1. *Content of the 'Topic Description' document*

1.1. Topic area

Diagnostics, field detection, surveillance

1.2. Links to the Euphresco Strategic Research Agenda

The topic addresses the following objective(s) of the 2017-2022 Euphresco Strategic Research Agenda.
☒ Objective 2017-R-1.1: to improve knowledge on the biology, epidemiology and ecology of priority invasive and (re)emerging pests
☒ Objective 2017-R-1.2: to support taxonomic research for the unambiguous identification of pests
☒ Objective 2017-R-5.3: to understand mixed infections through metagenomic analysis
☒ Objective 2017-R-5.4: to test and validate the use NGS (e.g. whole genome sequencing, metagenomics, deep sequencing, typing by sequencing) for routine diagnostics
☒ Objective 2017-I-2.1: to support data exchange, data use and re-use for the benefit of plant health research activities
☒ Objective 2017-I-2.2: to contribute to databases for plant pests identification and diagnostics

1.3. Topic title

Diagnosis and epidemiology of viruses infecting cereal crops

1.4. Description of the problem the research should solve

According to the FAO, cereals are the world's most important sources of food, for human consumption and as inputs to livestock production. What happens in the cereal sector is therefore crucial to global food security (Alexandratos & Bruinsma, 2012).
In Europe, cereals (wheat, barley, maize, oat, rye, triticale and rice) occupy more than half of the total planted arable land. On a global scale, Europe accounts for 20% of the total cereal production, however, recent modelling indicates that actual cereal yields in Europe are probably at 30–90 % of their theoretical potential (Schils *et al*., 2018). Yield reduction can be related to non-effective management practices or unfavourable soil and climate conditions, whereas also significant damage on cultivation can be linked to biological factors such as insect pests, fungal and virus infections.
Due to the current low profile in plant quarantine, only few cereal and grass viruses have been involved in regular monitoring or research programs in a few countries in Europe. The main reasons for that are: a) many of cereal infecting viruses are not seed-transmitted, therefore their distribution via global trade is not considered to present a high risk, b) the yield losses caused by viruses in cereal crops have been considered limited because of good insect vector control via effective insecticides (largely pyrethroids and neonicotinoids).
However, a recent European Union regulation prohibiting outdoor use of the neonicotinoid-insecticides has led to an increase in the number of applications of pyrethroid sprays, with an increase in the proportion of pests that have evolved insecticide resistance (McNamara *et al*., 2020). Among cereal viruses, many are disseminated by insect vectors. It is expected that changing climate will increase insect-transmitted disease outbreaks by increasing population growth and number of vector generations per year. Moreover, climate change is associated with increased virus titre, transmission and acquisition efficiency or changes in vector feeding behaviour/preferences (Trebicki, 2020). Another important source of cereal virus infection holds in the infested soil hidden in the viruliferous resting spores of the zoosporic vectors (e.g. *Polymyxa graminis*). Cultural practices (crop rotation, delayed sowing, *etc*.) and even application of fungicides as control measures for soilborne viral diseases have not proven

effective. Cultivation of susceptible varieties facilitates the build-up of several soil-borne viruses in the fields and dissemination of these viruses over expanding regions worldwide (Kühne, 2009). There is, therefore, a demonstrable need for a better understanding of the current cereal virus reservoir which could be achieved by simultaneous systematic surveys held in different countries. The collected data can be used as input for pest categorizations or pest risk analyses.

Key questions related to viral diseases in agriculture are the source of emerging virus infections, the role of host biodiversity and the severity of the infection. Asymptomatic virus infections in wild reservoir plants tend to be pathogenic in related crop hosts. Wild species may serve as a source for virus recombination through co-infections. Introduction of new viruses in specific areas, emergence of new strains or transmission of endemic viruses from wild plants to newly introduced crops or cultivars represent 47% of plant pathogen emergence worldwide (Anderson *et al*., 2004). Vice versa, viruses causing crop diseases can influence the species diversity in agro-ecological interface (Vincent *et al*., 2014; Alexander *et al*., 2017). The studies on virus discovery and epidemiology are required to assign the phytosanitary status (absence, presence), to determine a plant health status, to develop better agricultural strategies for future, and to establish the policies and approaches avoiding virus spread to native vegetation.

