



PROJECT DELIVERABLE REPORT
Deliverable 7.3: Generic exploitation plan



**Fruit Flies In-silico
Prevention & Management**

FF•IPM

Project Title:

**In-silico boosted, pest prevention and off-season focused IPM against
new and emerging fruit flies ('OFF-Season' FF-IPM)**

SFS-2018-2

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1 Summary

This document is the final version of the FF-IPM exploitation strategy titled D7.3 Generic exploitation plan. The exploitation plan covers operations of the FF-IPM platform, general principles of service providing and IPR handling/sharing, defining accession principles for exploitable outcomes. The FF-IPM exploitation plan defines the unique selling points and market potential of these services for the different potential customer groups and identifies the need for adaptation to the specific customer needs.

Its structure is as follows:

- Section 1 (Introduction) familiarizes the reader with the importance of a successful exploitation strategy, as well the objectives and methodology of the current exploitation plan;
- Section 2 (Problems) mentions the main problems related to fruit flies that the FF-IPM project is expected to tackle;
- Section 3 (Solutions) describes FF-IPM Platform as a SAAS (Software As A Service) and identifies project outputs that can be exploited in a commercial and in a non-commercial way;
- Section 4 (Exploitation Pathways) describes the high-level exploitation strategy by which the partners will ensure the long-term sustainability of FF-IPM's results and defines the different ways the FF-IPM outcomes may be exploited. The next chapter will elaborate the detailed exploitation plan for each of the identified FF-IPM's outcomes;
- Section 5 (Market analysis) is a preliminary overview of the market for FF-IPM products, including competitors and substitutes for it. It also lists potential risks that may hinder the adoption of FF-IPM's solution by third parties and potential customers;
- Section 6 (Strategy and action plan) is a first attempt towards defining a business development strategy for the post-project phase. It outlines the four key factors related to the definition of a Business Model: customer, value creation and capture, competition and distribution. These will be clarified and discussed in the next edition of this document;
- Section 7 (Intellectual Property Rights Management) describes the appropriate actions for protecting IPRs in compliance with the H2020 rules and regulations;
- Section 8 (Conclusions) summarizes the current understanding of the FF-IPM solution and points at the next project phase as crucial for verifying the solution potential, notably related to its scalability.

2 Introduction

In this deliverable, we present a draft of the generic exploitation plan for the FF-IPM project. It is important to keep in mind that this is a work in progress and the final exploitation plan may change to take into consideration the users feedback.

FF-IPM project will develop several kinds of outputs, which constitute the holistic solution system to empower stakeholders across all sectors along the fruit production and processing chain to (a) dynamically address the impending risks of fruit fly (FF) invasion, and (b) efficiently apply FF management throughout a spatial and seasonal continuum in a comprehensive, multi-actor and locally-adapted manner. The key novelties of the project include novel concepts, new knowledge, advanced tools, innovative services and businesses. Project's ambition is to drive a major increase in the European capacity to timely, proactively and optimally prepare for and respond to seasonally and spatially fluctuating risks of FF introduction and range expansion.

The exploitation strategy defines application segments of the innovation, economic size of the target markets and their geographic coverage. It identifies potential users and stakeholders and sets objectives for addressing and involving them in the project. It compares their needs to the kind of problem the proposed solution solves and outlines why this solution is better than existing ones in terms of benefits to users and society at large. In addition, it refers to the knowledge (IPR) that the project will generate compared to the state of the art or what is commercially available today. Finally, at the end of the project, it shall be clear which further actions shall be taken both in terms of scientific and commercial follow up. Options range from further internal research, collaborative research, internal product development, internal service creation, licensing, assignment, joint venture, to creating a spin-off, or supporting standardization activities (European IPR Helpdesk, 2015/2).

Research innovation is a driving force for economic growth, the creation of new job opportunities and the enhancement of the standard of living. It is therefore important to ensure that the knowledge generated within research and innovation projects is properly diffused and that the means through which such knowledge can be delivered to the society are being effectively explored. This is realized through the commercial exploitation of products and services, which is the primary way of delivering research results to the citizens (end-users).

2.1 Purpose and Scope

Overall objectives of the exploitation task are fostering exploitation by ensuring contacts to stakeholders, collecting needs and requirements, identifying challenges for implementation, summarizing impact, and developing the exploitation plan and strategy.

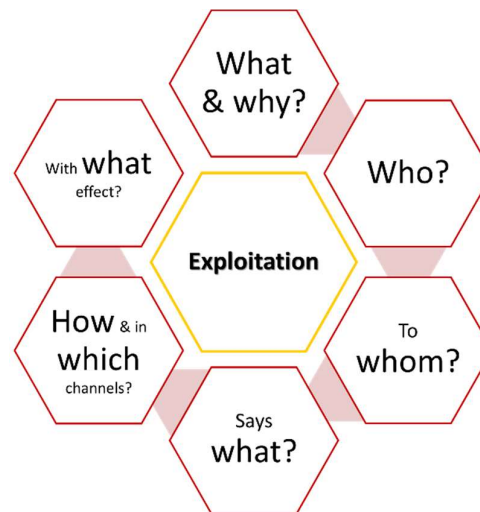
The objective of this deliverable is to provide an overview of the methodological approach for the development of the exploitation strategy

throughout the project and to summarize the first exploitation activities that have taken place so far.

The present report contains an overview of the exploitation strategy applied by the FF-IPM consortium to effectively distribute the results generated within the project to the relevant target audiences based on their interests and via a comprehensible manner.

The exploitation plan has been developed towards covering operations of the FF-IPM platform, general principles of service providing and IPR handling/sharing, defining accession principles for exploitable outcomes. D7.3. as the initial version of the exploitation strategy plan has the following specific objectives:

- To clearly identify the different types of the key exploitable outcomes (knowledge, methods, agreements, networks, technologies) and their direct and indirect value and impact for different stakeholders
- To define the unique selling points and market potential of these results/ services for the different potential customer groups and identifying the need for adaptation to the specific customer needs by e.g. engaging them in the project;
- Present the exploitation support actions and concrete activities implemented throughout FF-IPM to ensure the validity of the exploitable project results and the overall exploitation plan;
- To establish exploitation channels by developing a business plan and strategy for exploitable project outcomes.
- To describe the roles and responsibilities of partners in exploiting results or supporting results exploitation by other (intermediate or end) users



2.2 Exploitation Methodology

The FF-IPM exploitation methodology was structured in a 3-step process, having the aim to support the partners in the definition of the project exploitation strategy reported in this document. All partners were actively involved in the process and contributed to its application.

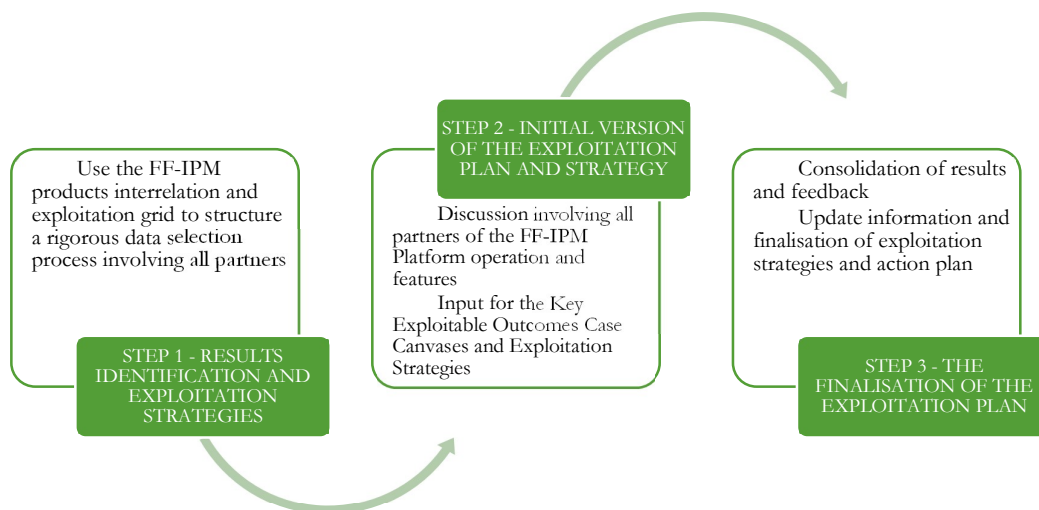


Figure 1. Exploitation Methodology and Process

The document is to be considered preliminary as it reflects the plans that the partners have at the current stage of the project (M36). A complete and more detailed version will be released at the end of the project (M48).

3 Problems

Fruit production is facing new challenges because of climate, environmental, social and political changes. FF-IPM will break new ground to confront imminent threats of new and emerging fruit flies (FF) (both Regulated Non-Quarantine FF and EU Quarantine pest species).

FF-IPM targets 3 invasive FF pests (Diptera: Tephritidae; *Ceratitis capitata*, *Bactrocera dorsalis*, and *B. zonata*) of global concern, which pose an imminent and severe threat to European horticulture (EPPO, EC directive 200/29/EC). These species cause devastating losses for the fresh fruit production industry worldwide. The risks of arrival, establishment and range expansion of these invasive FF are expected to escalate because of global climate change, increased trade and human mobility.

In addition, the ban of neonicotinoids, which is one of the main control tools against FF in Europe, poses an additional burden on fruit growers in Europe. The partial ban and use restriction of neonicotinoid pesticides in the EU and the limited availability of alternative plant protection options, will expose European fruit-producers to increased economic burdens of unmanageable FF populations.

Fruit Production in the EU provides an income for more than 1.5 million holdings, with more than EUR 21 billion of aggregate value, constituting a considerable part of the European agricultural output. FF poses a huge burden in this industry because of both direct effects and quarantine regulations that impede fruit trading.

4 Solutions

The FF IPM consortium is developing a holistic approach and solution towards Fruit Flies tackling pest invasion and applying an innovative management process: from prevention against pest invasions, to early detection of invasion/establishment/resurgence events, up to pest management.

In this context, the FF IPM partners will develop, adopt and adjust web-based robust modeling tools to radically alleviate the major operation obstacles in current FF prevention and early detection and control. Some of the solutions were based on the following existing modeling platforms which were further enhanced and combined to the FF-IPM's novel concepts during the project implementation.

