Final Report on the "International Workshop on Facilitating International Research Collaboration on Transboundary Plant Pests"

Summary of the Workshop

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Ministry of Agriculture, Forestry and Fisheries (MAFF)

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Executive Summary of the Workshop

Damage caused by plant pests is worsening year by year. This requires not only adequate countermeasures by competent authorities in each country, but also coordinated and collaborative efforts by national and international research institutes, (partially) based on joint, or coordinated resource mobilization. Further collaboration among the international research community is crucial. Regular exchange of the latest information on pest occurrence, exchange of research materials (data, germplasm, etc.) and support for developing countries are necessary in order to take effective measures against pests. Workshop participants confirmed that matters listed below are most urgent for the sake of international research collaboration.

- Greater participation in and use of existing international and regional activities and frameworks
- Compliance awareness of government authorities based on existing international and regional rules.
- Establishment of networks among researchers and stakeholders from respective countries as well as reinforcement of collaboration between reference laboratories through the framework of the discussion groups organized for this workshop.

I Need for facilitating international research collaboration on transboundary plant pests

1. Introduction

It is reported that damage caused by plant pests is responsible for loss of 20 – 40 % of global production. In particular, significant damage has been caused globally by transboundary pests against the background of climate change and global movement of people and goods. Furthermore, the expansion of overwintering areas of pests toward both northern and southern latitudes is observed due to ongoing global warming. The increasing threat of transboundary pests has become a global issue affecting all countries, and G20 members are well positioned to take a lead in contributing to solve this issue.[1]

In order to minimize the damage caused by transboundary plant pests, it is necessary to collect current information on pest occurrence, preventing introduction and spread of pests to unaffected areas, and actions for eradication. It is highly important for G20 members to discuss specific actions on pest management to accelerate international collaboration among researchers from interested G20 members and international institutes. As G20 members have diagnostic and control technologies against pests, it is important to address pest issues in cooperation with international communities including developing countries. Collaboratively managing pests is also particularly relevant given the year 2020 has been named as United Nations International Year of Plant Health (IYPH).[2]

2. Stocktaking of latest information on major transboundary pests and future challenges, and preparation for network development among researchers

At the 8th Meeting of G20 Agricultural Chief Scientists (MACS-G20) held in April 2019 in Japan, "Transboundary Pests" was one of the main topics. The participants recognized that transboundary plant pests are a growing threat to food security and the environment, and endorsed a proposal from Japan to organize a workshop later in 2019. The aim of this workshop was to share knowledge and experiences by G20 members on the occurrence and management of plant pests and promote research collaboration for effective countermeasures against them.[3]

Furthermore, it was discussed at MACS that exchanging views at an international workshop on major transboundary pests of particular concern by G20 members would be effective, while discussion on the strategies for research collaboration over crosscutting issues and specific pests in the medium and long term would also be important.

In this context, the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan organized an international workshop on 27 to 29 Nov. 2019 at Tsukuba City, Japan with researchers from interested G20 members and international organizations. It was attended by 66 participants from 15 countries and

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[1] FAO's website "Plant pests and diseases: FAO in Emergencies" lists Desert Hopper, Fall armyworm, Fruits Flies Banana Diseases, Cassava Virus and Wheat blast etc. as examples of serious transboundary pests. Apart from them, there are several pests which cause various problems.

[2] https://www.ippc.int/en/iyph/

[3] Paragraph No. 4, 5 and 6 on the communique of 8th G20MACS (2019 Japan)――― https://www.macs-g20.org/fileadmin/macs/Annual_Meetings/2019_Japan/MACS-G20_2019_Communique_Final.pdf

organizations with expertise in transboundary plant pests. Participants shared the latest information on the occurrence and management of major transboundary pests in the world, analyzed crosscutting challenges and discussed facilitation of international research collaboration through the development of researchers' networks.

Prior to this workshop, in September 2019, Japan launched nine discussion groups namely (a) Fall armyworm, (b) Fruit flies, (c) Red palm weevil, (d) *Xylella fastidiosa*, (e) Citrus greening, (f) Tomato brown rugose fruit virus, (g) Wheat blast, (h) Fusarium wilt tropical race 4, and (i) Crosscutting issues targeting major plant pests. The latest information and challenges relating to these pests were gathered through email consultation with researchers and experts from plant diagnostic laboratories and universities of interested G20 members and international organizations. About 150 experts from 28 countries participated in the discussion groups. In the workshop, leaders from respective discussion groups comprehensively reported their outcomes followed by open discussions.

