcionalna preden se škodljivec pojavi. Pri odločanju kdaj bomo postavili pasti nam lahko pomaga poznavanje biologije škodljivca in izkušnje s spremljanjem iz preteklih let ter vremenska napoved za kraj kamor bomo umestili past. • Past mora biti postavljena v posevek na višino posevka ali tik nad posevek, kjer je aktivnost škodljivcev največja, lahek dostop ne sme biti pogoj za izbiro mesta postavitve pasti. Na poljih morajo biti pasti postavljene na delovno površino z vhodom tik nad posevkom, v sadovnjakih pa morajo biti umeščene v zgornjo tretjino drevesne krošnje. • Za postavitev pasti moramo izbrati mesto, kjer je bila v prejšnji sezoni zastopanost škodljivca velika ali na ti »hot spot«. Pasti postavljamo v notranjost sadovnjaka/vinograda ali v notranjost polja. Izogibamo se postavljanju pasti v robne vrste, razen v primeru posebnih navodil zaradi specifičnega obnašanja škodljivca. • Razdalja med pastmi naj bo vsaj 40m, če spremljamo več kot enega škodljivca moramo za vsako privabilo uporabiti svojo past. Če damo v eno past več kot eno kemično privabilo lahko pride do kontaminacije, kar povzroči nedelovanje privabila. • Vhod v past mora biti žuželkam lahko dostopen.

		• Past mora biti postavljena vzporedno s smerjo vetra za optimalno razpršitev feromona. • Pasti označimo z imenom in vrsto škodljivca, ki ga spremljamo, še posebej, kadar spremljamo pojav več različnih škodljivcev na enkrat ali če vzpostavimo mrežo pasti, za spremljanje pojava različnih vrst škodljivcev. • Ko je past postavljena na mesto jo označimo s trakom svetle in močne barve, ta nam jo pomaga najti kasneje v rastni sezoni, ko so zaradi vegetacije pasti slabše vidne in jih delavci na polju ali v sadovnjaku/vinogradu težje opazijo. • Pasti, če je možno ne umestimo na območje z veliko prahu. Prah se prilepi na lepljivo površino in s tem zmanjša njeno učinkovitost. • Izogibamo se postavljanju pasti na območja kjer se pogosteje zadržujejo ptiči ali druge prostoživeče živali in tako preprečimo, da bi zašle v past. • Pasti postavimo na mesta, kjer jih ne bodo poškodovala kmetijska mehanizacija.
100	Spremljanje škodljivcev: pravila za rokovanje s privabili	Privabila morajo biti vedno skladiščene v skladu s priporočili proizvajalca. Pogoji skladiščenja so odvisni od lastnosti vrste vabe. Feromonske vabe so navadno skladiščene na suhem mestu, brez večjih temperaturnih nihanj in zaščitene pred direktno sončno svetlobo. Nikoli ne smemo puščati privabil v avtomobilu ali kateremkoli mestu, kjer bi bile izpostavljene visokim temperaturam, saj to lahko povzroči, da privabilo ne deluje. Dokler privabila ne uporabimo v pasti mora biti shranjeno v originalno zaprti embalaži. V past ga vstavimo tik preden pričakujemo pojav spremljanega škodljivca. Feromonske mešanice so specifične za vrsto, zato so žuželke občutljive že na zelo majhne količine feromona. Pri rokovanju s privabili s semiokemikalijami moramo vedno nositi rokavice za enkratno uporabo, da preprečimo navzkrižno kontaminacijo z drugimi privabili. Tudi v primeru, ko rokujemo samo z eno vrsto privabila moramo uporabljati rokavice ali pinceto za enkratno uporabo, ker se v stiku s kožo privabilo kontaminira kar poslabša delovanje. Embalažo privabila moramo vedno odstraniti iz polja/sadovnjaka/vinograda, saj že neznatna količina feromona, ki jo vsebuje embalaža, lahko konkurira vabi v pasti. Če past uporabljamo več rastnih sezon se moramo izogibati temu, da naslednjo sezono v isti pasti uporabimo privabilo za drugo vrsto škodljivca kot prejšnjo sezono.
101	Spremljanje škodljivcev: glavne razlike med	Glavna vloga vsakega aktivnega sistema spremljanja škodljivcev je privabljanje in zadrževanje žuželk v pasti. Zaradi posebnih karakteristik imajo avtomatske pasti vsaj dve dodatni potrebi:

		konvencionalnimi in avtomatskimi sistemi spremljanja škodljivcev	Napajanje: pasti delujejo samo z napolnjenimi baterijami, to lahko zagotovimo z baterijami z veliko kapaciteto ali s polnilnim sistemom za baterije. Ko za polnjenje uporabljamo sončne celice, jih moramo namestiti nad vegetacijo in zagotoviti dobro osončenost. Na severni polobli naj bodo obrnjene proti jugu, na južni polobli pa naj bodo obrnjene proti severu. Sončne celice ne smejo biti zasenčene, pomembno je, da vse liste okrog sončne celice redno odstranjujemo. Povezljivost: naprava mora vzpostaviti omrežno povezavo, da lahko deluje. Naprava ne deluje, če je omrežna povezava na območju slaba ali je ni. Na povezljivost lahko vpliva izbira SIM kartice z vsemi potrebnimi nastavitvami, ki omogočajo delovanje naprave pri operaterju, ki na terenu kjer imamo naprave nudi dobro omrežno povezavo. Na povezljivost pa vpliva tudi modem v napravi, ki nam določi tip omrežja, na katerega se naprava povezuje in antena, ki lahko poveča moč signala. Avtomatski sistemi za spremljanje škodljivcev samodejno beležijo in shranjujejo podatke. Natančno izmerjeni podatki in izvedeni nadzorni ukrepi so pomembni za boljše načrtovanje ukrepov v prihodnjih sezonah. Primerjava rezultatov nam da vpogled v bistvene spremembe v obnašanju škodljivcev in populacijski dinamiki vrste. Napredni avtomatski sistemi za spremljanje škodljivcev nam nudijo različne statistične analize, oblikujejo poročila in napovedi o stanju škodljivcev na terenu.
102	KU Leuven/ Dutch	Identificeren van insecten aan de hand van hun vleugelslag signatuur	Insectenmonitoring is een essentieel aspect van geïntegreerde plaagbestrijding, en het identificeren van insectensoorten is van cruciaal belang om effectieve bestrijdingsmaatregelen te garanderen. Vleugelslagsignalen zijn een uniek kenmerk van vliegende insecten dat kan worden gebruikt om onderscheid te maken tussen soorten. Deze signalen worden opgewekt door het op en neer bewegen van de vleugels van insecten en worden doorgaans gemeten met akoestische, optische of andere gespecialiseerde sensoren. Optische sensoren kunnen bijvoorbeeld de vleugelbeweging van een insect tijdens de vlucht volgen met behulp van een tegenover elkaar geplaatste lichtzender en -ontvanger. Het insect blokkeert het uitgezonden licht, waardoor een karakteristiek patroon van lichtintensiteitsmetingen ontstaat. Recent onderzoek is gericht op het gebruik van kunstmatige intelligentie (AI) om insectensoorten te identificeren op basis van hun vleugelslagsignalen. Door het vleugelslagsignaal rechtstreeks te analyseren of de frequentie of tijdfrequentie ervan te extraheren, kunnen convolutionaire neurale netwerken (CNN's) met grote nauwkeurigheid onderscheid maken tussen verschillende insectensoorten. Zo kan een akoestische sensor (microfoon) het zoemende geluid van een mug opnemen, dat vervolgens door AI-

