LIFE FROSTDEFEND

LIFE20 CCA/GR/001747

DA1.1 Report on stakeholders' meetings

June 2022

NATIONAL CENTRE FOR SCIENTIFIC RESEARCH "DEMOKRITOS"
ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ AGRICULTURAL UNIVERSITY OF ATHENS
INRAE la science pour la vie, l'humain, la terre
AGRICULTURAL COOPERATIVES' UNION AEGHION S.A.
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Deliverable DA1.1

Report on stakeholders' meetings

Project Number	**LIFE20 CCA/GR/001747**
Project Title	**Forecasting and protecting fruit crops from frost damage**
Project Acronym	**LIFE FROSTDEFEND**
Action	**A1. Stakeholders' consultation and mapping of needs**
Deliverable	**DA1.1 Report on stakeholders' meetings**
Beneficiary	**ACUA**
Date	**06/2022**

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Summary

The LIFE FROSTDEFEND project aims to establish efficient and effective interaction between the LIFE FROSTDEFEND team and interested stakeholders from the early beginning of the project. To this end, five stakeholders' meetings were organized to initiate this collaborative environment. The meetings involved local producers and potential end-users from the Aigialeia, Argolida, and Laconia regions of Greece, as well as the Champagne, Auvergne Rhone Alpes, and Provence Alpes Cote d'Azur regions of France. The aims of the meetings were to:

a) Identify the key stakeholders' needs and expectations,
b) Map the efficiency and effectiveness of the existing local agricultural practices for frost damage protection,
c) Discuss practical recommendations that will further support the efficient implementation of the project actions, and
d) Inform the participants about the replication activities of LIFE FROSTDEFEND planned for their area.

The participants were also informed about the replication activities of the project planned for their area during the project implementation. At the end of the meetings, the LIFE-FROSTDEFEND team introduced and distributed questionnaires to the participants to gather their feedback. This document captures the key points arising from the discussions during the meetings.

This document, is being delivered in the context of Action A1 " Stakeholders' consultation and mapping of needs".

1 Meeting with stakeholders from Aigialeia region

1.1 Introduction

The first meeting with stakeholders, who are farmers owning and cultivating lemon tree orchards in the area of Aigialeia (Figure 1), was organized by the ACUA and the AUA on January 28, 2022, at the ACUA meeting room in Aeghion. This was a physical meeting with 19 participants, as documented in the attached list (Figure 2). The meeting was also broadcast online and was attended by Professor V. Karathanos from Harokopeion University, Athens, who serves as a consultant to ACUA, and Dr. Gini Maria from NCSR-D.

1.2 Participants

Figure 1: Photos from the meeting with the stakeholders from Aigialeia

1.3 Agenda

Agenda of the meeting EL

Πρόγραμμα Συνάντησης Διαβούλευσης για το Πρόγραμμα

LIFE20 CCA/GR/001747 "FROSTDEFEND"

«Forecasting and protecting fruit crops from frost damage»

28/01/2022, Παναιγιάλειος Ένωση Συνεταιρισμών	
10:30-11:00	Προσέλευση/Καφές
11:00-11:30	Παγετός και Εσπεριδοειδή
	Γενική κατάσταση στην Ελλάδα, Καθ. Δ. Γεωργακόπουλος, ΓΠΑ
	Η κατάσταση στην περιφέρεια Αιγιαλείας, Θ. Λουκόπουλος, ΠΕΣ
	Ευαισθησία ειδών, συνδυασμών ποικιλίας/υποκειμένου σε κάθε είδος, Καθ. Ι . Παπαδάκης, ΓΠΑ
11:30-12:00	Μέτρα προστασίας
	Συμβατικά μέτρα προστασίας, Ι. Παπαδάκης, ΓΠΑ
	Παθητικά μέσα προστασίας - Ψεκασμοί με χαλκό/Έλεγχος του πληθυσμού των επιφυτικών παγοπυρηνωτικών βακτηρίων, Δρ. Δ. Γεωργακόπουλος, ΓΠΑ
12:00-12:10	Περιγραφή του έργου LIFE20 CCA/GR/001747 "FROSTDEFED". Δρ. Κ.Ελευθεριάδης, ΕΚΕΦΕ «Δημόκριτος»
12:10-12:20	Περιγραφή του FROSTDEFEND-tool, Δρ. Γ. Σαρτζιαννίδης, MSENSIS
12:20-12:30	Περιγραφή του Ερωτηματολογίου, Καθ. Δ. Γεωργακόπουλος, ΓΠΑ
12:30-13:00	Συζήτηση, Συμπλήρωση ερωτηματολογίου