II Challenges to prompt information sharing about pest occurrences and countermeasures against major plant pests (science-based recommendations from respective discussion groups and summaries presented in the workshop)

Leaders of all discussion groups have reported summaries of the discussions regarding respective pests prior to the open discussion. The summaries are as listed below 1 (1) – (8) and 2 (1) – (4). The presentation materials and other references are available at http://www.affrc.maff.go.jp/docs/e/index.htm

【Ref.】 Traits of target pests

Target pests	Origin	Hosts (Economic impact)	Routes of dissemination	Priority area of research collaboration(example)
Fall armyworm	Insects	Wide range	Flight (Estimated flight distance: 1000 - 1600km)	➢ Modeling of trajectory including temperature and climate factors（EUPHRESCO project） ➢ Analysis of genetic transformation between generations accounting host plants
Fruit flies		Vegetables and Fruits	Traded host fruits	➢ LAMP development, Smart traps（Horizon 2020 FF–IPM project） ➢ Development of improved male and female lures
Red palm weevil		Palm	Off shots & Flights	➢ Development of early detection instruments (e.g., diagnostic protocols) ➢ Improvement of biological control

Xylella fastidiosa	Bacteria	Olive, Grape and Citrus（more than 560 species）	Insect vectors, Plants for planting.	➢ Mechanisms of interactions with the other partners in the ecosystem (microbiota, vector, plant host) ➢ Modeling of pest occurrence ➢ Development of resistant varieties
Citrus greening		Citrus	Insect vectors, Plants for planting	➢ Development of detection methods
Tomato brown rugose fruit virus	Virus	Tomato	Plants for planting, Seed-borne	➢ Analysis of epidemiology, interaction with other viruses ➢ Development of resistant varieties
Wheat blast	Fungus	Wheat	Seed, airborne	➢ Development of resistant varieties
Fusarium wilt (TR4)		Banana	Plants for planting, infected soil (present on: shoes, agricultural engines), water (rivers, irrigation system)	➢ Development of resistant varieties ➢ Development of models for pest occurrence ➢ Data on dynamic of the epidemy

【Ref.】International Standard for target pests※1 （Diagnosis Protocol, etc.）

Target Pests	Diagnosis Protocol	Other procedures
Fall armyworm	n/a ad interim: Fall Armyworm R4D International Consortium partners shared protocols	n/a
Fruit flies	➢ Diagnostic protocols for fruit flies (ISPM 27 Annex 09 'Genus Anastrepha and Annex 29 '*Bactrocera dorsalis*')	➢ Establishment of pest free areas for fruit flies (*Tephritidae*) ➢ Irradiation treatment※2 ➢ Vapor heat treatment※3 ➢ Cold treatment※4 ➢ Systems approach for pest risk management of fruit flies (*Tephritidae*) ➢ Determination of host status of fruit to fruit flies (*Tephritidae*)
Red palm weevil	n/a	n/a
Xylella fastidiosa	➢ Diagnostic protocols for *Xylella fastidiosa* (ISPM 27 Annex 25, adopted in 2018)	n/a
Citrus greening	to be developed※5	n/a
Tomato brown rugose fruit virus	Diagnostic protocol under development by EPPO	n/a
Wheat blast	to be developed※6	n/a
Fusarium wilt (TR 4)	n/a ad interim: Fusarium wilt partners shared protocols	n/a ad interim: Fusarium wilt Consortium partners shared procedures

(*1) ISPMs (International standards for phytosanitary measures) approved by IPPC.

https://www.ippc.int/en/core-activities/standards-setting/ispms/

(*2) ISPM 28 Annex 1 '*Anastrepha ludens'*, Annex 2 '*Anastrepha obliqua*', Annex 3 '*Anastrepha serpentina*', Annex 4 '*Bactrocera jarvisi*', Annex 5 '*Bactrocera tryoni*', Annex 7 'Fruit flies of the family *Terphritidae* (generic)', Annex 8 '*Rhagoletis pomonella*', Annex 14 '*Ceratitis capitata*'.