Modelling platform – overview	Purpose - typical applications/ Main users	Role in FF-IPM
CLIMEX:		
<p>Primary function: Generates maps of the areas potentially suitable for pest establishment and thus projects potential pest distributions.</p> <p>Typical scale: Large-scale (global, regional, country-wide maps)</p> <p>Key inputs: Monthly climate/ weather data, basic pest demography parameters, historic records of pest presence.</p> <p>Resolution: Spatial: usually 15 km (1 km, if detailed climatic data available), Temporal: 1 week.</p>	<p>Pest risk assessment under current and future climates. Estimating potential geographical distribution and seasonal climate suitability for growth of pest population.</p> <p>Main users: NPPO's,</p>	<p>Serve as a basis for development of a dynamic (real-time) forecast toolbox, DSS-Alert, for informing decision- makers about the risk of introduction and establishment of <i>Bd</i> and/or <i>Bz</i>, and range expansion of <i>Cc</i> (WP5 Task 5.1)</p>
	<p>Dynamic pest surveillance: Week-specific estimates of the suitability of climatic conditions for pest population growth, with potential use in within-season forecast mode.</p> <p>Main users: RPPO's, NPPO's, GA's</p>	
DYMEX:		
<p>Primary function: Generates 'real-time' projections of seasonal pest development patterns according to weather forecasts.</p> <p>Typical scale: Medium-scale (country- or district-wide maps)</p> <p>Key inputs: Daily weather data, pest demographic data (preferably host-specific)</p>	<p>Alert of pest incursion & timing IPM operations: The outputs can be used to alert pest managers (farmers and agronomists) to emerging population threats, and guide targeting field operations.</p> <p>Main users: NPPO's, GAs', Agronomic consultants, Farmers</p>	<p>Serve as a basis for development of a DSS- Alert component for spatiotemporal optimisation of early detection systems (WP5, Task 5.1)</p>

<p>Resolution: Spatial – ca. 1 km, Temporal – 1 day</p>		
PESTonFARM:		
<p>Primary function: Simulates lifetime behaviour and development of individual insect and emulates IPM on-farm processes. Generates detailed projections of seasonal pest and fruit infestation patterns, effects and cost/benefits of IPM</p> <p>Typical scale: local, farm-scale, 10-100 ha Key inputs: individual behaviour, dispersion and development; host preference, suitability and phenology; terrain topography, schedules and traits of IPM treatments, local climate and daily weather.</p> <p>Resolution: Spatial:10-25m (depends on insect mobility), Temporal:1 day</p>	<p>“Virtual farm” - design site-optimised ‘precision’ IPM strategies: <i>in-silico</i> assessment of a range of IPM scenarios and selection of the most promising, according to traits of the local terrain, climate and site- typical weather fluctuations.</p> <p>Assessment of survival/fate of incipient populations: emulation of behaviour, dispersion, of ultra-low density populations according to traits of the local terrain, etc.</p> <p>Optimisation of local monitoring grids: <i>in-silico</i> assessment of various grid configurations based on pest density and traits of the local terrain, etc.</p> <p>Main users: NPPO’s, IPM advisors, farmers</p>	<p>Serve as a basis for development of decision-support toolbox, DSS- Virtual Farm, for design of locally-optimised ON & OFF-SEASON precision <i>Ce</i> IPM. (WP6, Task 6.1)</p>

To reduce the costs, enhance system reliability and responsiveness, and expand applicability of the current prevention operations, we will focus on development-implementation of automated systems and business-model services.

4.1 The FF-IPM Platform

The FF-IPM's proposed solution is to develop holistic knowledge-based approaches and web-based foundation for dissemination of technology and know-how, innovative tools and expert services, to empower stakeholders across all sectors along the fruit production and processing chain to

- (a) dynamically address the impending risks of FF invasion, and
- (b) efficiently apply FF management throughout a spatial and seasonal continuum in a comprehensive, multi-actor and locally-adapted manner.

Exploitation will link with the promotion of the project and with its accomplishments beyond its timespan, ensuring its sustainability, to enable decision - makers, organizations and other actors to incorporate project results into existing systems, practices, and processes. The rationale behind the FF-IPM Platform is to link services and products developed either by FF-IPM, or other researchers and innovators across the EU and beyond, thus providing technical support to the end-users.

According to the Deliverable 7.1, *Initial version of the FF Management Platform functional*, generally, the FF Management Platform will consist of two areas, the Project Accomplishment Archive and the Expert Services Catalog, which constitutes a client-communication tool with active links to external (e.g. SME based) expert services.

In line with the features above, the [FF-IPM Platform](#) houses documentation and research developed during the project as well as organized, dynamic web-based access to new expert services. It acts as an easy-to-use, intuitive showcase of the expert services and tools available, allowing visitors to quickly find a tool or service that suits their needs.

4.1.1 Services and tools

The expert services and tools in the FF-IPM platform have been categorized as illustrated in the figure below;

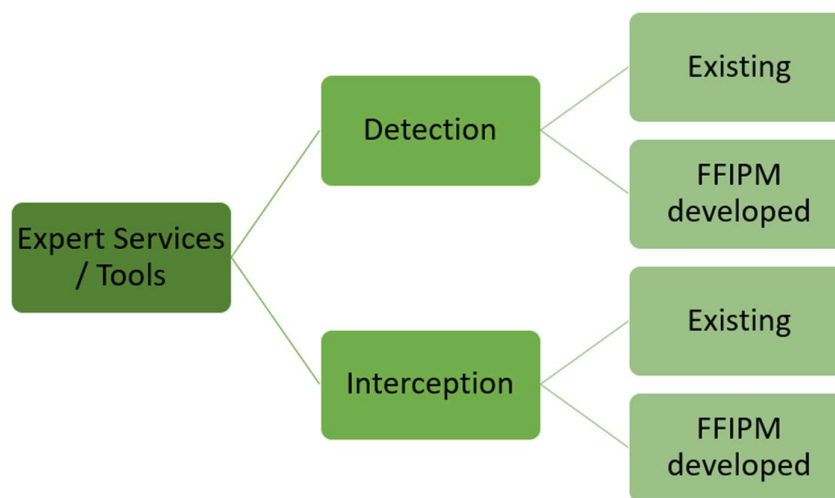


Figure 2. *Categorisation of FF-IPM's services and tools*

Each has been thoroughly researched and chosen to meet the sector's diverse needs. When it comes to Detection and Interception, there are inevitable overlaps in order to better respond to the relevant issues and be of greater benefit to the visitor.

An overview of the **expert services** offered in the FF-IPM Platform is shown in table below;

Name of Service	Brief Description	Categories	Service Type
RMCA -Key important fruit flies EU	The key contains characters to differentiate between adults of 29 fruit fly species of the subfamily Dacinae, that are considered of economic significance to agriculture and horticulture in Sub-Saharan Africa.	Detection, FF-IPM Developed	App
Fruit fly trapping	The guide includes an overview of the most common Mediterranean FFs and a thorough explanation of the FF-IPM e-trap.	Detection, FF-IPM Developed, Interception	Document
Major Pest Fruit Flies of the World	The guide aims to provide a general reference for those involved in plant quarantine activities, and the marketing of fresh fruits which may be infested with fruit flies.	Interception, Detection, Existing	Document
RMCA – A set of multi-entry identification keys to African frugivorous flies (Diptera, Tephritidae)	This tool assists specialists in the correct identification of pest species based on the use of traditional dichotomous identification keys, also known as ‘single-access’ keys (two choices for each identification step).	Detection, Existing	Online tool
Prevent fruit fly	In this site, the National Fruit Fly Council brings together different stakeholders and provides advice and research to promote the implementation of a cost-effective and long-term fruit fly management strategy across Australia	Detection, Interception, Existing	Website
QUT Science: Fruit Fly Research Group	This group aims to carry out research to underpin the sustainable management of fruit fly pests, both in Australia and globally.	Detection, Existing, Interception	Website

Biodelear	The project demonstrates the use of an innovative attractant throughout the Med region and provides farmers, stakeholders and policy makers an Integrated Med Strategy to address med fly by an environment friendly, effective and low cost way.	Detection, Existing, Interception	Website/ Project
EPPO Global Database	The aim of the database is to provide all pest-specific information that has been produced or collected by EPPO. The database contents are constantly being updated by the EPPO Secretariat	Detection, Existing, Interception	Database
Tephritid Workers Database	This database collects and shares information about the Tephritid fruit flies, so that workers worldwide can keep up-to-date on the most recent developments.	n/a	Database

Similarly, visitors can choose from a variety of FF-IPM **tools** collected and developed during the project, as shown below.

Name of tool	Brief Description	Categories	Tool Type	Crop type
Kobo-Fly: A field data collection system for fruit fly surveillance	Data collected in the field is made available for web-mapping almost instantly, reducing the amount of time needed to collect, digitise, clean and merge trapping data.	Detection, FF-IPM Developed	Mobile application	Orchards
DSS-Alert	A set of web-based risk reporting/ modeling/ forecasting information regarding FF.	Detection, FF-IPM Developed, Interception,	Online tool	Orchards, Vineyards
Delta Electronic Trap	A new, electronic, energy independent trap, used for automated early detection of invasive Tephritid species.	Detection, Interception, FF-IPM Developed,	Trap	Orchards

McPhail Electronic Trap	A new, electronic, energy independent trap, used for automated early detection of invasive Tephritid species.	Detection, Interception, FF-IPM Developed,	Trap	Orchards
Fytoweb – CASA	This Crop Adapted Application System (CASA) was developed to ensure precise, efficient and safe spray application in orchards, according to actual needs of the crop and with respect to the environment.	Existing, Interception	Technology Component	Orchards, Vineyards
Decis Trap	It constitutes a plastic trap made by Bayer AG, which can be used as a dry type trap for pest monitoring and mass trapping.	Detection, Interception, Existing	Trap	Orchards
Jackson Delta Trap	The Jackson trap is a Delta type trap, made from processed paper, used for mass trapping and monitoring.	Detection, Existing, Interception	Trap	Orchards
McPhail Trap	A funnel-like trap, which captures insects using different kinds of attractants.	Detection, Interception, Existing,	Trap	Orchards
A Motor-Driven and Computer Vision-Based Intelligent E-Trap for Monitoring Citrus Flies	This paper presents a monitoring scheme based on automatic e-traps and novel recognition algorithms, to address issues in reliable detection and identification.	Detection, Interception, Existing	Study	n/a
FruitFlyNet	This project aims to contribute to the development and implementation of	Detection, Interception, Existing	Project	Fruit Orchards

	environmentally effective e-monitoring and ground spraying control solutions, based on prototypes, technological innovations, and knowledge transfer for specific key-pests in the Mediterranean.			
Inovel CleverSpray	This control unit helps users in different spraying operations as well as monitoring and operating of sprayers with smartphone or tablet.	Existing, Interception	Technology Component	Orchards & Vineyards
Tephri Trap	A funnel-like trap, which captures insects using different kinds of attractants.	Detection, Existing, Interception,	Trap	Orchards
Perfect Life	The project seeks to demonstrate the reduction of the environmental contamination of pesticides which will lead to a decrease of the pesticide risk for fauna, flora and humans.	Existing, Other	Project	Arable Crops, Open field, Open field vegetables, Orchards & Vineyards

The platform's structure enables visitors to quickly browse and obtain information about the various services and solutions. It aspires to be a comprehensive solution for informing industry professionals on the one hand, and a first grouping of services for future commercialization on the other. After all, the platform plans to include the Decision-support system (DS-Alert) as well as On and Off-Season IPM services in a later version. This will be a live, interactive system, with the interface needs currently under development (D7.1).

In the sections below, we provide a more detailed overview of each of the services and tools developed by the FF-IPM project and explore their entrepreneurial potential and exploitation strategies.

4.1.2 Value Proposition

A range of entirely new expert services are developed and integrated under a central FF Management Platform. **In FF domain, no examples of such integrative service systems exist in Europe to date.**

To address the European needs (small size, scattered farms, operated under diverse socioeconomic and regulatory frameworks), FF-IPM will build on existing knowledge, identify and fill the critical information gaps, boost regional FF prevention by developing new and enhancing the existing interception and detection tools and provide new in silico assisted IPM approaches that will be validated and adapted to European socioeconomic and agricultural conditions.

The FF Management Platform is foremost a marketing/dissemination and not a commercialization tool. However, each product/service will have varying degrees of “exploitation” on the platform (from simple presence to full functional service). There are already good paradigms of potential successful products and services from the list indicated in the following section.

Regarding business plans/exploitation plans, issues of availability i.e. availability to the whole community of the FF-IPM project or availability through "private" areas, it will be provided only a summary on the website, where they are being discussed.

The Platform is scheduled to be continued after the end of the project and our main role is to keep it sustainable for at least 5 years after that. A business model is foreseen in Section 5.2 to commercialize this tool and explore further opportunities for its sustainable future.

4.1.3 Key exploitable results

This section intends to give a first concentrated overview of the key project outputs that are going to be developed/delivered and provided via the FF-IPM Platform and how each serves the users as well as the bottlenecks their usage addresses. The outputs of the project can be either used separately or the interrelation between the outputs will also be discussed as some of them are very closely linked.

In this section we focus on the business case, the market potential/ analysis and the interalliances of novel concepts, tools and services that will be developed, adopted, adjusted and integrated in the FF-IPM Platform to facilitate prevention, detection and control of FF.

The exploitable products of the project were analyzed and categorized to note down the individualized levels of development (TRL level).