Το έργο συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση

Agenda of the meeting EN

Project LIFE20 CCA/GR/001747 "FROSTDEFEND"

«Forecasting and protecting fruit crops from frost damage»

28/01/2022, Panaigialios Union of Cooperatives (ACU)	
10:30-11:00	Registration
11:00-11:30	Frost damage on Citrus crops
	The general situation in Greece, Prof. D. Georgakopoulos, AUA
	The situation in the region of Aigialeia, Mr. Themis Loukopoulos, ACU
	Sensitivity of species, cultivar/rootstock combinations to frost, Prof. I. Papadakis, AUA
10:30-12:00	Methods for protection from frost
	Conventional protection methods, Prof I. Papadakis, AUA
	Passive methods of protection - Sprays with copper / Control of the population of epiphytic ice-nucleation active bacteria, Prof. D. Georgakopoulos, AUA
12:00-12:10	Description of the project LIFE20 CCA/GR/001747 "FROSTDEFED". Dr. K. Eleftheriadis, NCSR "Demokritos"
12:10-12:20	Description of the FROSTDEFEND-tool, Dr. G. Sarigiannidis
12:20-12:30	Description of the Questionnaire, Prof. D. Georgakopoulos, AUA
12:30-13:00	Discussion, Completion of questionnaire

1.4 Summary of Discussion and Key Outcomes

The chairman and vice chairman of ACUA, the organizers of the event, extended a warm welcome to the audience and the FROSTDEFEND scientists on the panel. They highlighted that lemon cultivation and harvests in Aegialeia had seen a significant decline over the past 12 years, with frost damage being a major contributing factor to this reduction. They expressed a strong interest in revitalizing lemon cultivation in Aegialeia, which motivated their participation in LIFE FROSTDEFEND.

Professor Georgakopoulos from AUA introduced the LIFE FROSTDEFEND consortium and emphasized the project's importance for lemon producers in Aegialeia and citrus growers in the Peloponnese region, who had recently experienced frost damage to their trees. He presented data illustrating the decline in citrus growing acreage in Greece's main citrus areas over the past twelve years, attributing it to frequent frosts as well as commercial factors such as cheap imports of lemons.

Professor Papadakis from AUA delved into the mechanisms of frost damage on crops, emphasizing the sensitivity of lemon varieties and rootstock combinations to frost in relation to factors such as temperature drop, duration, and geographical parameters. He discussed proper cultivation practices aimed at reducing frost damage to trees and explored various frost mitigation measures available today, including their cost-benefit analysis and effectiveness.

Subsequently, the participating stakeholders were queried about the frost mitigation measures implemented in their orchards. A notable outcome of this discussion was that stakeholders no longer utilized air mixers due to their high operational and maintenance costs. Instead, they relied on misting beneath the tree canopy and occasionally resorted to burning various materials to locally elevate temperatures around the orchard and mitigate frost damage.

Professor Georgakopoulos provided farmers with information about ice nucleation active bacteria, which colonize plant surfaces and play a significant role in crop frost damage. He emphasized that reducing the populations of these bacteria through copper sprays is a crucial measure for enhancing tree resilience to frosts. Furthermore, he presented data from copper application studies conducted in the USA and other parts of the world, supporting the efficacy of this strategy. He underscored the importance of timing the application of these sprays to maximize effectiveness, highlighting that this practice is an adaptation of standard cultural

practices used for protecting against plant pathogens, aimed at reducing the numbers of ice nucleation-active bacteria.

Professor Georgakopoulos then outlined the consortium and the planned activities of LIFE FROSTDEFEND in Aegialeia. He explained the concept of the FROSTDEFEND tool for forecasting frost damage and stressed the importance of active stakeholder participation in the project's events. Additionally, Dr. Sarigiannidis from MSENSIS presented the main structure and functions of the FROSTDEFEND smartphone tool online, highlighting its simplicity, ease of use, and usefulness for farmers.

Finally, Professor Georgakopoulos introduced the questionnaire to the farmers, emphasizing the significance of completing and returning it to ACUA. He explained that this step is crucial for mapping the current situation of lemon tree cultivation in Aegialeia and for determining the stakeholders' needs regarding protecting their crops from frost events. The meeting concluded with an active discussion between the audience and the project team.

Stakeholders expressed interest in completing the questionnaire, resulting in the submission of fourteen completed questionnaires. While most questions were answered, not all were addressed. It is evident that the questionnaire needs to be shortened and simplified for improved usability. Nonetheless, the responses provided valuable insights into the current situation and the stakeholders' needs regarding frost damage mitigation.