The aim of the current Euphresco project is to develop an international research network on the diagnosis and epidemiology of viruses infecting cereal crops to understand the current state of occurrence of cereal viruses and their vectors and reservoirs. Depending on research findings, development of diagnostic methods is planned for the viruses with higher pathogenicity potential.

1.5. Description of the expected results

The expected results are:

- the creation of a scientific network for cereal virus studies to share up-to-date information, expertise and protocols for efficient virus identification;
- a better understanding of the current cereal virus reservoir: knowledge on the species present and their geographical distribution;
- the sharing of data on major insect vectors and potential reservoir host species associated with agricultural fields;
- the development of a knowledge database of historical records about cereal virus outbreaks and epidemiological studies performed in different countries;
- the update of existing diagnostic protocols;
- the development of recommendations on the resistance strategy for insect-transmitted viruses in a post-neonicotinoid agriculture.

1.6. Beneficiaries of this research product

Farmers, inspectors, diagnosticians, NPPO's, researchers.

1.7. Research funders and research contribution/ distribution

Funding organisation	Research activity and researchers involved
1. Ministry of Rural Affairs, Estonia Maarja Malm maarja.malm@agri.ee	-Project coordination; -HTS survey on different cereal crops (wheat, barley, oats, rye, triticale) in Estonia; -Identification of potential reservoir plants and insect vectors for viruses of interest (e.g. barley yellow dwarf virus OYV) Contact person: Merike Sõmera

	E.mail: merike.somera@taltech.ee
2. Department of Agriculture, Water and the Environment, Australia Con Goletsos ACPPO@agriculture.gov.au	-Contribution to be detailed; Contact person: to be detailed
3. Ministry of Agriculture and Forestry, Finland Johanna Nykyri Johanna.Nykyri@mmm.fi	-Effect of undergrowth on the prevalence of various viruses and severity of infections; -HTS survey on barley grown in experimental field plots where the undergrowth is grown individually, in pairs, and in groups of four and eight plant species together; Contact person: Johanna Santala E.mail: Johanna.Santala@ruokavirasto.fi
4. Federal Ministry of Food and Agriculture, Germany Silke Steinmöller silke.steinmoeller@julius-kuehn.de	-Virus biology, occurrence, variability, distribution, focus on *Polymyxa graminis* – transmitted cereal viruses; -Development of diagnostic tools: ELISA, real-time RT-PCR, HTS, sanger sequencing, cloning; Contact person: Annette Niehl E.mail: Annette.Niehl@julius-kuehn.de
5. Department of Agriculture Food and the Marine, Ireland Maria Laura Destefanis Maria.Destefanis@agriculture.gov.ie	-Understanding the incidence and diversity of viral (barley/cereal yellow dwarf strains) strains in cereals; -Enhancing the sensitivity and specificity of molecular-based barley/cereal yellow dwarf strains detection in aphids and plants; -Viral transmission studies; Contact Person: Louise McNamara E.mail: Louise.McNamara@teagasc.ie Contact person: Stephen Byrne E.mail: stephen.byrne@teagasc.ie
6. Ministry of Agriculture, Plant Biosecurity, Plant Protection and Inspection Services, Israel Yael Meller Harel YaelM@moag.gov.il	-Virus transmission by insect vector in agricultural crops; -Virus evolution in mixed infections; -The emergence of new viruses; -The factors that influence virus transmission; Contact person: Murad Ghanim E.mail: ghanim@volcani.agri.gov.il
7. All Russian Plant Quarantine Center, Russian Federation Yuri Shneyder yury.shneyder@mail.ru	-Contribution to be detailed; Contact person: Yuri Shneyder E.mail: yury.shneyder@mail.ru