Emphasis was given on the development of the pilot product “e-trap” and its characteristics, as a guide that can be used further for additional products and services. In this direction, the end users per case (farmers etc.) were considered, in relation with the connection of the product to other similar products (“traps”) and with the other outcomes of the project, the potential users/target groups and the overall cost of the product.

The project has products and services at different TRL advancement, with the aim being to approach TRL 7 for all products. The different envisaged TRLs were also discussed.

As reference the definition of the TRL is given below:

TRL 1 –basic principles observed

TRL 2 –technology concept formulated

TRL 3 –experimental proof of concept

TRL4 –technology validated in lab

TRL 5 –technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)

TRL 6 –technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)

TRL 7 –system prototype demonstration in operational environment

TRL 8 –system complete and qualified

TRL 9 –actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space

Not all outputs of the FF-IPM project can be commercialized. Each service/product was analyzed based on the opportunity for exploitation. Researchers will provide an actual update on each product and service that they develop. This information will be uploaded to the FF-IPM platform.

Priority level in exploitation was decided after discussions between the Consortium Partners and is indicated in each business case.

CASE Template Analysis

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	<i>Commercial or non-commercial (scientific) use?</i>	
<i>as indicated the in the DoA</i>	- who is going to benefit from this product/ service/ tool? - who is going to use it? - who is the customer/ end-user?	Exploitation Priority: <i>as defined by the consortium</i> Joint Exploitation with another outcome: <i>can be jointly exploited with another project outcome? if yes, which one(s)?</i>	
Our ambition	The problem	BUSINESS MODEL	
- what is the consortium seeking to achieve with this product/ service/ tool? - what is the main objective?	- what is the issue it addresses? - what is the challenge it focuses on?	- how this product/ service/ tool is going to be (commercially) exploited? - what are the steps to be followed?	
The service	Competitors	Progress	TRL Status
- what is the service which will be provided? - if it is not a service/product, how is this concept/ approach going to be implemented? - what will it offer to the end-users?	From the market analysis already implemented, are there any known competitors offering similar (or the same) product/ service/ tool?	Current	<i>As indicated the in the DoA</i>
		By the end of the project	<i>As indicated the in the DoA</i>
	Our competitive advantage	IPR rights	Partner/ Owner
	- what does this product/ service/ tool offer? - how does this service differentiate from similar ones existing already in the market or from the tools currently available?	Existing or Developed in the project	<i>Has this product/ service/ tool been developed by a project partner before or during the project? -does this partner hold or is expected to hold the ownership?</i>
		Technology licensing considerations	<i>Are there any technology licensing considerations which are relevant to this product/ service/ tool and should be considered?</i>

CASE 1. Automated pan-European alert system

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	COMMERCIAL Exploitation	
Novel concepts and approaches	National Plan Protection Organisations	Exploitation Priority: 1 – High	
Our ambition	Grower's Organisations	Joint Exploitation with another outcome: DSS-Alert	
	Non-EU stakeholders can be considered as well.		
To drive a major increase in the European capacity to timely, proactively and optimally prepare for and respond to seasonally and spatially fluctuating risks of FF introduction and range expansion. The goal will be achieved by developing an entirely new pan-European computerized decision support system that will be able to support full-service provision, regarding planning, executing, and evaluating detection activities regarding FF and new pest incursions and to reduce the lag-time in reporting.	The problem	BUSINESS MODEL	
	Introduction of a system that will be different and more effective than the current Rapid Alert System.	A service that is offered under subscription. The service will be low cost products (highly automated). SMEs and services UTH New SME linked to UTH, will ensure continued operation of the Platform, FF Alert system, links to other services and products developed by FF-IPM and provide technical support to the end-users.	
The service	Competitors	Progress	TRL Status
The service will have the following components: <ul style="list-style-type: none">• A Central Algorithm with specific modules• Geographic databases• Tailored dynamic risk maps of invasion pressure• Weekly climate suitability maps (in the areas of FF)• Weekly pest entry risk estimate (for at the border entry risk estimates)• Simulated population dynamics through space and time for FFs• FF-trap data maps• Historical interception data capture and analysis	No data available	Current	2
		By the end of the project	7-8
	Our competitive advantage	IPR rights	Stakeholders
	Integrating all the key elements into an automated pan-European alert system (DSS-Alert), will constitute a major innovation, setting new response standards in FF biosecurity and serving as a model	Existing	UTH
		Developed in the project	ARO; Cervantes; Corvus
		Technology licensing considerations	Dymex, ECMWF, MET data

• Web-mapping	for preventing spread of other harmful pests into Europe.		
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CASE 2. In-silico boosted OFF-season IPM paradigm

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	COMMERCIAL Exploitation	
Novel concepts and approaches	Fruit growers and NPPOs	Exploitation Priority: 1 – High Joint Exploitation with another outcome: e-Trap; Entomopathogenic Nematodes for OFF-season IPM; Lure & Kill for OFF-Season IPM	
Our ambition	The problem	BUSINESS MODEL	
Our ambition is to introduce a fundamental paradigm shift in FF IPM in Europe, by a radical change in (a) seasonal timing of IPM operations towards OFF-Season, (b) utilising landscape heterogeneity as opportunity for effective spatially-focused IPM, and (c) applying in-silico boost to design, optimisation and implementation of both OFF- and ON-Season IPM at the local, farm level.	InSilico-IPM are expected to have a significant involvement in exploiting the new IPM and detection strategies that will be developed during the project.	ARO, UNIMOL, UTH and CSIRO will contribute to the development of the exploitation business model. Exploitation of the molecular and morphological interception tools and the involvement of RMCA, SU, AGES, UJI and CAU is also expected. Involvement of stakeholders such as ANECOOP and CRI, as well as associated organization such as EPPO, IAEA and fruit growers and NPPOs will further contribute to exploitation of the results of the FF-IPM project.	
The service	Competitors	Progress	TRL Status
The service is related with site-optimised IPM scenarios that will be applied in pilot sites, with different landscapes and conditions, through stakeholder inputs and recommendations. It will be provided in conjunction with the previous support system. The service providing strategy OFF-season IPM, exploiting landscape complexity to enhance IPM, and using Virtual-Farm	No Data Available	Current	2
	Our competitive advantage	By the end of the project	7-9
	The OFF-season IPM strategy and Virtual-Farm DSS, combined into a single functional system, will introduce a ground-breaking shift in the paradigm of FF management in fragmented European fruit	IPR rights	Partner/ Owner
		Developed in the project	

DSS for holistic farm-system emulation and in-silico boost to IPM - contains major innovative merits.	production landscapes. It is a novel concept that is expected to change IPM approaches also for other FF pests.		Corvus
		Technology licensing considerations	n/a

CASE 3. DSS-Alert

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL		
Key Novelty Category	Target audience	COMMERCIAL Exploitation		
New products, tools, protocols	<ul style="list-style-type: none"> - PPOs aiming at an EU-wide contract - Businesses that supply farmers with information, such as businesses in the agrichem sector, farm advisory or farmer co-operatives. - Policymakers will also benefit from access to foundational information (e.g. CLIMEX risk maps and publications). 	Exploitation Priority: 1 – High		
Our ambition		Joint Exploitation with another outcome: e-Trap		
To capitalise on existing models and integrate them into a dynamic system, giving stakeholders access to dynamic forecast information on climate suitability for the FFs, along with other relevant risk factors such as the climate suitability of source regions & commodity movement data.	The problem	BUSINESS MODEL		
The Service	There are no available real-time pest forecasts for farmers on climate suitability for the FFs	The system is highly scalable and benefits from economies of scale. The operation of alert DSS system Workspace and CLIMEX/DYMEX Server will be installed on the FF-IPM platform. The alert system will “ping” relevant subscribers, alerting them to emerging issues of concern (e.g., the detected presence of an exotic FF) and the climate suitability context (e.g., moderately suitable and trending up/down).		
The platform will be able to communicate real-time FF alerts to relevant end-users This DSS will utilize tailored info. <i>The DSS-Alert system</i> will, for the first time, actively integrate the key, relevant and comprehensive streams of information: (a) realistic empirical information on biology of various wild FF biotypes truly representative for Europe (WP2), (b) climate and weather forecasts (WP5), (c) human and commodity (fruit) movement (WP5), (d) history of pest detection/interception(WP5), (e) feedback from automated early pest detection (e-Trap) and interception (e- Nose) tools (developed by	Competitors	Progress	TRL Status	
	Existing pest alert systems (e.g., Trapview and Rapidaim) have good trapping technology, but very limited capacity for forecasting. They can tell the farmer what the farmer can establish by going and looking at their fields. There are competitors in the US, e.g., Climate Corporation. Similar dynamic and automatic FF risk projection and alert systems are currently under development in the USA and Australia, but none in Europe.		Current	1-2
			By the end of the project	7-9
			IPR rights	Partner/ Owner
			Developed in the project	UTH; ARO; Cervantes; Corvu
	Our competitive advantage			

<p>WP3), and (f) reports from rapid and reliable pest ID protocols (WP3).</p>	<p>This new DSS system will focus on seasonal timing of IPM operations towards OFF-Season, considering specialized needs, at the farm level.</p> <p>PPO inspection services can use the information products to deploy their inspection resources seasonally and toward the highest risk freight consignments and flight, simulating the development of invasive FF populations and their treatment. Inspection services will be more efficient and effective at detecting consignments contaminated with FF. Biosecurity surveillance will be more efficient. Coupled with e-traps, the surveillance effort will be better-targeted in time and space, reflecting the dynamic risk patterns due to weather variability.</p> <p>Farmers will be able to make more informed decisions on pest management options. FF management will be more environmentally friendly and efficient. The surveillance will be targeted in space and time and monitored to allow informed consideration of emerging FF population trends due to the weather.</p>	<p>Technology licensing considerations</p>	<p>DYMEX, ECMWF, MET data</p>
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CASE 4. DSS-Virtual-Farm

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	COMMERCIAL Exploitation	
New products, tools, protocols	Fruit growers and advisors	Exploitation Priority: 2 – Medium Joint Exploitation with another outcome: In-Silico IPM	
Our ambition	The problem	BUSINESS MODEL	
A ‘service-oriented’ software that will take in account specialized scenarios and provide guidelines for further actions for OFF- & ON-Season FF IPM.	At smaller, farm-relevant spatial scales, typical for fragmented perennial horticulture in Europe, generic population models tend to be less applicable.	The model, after necessary adaptations, will be ‘converted’ into a DSS tool (Virtual-Farm), which in turn will constitute a basis for establishment of commercial expert advisory services by the SME Partner (inSilico-IPM) for in-silico design of the locally optimised ‘precision’ for OFF- & ON-Season FF IPM.	
The service	Competitors		
The model contains detailed ‘virtual’ representation of seasonally fluctuating spatial structure of terrain with pest-relevant traits. Projections are derived from emulation of lifetime behaviour, dispersion and fate of each individual insect (from egg to adult) present in each farm sector, throughout the whole year.	To the best of our knowledge in the FF domain, only two examples of such approach exist to date, developed by Manoukis et al. and by project partner (inSilico-IPM). Out of these, only the latter one (PESTonFARM) holistically emulates the local system (pest- terrain-climate-IPM), was validated recently on-farm, and hence postulated for application for in-silico design of the local IPM of R. cerasi cherry orchards.	Progress	TRL Status
		Current	2
		By the end of the project	7-9
		IPR rights	Partner/ Owner
		Existing	inSilico-IPM
	Our competitive advantage	Technology licensing considerations	PESTonFARM generic Cc sub-model, recently developed by Lux
	The development of an excellent tool to emulate Cc populations OFF- and ON-Season, and apply control strategies with great precision throughout the crop-cycle. The new knowledge generated by the FF-IPM will allow model fine-tuning to the biology of		

	wild Cc populations prevalent in various parts of Europe.		
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CASE 5. e-Traps for automated FF detection and identification

