

TITLE: Pilot 3.3 Pest Management Control on Fruit Flies

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# Pilot 3.3 – Pest Management Control on Fruit Flies

## 1 Introduction

DEMETER aims to lead the Digital Transformation of the European agrifood sector based on the rapid adoption of advanced technologies, such as Internet of Things, Artificial Intelligence, Big Data, Decision Support (DSS), Benchmarking, Earth Observation, etc., to increase performance in multiple aspects of farming operations, as well as to assure the viability and sustainability of the sector in the long term. It aims to put these digital technologies at the service of farmers using a human-in-the-loop approach that constantly focuses on mixing human knowledge and expertise with digital information. DEMETER focuses on interoperability as the main digital enabler, extending the coverage of interoperability across data, platforms, services, applications, and online intelligence, as well as human knowledge, and the implementation of interoperability by connecting farmers and advisors with providers of ICT solutions and machinery.

DEMETER focuses on the deployment of farmer-centric, interoperable smart farming-IoT (Internet of Things) based platforms, to support the digital transformation of Europe's agri-food sector through the rapid adoption of advanced IoT technologies, data science and smart farming, ensuring its long-term viability and sustainability.

Twenty real-world pilot projects, grouped into five pilot clusters, are running within DEMETER to demonstrate and evaluate how agricultural innovations and extended capabilities benefit farmers, technology providers, and society. The topics, scope and size of the pilots are diverse, from saving resources, such as water and energy, to a more environmentally compatible crop management with reduced application of fertilisers and pesticides, to improved animal welfare and the tracing of complete supply chains.

This white paper describes the pilot Pest Management Control on Fruit Flies, which focuses on providing a set of tools to monitor and manage the Mediterranean fruit fly (Ceratitis capitata) which is a dangerous pest with a wide range of distribution and host plants. Automatic capture traps and remote sensing technologies will be employed to predict and support in taking decision and tested in citrus farms in Valencia region.

## 2 Importance of digital agriculture

Cluster 3 focuses on farmer support scenarios when protecting the health and the quality of production of both woody and vegetable crops in several European countries. The aim of pilot 3.3 is to provide ICT solutions to support farmers in the decision-making of addressing pest management by incorporating IoT sensors, automatic traps and automatic image recognition software.

Digitalization is crucial for an efficient pest management and control. The adoption of digital technology will be facilitated using image recognition platforms and solutions. To overcome the difficulties in encouraging farmers to adopt digital technology, the pilot will define trials to help provide an understanding and prove the benefits for the pest management activities.

## 3 Pilot Overview

### <u>Challenge</u>

The citrus sector in the Valencian Community is significant to the national and regional economy, supported by the Ministry of Agriculture who promote a program to control the main pest that attack crops and citrus; the Mediterranean fruit fly.

### <u>Aim</u>

This pilot aims to improve the monitoring network through automatic capture traps to predict and support decision making in citrus farms. The pilot is being deployed in the Valencian Community region with more than 170.000 hectares involved.

In essence, the intelligent pest management application decides where the different traps are to be placed and then decides how many sterile flies to release and where. To do this, the different traps catch different flies and take a photo that will be sent to the automatic insect recognition system. Based on the data obtained, decisions will be made about the number and location of sterile flies to be released. Finally, it will be possible to visualize historical data related to the fly classification performed by the automatic detection system.

### Where pilot is being deployed and who are the partners on this pilot

The pilot is deployed in Valencian Community region and the involved partners are TRAGSA and ATOS.

#### Solution/Innovation

Real-time data is captured, and image recognition software is deployed to achieve automated counting of the flies independent of the lab inspector.

Pest management system based on historical data and automatic detection software is also used.

#### Key Benefits

The automatic counting traps would mean an important reduction in staff and displacements costs.

Also, this savings would increase the trap density according to the levels indicated and recommended by the International Atomic Energy Agency (IAEA). Also, the possibility of having real-time capture data would allow farmers to evaluate the distribution and longevity of sterile males in the field as well as to better adjust the liberation strategy of males depending on wild population dynamics. In addition, the automation of the process will send real-time data to the farmers giving an upto-date status of the pest in the field.

The improvement in the monitoring allows more information to be sent to the farmers and managers about the status of the pest in the field, so they can react quickly in case of an increase in the pest.