8. Ministry of Agriculture Forestry and Food, Slovenia Erika Oresek Erika.Oresek@gov.si	-HTS on symptomatic crops; -Soil transmitted viruses; -Development of diagnostic methods; Contact person: Irena Mavrič Pleško E.mail: Irena.MavricPlesko@kis.si
9. Ministry of Agriculture, Tunisia Mohamed Lahbib Ben Jamâa benjamaaml@gmail.com	-Survey on virus infections in different cereal crops (wheat, barley, triticale, oat); -Identification of potential reservoir plants and insect vectors for viruses of interest; -Genetic diversity of barley/cereal yellow dwarf strains; -Identification of resistant genotypes for barley/cereal yellow dwarf virus; Contact person: Asma Najar E.mail: asmanajara@yahoo.fr
10. Department for Environment Food and Rural Affairs, United Kingdom Iain Dummett Iain.Dummett@defra.gov.uk	-Investigation into presence of cereal viruses in the United Kingdom; -Data sharing from HTS on collection samples from cereals; -Development of real-time RT-PCR where needed; Contact person: Adrian Fox E.mail: Adrian.Fox@fera.co.uk
11. University of Western Australia, Australia Roger Jones roger.jones@uwa.edu.au	-Contribution to be detailed; Contact person: Roger Jones E.mail: roger.jones@uwa.edu.au
12. University of Copenhagen, Denmark Carsten Pedersen cpr@plen.ku.dk	-Contribution to be detailed; Contact person: Carsten Pedersen E.mail: cpr@plen.ku.dk Contact person: Hans Jørgen Lyngs Jørgensen E.mail: hjo@plen.ku.dk Contact person: Lene Sigsgaard E.mail: les@plen.ku.dk
13. GEVES, France Valerie Grimault valerie.grimault@geves.fr	-Contribution to be detailed; Contact person: Sophie Perrot E.mail: sophie.perrot@geves.fr Contact person: Valerie Cadot E.mail: valerie.cadot@geves.fr Contact person: Thomas Baldwin E.mail: Thomas.baldwin@geves.fr

14. National Research Institute for Sustainable Development, France Eugénie Hébrard eugenie.hebrard@ird.fr	-Detection, epidemiology, characterization of genetic and pathogenic diversity of rice viruses (e.g. rice yellow mottle and rice stripe necrosis) and sorghum and millet viruses; Contact person: Eugénie Hébrard E.mail: eugenie.hebrard@ird.fr
15. Agrinnova, University of Turin, Italy Vladimiro Guarnaccia vladimiro.guarnaccia@unito.it	-Diagnostics tools for the detection of maize chlorotic mottle virus, wheat streak mosaic virus, barley stripe mosaic virus in seed and plants (ELISA, RT-PCR, RT-LAMP, RT-RPA); -Knowledge on virus epidemiology, host-vector interactions, virus diversity and control methods; -Phytosanitary protocols and seed health testing procedures; Contact person: Monica Mezzalama E.mail: monica.mezzalama@unito.it
16. National Research Council, Italy Marina Ciuffo marina.ciuffo@ipsp.cnr.it Gian Paolo Accotto Gianpaolo.accotto@ipsp.cnr.it	-Contribution to be detailed; Contact person: Marina Ciuffo E.mail: marina.ciuffo@ipsp.cnr.it -Soil-borne cereal viruses: occurrence and distribution of wheat viruses transmitted by *Polymyxa graminis*; development of diagnostic tools for their detection at landscape level; Contact person: Gian Paolo Accotto E.mail: Gianpaolo.accotto@ipsp.cnr.it
17. Bioreba AG, Switzerland Marco Kaiser kaiser@bioreba.ch	-Contribution to be detailed; Contact person: Marco Kaiser E.mail: kaiser@bioreba.ch
18. International Maize and Wheat Improvement Center, International Victor Kommerell V.Kommerell@cgiar.org	-Knowledge on maize streak virus epidemiology, host-vector interactions, virus diversity and control methods; -Versatile diagnostics tools for the detection of maize streak virus in plants and vectors (PCR, LAMP, RPA and HTS protocols); -Knowledge on maize chlorotic mottle virus epidemiology, host-vector interactions, virus diversity and control methods; -Versatile diagnostics tools for the detection of maize chlorotic mottle virus in plants and vectors (RT-PCR, RT-LAMP, RT-RPA and HTS protocols);