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	COMMERCIAL Exploitation	
New products, tools, protocols	Phytosanitary service organization, NPPOs Growers' organizations & Individual farmers Area wide operation projects (e.g. SIT)	Exploitation Priority: 1 – High Joint Exploitation with another outcome: In-silico boosted OFF-season IPM paradigm; FF-Alert services	
Our ambition	The problem	BUSINESS MODEL	
Development and adoption of e-Trap system as an integral part of the spatial model-driven detection strategy can also be commercialized and become available to national and regional organizations with vital interest in FF invasion in Europe and beyond. E-traps will be developed for 3 target species for early detection & identification, that will provide automated alarms and could also be used for surveillance.	The most advanced FF trap, which is still at development stage though, can distinguish 3 FF species based on analysis of their wing-beat characteristics. Such traps, although useful in typical IPM, have a major drawback in early-detection applications: they require visiting the trap to reconfirm detection of alien pests.	Emphasis was given in the development of the pilot product “e-trap” and its characteristics, as a guide that can be used further for additional products and services. In this effort, we also considered the end users per case (farmers etc.). The discussion was over the involved partners, the connection of the product to other similar products (“traps”) and also to the other outcomes of the project, the possible users/target groups and the overall cost of the product. RMCA will identify relevant commercial partners for production and commercialization of FF ID kits and will establish an SME linked to RMCA which will provide expert FF ID service and app for identification of FF larvae.	
The service	Competitors	Progress	TRL Status
A system that attracts, captures and takes pictures of adult medflies at real time intervals and transmits images to a remote server/cloud. The images are inspected by entomologists and captured adults identified and counted. e-Traps for Cc, Bd, Bz + Tools, methodology for the identification of intercepted FF + App for the morphological identification of intercepted FF larvae.	Italian companies; Slovenian Company	Current	4-5
	Our competitive advantage	By the end of the project	7-9
	This prototype (small size e-Trap) will allow field-handling and lower costs compared to currently available commercial traps. The delta e-trap developed in FF_IPM , sends photos to a server in the cloud. An	IPR rights	Partner/ Owner

Automated system for pest surveillance and immediate invasion alert.	operator can access the server from a remote device (PC or smart phone) and, looking at the image of the bottom glued panel, count the trapped flies. This process is defined “semiautomatic” because requires the manual count of trapped flies from the image sent by trap and allows to avoid human mobility that is required periodically as routine scouting operations.	Existing	ARO; UNIMOL
		Technology licensing considerations	ENPI-MED project; FruitFlyNet

CASE 6. E-Nose for interception of infested fruits

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	COMMERCIAL Exploitation	
New products, tools, protocols	Governmental Extension service for FF control Phytosanitary inspection	Exploitation Priority: 1 – High Joint Exploitation with another outcome: None	
Our ambition	Fruit Pack and store houses Large growers or growers’ organizations Importing facilities	BUSINESS MODEL	
<p>FF species-specific e-Nose technology will be developed, for pre-shipment and quarantine purposes, in ports of entry and distribution centers, to improve interception.</p> <p>Our ambition is to progress development of e-Nose technology and reach the stage of end-user validated e-Nose prototype, capable to intercept FF infested fruits (5 fruit species, 3 FF species), ready for implementation in routine quarantine fruit commodity checks. Enhancement of the e-Nose technology will constitute major innovation of tremendous practical importance for managing horticultural threats.</p>	<p>The problem</p> <p>Currently, identification of the individual pest-infested fruits within the bulks of the imported commodities is conducted through “manual” commodity inspections, which constitutes a truly daunting and increasingly expensive task. To date, no satisfactory alternative solutions are known. In addition, no practical solution, implementable for effective fruit commodity screening and suitable for the purpose of border quarantine - exists to date.</p>	Business plan will be developed by PCA and BPI having due regard to the FF-IPM project provisions and requirements. The knowledge will become published and freely available as stipulated in the FF-IPM project provisions and requirements.	
		Progress	TRL Status
		Current	2-3
		By the end of the project	7-8
		IPR rights	Partner/ Owner

The service	Competitors	Existing	PCA and Benaki Phytopathological Institute (or BPI) have developed the libraries and the application method.
<p>e-Nose system for tracing FF-infested fruit: FF-IPM Partner SME (PCA) will produce and commercialize the e-Nose device for detection of FF-infested fruits</p> <p>On the other hand, PCA will contribute to commercializing the e-Nose system for detecting infested fruit by invasive FF.</p> <p>This will be based on LAMP technology that is able to provide results rapidly.</p>	No data available		
	Our competitive advantage		
	The ability to provide fast results, since the sensors are able to respond in less than one second, allowing efficient controls in environments where time could be crucial (i.e ports). The direct answers that it could give, since the sensors are able to respond in less than one second. Additionally, of equal importance is the fact that e-Nose is portable, small and easy to use.	Developed in the project	PCA and BPI
		Technology licensing considerations	n/a

CASE 7. Molecular and morphological ID tools and protocols and origin tracing

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	NON-COMMERCIAL Exploitation	
New products, tools, protocols	Phytosanitary service organization; NPPO Regional and national plant protection organizations; Researchers in agriculture, pest management, taxonomy; Growers' organizations Area wide operation projects (e.g. SIT).	Exploitation Priority: 2 – Medium	
Our ambition		Joint Exploitation with another outcome: None	
<p>Multiplex detection tools will be developed for non-EU target species, for rapid and low cost identification, without the need for specialized equipment.</p> <p>Fully explore the genetic information of all target FF and, based on it, develop novel FF taxonomic diagnostic tools for all life stages according to the "ASSURED" standard as put forward by WHO.</p>	The problem	BUSINESS MODEL	
		Current molecular approaches such as DNA-barcoding or microsatellite technology do not provide the required resolution to establish actual origin of individual FF specimens, or have not yet been fully explored for the target FF. While a	n/a
Progress	TRL Status		
Current	4-5		
By the end of the project	8		
The service		IPR rights	Partner/ Owner

<p>Based on already existing LAMP protocols.</p> <p>Existing (for adults) and new (for third instar larvae) multimedia morphological identification tools, will be respectively adapted and developed comprising all the target tephritid species, and their closest congeners.</p> <p>Real time identification of adults. Can be used in detection and interception</p>	<p>plethora of diagnostic tools is available, the majority of them do not allow an unambiguous and “ASSURED” (Affordable, Sensitive, Specific, User-friendly, Robust and rapid, Equipment free, Deliverable to the end user) identification.</p>	Existing	RMCA
	<p>Competitors</p>	<p>Technology licensing considerations</p>	<p>n/a</p>
	<p>Plant Health Australia and USDA – Delta key</p>		
	<p>Our competitive advantage</p>		
<p>Mobile application for morphological identification of larvae and adults of target species. None of the existing applications are converted into a mobile application nor target species of E interest.</p>			

CASE 8. Entomopathogenic fungi formulations for OFF Season FF IPM

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	NON-COMMERCIAL Exploitation	
New products, tools, protocols	n/a	Exploitation Priority: 2 – Medium Joint Exploitation with another outcome: Could benefit from Case 9 (Entomopathogenic nematodes formulations for OFF season FF IPM) exploitation efforts	
Our ambition	The problem	BUSINESS MODEL	
In this case, there are going to be applications with entomopathogenic nematodes. Comprehensively evaluate and identify <i>B. bassiana</i> (strains) suitable for OFF-Season FF management.	Several entomopathogenic fungi including strains of <i>Beauveria bassiana</i> have been tested against adults and pupae of Cc and that of other FF demonstrating satisfactory efficacy in controlled laboratory conditions. Different strains express different killing abilities against Cc and other insect species. However, there is only little adoption of such biocontrol treatments in current IPM project and the absolute lack of tests against the overwintering generation of Cc	n/a	
The service		Progress	TRL Status
Entomopathogenic fungi formulations for OFF Season FF IPM: CIRAD and UNIMOL, jointly with relevant commercial producers will evaluate fungi.	Competitors No data available	Current	3-4
		By the end of the project	4-5
		IPR rights	Partner/ Owner
		Developed in the project	CIRAD ;UNIMOL
Our competitive advantage	Technology licensing considerations	The product is commercialized but used for other pest.	
n/a			

CASE 9. Entomopathogenic nematodes formulations for OFF season FF IPM

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	COMMERCIAL Exploitation	
New products, tools, protocols	Governmental Extension service for strategic fruit fly control Researchers in agriculture, pest management, taxonomy Growers' organizations Area wide operation projects (e.g. SIT)	Exploitation Priority: 1 – High Joint Exploitation with another outcome: In-silico boosted OFF-season IPM paradigm	
Our ambition	The problem	BUSINESS MODEL	
In this case, there are going to be applications with entomopathogenic fungi. Comprehensively evaluate and identify nematodes (species and strains) suitable for OFF-Season FF management.		n/a	
The service	Competitors	Progress	TRL Status
Entomopathogenic nematodes formulations for OFF season FF IPM: FF-IPM Partner SME (E-nema) will produce and commercialize nematode IPM products for OFF-Season FF control	Other nematode producers (Koppert Biosystems, BASF)	Current	3-4
	Our competitive advantage	By the end of the project	7-8
	Pending	IPR rights	Stakeholders
		Developed in the project	E-nema

<p>A control method for off-season control of larvae and emerging adults of mediterranean fruitfly (<i>Ceratitis capitata</i>).</p> <p>Method controls larvae and emerging flies in the soil and larvae inside infested fruits on the ground.</p>		<p>Technology licensing considerations</p>	<p>n/a</p>
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CASE 10. Predators for off-season IPM

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
<p>Key Novelty Category</p>	<p>Target audience</p>	<p>NON-COMMERCIAL Exploitation</p> <p>Exploitation Priority: 3 – Low</p> <p>Joint Exploitation with another outcome: In-silico boosted OFF-season IPM paradigm</p>	
<p>New products, tools, protocols</p>	<p>Growers' organizations</p> <p>Fruit producers</p> <p>Individual farmers</p>		
<p>Our ambition</p>	<p>The problem</p>	BUSINESS MODEL	
<p>Evaluation of the compatibility of OFF-season application of predators for FF control.</p>	<p>There is no quantitative data regarding the impact of natural enemies on the population of FFs and virtually no information on their performance during autumn and winter especially in cooler areas, marginal for the overwintering of tropical FF.</p>		
<p>The service</p>	<p>Competitors</p>	Progress	TRL Status
<p>Implementation protocols for rearing & augmenting ground dwelling predators: UJI, jointly with relevant commercial partners, will explore commercialization of predator-based IPM products for OFF- Season FF control.</p>	<p>No data available.</p>	<p>Current</p>	<p>4-5</p>
	<p>Our competitive advantage</p>	<p>By the end of the project</p>	<p>8-9</p>

This is mostly based on trials for the evaluation of the efficacy of predators in FF control and their overall contribution to the DYMEX and PESTonFARM models	For the first time, elucidate and quantify the OFF-Season role of the key predators in reducing overwintering and early spring Cc populations.	IPR rights	Stakeholders
		Existing	UJI
		Technology licensing considerations	n/a

CASE 11. Lure & Kill for OFF-season IPM

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	COMMERCIAL Exploitation	
New products, tools, protocols	Growers' organizations Fruit producers Individual farmers Researchers	Exploitation Priority: 2 – Medium Joint Exploitation with another outcome: In-silico boosted OFF-season IPM paradigm	
Our ambition	The problem	BUSINESS MODEL	
The overall OFF-season IPM strategy will introduce a ground-breaking shift in the paradigm of FF management in fragmented European fruit production landscapes	Only a few Lure and Kill devices have been thoroughly tested in different environmental conditions, and none off season. Furthermore, due to low off season temperatures Cc may not be reproductively active, and its responsiveness to various baits, so critical for effectiveness of the Lure and Kill approach, has not been studied to date.	These are readily available tools, now used for ON-season implementation. After rigorous testing, the most efficient systems for OFF-season use will be included in the overall IPM strategy.	
The service	Competitors	Progress	TRL Status
Adaptation of already existing lure and kill methods for FF control, but for OFF-season control	No data available.	Current	5-6
	Our competitive advantage	By the end of the project	8-9