		modellen kan worden geanalyseerd om het niet alleen te onderscheiden van het geluid van een bij, maar ook om de specifieke muggensoort aan te wijzen waartoe het geluid behoort. Bovendien hebben recente studies aangetoond dat CNN's de vleugelslagen van insecten effectief kunnen categoriseren, zelfs wanneer hun vluchtpatronen sterk op elkaar lijken. Zo hebben Kalfas et al. (2022) met succes vleugelslagsignalen van twee nauw verwante soorten fruitvliegen van het geslacht *Drosophila* (*melanogaster* en *suzukii*) geclassificeerd met behulp van een model met de naam "InceptionFly". Dit model behaalde een hoge mate van nauwkeurigheid, met een gebalanceerde nauwkeurigheid van 92,1% op een onafhankelijke test set en 91,7% op een bijkomende, onafhankelijke dataset die real-world, in-field omstandigheden simuleerde. Deze bevindingen suggereren dat deze aanpak een vroege en geautomatiseerde detectie van *D. suzukii* aantasting in fruitboomgaarden mogelijk zou kunnen maken, wat een veelbelovende oplossing biedt voor dit economisch belangrijke plaagprobleem. De toepassing van dergelijke technieken bij het monitoren van insecten is een efficiënte methode gebleken om de opkomst van invasieve plagen in een vroeg stadium op te sporen en de gevolgen voor de gewasproductie tot een minimum te beperken. Met de ontwikkeling van nieuwe technologieën zoals optische sensoren en modellen voor “machine learning” is insectenmonitoring toegankelijker geworden, waardoor boeren waardevolle inzichten krijgen in hun plaagdierpopulaties.
103	Monitoren van insecten met behulp van artificiële intelligentie (AI)	Insectenbewaking is een cruciaal aspect van de moderne landbouw, omdat plagen aanzienlijke schade aan gewassen kunnen toebrengen, wat leidt tot aanzienlijke economische verliezen. Traditionele methoden van insectenbewaking bestaan uit handmatige observatie en vangst, wat tijdrovend en arbeidsintensief kan zijn. De komst van automatisering en kunstmatige intelligentie (AI) biedt echter nieuwe mogelijkheden om de efficiëntie en efficiëntie van insectenmonitoring te verbeteren. Een mogelijke toepassing van automatisering in de insectenbewaking is het gebruik van sensoren om de aanwezigheid van insecten in velden te detecteren. Deze sensoren kunnen op strategische plaatsen in het veld worden geplaatst, in slimme vallen worden ingebouwd en worden geprogrammeerd om kenmerkende patronen van beweging of gedrag van insecten te detecteren. Sommige sensoren kunnen bijvoorbeeld het geluid van insectenvleugels waarnemen tijdens vlucht, terwijl andere gebruik kunnen maken van trillingen of licht om de beweging van insecten te detecteren. Andere technologieën maken gebruik van teledetectie door gebruik te maken van radar- of satellietgegevens die een indicatie kunnen geven van de aanwezigheid van insecten op basis van de gezondheid van de gewassen. De met deze vallen verzamelde gegevens kunnen worden gebruikt om kaarten te maken van de

verspreiding van plagen, die met telers kunnen worden gedeeld om hen te helpen bij het nemen van beslissingen.

Complexe sensorgegevens kunnen worden geanalyseerd met behulp van AI-algoritmen om specifieke plagen te identificeren en hun populatiedichtheid in te schatten. AI kan de verwerking van sensorgegevens helpen automatiseren en realtime informatie verschaffen over de aanwezigheid en het gedrag van insecten in het veld. Door gebruik te maken van deze informatie kunnen telers effectief gerichte plaagbestrijdingsmaatregelen uitvoeren, waardoor de afhankelijkheid van insecticiden met een breed spectrum aanzienlijk kan worden verminderd. Deze aanpak kan nuttige insecten helpen beschermen en de ontwikkeling van resistentie tegen pesticiden voorkomen, waardoor uiteindelijk een duurzamere en milieuvriendelijkere landbouwpraktijk wordt bevorderd. Bovendien kunnen AI-modellen op basis van historische gegevens (bv. seizoensgebonden trends) de potentiële toekomstige bedreiging van plagen voorspellen, zodat telers plagen kunnen voorkomen voordat ze zich voordoen.

In het algemeen heeft het gebruik van automatisering en kunstmatige intelligentie bij het monitoren van insecten het potentieel om de efficiëntie en nauwkeurigheid van het opsporen en beheren van plagen te vergroten. Door de noodzaak van handmatige arbeid te verminderen en telers real-time informatie te verschaffen over het gedrag van insecten, kan deze technologie helpen de gewasopbrengsten te verbeteren en de economische impact van insectenschade op de landbouw te verminderen.