(*3) ISPM 28 Annex 15 '*Bactrocera cucurbitae* on *Cucumis melo* var. reticulatus', Annex 21 '*Bactrocera melanotus* and *Bactrocera xanthodes* on *Carica papaya*', Annex 30 '*Ceratitis capitata* on *Mangifera indica'*, Annex 31 '*Bactrocera tryoni* on *Mangifera indica*', Annex 32 '*Bactrocera dorsalis* on *Carica papaya*'.

(*4) ISPM 28 Annex 16 '*Bactrocera tryoni* on *Citrus sinensis*', Annex 17 '*Bactrocera tryoni* on *Citrus reticulata* x *C. sinensis*', Annex 18 '*Bactrocera tryoni* on *Citrus limon*', Annex 24 '*Ceratitis capitata* on *Citrus sinensis*', Annex 25 '*Ceratitis capitata* on *Citrus reticulata* x *Citrus sinensis*', Annex 26 '*Ceratitis capitata* on *Citrus limon*', Annex 27 '*Ceratitis capitata* on *Citrus paradisi*', Annex 28 '*Ceratitis capitata* on *Citrus reticulata*', Annex 29 '*Ceratitis capitata* on *Citrus clementina*'.

(*5) Technical Panel on Diagnostic Protocols endorsed "*Candidatus liberibacter* spp. on *Citrus spp*." as a topic to be discussed (Standards Committee Nov. 2004). https://www.ippc.int/en/core-activities/standards-setting/list-topics-ippc-standards/list

(*6) Technical Panel on Diagnostic Protocols endorsed "*Pyricularia oryzae* (syn. *Magnaporthe oryzae*) on *Triticum spp*." as a topic to be discussed (Standards Committee May 2019).

1. Discussion on Major Plant Pests

(1) Fall armyworm （FAW）

(a) Main suggestions from the Discussion Group

Area	Major Challenges	Way Forward for International Collaboration to tackle FAW
Diagnostics	➢ Lack of mechanism for information exchange among neighbouring countries ➢ Wider host range, mix of strains, variations in semiochemical response	➢ Networking diagnostic laboratories that are referent for phytosanitary services under IPPC. ➢ A global platform for comprehensive studies establishing phylogeny and evolution of spatial and temporal strains of FAW with available information and advanced approaches. ➢ Preparation of rapid precise diagnostic detection kits including artificial intelligence, environmental DNA (eDNA) technology coupled with isothermal nucleic acid amplification tests (iNAATs) such as loop-mediated isothermal amplification (LAMP) and their standardization.
Monitoring	➢ Lack of year-round detection and delimitation surveys and reporting	➢ Development and deployment of precise pheromone blends for monitoring and mass trapping considering strain variations in relation to geography and host plants of FAW through semiochemical research. ➢ Development of customised (regional/national) digital tools for FAW monitoring and advisory dissemination including artificial intelligence
Border Measures	➢ Lack of efficient and effective quarantine of agricultural commodities and phytosanitary measures	➢ Development of effective protocols for inspection of FAW in countries where FAW is absent with deployment of certification system and capacity building of National Plant Protection Organizations for phytosanitary measures coupled with robust official documentation and reporting procedures. ➢ Regional and international research collaboration for holistic understanding of FAW migratory patterns, host plants, overwintering and forecast of FAW in the context of climate change spearheaded by global organisations (e.g., CABI, FAO, CIMMYT, RPPOs) with data exchange and analytics including capacity development.

Prevention & Control	➢ Lack of fast-paced research on conservation biocontrol and action thresholds ➢ Applied biocontrol is associated with problems of timely availability, quality, effectiveness & scale of operation ➢ Resistance to Bt synthetic insecticides	➢ Studies on relations between levels of FAW infestation and yield for major host crops ➢ Innovative habitat management practices to enhance native natural enemies ➢ Accelerated breeding efforts to develop and deploy elite crop cultivars with native genetic resistance to FAW through international collaboration (e.g., the first set of FAW-tolerant maize hybrids by CIMMYT to be announced in 2020) ➢ Development of biological control approaches suitable for local conditions ➢ International exchange of germplasm with native genetic resistance for FAW

(b) Suggestions from the Workshop

While the rapid spread of the Fall armyworm invading Africa and Asia from the American continents is observed, official information on pest occurrence is not available in time due to the negligence of some NPPOs in reporting to IPPC, despite the fact that precise data is indispensable in helping to reduce the spread of pests.