	First-time evaluation of responsiveness of Cc overwintering in realistic winter conditions to the main baits used in FF management and assess OFF-Season effectiveness of bait stations.	IPR rights	Stakeholders
		Existing	UNIMOL
		Technology licensing considerations	n/a

CASE 12. FF-Alert services

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	COMMERCIAL Exploitation	
Innovative expert services or businesses	Growers' organizations Fruit producers Individual farmers Researchers	Exploitation Priority: 1 – High Joint Exploitation with another outcome: e-Trap & Alert DSS	
Our ambition	The problem	BUSINESS MODEL	
An integrated tool that will operate the FF-IPM developed DSS-Alert system, as well as the rest of the services offered by the project.	Currently in Europe pest alert information is centrally distributed (EPPO) only AFTER incursion of an alien pest has been detected by one of 27 national systems (EUROPHYT outbreak tool for NPPOs).	This service may eventually lead to a new SME linked to UTH, that will continue the operation of the Platform, FF Alert system, as well as the other services that are to be offered by FF-IPM and provide technical support to the end-users.	
The service	Competitors	Progress	TRL Status
The service created will operate the FF-IPM developed DSS-Alert system and provide weekly-updated FF risk maps of incursions of new invasive FF and northward range expansion of the already present (Cc).	No data available.	Current	1-2
	Our competitive advantage	By the end of the project	7-9
		IPR rights	Stakeholders

	No central service is available in Europe, which would reliably and in real-time map and alert about upcoming risks of FF incursion.	Developed in the project	
		Technology licensing considerations	n/a

CASE 13. Virtual-Farm services

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL						
Key Novelty Category	Target audience	COMMERCIAL Exploitation						
Innovative expert services or businesses	Growers' organizations Fruit producers Individual farmers Researchers	Exploitation Priority: 1 – High Joint Exploitation with another outcome: DSS-Virtual-Farm & DSS-Alert						
Our ambition	The problem	BUSINESS MODEL						
To introduce a fundamental paradigm shift in FF IPM in Europe, by a radical change in (a) seasonal timing of IPM operations towards OFF-Season, (b) utilizing landscape heterogeneity as opportunity for effective spatially-focused IPM, and (c) applying in-silico boost to design, optimisation and implementation of both OFF- and ON-Season IPM at the local, farm level. The model, after necessary adaptations, will be 'converted' into a DSS tool (Virtual-Farm), which in turn will constitute a basis for establishment of commercial expert advisory services for in-silico design of the locally optimised precision IPM.	Currently in Europe FF management operations are planned based on generic IPM principles, personal experience and expensive hit-and-miss experimentation. Additionally, modeling the role of landscape traits on insect behaviour, dispersion and development remains largely restricted to larger-scale academic ecological studies, while smaller, farm-relevant spatial scales, typical for fragmented perennial horticulture in Europe, generic population models tend to be less applicable.	The services will be provided by the already existing Partner SME (inSilico-IPM) and based on proprietary software (PESTonFARM). This will be done in conjunction with WP 6, and refers to a fully operated DSS-Virtual-Farm system, under a "service oriented" basis.						
		<table border="1"> <thead> <tr> <th>Progress</th> <th>TRL Status</th> </tr> </thead> <tbody> <tr> <td>Current</td> <td>1-2</td> </tr> <tr> <td>By the end of the project</td> <td>7-9</td> </tr> </tbody> </table>	Progress	TRL Status	Current	1-2	By the end of the project	7-9
Progress	TRL Status							
Current	1-2							
By the end of the project	7-9							

The service	Competitors	IPR rights	Stakeholders
The services will include: (a) in-silico evaluation of putative IPM scenarios in fragmented multifruit production systems before their implementation on-farm, and (b) development of locally optimised IPM schemes according to terrain structure and traits, configurations and phenology of host fruits etc.	No data available	Existing	In-Silico IPM
	Our competitive advantage	Technology licensing considerations	n/a
A novel system that does not yet exist in Europe and beyond.			

CASE 14. Pest ID & origin tracing

RESULT/OUTCOME OVERVIEW	MARKET ANALYSIS	EXPLOITATION POTENTIAL	
Key Novelty Category	Target audience	NON-COMMERCIAL Exploitation	
Innovative expert services or businesses	Growers' organizations; Fruit producers Individual farmers; Researchers	Exploitation Priority: 1 – High Joint Exploitation with another outcome: e-nose, e-trap	
Our ambition	The problem	BUSINESS MODEL	
Establishment of services that have been already developed in WP3 and 4 (diagnostics etc.), for identification and tracing origin in order to address the gap currently existing in routine identification of FF. E-nose, e-trap etc. will play an important role here	Currently in Europe routine identification of FF detected by quarantine operators is based on morphological identification of adult forms, and time-consuming rearing of intercepted larvae up to adulthood. Advanced molecular identification kits, ready to use on 'on-the-spot' are not available. Occasionally, determination of molecular ID is being ad hoc commissioned to academic experts.	These taxonomic ID services will be provided by a newly established SME, affiliated to RMCA.	
The service	Competitors	Progress	TRL Status
	No data available	Current	3-4

<p>Services in conjunction with the above, that will include identification and origin tracing.</p> <p>To convert the FF-IPM developed and validated molecular ID tools, kits and protocols into novel expert taxonomic services that include: (a) providing expert taxonomic service on resolving complex FF ID troublesome cases, (b) advice on application of FF-IPM developed molecular kits and protocols, and in particular, (c) conducting advanced molecular pest identifications, ID verification and authoritative FF ID confirmation in quarantine-related queries and disputes.</p>	Our competitive advantage	By the end of the project	7-9
	The holistic response to the need, provided by this tool, is not yet available in the European market.	Technology licensing considerations	No data available

5 Exploitation Pathways

This section defines the different ways in which FF-IPM outcomes may be exploited. Evidently, not all outputs of the FF-IPM project can be commercialized. Each service/product has to be analyzed based on the opportunity for exploitation both commercial and non-commercial, as well as other applicable variables.

Specifically, the private companies/technology providers of the consortium will use the FF-IPM system and/or its major components to enhance and advance their product portfolios (i.e. upgrade their regular product/service portfolio and/or to develop new innovative products and services). As a general strategy, in the development of DSS and IPM tools and protocols, we will progress not only beyond the state of the art in terms of technology development but will also move beyond the purely academic stage of model/tool demonstration and validation.

Obviously, some of the project results are the work of research partners, thus the IPR will belong to them, to be exploited either in their framework of their scientific activities or by licensing the technologies to private entities.

Research partners will explore alternatives for exploiting the project results for scientific and research purposes. Specifically, they will exploit the scientific and business breakthroughs of FF-IPM (i) under new research projects, (ii) under other existing research activities and/or (iii) for educational and training purposes.

Therefore, we have chosen to divide the modes into three main strands as in detail presented in the following sections: **Commercial**, **Non-commercial** and **Open source**. Each strand includes a number of different measures that may be employed to ensure that the solutions and the innovative methodologies are adopted and brought forward.

5.1 Commercial Exploitation

Commercial exploitation exists when the partner intends to use the result according to a market-oriented strategy, based on offering a new service or a new product on the market. FF-IPM's cases that are suitable for commercial exploitation must have a significant market potential, must have clear IPR, must be simple to define and easy to put a price tag on.

We have chosen to further subdivide commercial exploitation into four types:

- **Sale of software licenses including all common software delivery paradigms:** buy over-the-counter, download-and-install and software-as-a-service (Automated pan-European alert system; DSS-Virtual-Farm; e-Traps; e-Nose; Entomopathogenic nematodes formulations for OFF season FF IPM)
- **Sale of software library licenses for embedding of modular FF-IPM's solutions within existing software products**, thereby linking into existing business models and value chains (In-silico boosted OFF-season IPM paradigm; DSS-Alert; Lure & Kill for OFF-season IPM)
- **Sale of consultancy services on hourly or project basis** (FF-Alert Services; Virtual Farm services; expert advisory services for in-silico design of the locally optimised 'precision' for OFF- & ON-Season FF-IPM with the utilisation of the DSS-Virtual-Farm tool)
- **Spin-off creation from the UTH partner** for the novel DSS-Alert system, which links to other services and products developed by FF-IPM, such as FF-Alert services, the Virtual-Farm service and the e-Traps and provides technical support to the end-users. A market exploration and start an iterative process to develop the spinoff as presented in the iterative process of startup development below. However, the methodology does not aim to be followed step by step. Even if a kind of

hierarchy can be highlighted from the technology analysis to the business development, the experiences show that all steps are interdependent, which implies that all actions will be undertaken by iteration until reaching a certain spinoff concept maturity:

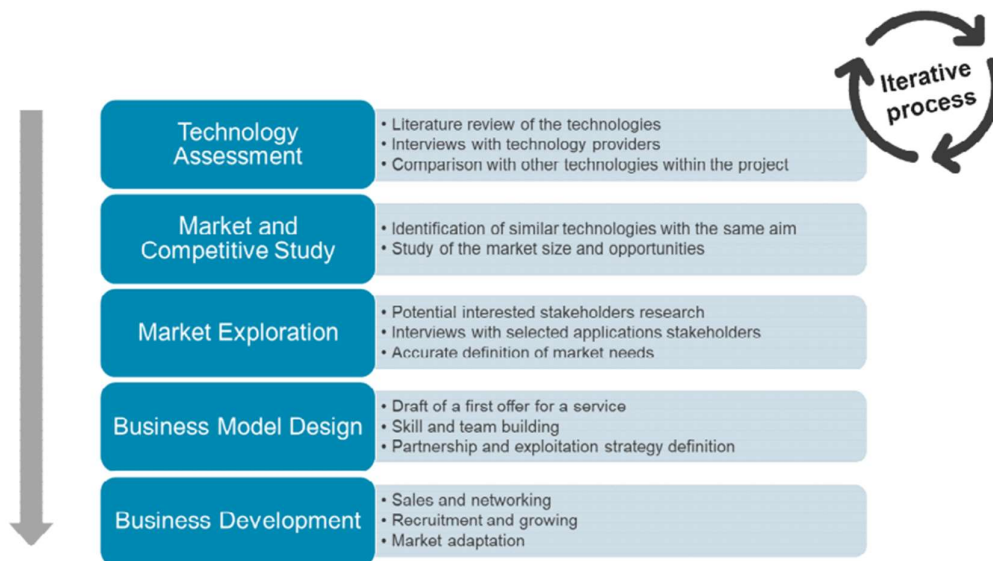


Figure 3. Iterative process of startup development

Joint Commercial Exploitation: No clear business models emerged for the exploitation of each solution/case individually, except from the DSS-Alert system, which will probably lead to the establishment of a spin-off. At this stage, it is only possible to suggest that partners will work together in various configurations and combinations of the solutions, as indicated in each case table, to ensure FF-IPM's results remain sustainable in the long-run. Several partners would like to follow a commercial route and offer consultancy, advanced data analysis & visualisation/mapping tools, customisation and technical support to help FF control create effective and smart solutions at an affordable cost.

In more detail, the partners indicate as a high priority for commercial exploitation the Automated pan-European alert system, the In-silico boosted OFF-season IPM paradigm, the DSS-Alert, the e-Traps, the E-Nose, the FF-Alert services and the Virtual-Farm services. While, the In-silico boosted OFF-season IPM paradigm is the solution that appears to be the most popular in terms of joint exploitation.

According to the internal survey, the commercial route was rated as “very important” for the majority of solutions, clearly showing that commercial sustainability is a priority for the Consortium. In parallel, non-commercial exploitation pathways are also explored for the solutions, as presented in the following section.