Key findings from the questionnaire include:

- 1.3 (Do you keep agronomic records): 7/14 (50%)
- 1.6 (Do you use sensors in your orchard): 4/14 (29%)
- 1.7, 2.6 (Frost mitigation measures): 14/14 (100%), of which
    - Wind fences: 2/14
    - Fans: 0/14
    - Heaters: 0/14
    - Misting: 10/14
    - Surface irrigation: 1/14
    - Copper sprays: 1/14
- 3.3 (Use of social media): 4/14 (29%)
- 3.4 (Participation in local, national and international events): 14/14 (100%)
- 4.1 (Acceptance of a frost warning service): 14/14 (100%)
- 4.3 (Acceptance of a frost warning service for a small fee): 12/14 (86%)

- 4.4, 4.5, 4.6 (Collaboration in FROSTDEFEND demonstrations): 12/14 (86%)

The key outcome and main conclusions from questionnaires of the Aegialeia stakeholders are:

- They keep agronomic records, but they do not use in-field sensors that much.
- They all take frost mitigation measures. Misting is the method of choice by the majority. No energy-consuming methods are used (fans, heaters).
- The majority do not use social media but participate in local events concerning their crop.
- They all find useful and helpful an online frost-warning service.
- A great majority accepts to pay a small fee for this service.

A great majority accepts to participate in FROSTDEFEND demonstration events in some way (allocating space in orchard, permitting the installation of sensors).

2 Meeting with stakeholders from Argolis region

2.1 Introduction

The second meeting with stakeholders took place in Nafplion, Argolis (or Argolida), on February 25, 2022. Organized by ANYFION S.A., a local organic citrus company, the physical event was overseen by Mr. Vaggelis Kyriakou from ANYFION and was attended by sixteen orange producers. Dr. Kostas Eleftheriadis (project coordinator) and Professor Dimitrios Georgakopoulos presented the project online, while Professor Giannis Papadakis attended the meeting in person.