	-Recombinant antibodies generated against the maize chlorotic mottle virus coat protein gene; -Diagnostics tools (RT-PCR) for maize yellow mosaic virus; -Diagnostics tools (RT-PCR) for sugarcane mosaic virus, virus epidemiology, host range, virus diversity; -Research on rice-infecting viruses: rice tungro virus (SouthEast Asia), rice dwarf virus (China, Korea), yellow mottle virus (SubSaharan Africa) – alternative hosts and insect vectors; -Phytosanitary protocols and seed health testing procedures; Contact person: Victor Kommerell E.mail: V.Kommerell@cgiar.org
19. Eskisehir Osmangazi University, Turkey Refik Bozbuğa refik.bozbuga@ogu.edu.tr	-Diagnostics tools for the detection of maize chlorotic mottle virus, wheat streak mosaic virus, barley stripe mosaic virus in seed and plants (ELISA, RT-PCR, RT-LAMP, RT-RPA); -Virus transmission by nematode vectors in some cereal crops; -Validation of real-time RT-PCR; Contact person: Refik Bozbuğa E.mail: refik.bozbuga@ogu.edu.tr Contact person: Pakize Gök Güler E.mail: pakize.gokguler@tarimorman.gov.tr Contact person: Elen Ince E.mail: elen.ince@tarimorman.gov.tr Contact person: Mahmut Yegül

1.8. Research project partnership outside Euphresco

Euphresco funding ensures a certain level of transnational collaboration among Euphresco member countries. It is possible, if the funding consortium is interested, to contact funding organisations or research groups outside the geographical area covered by Euphresco members. The Euphresco coordinator could advertise the research topic in order to have an enlarged collaboration. If funders are interested in this possibility, please check the case below:

☐ The funding consortium of the topic mentioned in section 1.2 requires that the topic is advertised outside the Euphresco network

1.9. Any other relevant information on content

Close collaboration with other Euphresco projects in the field is envisioned to obtain information on best practices about sampling and data analysis, and to develop and strengthen

a research network between the plant virologists involved in virus discovery, identification and diagnostics. Relevant Euphresco projects are:
2020-G-346 Data sharing initiative: the project aims to allow easy data sharing on new and unusual viruses which infect plants across the Solanaceae, Plantaginaceae, and Actinidiaceae families;
2020-A-347 Baseline study of virus reservoirs: the project aims to identify what is present and which are the reservoir hosts of viruses infecting Solanaceae and Cucurbitaceae families, but also genus Vaccinium or wild species from Fabaceae family;
2019-I-321 Community network for practices in plant virology: the project aims to pull as many Euphresco virology projects together as possible to save travel time and costs;
2019-E-312 Using High Throughput Sequencing to gain insights from virus collections and strengthening the infrastructure of Plant Virus Collections: the project aims to characterize viral sequences from historical plant virus collections to support risk analyses of ‘novel’ viral species using high-throughput sequencing.

2. *Euphresco management aspects of the project*

2.1. Indication of the topic budget

Funding organisation [a]	Mechanism [b]	Total Budget [c]
1. MAARD (EE)	NC	€
2. DAWE (AU)	NC	€
3. MMM (FI)	NC	€
4. BMEL (DE)	NC	€
5. DAFM (IE)	NC	€
6. MOAG (IL)	NC	€
7. VNIIKR (RU)	NC	€
8. MAFF (SI)	NC	€
9. MoA (TN)	NC	€
10. DEFRA (GB)	NC	€
11. USE (AU)	NC	€
12. UoK (DK)	NC	€
13. GEVES (FR)	NC	€
14. IRD (FR)	NC	€
15. AGROINNOVA (IT)	NC	€
16. CNR (IT)	NC	€
17. Bioreba AG (CH)	NC	€
18. CIMMYT (Int)	NC	€
19. EOU (TR)	NC	€

2.2. Expected duration of the project (only for non-competitive topics)

24 months

2.3. Identification of project coordinator

Has the research project coordinator been identified?

☒ Yes
☐ No

2.4. Any other relevant information on topic organisation and management

[a] First member is project coordinator. A minimum of two partners are necessary for each proposal. Add lines as needed.
[b] Please indicate the preferred mechanism (e.g. real pot RP; virtual pot VP; non-competitive NC), or several mechanisms if there is flexibility.
[c] Optional, as this amount can still change in the next phase. In-kind contribution should also be indicated in this column.