5.2 Non-commercial Exploitation

While the prime objective of the project is to develop new knowledge that can form the basis for marketable products, it is also necessary to acknowledge that there are several steps between the outcomes of a scientific research project and a commercial product or service and non-commercial exploitation pathways are investigated to ensure the sustainability and scalability of the FF-IPM's solutions.

The non-commercial exploitation pathway, when a solution is not market oriented and not connected to any financial benefit or income for the partner. Based on the partner's input we have chosen to further subdivide non-commercial exploitation into the following four (4) types:

- **Scientific/ research exploitation**, when the results are intended to be used for publications and to be involved in new or ongoing research projects and activities, and the re-utilisation of the research know-how acquired in future research activities

- **Further technological exploitation**, which implies the re-utilisation of the technological knowhow acquired for the development of innovative products and the provision of advanced services built on top of them.
- **Internal exploitation**, when the partner plans to use the results internally to improve the knowledge within the organisation or improve the internal procedures
- **Free use**, when a provides free access to the result/ product/ solution for informative, educational and/or training purposes.

The following figure presents the pathways of each case/ solution both the verified as well as the potential non-commercial exploitation:

Cases	Non-commercial exploitation Pathway			
	Scientific/ Research exploitation	Further technological exploitation	Internal adoption	Free Use
1. Automated pan-European alert system	Verified	Potential		
2. In-silico boosted OFF-season IPM paradigm	Verified		Potential	
3. DSS-Alert		Verified	Potential	
4. DSS-Virtual-Farm	Verified	Verified	Verified	
5. McPhail e-Trap	Verified	Verified	Verified	
5. delta e-Trap	Verified	Verified	Verified	
6. PEN e-Nose	Verified	Verified	Verified	
7. Molecular and morphological ID tools and protocols and origin tracing	Verified		Verified	Potential
8. Entomopathogenic fungi formulations for OFF Season FF IPM	Verified			
9. Entomopathogenic nematodes formulations for OFF season FF IPM			Verified	
10. Predators for off-season IPM			Verified	Verified
11. Lure & Kill for OFF-season IPM			Verified	
13. Virtual-Farm services	Verified	Verified	Verified	
14. Pest ID & origin tracing	Verified			Potential

	Verified exploitation pathway
	Potential exploitation pathway

Figure 4. Non-commercial exploitation pathways per case

5.3 Sustainability through Open source

The FF-IPM platform as a totality is not marketable as it has too many dependencies on data, technologies and people to be possible to sell at a fixed price with a sufficient profit margin. Thus, its sustainability and maintenance beyond the project lifetime will be available as a free and open source or be entirely in the public domain.

Open Source is not the same as free and there are many actors in the market generate income from sales of Open Source software (i.e. professional support licenses, customization, richer feature editions vs Community editions etc.) - but even free Open Source software provides a significant potential for Consultancy services whereby the FF-IPM's solutions can enter into a software-life-cycle suitable for marketing.

The FF-IPM Platform will host the FF-Alert services, the DSS-Virtual-Farm and the Virtual-Farm services to be provided as an integrated service via the platform, while the following services could potentially be integrated in the platform:

- Automated pan-European alert system
- In-silico boosted OFF-season IPM paradigm
- DSS-Alert
- McPhail e-Trap
- Pest ID & origin tracing

The rest of the outcomes (Delta e-trap; E-Nose for interception of infested fruits; Molecular and morphological ID tools and protocols and origin tracing; Entomopathogenic fungi formulations for OFF Season FF IPM; Entomopathogenic nematodes formulations for OFF season FF IPM; Predators for off-season IPM; and Lure & Kill for OFF-season IPM) could be provided as individual products/ services directly via the partners with the respective IPR either for commercial and/or non-commercial exploitation.

5.4 Responsibility and Implementation

To ensure real impact and sustainable stakeholder access to the developed technology, we will upgrade the developed tools with end-user friendly communication facilities, prepare technology documentation and service prospectuses, and establish innovative expert services sustainably provided on a commercial basis, either by project partner SMEs or newly established businesses when relevant.

Note that it is quite possible that the exploitation committee will eventually decide that some of the outputs are not commercially exploitable, either because there is no market interest or because key partners that hold the property rights for the technology/methodology/product are not interested to jointly exploit their product. In case that there is no market interest, the exploitation committee may find other exploitation paths distributing the output for free for interested parties that are not willing to pay for it.

Pathway	Strengths	Weaknesses
Commercial partnership	Strong motivation for business partners to exploit project results	Profit and commission sharing requires transparent, ethical and fair framework
FF-IPM Open Source Platform with integrated solutions	Long-term sustainability & exposure to continuous innovation activities	Few opportunities for individual partners to derive financial benefit
Joint cross-project cooperation for exploitation	Good multiplication potential	Dependency on other partners and interoperability of solutions

Non-commercial partnerships	Beneficial for research and innovation in the field of FF control	Limited rights management for the use of the solutions.
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Table 1. Comparison of Exploitation Pathways

6 Market Analysis

To develop a complete market analysis, we need to have the specific features of the product; how it is going to look like, what it will offer, how the user will be able to interact with it and up to which point.

The current world population of 7.7 billion is expected to reach 8.6 billion in 2030, 9.8 billion in 2050 and 11.2 billion in 2100, according to a United Nations report being launched in 2019. The demand for vegetables, fruits, and other agricultural products will rise as the human population grows. Furthermore, altering climatic circumstances, such as global warming, may have an impact on crop yield since crops mature faster and produce less grain as a result.

Fruit flies are devastating agricultural pests worldwide. From an economic point of view FF are by far the most important insect family causing enormous damage on horticulture that annually is estimated at >2 Billion EUR worldwide (including production, marketing, packing etc.).

FF - IPM developments have a strong impact on maintaining and promoting employment in the horticultural industry sector, since both production and trading within EU and between EU and third countries will be sustained and enabled to grow. A range of FF - IPM developed tools (i.e. e - Traps for 3 target species, interception tools, new farm tailored pest management strategies, OFF - Season adjusted IPM tools, advanced IPM strategies, interactive app for FF population densities) is planning to be adopted by SMEs and larger companies (inSilico - IPM, PCA and E - nema, ANECOOP respectively) and applied to various horticultural production systems. This will facilitate growth of specialized pest management companies across Europe and the Mediterranean that will rely on skilled personnel to implement the high tech IPM and detection strategies that the project will develop. Therefore, FF - IPM will increase employment of high profile personnel to satisfy the needs of these companies. In addition, new SMEs are expected to emerge to utilize some of the newly developed tools, to provide innovative, specialized prevention, detection services such as pest ID and origin, and which are not yet available in the European market.

6.1 Mapping of FF-IPM Stakeholders

FF-IPM has seven target stakeholder groups which were considered as the main beneficiaries of the project. These stakeholder groups are either entities or individuals that can apply the knowledge and solutions that were co-designed and co-produced during FF-IPM in their own activities within their specific contexts.

Who	Why
Fruit farmers and traders	Better understanding of alien pest situation in Europe, understanding of FF seasonal biology, increased knowledge of methodologies & tools for pest management
Research community in agriculture, pest management & food protection sectors	Exchange of knowledge, latest research updates, new networks, new research

	methodologies, future research cooperation, advances in pest invasion & FF pest management
Private sector & investors (agro-sectors, entrepreneurs, food processing and distributing companies)	Better understanding of alien pest situation in Europe / need for closer cooperation with universities, increased knowledge of methodologies & tools for pest management
Policy makers (local, national, European and international, EFSA, EPPO, FAO, IPPC, IOBC)	Need for coordinating a holistic approach against invasive pests. Enhanced cooperation & coordination for prevention & detection efforts. Climate change & FF emergence as pests in more temperate areas, promotion of adoption of new technology & approached in IPM
General European public	Understanding of the importance of pest management, impact on eco-systems, greater awareness regarding alien and native pests
Youth (school-age children, young adults)	Integrated approach to fruit production, invasion biology threats, environmentally sound control of insect pests
Local community	Threads by invasive FF, community engagement in prevention campaigns against invasive FF, in-silico assisted precision pest management

6.2 Market size and trends

Global horticulture market size:

The **global horticulture market** reached a value of USD 20.77 Billion in 2021 and is projected to reach USD 40.24 Billion by 2026 at a CAGR of 10.2%¹. Fruits, vegetables and flowers are the major products of the export and import market. The increase in food demand is one of the primary elements driving this horticulture market's expansion. Europe is estimated to hold the highest market share in the horticulture market.

Market size in 2021	USD 25.83 billion
Revenue forecast in 2026	USD 40.24 billion

¹ [Global Horticulture Market Size](#), *Global Market Estimates, 2022*

Growth rate	CAGR of 10.2% from 2021 to 2026
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The major driving factors for the horticulture market include the significant advancement in the agricultural sector; growing penetration of sustainable horticulture practices; comprehensive R&D activities and the enactment of favorable government initiatives; rapid urbanization; a growing global populace; income growth.

As a result of rising urbanization, there is a greater need for immediate and unique horticulture output, which is a critical determinant driving the expansion of this market segment. According to the United Nations Food and Agricultural Organization (FAO), food and feed production will need to increase by 70% by 2050 to meet global food demand. As a result, the aforementioned factors will contribute to the segment's dominance.

Management of fruit flies market size:

According to the Quince Market Insights² the **global pest control market** is expected to grow at a CAGR of 5.5% during the forecast period from 2018 to 2030. The market growth can be attributed to the increasing demand for food and rising worries for food safety. The liquid medicine segment is expected to dominate the market during the forecast period, owing to its easy application and high efficacy.

In 2017, the worldwide fruit fly control market was dominated by North America. During the forecast term, the region is expected to hold its position. This can be linked to consumers being more aware of the benefits of utilizing natural products, as well as a growing demand for organic farming practices in the United States, Canada, and Mexico.

Pest management pheromones market size:

The global integrated **pest management pheromones market size** was valued at USD 743.1 million in 2019 and is expected to expand at a CAGR of 7.4% from 2020 to 2027. Growing awareness regarding food security and concerns over the ill effects of synthetic crop protection chemicals are expected to drive the market. Integrated pest management (IPM) pheromones are considered clean and eco-friendly as compared to pesticides³.

Market size in 2021	USD 793 million
Revenue forecast in 2027	USD 1,31 billion
Growth rate	CAGR of 7,4% from 2020 to 2027

² Press release, 2021, GLOBE NEWSWIRE

³ Integrated Pest Management Pheromones Market Size, 2020 – 2027 - Grand View Research, Inc.

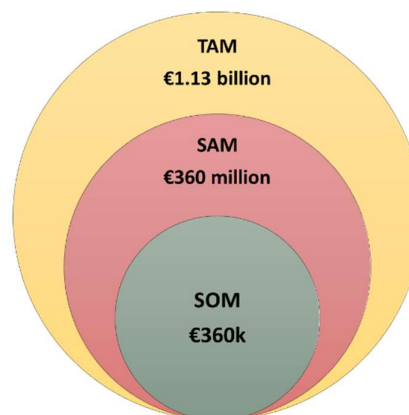
The application modes of pheromones include monitoring and detection, mass trapping, mating disruption, and others such as push-pull strategy and biological control. Monitoring and detection are anticipated to expand at a CAGR of 7.4% over the forecast period.

North America was the largest regional market for integrated pest management (IPM) pheromones, accounting for a 40.59% share of the overall revenue in 2019. Europe is the second largest market and is anticipated to exhibit a CAGR of 6.8% from 2020 to 2027 due to rising demand in countries, such as Spain, Italy, and the UK. The government bodies in the country are adopting several environmental quality objectives that are aimed at promoting biodiversity, which includes stringent regulations against pesticides.

Global integrated pest management pheromones market is expected to reach €1.13 Billion by 2025. That will be the Total Available Market (TAM).