2.2 Participants

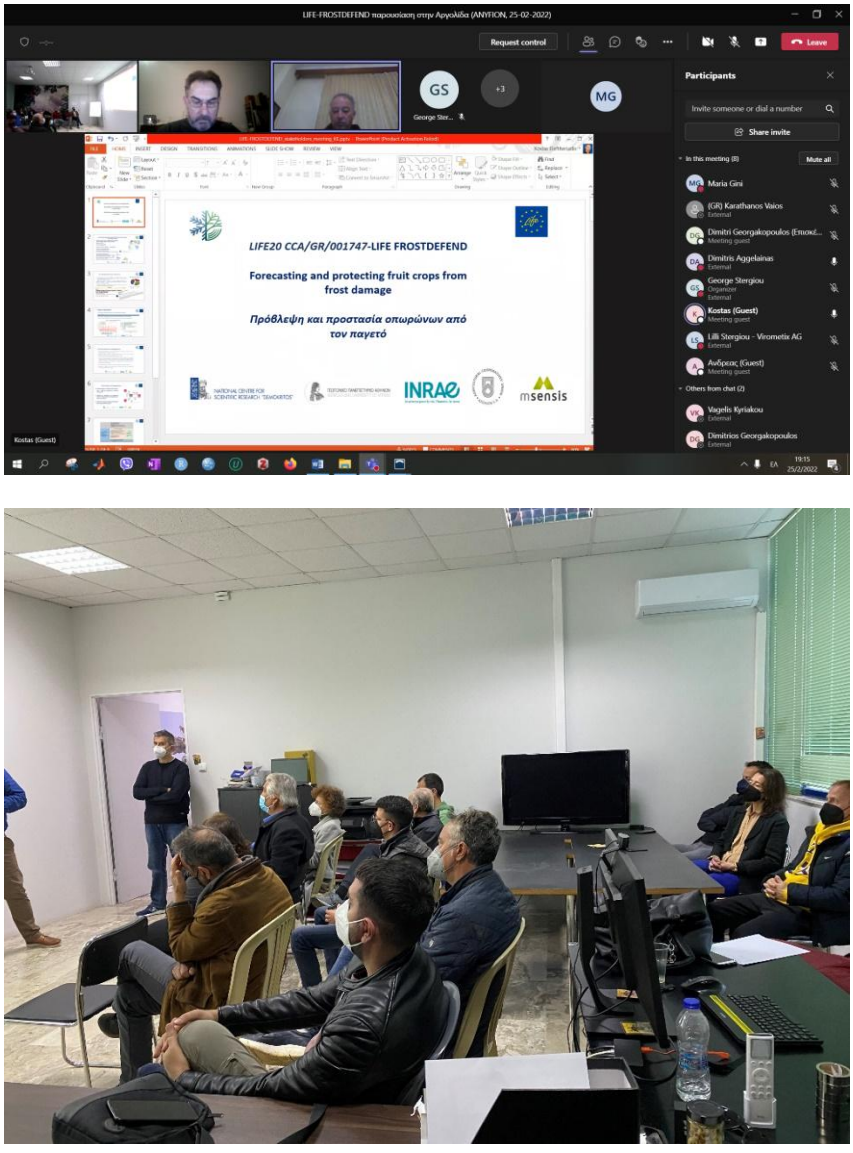

Figure 3: Photos from the meeting with the stakeholders at ANYFION premises in Nafplion

2.3 Agenda of the meeting

Έργο LIFE20 CCA/GR/001747 "FROSTDEFEND"

«Forecasting and protecting fruit crops from frost damage»

25/02/2022, ΑΝΥΦΙΟΝ - Κέντρο Βιολογικής Γεωργίας - Ναύπλιο - Αργολίδα	
17:00-17:30	Προσέλευση/Καφές
17:30-18:15	Παγετός και Εσπεριδοειδή
	Γενική κατάσταση στην Ελλάδα, Καθ. Δ. Γεωργακόπουλος, ΓΠΑ
	Η κατάσταση στην Αργολίδα, Βαγγέλης Κυριάκου, Γεωπόνος, ΑΝΥΦΙΟΝ
	Ευαισθησία ειδών, συνδυασμών ποικιλίας/υποκειμένου σε κάθε είδος, Καθ. Ι . Παπαδάκης, ΓΠΑ
18:15-19:00	Μέτρα προστασίας
	Συμβατικά μέτρα προστασίας, Ι. Παπαδάκης, ΓΠΑ
	Παθητικά μέσα προστασίας - Ψεκασμοί με χαλκό/Έλεγχος του πληθυσμού των επιφυτικών παγοπυρηνωτικών βακτηρίων, Δρ. Δ. Γεωργακόπουλος, ΓΠΑ
19:00-19:10	Περιγραφή του έργου LIFE20 CCA/GR/001747 "FROSTDEFED". Δρ. Κ.Ελευθεριάδης, ΕΚΕΦΕ «Δημόκριτος»
19:10-19:20	Περιγραφή του FROSTDEFEND-tool, Δρ. Γ. Σαριγιαννίδης
19:20-19:30	Περιγραφή του Ερωτηματολογίου, Καθ. Δ. Γεωργακόπουλος, ΓΠΑ
19:30-20:00	Συζήτηση, Συμπλήρωση ερωτηματολογίου

2.4 Summary of Discussion and Key Outcomes

The manager of ANYFION and the organizer of the event Mr. Vangelis Kyriakou welcomed the audience and the FROSTDEFEND scientists in the panel. He stated that the recent January 2022 frosts were responsible for severe frost damage on orange tree orchards in Argolis. They expressed their strong interest in the activities of FROSTDEFEND and their willingness for future collaboration.

Professor Georgakopoulos (AUA, participated online) introduced the FROSTDEFEND consortium and pointed out the significance of this project for the lemon producers and citrus growers in the region of Peloponnese, who suffered frost damage on their trees only days before this meeting. He presented data on the reduction of citrus growing acreage in the main citrus areas of Greece over the last twelve years, which has been attributed to frequent frosts, but also to commercial reasons (cheap imports of lemons).

Professor Papadakis (AUA) talked about the mechanisms of frost damage on crops, the sensitivity of lemon varieties/rootstock combinations to frost with relation to temperature drop, duration and geographical parameters. He mentioned the proper cultivation practices to be followed in order to reduce frost damage of trees, and he discussed the various frost mitigation measures available today, their cost/benefit analysis and effectiveness. The participating stakeholders were then asked about the frost mitigation measures they follow in their orchards. A key outcome of this discussion is that the stakeholders no longer use air mixers because of the high operational and maintenance costs. They rely on misting under the tree canopy and sometimes on burning various materials to locally increase the temperature around the orchard and reduce frost damage.