In recognition of the growing importance of international collaboration in pest management and development of resistant varieties, further cooperation with existing initiatives should be emphasized to avoid duplication.

The international protocol for FAW by IPPC is expected to be applied worldwide and a strong global platform on transboundary plant pests in general and FAW in particular should be promoted.

(2) Fruit Flies

(a) Main suggestions from the Discussion Group

Area	Major Challenges	Way Forward for International Collaboration to tackle FF
Diagnostics	➢ Morphological: High skill level required for morphological identification of adults ➢ Molecular: ➢ Some species complexes indistinguishable ➢ LAMP only for Medfly, Melon fly and Spotted Wing Drosophila (SWD)	➢ Morphological training in taxonomy and diagnostics ➢ Molecular ➢ Rapid point of entry multiplex test ➢ LAMP development (e.g., Horizon 2020 FF-IPM project developing for peach FF, Oriental FF)
Monitoring	➢ Trapping ➢ Cost of manually servicing widespread traps ➢ Lag of 7-14 days to get a result ➢ Male lures ➢ Cue-lure/ Melon fly: lower attractiveness (than ME to Oriental FF), high temperatures reduce efficacy ➢ Female/ Other lures ➢ No female lure for Oriental FF, Melon fly, Qfly, Olive FF	➢ Smart traps (e.g., Horizon 2020 FF-IPM project developing e-traps) ➢ Stronger male lures (e.g., Melon fly, Medfly) ➢ Female lures (e.g., Oriental FF, Melon fly, Olive FF, Qfly) ➢ Other lures (e.g., Lesser pumpkin FF (more specific/attractive lure), SWD (more specific/lasting lure; optimising trapping)

	➢ Biolure not species specific to Medfly ➢ Vinegar not species-specific to SWD	
Border Measures	➢ Effective early detection systems ➢ Lacking data on source populations ➢ Modelling needs development/ expansion	➢ Citizen detections ➢ Modelling (e.g., Occurrence data in source country; Population dynamics)
Prevention & Control	➢ Sterile insect technique (SIT) ➢ Improving efficacy and cost effectiveness ➢ Developing mass-rearing facility ➢ Insecticide alternatives needed ➢ Potential deregistration organophosphates ➢ Toxicity to natural enemies/ pollinators/ environment ➢ Reduce chemical usage	➢ SIT ➢ Oriental FF: Genetic sexing strains such as female lethality, male sterility ➢ International cooperation/ training on SIT implementation ➢ Insecticides compatible with natural enemies ➢ Less toxic alternatives (e.g., Biopesticides, Molecular insecticides RNAi) ➢ Classical/augmentative biological control approaches using parasitoids

(b) Suggestions from the Workshop

Many species of fruit flies exist globally and many countries are undertaking various research activities on different pests. Collaborative international research is needed on pest management techniques including improved male and female lures, biopesticides and SIT, as well as cutting edge technologies such as smart traps and LAMP. Maintaining discussion groups will also be useful for knowledge exchange.

(3) Red palm weevil

(a) Main suggestions from the Discussion Group

Area	Major Challenges	Way Forward for International Collaboration to tackle RPW
Diagnostics	➢ Unavailability of early detection instruments ➢ There are numerous different detection technologies under different stages of development.	➢ Knowledge sharing about RPW among interested G20 members (e.g., research gaps, risk management, capacity building, technology sharing and research collaboration)
Monitoring	➢ Improvement from current traps (e.g., Food baited pheromone traps, Bucket traps)	➢ Developing a smart trapping system with less service such as dry traps and others
Border Measures	➢ Cryptic life habit ➢ Lack of strict quarantine regulatory mechanism ➢ Lack of training to the quarantine staff ➢ Lack of awareness leads the failure for the implementation of quarantine regulations	➢ Increase awareness of the destruction of RPW among policy-makers, industry and farmers
Prevention & Control	➢ Botanical insecticides under development (e.g., Plant extracts, Essential oils, Plant secondary metabolites) ➢ Biological control agents working on augmentation, conservation and evaluation	➢ Molecular insecticides developments ➢ Resistant varieties development ➢ Augmentation of natural enemies

(b) Suggestions from the Workshop

As a workshop on the 'Red palm weevil' was held by FAO in order to set the platform, interested G20 members are recommended to join the platform and continue discussing research priorities in early detection and biological prevention at the discussion group for the sake of research and development on this pest.