Based on mode of application, mass trapping held the second largest share of 32.75% in 2019⁴ and is anticipated to be the fastest-growing segment due to its ability to treat a large area infested by insects, we estimate a Serviceable Available Market (SAM) of €360million.

Taking in respect that by 2025, we estimate that our Serviceable Obtainable Market (SOM) with a 0.1% market share will be €360,000.



6.3 Competitors and substitutes

In this section, we describe the biggest direct competitors and/or substitutes operating in the selected market.

1. **Automated pan-European alert system:** At the moment, there isn't any available, known data for competitors. Currently in Europe, prevention of invasive and expanding FF is largely based on: (a) 'manual' commodity inspection and interception of infested imported fruit, (b) fragmented and 'manually operated' FF detection schemes (traps), and (c) lengthy and uncertain identification of the intercepted/trapped specimens - all executed independently at national levels.
2. **In-silico boosted OFF-season IPM paradigm:** At the moment, there isn't any available, known data for competitors.
3. **DSS-Alert**
 - **Trapview:** It is an automated pest monitoring system that allows growers to keep track of nuisance insects caught in pheromone traps from afar. Farmers are no longer compelled to visit their field traps. They are also notified in real time when a large quantity of pest insects necessitates insecticide application. This enables growers to make the most of pesticides and, as a result, produce better crops with fewer pesticide residues. Eating healthier food benefits society, as does minimizing the risk of pest insects developing insecticide resistance. It was developed by the Slovenian company Efos and received an EU commission H2020 grant (733979). Location: EU
 - **RapidAIM:** The RapidAIM's platform technology of low-power novel sensors plus edge

⁴Integrated Pest Management Pheromones Market Growth & Trends – Grand View Research, Inc.

computing offers a service to the agriculture industry of regional pest surveillance, crop border security, and pest forecasts. The IoT sensor technology provides exceptional pest detection accuracy, combined with extended autonomy and low maintenance, packed in a portable design. The mobile app displays pest activity in a clear and intuitive way. Location: Australia

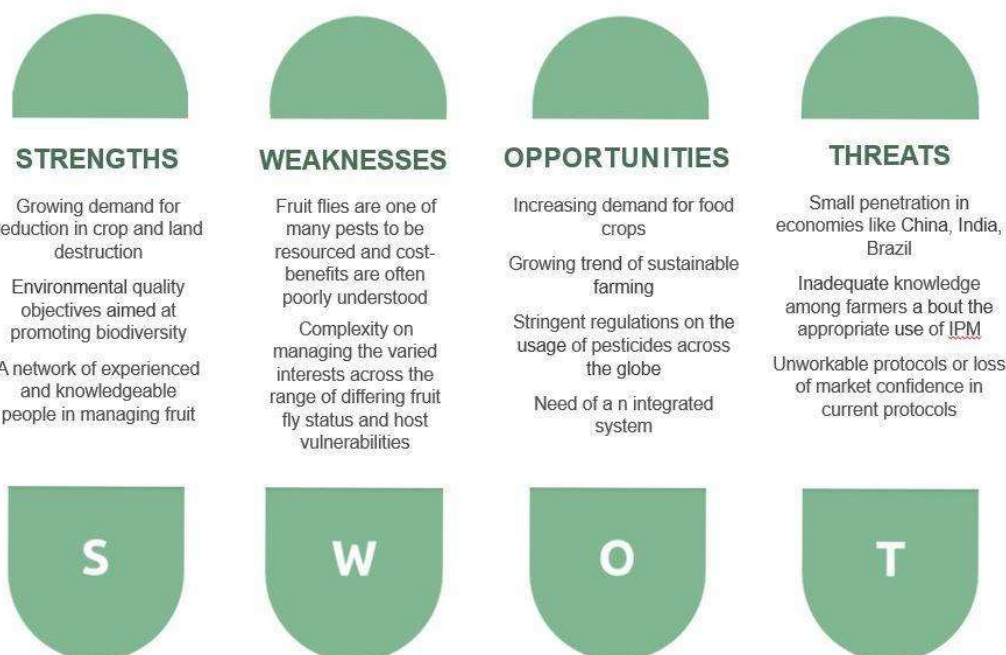
- **FarmSense:** This agricultural smart trap is using optical sensor technology to monitor insects in the fields. Its technology catches flying insect signals in the field and delivers this categorized data, as well as environmental data, to enable early detection, reducing pesticide use and increasing crop yields. Location: USA
 - **Semios:** It is a data analytics platform for growers of tree fruit and tree nut crops that helps predict, identify, and prevent pest and disease pressure. The Semios analytics engine draws on multiple sources of data and information including a robust, wireless network of in-canopy sensors on every customer farm measuring climate, soil and insect pest activity. Location: USA
 - **The Climate Corporation:** It provides software, hardware and insurance products to help farmers protect and improve their farming operations. Its Climate Technology Platform combines weather monitoring, agronomic modeling, and weather simulations to deliver Climate Basic and Climate Pro, mobile SaaS solutions that help farmers make operating and financing decisions. Location: USA
4. **DSS-Virtual-Farm**
- **TrapGrid:** It depicts the probability model of trap attraction based on the hyperbolic secant function and distance from a trap. It is beneficial for comparing the sensitivity of networks with different densities or placements, as well as improving trap placement to reduce program operational costs. It takes into account a diverse environment in two ways: 1) by allowing per-trap attractiveness to change depending on the ecosystem at each trap's location, and 2) by including a risk map of where outbreaks or bug populations are most likely to occur. When no insects are captured, the model can be used to accurately estimate the chance of insects existing in the area, which is a matter of great ecological, economic, and regulatory interest.
5. **e-Traps for automated FF detection and identification**
- **e-FlyWatch trap:** It trap is a unique, fully autonomous insect trap with integrated electronics and communication modules able to capture real time images of Mediterranean and Olive fruit flies and to transmit the images and other information such as environmental and location data. e-FlyWatch system consists of the trap and a centralised data collection service providing: real-time warning to end-users and historical analysis of infested areas presented in a user friendly web-application. The e-FlyWatch product enables the producers in the Fruit, Vegetable and Olive sectors to improve their production, limit the amount of insecticides/pesticides, reduce the labour cost for spraying activities and reduce the routine trap inspection. It is a powerful new tool that will certainly improve IPM and promote sustainability in the particular agricultural sectors. It was developed by the Cypriot company CNE TECHNOLOGY LTD and received an EU commission H2020 grant (262362). Location: EU
6. **E-Nose for interception of infested fruits:** There isn't any practical solution, implementable for effective fruit commodity screening and suitable for the purpose of border quarantine - exists to date.
7. **Molecular and morphological ID tools and protocols and origin tracing**
- **Plant Health Australia (PHA):** It is the national coordinator of the government–industry partnership for plant biosecurity. PHA developed “The Australian Handbook for the Identification of Fruit Flies” (the handbook), which has been compiled by diagnosticians for diagnosticians using some of the latest research outcomes and resources available. An electronic copy of this handbook is available from fruitflyidentification.org.au (Fruit Fly ID Australia).

- **USDA – Delta key:**
https://www.aphis.usda.gov/plant_health/plant_pest_info/fruit_flies/downloads/feed-strategic-plan-en.pdf
8. **Entomopathogenic fungi formulations for OFF Season FF IPM:** At the moment, there isn't any available, known data for competitors.
 9. **Entomopathogenic nematodes formulations for OFF season FF IPM:** Potential competitors are other nematode producers such as Koppert Biological Systems, BASF, Nemaplex, Dragonfli and others.
 - **Koppert Biological Systems:** They provide biological solutions for crop protection and pollination to the farmers around many countries in the world. Apart from the portfolio of crop protection and pollination biologicals, it has developed a system called "Natugro" which contains microorganisms such as Trichoderma Harzianum to induce the beneficial organisms present in the soil.
 10. **Predators for off-season IPM:** At the moment, there isn't any available, known data for competitors.
 11. **Lure & Kill for OFF-season IPM:** At the moment, there isn't any available, known data for competitors.
 12. **FF-Alert services:** At the moment, there isn't any available, known data for competitors.
 13. **Virtual-Farm services:** At the moment, there isn't any available, known data for competitors.
 14. **Pest ID & origin tracing:** At the moment, there isn't any available, known data for competitors.

6.4 SWOT Analysis

This section outlines the internal and external environment in which the FF-IPM's solutions exploitation strategy will operate. To optimise the chances of successful project completion it is crucial to have a general understanding of internal and external drivers and barriers in the pest control market. This SWOT provides also a number of important considerations for decision-makers, useful for the initiation and evaluation of the FF-IPM's solutions.

For this purpose, a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of the FF-IPM project combined with the analysis of potential competitors to the FF-IPM solutions performed in the previous section, are useful techniques to assess the state of the project and to gather relevant information to capitalise on the work carried out during the project.



The final SWOT matrix entails barriers and drivers, which have not been mentioned in previous scientific literature (e.g. European Commission requirements in terms of reporting and accounting). These barriers highlight the importance of creating an appropriate context for stakeholders' cooperation in all phases of the project (planning, implementation, monitoring etc.).

Following this analysis, we found the following major **Gaps**:

- Lack of current market access data packages and address any perceived gaps to support negotiation of international market access
- Alignment of management practices to the Fruit Fly Management Protocols
- Lack of acceptance of the Fruit Fly Management Protocols from trading partners
- Research gaps
- Analysis should be performed for each FF-IPM solution in evaluate the technical skills for the end users
- Potentially the end users (farmers) do not see the long-term benefits of the FF-IPM technology applications and they focus on the complexity of the e-solutions.

6.5 Risks Analysis

Risk	Likelihood	Impact	Mitigation
Development and availability of a 'commercialization-ready' prototypes and	Low	Medium	Partnership with SMEs who can assist in more rapid commercial production will be explored

associated software delayed			
Market not advanced enough for Policy Makers to consider policy visualisations a spending priority	Low	Low	Policy Makers can choose to use FF-IPM's tools or their own existing data tools so the impact of FF-IPM is not dependent on public authorities spending money with the project.
Open nature of the data and the tools makes it hard to create an attractive commercial offering	Medium	High	FF-IPM's uses existing tools to deliver visualisations and forecasts, the owners of which will benefit from product improvement based on the pilot work which will improve their commercial offerings. Other services will be developed by the project and commercial potential will be explored.
Other FF control tools and systems competing with PoliVisu gain market traction first	Medium	High	FF-IPM will reach out to other data and policy projects and explore complementary approaches to sustainability, for example the consortium will collect and share experience through the FF-IPM platform.
Multiple partners serving solutions appears too complicated to potential customers	Medium	High	FF-IPM creates user pathways through the Platform so users will be able to follow a link to the tool/ solutions that best meets their needs. The tools are linked to stories, examples, techniques and processes.
Only a few Partners appear to benefit from the project in terms of sustainability	Low	Medium	FF-IPM consortium is designed to ensure all partners benefit from participation in terms of new research, experiences and/or product improvements. Each Partner is involved in the development of the exploitation strategy of FF-IPM's solutions to leverage their involvement.

FF-IPM platform not attractive/user friendly for users	Medium	High	The first version of the FF-IPM platform will be publicly available and accessible for feedback so that improved future versions will personalise the user journeys for different types of user.
Stakeholders that give visibility and credibility to FF-IPM's work are not considered	Low	Medium	As above, future versions of the FF-IPM platform will include pathways to content and benefits for multiple user categories.

7 Strategy and action plan

7.1 Differentiating and positioning of the FF-IPM solutions

The differentiation and novelty of the FF-IPM solutions is the development and implementation of innovative, holistic, and computer (in-silico) assisted IPM strategies and expert services to enable effective prevention, detection and control of FF that pose a major threat to the lucrative European horticultural production sector.