Professor Georgakopoulos presented information to farmers about the ice nucleation active bacteria, which colonize plant surfaces and, to a significant degree, are important factors in frost damage of crops. He mentioned that reducing populations of these bacteria by copper sprays is a key measure to improve the resilience of trees to frosts and presented data from application of copper in the USA and elsewhere in the world that support this strategy. He pointed out the significance of timing in applying these sprays to maximize effectiveness and that this is an adaptation of a standard cultural practice in use for protection against plant pathogens, to include the reduction of numbers of ice nucleation-active bacteria.

Dr. K. Eleftheriadis from NCSRD (online participant) then presented the consortium and planned activities of FROSTDEFEND. He described the concept of the FROSTDEFEND tool for

forecasting frost damage. He also mentioned the significance of stakeholders' active participation in the events of the project and that duplication experiments will be organized in Argolis later on in the project.

Dr. Sarigiannidis (MSENSIS) (online participant) presented the main structure and functions of the FROSTDEFEND tool for a smartphone, indicating its simplicity, ease of use and usefulness for the farmer.

Finally, Professor Georgakopoulos presented the questionnaire to farmers. He stated that filling the questionnaire and returning it to ACUA, is very significant for mapping the current situation of lemon tree cultivation in Aegialeia and for determining the needs of the stakeholders with respect to protecting their crops from frost events.

The meeting ended with questions and answers between the audience and the FROSTDEFEND scientists in the panel, as well as an active discussion about the prospects of orange cultivation in Argolis and the benefits that FROSTDEFEND can bring to the stakeholder.

Stakeholders were interested in filling the questionnaire. Twenty two questionnaires were turned in, with answers to most but not all the questions. The questionnaire must be shortened and simplified. However, the output of answers produced interesting and useful results on the current situation and the needs of the stakeholders concerning frost damage mitigation. Answers to the most significant questions are:

- 1.3 (Do you keep agronomic records): 9/22 (41%)
- 1.6 (Do you use sensors in your orchard): 10/22 (45%)
- 1.7, 2.6 (Frost mitigation measures): 22/22 (100%), of which
    - Wind fences: 0/22
    - Fans: 3/22
    - Heaters: 0/22
    - Misting: 2/22
    - Surface irrigation: 2/22
    - Copper sprays: 0/22
- 3.3 (Use of social media): 1/22 (4%)
- 3.4 (Participation in local, national and international events): 4/22 (18%)
- 4.1 (Acceptance of a frost warning service): 22/22 (100%)
- 4.3 (Acceptance of a frost warning service for a small fee): 21/22 (95%)
- 4.4, 4.5, 4.6 (Collaboration in FROSTDEFEND demonstrations): 22/22 (100%)

The key outcome and main conclusions from questionnaires of the Argolis stakeholders are:

- About 50% keep agronomic records and use in-field sensors that much.
- They all take frost mitigation measures. Misting is the method of choice by the majority. Energy-consuming methods are used sparingly (fans).
- The vast majority do not use social media and do not participate in events concerning their crop.
- All find useful and helpful an online frost-warning service.
- A great majority accepts to pay a small fee for this service.
- All accept to participate in FROSTDEFEND demonstration events in some way (allocating space in orchard, permitting the installation of sensors).

3 Meeting with stakeholders from Laconia region

3.1 Introduction

This meeting occurred in Sparta, Laconia, Greece, on Friday, March 13, 2022. Hosted by Sparta Valley Fruits S.A., a wholesale seller and exporter of citrus fruits, which also provides consultancy services to many local farmers, the event was attended by Mr. Neoklis Kritikos, Member of the Hellenic Parliament for Laconia. Mr. Kritikos addressed the audience, emphasizing the significance of such events for the local orange producers.

3.2 Participants

Figure 5: Photos from the meeting with the stakeholders in Sparta

3.3 Agenda

Έργο LIFE20 CCA/GR/001747 "FROSTDEFEND"

«Forecasting and protecting fruit crops from frost damage»