(4) *Xylella fastidiosa*

(a) Main suggestions from the Discussion Group

Area	Major Challenges	Improve knowledge on
Surveillance & Sampling	➢ Wide potential host range in natural environments and crops ➢ Asymptomatic infections => small *Xylella fastidiosa* population sizes ➢ Irregular distribution in time along seasons, years ➢ Discontinuous distribution in plant	➢ Sentinel plants and sentinel insects ➢ Early detection by using innovative technologies ➢ Dynamics of *Xylella fastidiosa* population sizes within the plant, along the seasons, the years
	=> Outputs for pest risk managers ⇒ Tools for early detection of low level presence of *Xylella fastidiosa* ⇒ Guidelines for sentinel strategy and results of specified area monitoring ⇒ Guidelines for sampling of symptomatic and asymptomatic plants per group of species, including specified optimal sampling timeframes	
Testing	➢ Wide range of plant species and potential PCR inhibitors ➢ Asymptomatic infections characterized by small *Xylella fastidiosa* population sizes ➢ Diversity of *Xylella fastidiosa* strains/subspecies that are epidemiologically relevant ➢ Cost and time of typing method (MLST) ➢ Range of potential insect vectors and PCR inhibitors	➢ Improve knowledge on the capacity of WGS technologies to tackle current limitations of detection methods for *Xylella fastidiosa* typing ➢ Develop rapid, inexpensive, and automated pipelines for genome sequencing, assembly, and annotation to complement and extend existing PCR based identification ➢ Rethink – Develop new detection protocols to decrease LOD ➢ Assess detection tests for insect vectors
	=> Outputs for pest risk managers ⇒ Tools for early detection of low level presence of *Xylella fastidiosa* ⇒ Reliable and accurate detection	
Dissemination	➢ Very limited data on seed transmission ➢ Limited knowledge on plant, insect, and environmental factors impacting dissemination	➢ Seed transmission: adequate size lots of seeds from various types (e.g., Olive pit, Oak acorn etc.) ➢ Plant, insect, and environmental factors impacting dissemination ➢ - Test of individual parameters in confined conditions ➢ - Large experiments in infected area ➢ - Statistically based models to forecast probability of spreading and establishment
	=> Outputs for pest risk managers ⇒ Identification of entry pathways ⇒ Identification of means of short- and long-range spread to suggest revision of the	

	size of the buffer area, if introduction and/or establishment occur	
Prophylactic measures/ Curative measures	➢ Curative measures are limited to thermotherapy for grapevine dormant material ➢ Tolerance identified in a few cases only, nearly no resistance to *Xylella fastidiosa* ➢ Emergence of resistance in insect vectors to widely used insecticides	➢ *Xylella fastidiosa* biology and physiology to conceive curative measures ➢ *Xylella fastidiosa* ecology: interactions in the natural environments ➢ Encouraging preliminary data concerning biocontrol (*Paraburkholderia phytofirmans*) ➢ Basis of genetic resistance/ tolerance, breeding for resistant/ tolerant varieties ➢ Vector communication behaviors
	=> Outputs for pest risk managers ⇒ Treatment solutions against vectors and pathogen: chemical, biological and mechanical tools (IPM)	
Awareness & preparedness	➢ Reluctance of some groups, general public, etc. to apply eradication procedures, including insecticide application	➢ Conditions for adoption of eradication/containment methods, limit unintentional consequences ➢ "Actual risk vis-a-vis perceived risk" of affected communities: factors involved, targeted measures for specific target audiences (e.g., operators, general public, etc.)
	=> Outputs for pest risk managers ⇒ Facilitated application of eradication/ containment measures	

(b) Suggestions from the Workshop

This disease has specific traits, such as long-term latent (asymptomatic) infection that render detection still challenging while it is known that early detection is a key in eradication success. The environmental factors leading to disease occurrence from asymptomatic infection remain to be disclosed. It is, therefore, very challenging for yet *Xylella fastidiosa*-disease free countries to invest in surveys using highly sensitive detection methods and collaborate to a better understanding of *Xylella fastidiosa* biology and mechanisms of interactions with the other actors of the ecosystem in order to develop control methods.

It is useful to continue to exchange information on surveys of disease traits and the development of resistant varieties at discussion groups. At the same time, suggestion was made to prioritize the area of research collaboration in consultation with concerned stakeholders more specifically in order to enhance attention from multilateral funding communities since it is great concern for both of crops and landscape.