The proposed FF-IPM solutions will address both the —resident| FF (Cc), and destructive potential invaders (Bd & Bz), which are already present close to the European borders, by applying in-silico methodology to boost and enhance the prevention and management of noxious FF. A comprehensive package for FF prevention and management, composed of integrated novel IPM tools, state-of-the-art decision support systems, and innovative expert services will be generated. In addition, during the project implementation the novelty of the FF-IPM solution development and testing from the project partners led to the development new SME's that have been created in the frames of the project, or the new business units within existing companies.

7.2 Business Model

Project outputs will be made available to stakeholders and end-users (clients) through an FF Management Platform. The FF Management Platform will integrate the novel expert services that FF-IPM will establish. The FF Management Platform is foremost a marketing/dissemination and not a commercialization tool. However, it can act as such.

It is important to evaluate the business model through the customer's, i.e. intermediate user's, perspective before and after launching the FF-IPM platform. There are four factors that we need to consider: customer, value creation and capture, competition and distribution⁵. FF Management Platform will continue its operation after the end of the project and aims to be a sustainable tool/product that will serve the specific

⁵ Aulet, B., 2013. Disciplined entrepreneurship: 24 steps to a successful startup. John Wiley & Sons.

scientific and business community. UTH committed to continue the operation and maintenance of the FF Management Platform for at least five (5) years after the end of the project.

The first step is understanding the Decision-Making Unit and Process to Acquire a Paying Customer. In the case of FF-IPM, it is crucial to distinguish between primary customers (end users) and secondary customers (the intermediate users), as the end users, i.e. individual farmers, growers, are not likely to have the resources to pay for or to utilize digital services. It is the secondary customers, i.e. National Plant Protection Organisations (NPPOs), business customers will be in the agrichem, farm advisory or farmer co-operatives who are more likely to become the economic buyer and the Decision-Making Unit. This is why the suggested business model is B2B2C: Business to Business to Customer.

Opportunities will be explored to commercialize the on-going provision of expert services so that the benefits can be delivered sustainably.

However, each product/service will have varying degrees of “exploitation” on the platform (from simple presence to full functional service). There are already good paradigms of potential successful products and services from the list indicated above.

Regarding business plans/exploitation plans, issues of availability i.e. availability to the whole community of the FF-IPM project or availability through "private" areas, providing only a summary on the website, they are being discussed.

*Suggested business model to be developed **B2B2C**.*

Paid use: The platform can grow big enough and create a mass of followers open to pay for a subscription and get newsletter services. The platform can have and sell advertising space to possible sponsors of related fields. It aims to generate revenues that will contribute to its sustainability.

Pricing per end user: alternatively, a plan based on the users could be anticipated, eg number of registered users, number of visits.

Free use: the platform will be free for the end user as an open source software.

7.3 Business development strategy

In this framework, certain suggestions/ parameters for the FF-IPMs' solutions and the FF-IPM Platforms' **sustainability and development strategy** will be analyzed such as:

- the establishment of tactical alliances with other industrial or research organisations that hold the potential of promoting the FF Management platform,
- the establishment of relationships of trust with customers early within the project, who can facilitate the quicker adoption of the solution and provide valuable feedback which can be used in the commercialization phase,
- the identification of financial support from diversified funds that can be used to support direct and/or indirect commercial transformation, ranging from additional research activities to bug fixing and to technology integration in existing or future solutions.

The FF-IPM solutions will also be provided, demonstrated and distributed by the project partners and further alliances will be formed with the partner's new SME's and/ or business units that were developed and in the frame of the project, to enhance the FF-IPM's exploitation and impact. For example, Cervantes is planning to either open a subsidiary or move to Greece for better access to the European market.

7.4 FF-IPM Exploitation Committee

The **Innovation and Exploitation Committee (IEC)** of the FF-IPM project (Task 1.6: Establishment and Operation of the FF-IPM Innovation and Exploitation Committee) is responsible for the oversight of innovation management, IPR handling with expert support and the creation of models and plans to support the partners in exploiting the project results. The IEC is chaired by the Innovation and Exploitation Manager (IEM), who with the committee helps the consortium identify, assess and support plans to exploit the potential IP and innovation opportunities arising from the work carried out. Membership of the IEC is made up of representatives from UTH, RNDO, CIRAD, inSilico-IPM, E-nema and ARO. (Slawomir Lux, Darren Kriticos, Hélène Delatte, Christos Genitsefsis, Arne Peters, Christos Athanassiou, David Nestel, Nikolaos Papadopoulos, Filippos Karamanlis)

The IEC is responsible for developing the innovation and exploitation strategies, identifying and connecting with potential users of the information and results being generated, looking for potential funding opportunities for commercialization of project results and collateral whilst helping partners safeguard any IPR being created. More specifically, the IEC deals with management of innovation and knowledge arising throughout the project life, in order to successfully achieve the potential impact of the project including the IPR. The main commitments concerning Intellectual Property (IP) are agreed among consortium partners. The IEC is reviewing its work on an annual basis and adjusting its focus and modus operandi if considered necessary.

8 Intellectual Property Rights Management

8.1 General IPR framework

Bearing in mind that results and products will be generated by the project, the essential ground rules for IPR management had been created and agreed in the partnership from the project's development phase, with the goal of having certain broad standards in place, in compliance with the H2020 regulations, which are also part of the Consortium Agreement. The CA's basic principles will follow the EC criteria in terms of background knowledge and, when practicable, will use a "publishing by default" strategy to reach the broadest possible audience. Furthermore, the consortium has considered IPR management in terms of background IP, as well as commercial and R&D expectations, from the start of the project, which would serve as the foundation for foreground IP conversations and subsequent agreements.

The following principles have already been defined:

Background knowledge: all consortium partners will bring in their expertise and knowledge without charging cost and will retain full ownership of the IPR of this expertise and knowledge.

Foreground knowledge: all newly developed expertise, knowledge and technologies will be owned by the participants in the project that were involved in the development of this specific expertise/technology. In case several participants have jointly carried out work generating foreground and where their respective share of the work cannot be ascertained, they shall have joint ownership of such foreground.

With regards to the aforementioned starting points involving IPR and individual exploitation interests, the CA signed before the project start allowed all participants to be provided exploitation alternatives. Additional to that, the partnership will continuously assess results that may qualify for IPR protection throughout the project's lifetime, which potentially were not identified in earlier stages. Finally, the CA further regulates rights, regulations and responsibilities regarding ownership of results, transfer of results, dissemination activities, potential legal limitations and access rights.

8.2 IPR Management in FF-IPM

In the framework of the FF-IPM project, both the Grant and Consortium Agreements lay the foundation for IPR Management. While background knowledge is more straightforward and undisputed, foreground knowledge can be more challenging and must be approached carefully. In principle, foreground intellectual property is owned by the partner developing it, i.e. scientific and research publications, software etc. If, however, this has been developed by two or more partners and is not possible to clearly distinguish each partner's contribution it will be jointly owned (GA, article 26.2).

As a result, there are three exploitation possibilities identified thus far, taking into account the diversity of the consortium as well as the background knowledge available.

- a. **100% Joint exploitation**, meaning one company that incorporate all exploitable outcomes
- b. **Cluster or singular exploitation**, meaning several teams of partners that can agree in the basics and create different structures (where a partner may be part in more than one cluster)
- c. **A mixture of the two**, meaning one company with most of the outputs which will collaborate with one or more of the clusters (partner or supplier relation)

The obvious benefit of having a single umbrella for a project result is that economies of scale may be achieved in terms of cost structure and revenue sources. Similarly, marketing and sales costs, legal and accounting costs, and financing costs would all function much more efficiently and smoothly, decreasing complications. It is also simpler to apply for financing or funding from venture capitalists or banks through a single joint venture.

To this end, specific agreements should be negotiated between joint owners on a case-by-case basis wherever possible, preferably at the start of the joint effort or when the joint outcome is generated. The joint owners must agree on a fair sharing system based on each beneficiary's contribution, an exploitation and licensing strategy, as well as protective measures and cost sharing. These aspects will be explored and presented more concretely in *D.1.4 Report on accomplished innovations, IPR arrangements and protection, and implementation* due in M48.

8.3 Results and Existing IPR

The table below presents exploitable results which are the outcome of research partners' efforts, and as such the IPR will belong to them, to be used either in the course of their scientific work or by licensing the innovations to private businesses (GA p. 32), while more details per result have already been provided in the tables in Section 3.2.

Result/Outcome	Partner	Envisaged exploitation
FF Management Platform with links to SMEs and services	UTH	New SME linked to UTH, will ensure continued operation of the Platform, FF Alert system, links to other services and products developed by FF-IPM and provide technical support to the end-users
DS-Alert System	Cervantes Ltd.	
'Virtual-Farm' IPM emulation system	In-Silico IPM	FF-IPM Partner SME (inSilico-IPM) will provide advisory service for development and implementation of the locally optimized OFF- & ON-Season FF IPM
e-Nose system for tracing FF-infested fruit	PCA, BPI	FF-IPM Partner SME (PCA) will produce and commercialize the e-Nose device for detection of FF-infested fruits.
Entomopathogenic fungi formulations for OFF Season FF IPM	CIRAD	CIRAD, jointly with relevant commercial producers of the evaluated fungi, will commercialize formulated entomopathogenic fungal IPM products for OFF-Season FF control.
Entomopathogenic nematode formulations for OFF season FF IPM	ENEMA, BPI	FF-IPM Partner SME (E-nema) will produce and commercialize nematode IPM products for OFF-Season FF control
Implementation protocols for rearing & augmenting ground dwelling predators	UJI	UJI, jointly with relevant commercial partners, will explore commercialization of predator-based IPM products for OFFSeason FF control
e-Traps for Cc, Bd, Bz	ARO, UNIMOL	ARO & UNIMOL will identify relevant commercial partners for production and commercialization of e-Traps.

Tools, methodology for the identification of intercepted FF	RMCA	RMCA will identify relevant commercial partners for production and commercialization of FF ID kits and will
App for the morphological identification of intercepted FF larvae	SU, RMCA	establish an SME linked to RMCA which will provide expert FF ID service and app for identification of FF larvae.

Table 1. FF-IPM results and ownership

8.4 Access Rights

As indicated in the Grant Agreement (p. 32-33), a **Gold Open Access** will be offered for project publishing in scientific and other journals/outlets, ensuring that the associated work will be made freely available to end users on the publisher's website. In addition, **Creative Commons** licensing models can be applied to project outputs, outcomes, deliverables, and services in a variety of ways, allowing for diverse levels of access and use. This has already been foreseen in the budget allocation to support partners in this effort, while this is coordinated by RNDO.

9 Conclusion

The purpose of this deliverable was to investigate the exploitation aspects of the FF-IPM project's outcomes. The project's primary exploitable outcomes were given specific attention in order to investigate their commercial potential as a comprehensive approach to pest invasion prevention and management.

Despite various limitations and constraints relating to the TRL level, IPR, and the intended audience of each product and service, the project aims to provide its services and products in an efficient and intuitive manner via the FF-IPM platform, as well as to continuously monitor the market maturity. To that purpose, the initial market analysis considered the existing market size and trends, revealing that there is a clear need as well as a bold forecast for future demand and revenue.

In addition, for the project's products and services, an overview of competitors was provided; it's worth noting that no data is available for the innovative experts services developed in the project, which can be examined further during the next few months and taken into account in terms of FF-IPM's competitive advantage. Moreover, a preliminary definition of a post-project business development strategy has been established in the hopes of further adapting and developing it to better meet the project's outcomes, potential, and constraints.

Finally, the questions of intellectual property rights were explored and investigated. IPR management must be considered early on in a project where a diverse team is either building on current results or producing new ones. As a result, the GA and CA in the Horizon 2020 program offer a foundation for these features and regulate the management of IPR in a horizontal manner. However, it has become clear that more work

needs to be done on this front, and IPR issues must be clearly addressed and defined under the guidance of the relevant WPs and tasks, so that the project's IPR final framework, within which the partners will be able to operate after the project's lifetime, can be clearly designed.

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