13/05/2022, Sparta Valley Fruits, Σπάρτη, Λακωνία	
17:30-18:00	Προσέλευση
18:00-18:05	Εισαγωγή, Καθ. Δ. Γεωργακόπουλος, ΓΠΑ
	Χαιρετισμός, Δρ. Νεοκλής Κρητικός, Βουλευτής Λακωνίας
18:05-18:45	Παγετός και Εσπεριδοειδή
	Γενική κατάσταση στην Ελλάδα, Καθ. Δ. Γεωργακόπουλος
	Η κατάσταση στην Λακωνία, κ. Ι. Μπεκιάρης, Sparta Valley Fruits
	Ευαισθησία ειδών, συνδυασμών ποικιλίας/υποκειμένου σε κάθε είδος, Καθ. Ι . Παπαδάκης, ΓΠΑ
18:45-19:30	Μέτρα προστασίας
	Συμβατικά μέτρα προστασίας, Καθ. Ι. Παπαδάκης
	Παθητικά μέσα προστασίας - Ψεκασμοί με χαλκό/Ελεγχος του πληθυσμού των επιφυτικών παγοπυρηνωτικών βακτηρίων, Καθ. Δ. Γεωργακόπουλος
19:30-19:40	Περιγραφή του έργου LIFE20 CCA/GR/001747 "FROSTDEFED". Δρ. Κ.Ελευθεριάδης, ΕΚΕΦΕ «Δημόκριτος»
19:40-19:50	Περιγραφή του εργαλείου FROSTDEFEND, Δρ. Γ. Σαριγιαννίδης, MSENSIS
19:50-20:00	Περιγραφή του Ερωτηματολογίου, Καθ. Δ. Γεωργακόπουλος
20:00-20:30	Συζήτηση, Συμπλήρωση ερωτηματολογίου

3.4 Summary of Discussion and Key Outcomes

Professor Georgakopoulos (AUA) introduced the FROSTDEFEND consortium and pointed out the significance of this project for the orange producers of Laconia and citrus growers in the region of Peloponese, who suffered frost damage on their trees only days before this meeting. He presented data on the reduction of citrus growing acreage in the main citrus areas of Greece over the last twelve years, which has been attributed to frequent frosts, but also to commercial reasons (cheap imports).

Professor Papadakis (AUA) talked about the mechanisms of frost damage on crops, the sensitivity of lemon varieties/rootstock combinations to frost with relation to temperature drop, duration and geographical parameters. He mentioned the proper cultivation practices to be followed in order to reduce frost damage of trees, and he discussed the various frost

mitigation measures available today, their cost/benefit analysis and effectiveness. The participating stakeholders were then asked about the frost mitigation measures they follow in their orchards. A key outcome of this discussion is that the stakeholders no longer use air mixers because of the high operational and maintenance costs. They rely on misting under the tree canopy and sometimes on burning various materials to locally increase the temperature around the orchard and reduce frost damage.

Professor Georgakopoulos presented information to farmers about the ice nucleation active bacteria, which colonize plant surfaces and, to a significant degree, are important factors in frost damage of crops. He mentioned that reducing populations of these bacteria by copper sprays is a key measure to improve the resilience of trees to frosts and presented data from application of copper in the USA and elsewhere in the world that support this strategy. He pointed out the significance of timing in applying these sprays to maximize effectiveness and that this is an adaptation of a standard cultural practice in use for protection against plant pathogens, to include the reduction of numbers of ice nucleation-active bacteria.

Professor Georgakopoulos (on behalf of Dr. Eleftheriadis, who was unable to connect online) then presented the consortium and planned activities of FROSTDEFEND. He described the concept of the FROSTDEFEND tool for forecasting frost damage. He also mentioned the significance of stakeholders' active participation in the events of the project and that duplication experiments will be organized in Argolis later on in the project.

Professor Georgakopoulos (on behalf of Dr. Sarigiannidis (MSENSIS) who was unable to connect online) presented the main structure and functions of the FROSTDEFEND tool for a smartphone, indicating its simplicity, ease of use and usefulness for the farmer.

Finally, Professor Georgakopoulos presented the questionnaire to farmers. He stated that filling the questionnaire and returning it to ACUA, is very significant for mapping the current situation of lemon tree cultivation in Laconia and for determining the needs of the stakeholders with respect to protecting their crops from frost events.

The meeting ended with questions and answers between the audience and the FROSTDEFEND scientists in the panel, as well as an active discussion about the prospects of orange cultivation in Laconia and the benefits that FROSTDEFEND can bring to the stakeholder.

Stakeholders were interested in filling the questionnaire. Fifteen questionnaires were turned in, with answers to most but not all the questions. The questionnaire must be shortened and

simplified. However, the output of answers produced interesting and useful results on the current situation and the needs of the stakeholders concerning frost damage mitigation. Answers to the most significant questions are:

- 1.3 (Do you keep agronomic records): 0/15 (0%)
- 1.6 (Do you use sensors in your orchard): 0/15 (0%)
- 1.7, 2.6 (Frost mitigation measures): 3/15 (20%), of which
    - Wind fences: 0/15
    - Fans: O/15
    - Heaters: 0/15
    - Misting: 3/15
    - Surface irrigation: 2/15
    - Copper sprays: 1/15
- 3.3 (Use of social media): 3/15 (20%)
- 3.4 (Participation in local, national and international events): 5/15 (33%)
- 4.1 (Acceptance of a frost warning service): 12/15 (80%)
- 4.3 (Acceptance of a frost warning service for a small fee): 11/15 (73%)
- 4.4, 4.5, 4.6 (Collaboration in FROSTDEFEND demonstrations): 12/15 (80%)

The key outcome and main conclusions from questionnaires of the Laconia stakeholders are:

- None of the participants keeps agronomic records and uses in-field sensors.
- Few take frost mitigation measures. Misting is the method of choice by the majority. Energy-consuming methods are not used (fans).
- The vast majority do not use social media and do not participate in events concerning their crop.
- The majority find useful and helpful an online frost-warning service.
- A smaller majority accepts to pay a small fee for this service.
- The majority accept to participate in FROSTDEFEND demonstration events in some way (allocating space in orchard, permitting the installation of sensors).

4 Meeting with stakeholders from Champagne region, France

4.1 Introduction

The first meeting in France with stakeholders from the Champagne region was conducted online via the Microsoft Teams platform on February 8th, 2022 (Figure 7). The objective of the meeting was to provide an overview of the LIFE-FROSTDEFEND project to grape producers from prestigious domains and smaller farms in the Champagne region, and to solicit feedback on current needs and existing local agricultural practices for frost damage protection and climate change adaptation. Dr. Guillaume Charrier from INRAE represented the LIFE FROSTDEFEND project team in the meeting, serving both as the chair and the rapporteur.

4.2 Participants

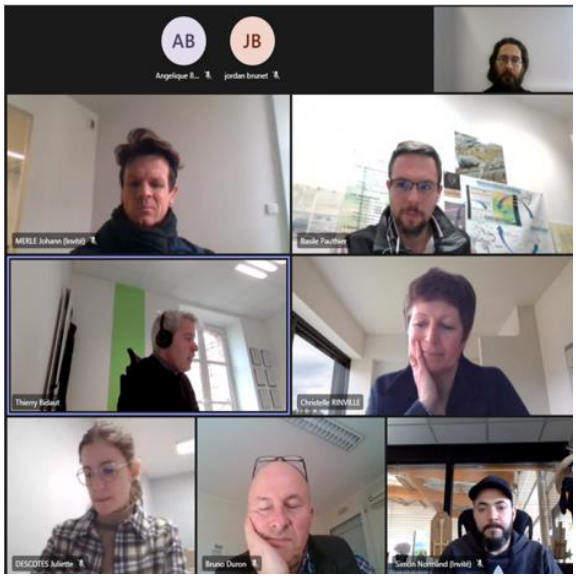

Figure 7: Photo from Microsoft Teams meeting with stakeholders from Champagne region

4.3 Agenda

The meeting started with a 30 min presentation of the project, the timeline, the objectives and expected outcomes by Dr Guillaume Charrier (INRAE). After the 30 minute presentation, an hour and a half of feedback and discussion took place.

4.4 Summary of Discussion and Key Outcomes

The main points of the discussion were related to:

The need for a reliable warning tool and an effective and efficient frost protection technique. For example, timing is crucial when using sprinklers: if water aspersion plants starts in a dry air, water will evaporate from the plants tissue and, the latent heat flow from the plant to the air will decrease plant organ temperature. Sprinkling should therefore be monitored using wet temperature (generally though a correlation with air relative humidity and air 'dry' temperature). Sprinkling for a too long duration may impact water reserves for subsequent freezing events in the spring. The farmers that use sprinklers would therefore be interested in using a real-time monitoring and early-warning system with high time resolution (update every hour if feasible) and 2-day forecast. Therefore, the novelty of the LIFE-FROSTDEFEND tool to provide early warning on frost risk should be demonstrated to highlight its usefulness.

Farmers in Champagne who utilize other protection techniques do not prioritize energy conservation and predominantly rely on wind mixers, consuming an average of around 30 liters of fuel (gasoil) per hour, and/or heaters (which incur higher operating costs in both carbon emissions and monetary terms) to mitigate frost damage and safeguard their grape crops. They perceive the cost of protection as reasonable when weighed against the significant loss of grape yield, particularly considering the added value of Champagne.

In total, 2000 hectares of grapes were protected in Champagne in 2020, which is twice the amount protected 25 years ago. Reliable and timely predictions could help minimize the costs associated with frost protection.