(5) Citrus Greening

(a) Main suggestions from the Discussion Group

<Way Forward for International Collaboration to tackle HLB>

1. Establishment of a new international collaboration framework
   i) "International Grand Challenge on Citrus Greening" by linking with ARS Grand Challenge, USDA,
   ii) Data collected in the discussion group will be shared by all members of the "International Grand Challenge on Citrus Greening", and activities of the new organization (e.g., web-conferences, digital newsletter etc.) will be updated.
2. Technical collaboration (basic)
   i) Development of research tools for studying HLB (e.g., inoculation methods, single leaf bioassays,

rapid whole plant bioassays, rapid sequencing of the pathogen (CLas), culturing, screening for tolerance/ resistance in citrus and near relatives, etc.)
   ii) Development/ optimization of delivery strategies for control agents
   iii) Systematic approach to identification of psyllid/ CLas control molecules- understanding regulatory and public acceptance issues associated with different strategies
3. Technical collaboration (applied)
   i) Cross-checking of detection methods (and exchange of materials)
   ii) Epidemiological study using DNA markers (e.g., VNTR etc.)
4. Technical collaboration (extension)
   i) Training growers and technicians
   ii) Discussion on the standard and policy of eradication of HLB citrus trees

Field trials to compare citrus greening management strategies

(b) Suggestions from the Workshop

Currently an initiative named the "Grand Challenge on Citrus Greening" is ongoing in the USA based on cooperation among producers, private sectors and government entities. The discussion group is considering taking an action in possible expansion of the on-going "Grand Challenge" to a new international platform, while other interested countries are highly encouraged to participate.

(6) Tomato brown rugose fruit virus

(a) Main suggestions from the Discussion Group

Area	Major Challenges	Way Forward for International Collaboration to tackle ToBRFV
Diagnostics	➢ Commercial ELISA's, and several published conventional PCR and qPCR available - Unclear whether they are useful for seeds, plants or both - Limited validation data available	➢ Initiatives underway - EU Valitest - EUPHRESCO project (Validation of molecular diagnostic methods for the detection of ToBRFV in seeds of tomatoes, chilies and eggplants) - EU Reference Laboratory activities ➢ Standard protocols - International Seed Federation - EPPO Standard in preparation
Monitoring (Border Measures)	➢ Visual surveillance largely ineffective: - Risks from infected seeds entering the production chain - Plants for planting may be asymptomatic at time of movement - Infected fruit may be asymptomatic ➢ Questions around sampling for diagnostic surveillance - Seed sampling – how many seeds? (e.g., International Seed Federation's protocol: 3000; Australia seed regulations for import: 20,000 seeds or 20% of small seed lots) ➢ Asymptomatic plant sampling and testing? How many plants per batch are enough?	➢ Need for transnational project to ascertain both experimental scenarios (from 100% inoculated seeds) and simulated scenarios (real seed lots with known infection, and/or artificial inoculation combined with seed treatments) ➢ Need for work across a number of approaches to investigate outbreak dynamics

Prevention & Control	➢ Unclear whether seed treatments are effective for disinfection of infected seed ➢ No commercially available varietal resistance (research underway) ➢ Disinfection studies underway	➢ Prophylactic hygiene measures best current defence (e.g., similar measures recommended for viroids, Clavibacter, etc.)
Knowledge Gaps	➢ Unclear on infection origins: ➢ Have previous outbreaks been misidentified due to ELISA cross-reaction with TMV/ ToMV? ➢ Track back on specific outbreaks? - Difficult as information may be commercially sensitive and seed production pathways highly complex ➢ Broader question on origin of virus (e.g., historic isolates) ➢ Interactions with other viruses (PepMV, TSWV, PVY, etc.) and pathogens	➢ Joint working/communication between seed companies, producers, retailers and regulatory authorities needed

(b) Suggestions from the Workshop

Since the first detection in 2014, there have been many unknown factors about this disease and such uncertainty hinders development of effective countermeasures. Therefore, it is important to fill knowledge gaps by strengthening cross-border cooperation and communication among researchers, seed companies, producers, retailers and regulatory authorities.

G20 members need to recognize the presence and threat of this disease to tomato, a very important vegetable, and they are requested to contribute financially. Researchers from each country are encouraged to share information on their research outcomes in positive manner.