## **4. DEMETER Integration**

### Key technologies employed

To achieve the objectives of the pilot different components have been developed taking advantage of the technology provided by DEMETER. These components or advanced DEMETER enablers, once virtualized, deployed and integrated in DEMETER infrastructure by means of the Access Control Enabler (ACS), DEMETER Enabler Hub (DEH) and Brokerage Service Environment (BSE), will provide a decision support system for the final user, making usage of their interoperability based on the DEMETER Agriculture Information data Model (AIM).

#### DEMETER enablers and other technologies

It has developed two components in DEMETER to provide the DSS for Pest Management Control of Fruit Fly. *DEMETER AIM* is used for information modelling of all data. <u>DEMETER Adaptive Visualization Framework</u> is used to show the results to the final user using the pilot's DEMETER components "*Pattern extraction with computer vision*" (WP2) and "*Pest estimation with sterile fruit flies*" (WP4). The following DEMETER Core Enablers are used: ACS, DEH and BSE using REST APIs.

Through the Knowage user interface, the end user can select a trap and see the count of wild and sterile flies caught in the selected trap, as well as a graph where the user can easily and visually monitor the results of the captured insects and quickly check the evolution of the fruit fly pest taking actions according to the results.

This pilot uses the following Demeter Enabler of WP2:

- The Agricultural Information Model (AIM) is used to model captured data from automatic traps.
- Pattern Extraction with Computer Vision: This component aims to detect patterns in pictures, using as a base for a pre-trained model. Users can create their own model (that depends on the quality and size of a labelled image dataset to train the model) or can reuse an existing one coming from the MLFLOW framework. The input and output data are based in the AIM format. The component is deployed within a docker container and is needed by other components that need pattern extraction capabilities in order to work properly (i.e. Pest Estimation with Sterile Fruit Flies component described below).

From WP3, this pilot uses the following DEMETER enablers:

- Access Control Enabler (ACS): used for the pilot user registration and access to other core and advanced DEMETER enablers.
- Brokerage Service Environment (BSE): is used to deploy the components used in the pilot.
- DEMETER Enabler Hub (DEH): is used to register the components developed.

From WP4, the pilot is working on the deployment of all enablers related to Knowage purposes as all the information provided will be finally integrated and be shown in a dashboard by the DEMETER visualization tool Knowage. All these components expose data using the DEMETER AIM data model and a REST API. The pilot uses the following components developed in WP4:

- Pest Estimation with Sterile Fruit Flies: The purpose of this component, is to detect the amount of fruit flies inside of traps and classify them (sterile or normal). Traps can take pictures of the captured specimens. The component uses the "Pattern Extraction with Computer Vision" component to detect the number of flies inside of such images, stores the data collected in a database and can give an estimation of the near-future captures (in a daily estimation). The component is deployed within a docker container and uses the AIM format.
- Decision Support System for Pest Management: Decision support systems (DSS) allow the delivery of tailored advisory services to users, citrus farmers or agriculture advisors, gathering and processing all the information provided by the enablers offered by the DEH.

Next, we show some figures from the Adaptive Visualization Framework Hub (Knowage) to show the results to the final user, using the pilot's DEMETER components:

- Pattern extraction with computer vision WP2
- Pest estimation with sterile fruit flies WP4





#### AIM usage

In the following sample (from "Pattern Extraction with Computer Vision", WP2), the AIM gives the information about the image that has been processed. We can find two flies in two different "Observation" class elements. "boxCoordinates" indicates the area where the fly was found within the picture and "hasSimpleResult" could be considered as a reliability value of the kind of fly that has been found (Normal Fly or Sterile Fly).

```
"@context": [
                "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/imageRecognitionModel-context.jsonld"
  ],
"@graph": [
´
        {
                "@id": "urn:demeter:ObservationCollection/1234",
                "@type": "ObservationCollection",
                "description": "testpicture.JPG",
                "observedProperty": {
                         "@id": "urn:demeter:ObservationCollection/1234/op",
                         "@type": "ObservableProperty",
                         "description": "Number of Flies in a trap"
                },
"hasMember": ["urn:demeter:Observation/1a", "urn:demeter:Observation/2a",
"urn:demeter:Observation/3a"],
                "resultTime": "2021-07-01T12:36:12Z"
        },
{
                                         www.h2020-demeter.eu
```