The frost vulnerability of grape buds

At the more critical stage (when first leaves start to appear below the scales at the tip of the bud), the frost sensitivity is evaluated at -1.5°C. One missing point is the relation between

frost vulnerability, air temperature and relative humidity. This will be assessed in the LIFE FROSTDEFEND project.

Current warning in CIVC

In CIVC, warning news is released in the evening after the weather forecast by Meteo France has been released for the night (ca. 18:00). A phenological model, developed locally, is used for the predictions; an increase in frost risk is predicted until 2035 and thereafter frost risk should decrease. In CIVC they are interested in new protection and more efficient solutions to protect their crops.

Ice Nucleation Active Bacteria

The control of INA bacteria was tested 20-30 years ago. Although interesting results were obtained in the laboratory, the methodology was not adopted widely for field application. The LIFE FROSTDEFEND consortium will apply an integrated approach to assess the role of airborne and epiphytic bacteria on frost damage and effectively control their population in order to reduce the frost risk.

Miscellaneous

An herb *Plantago major* (Plantain in French) is used as an alert, as it freezes earlier than other plants. Farmer touches the plant and when it becomes stiff, he can start the frost protection method.

5 Meeting with stakeholders from the Auvergne Rhone Alpes and Provence Alpes Cote d'Azur regions

5.1 Introduction

The meeting with grape and fruit producers from the Auvergne Rhone Alpes and Provence Alpes Cote d'Azur regions (Figure 9) was conducted online via Zoom on February 22nd, 2022. The objective of the meeting was to introduce the project to stakeholders involved in both fruit and grape production from the Rhone Valley and gather feedback on current needs and existing local agricultural practices for frost damage protection and climate change adaptation. Dr. Guillaume Charrier from INRAE represented the LIFE FROSTDEFEND project, serving both as the chair of the meeting and the rapporteur.

5.2 Participants

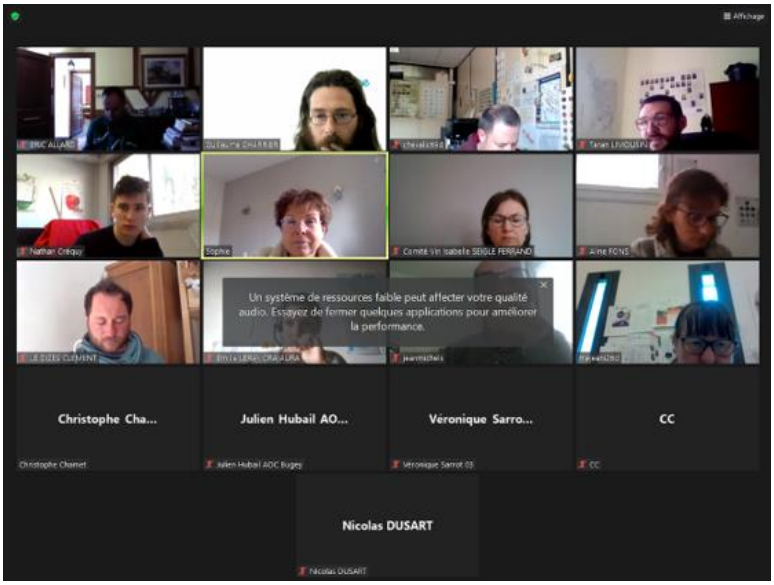

Figure 9: Picture from the Zoom meeting

5.3 Agenda

The meeting started with a 30 min presentation of the project, the timeline, the objectives and expected outcomes by Dr Guillaume Charrier. After the 30 minute presentation, an hour and a half of feedback and discussion took place.

5.4 Summary of Discussion and Key Outcomes

The main points of the discussion were related to:

Tests to reduce INA bacteria activity showed mixed and inconsistent results. Trials using tartaric acid and other products produced some positive effects in certain frost events, but results were not convincing across multiple events—especially at lower temperatures.

The FROSTDEFEND tool is expected to integrate microclimatic and biological factors. The algorithm should account for local microclimate conditions, aerosol properties, agronomic/biological parameters, and plant phenology to better predict frost damage risk, including effects linked to plant structure and windbreaks.

The prototype will support a spray-based protection strategy. The project's protection method focuses on applying copper-compound sprays to reduce INA bacteria populations. The tool's role will be to provide timely alerts so spraying can occur before frost events, maximizing bacterial ice nuclei reduction.

Hailstorm prevention is also a high priority for growers. While nets help protect against hail, they can worsen frost risk by trapping cold air and may fail under snow load. Hail risk is also more variable over time and region, but the consortium sees it as an important topic to address in the future.

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