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```
"@id": "urn:demeter:Observation/1a",
       "@type": "Observation",
       "description": "Normal fly",
                "hasSimpleResult": 60.0000000000000,
"boxCoordinates": "[2150, 10, 1543, 254]"
       },
       {
                 "@id": "urn:demeter:Observation/2a",
       "@type": "Observation",
       "description": "Sterile fly",
       "hasSimpleResult": 24.08818745613458,
"boxCoordinates": "[2150, 10, 1543, 254]"
       },
       {
                 "@id": "urn:demeter:Observation/3a",
       "@type": "Observation",
       "description": "Sterile fly",
       "hasSimpleResult": 37.08818745613981,
                 "boxCoordinates": "[3151, 20, 2125, 324]"
       }
]
```

"Pest Estimation with Sterile Flies" (WP4) can provide, among many other features, statistics about the information that has been collected around all the traps. In this AIM sample, we can see all the traps with total amount of both Normal and Sterile Flies:

```
"@context": ["https://w3id.org/demeter/agri-context.jsonld",
"https://w3id.org/demeter/agri/ext/imageRecognitionModel-context.jsonld"],
"@graph": [
                          {
                                   "@id": "urn:demeter:ObservationCollection/1234",
                                   "@type": "StatisticsCollection",
                                   "description": "Statistics collection",
"hasMember": ["urn:demeter:Observation/1","urn:demeter:Observation/4"],
                                   "observedProperty": {
                                                                                        "@id":
"urn:demeter:ObservationCollection/1234/op",
                                                                                        "@type":
"ObservableProperty",
                                                                                        "description": "Number
of Flies in a trap"}
                                                                               },
                                                                               {
                                                                                        "@id":
"urn:demeter:Observation/1",
                                                                                        "@type": "Observation",
                                                                                        "resultTime": "2021-09-
14T11:08:45Z",
                                                                                        "hasFeatureOfInterest":
{
                                   "@id": "urn:demeter:Observation/1/trap ",
                                   "@type": "FeatureOfInterest",
                                   "name":"Trap",
                                   "identifier": "trapID1"
                          },
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                                                                                                         PAGE 8
```

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```
"observationType":
"real",
                                                                                        "hasResult":[
        {
                 "@id": "urn:demeter:Observation/1/result1",
                 "@type": "FliesQuantityValue",
                 "identifier":"1",
                 "description": "esteril",
                 "numericValue": 1468}]
                                                                              },
{
                                                                                        "@id":
"urn:demeter:Observation/4",
                                                                                       "@type": "Observation",
"resultTime": "2021-09-
14T11:08:45Z",
                                                                                        "hasFeatureOfInterest":
{
                                   "@id": "urn:demeter:Observation/4/trap ",
                                   "@type": "FeatureOfInterest",
                                   "name":"Trap",
                                   "identifier": "trapID1"
                          },
                                                                                        "observationType":
"real",
                                                                                        "hasResult":[
        {
                 "@id": "urn:demeter:Observation/4/result1",
                 "@type": "FliesQuantityValue",
                 "identifier":"1",
                 "description": "silvestre",
                 "numericValue": 1791
        }
        ]
```

## 4 Feedback from farmers

#### Farmer interactions

Five farmers (< 5 hectares) are directly involved in the pilot. However, considering this technology is applied to large citrus-growing areas, the indirect impact will affect the entire sector in Valencian Community, which is the largest national producer and the leading region for fresh citrus exports in the world.

### 5 Benefits

#### KPIs

- 1. Increase the trap density as suggested in the trapping guidelines for areawide fruit fly programs:
  - Beginning of the project: 1 visit per week
  - Expected in pilot round 2: 1 visit per month
- 2. Increase of the monitoring frequency to get a short-term reaction to an outbreak of fruit flies:
  - Beginning of the project: data monitoring 4 times per month
  - Expected in pilot round 2: daily data monitoring.
- 3. Reduction of the use of pesticides in extra-early and late citrus varieties due to an improvement in the monitoring management.
  - Beginning of the project: weekly frequency of notifications of pest levels
  - Expected in pilot round 2: notifications in case treatment threshold is reached

## 6 Conclusion

Pilot 3.3 is very beneficial in terms of improvements of farmer's pest management and taking advance of DEMETER enablers as they allow the improvement of the monitoring network by increasing the trap density per hectares and the daily information about the status of the pest in the fields.

Thanks to DEMETER, the pilot will benefit from automated counting, independent of the lab inspector, by image recognition systems. Based on the data obtained, decisions will be made about the number and location of sterile flies to be released. Also, thanks to automatic capture traps and real time communication the cost in terms of staff, vehicles and carbon footprint will be reduced, as well as the conditions of laboratory technicians will be improved.



# CONTACT US

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