(7) Wheat blast

(a) Main suggestions from the Discussion Group

<Way Forward for International Collaboration to tackle WB>

Open communication and collaboration among scientists, stakeholders, and the general public from different parts of the world will pave the path to understand and combat wheat blast.

In this connection, the discussion group has identified the following:

- International breeding efforts will be needed to develop wheat varieties with more durable resistance.
- To exploit novel genetic diversity based on discovery/ pre-breeding research– cast a wider net (e.g., synthetics/alien introgressions, multi-gene sources, etc.)
- To develop accurate, robust and simple diagnostics, especially in areas with climate suitability to the occurrence of the wheat blast. Once available, such detection protocols would have applications in monitoring wheat seed and grain movement.
- To promote information sharing leading to knowledge enhancement of *Magnaporthe oryzae* population diversity, including fungicide resistance.

Collaborate to improve ex-ante modeling (data & methods), both to improve Pest Risk Analysis and support policy/ extension/ farmer decision-making.

(b) Suggestions from the Workshop

Based on research finding to-date, utilization of resistant genes in breeding is considered the most effective means to tackle wheat blast emerging in South America and Asia. Researchers are requested to share information on resistant genes, results of field experiments and evaluation implemented at each country.

In addition, exporting countries are responsible for seed quality control and timely information sharing on disease occurrence as grains are traded internationally.

(8) Fusarium wilt (TR4)

(a) Main suggestions from the Discussion Group

Area	Major Challenges	Way Forward for International Collaboration to tackle TR4
Diagnostics	➢ Limitations of several molecular detection methods. ➢ Need of rapid detection kits for detection in the field (e.g., LAMP, RPA PCR) ➢ Most developing countries do not have the access to molecular technologies and lack trained/ qualified personnel capacities in collecting and analyzing samples	➢ Validation of the molecular diagnostic tools for monitoring in the field ➢ Epidemiological studies to follow the inoculum in different areas ➢ Building capacities with simple diagnosis protocols and tools ➢ An international standard for diagnostic of Foc TR4
Monitoring	➢ Lack of validated in-field monitoring methods	➢ Development of new tools for the monitoring ➢ Validation of statistic models for sampling
Border Measures	➢ Lack of adequate surveillance due to shortage of capacity and reluctance to disclose the survey information in some cases ➢ Lack of tools (e.g., molecular) to easily check large and numerous passengers and pathways in terminals ➢ Need of regional quarantine protocols	➢ Facilitation of surveys in countries where capacities and expertise are lacking ➢ Detection and quantitative assessment in the environment to anticipate TR4 introduction and prevent the onset of an epidemic ➢ Development of a monitoring system for TR4 counting on collecting geo-referenced data at the field level with a tracking system for collected samples and the results of analyzing these samples
Prevention & Control	➢ No way of getting rid of the fungus, once it is in the soil ➢ Fungicides and soil fumigants are not efficient in controlling or eradicating the disease from infested soil ➢ The spores of the fungus persist in the soil for decades	➢ International collaboration for breeding program (target genes) and evaluation of the new varieties in different affected countries ➢ Microbiome in TR4-suppressive soils and suppressive cover crops in TR4-infected fields ➢ Studies on prevention cost for producers and sanitary plant services

(b) Suggestions from the Workshop

Effective management guidance and further research to improve pest management practices is lacking. Besides Cavendish, the most popular variety globally, information on cooking bananas and mini bananas, which are common in Africa, is particularly scarce.

Research on mutation breeding has potential in cooperation with IAEA, etc.

There are several research institutes equipped with diagnosis technology and few resistant varieties ("Cavendish like") are actually proposed, but it is expected they will develop new varieties integrated a global management of the disease (growers practices, climate and soil data, food security) for sustainable agro-systems in collaboration with relevant international organizations and research institutes.

2. Discussion on crosscutting issues

(1) Reference Laboratory

(a) Main suggestions from the Discussion Group

General mission	➢ Pest finds & interceptions are sent to official laboratories for identification or diagnosis ➢ Actions taken against pests & infested commodities are official controls ➢ A national reference laboratory is required when the effectiveness of official controls: - depends on the quality, uniformity and reliability of the methods of analysis (e.g. pest diagnosis), and - depends on the results of the analyses and diagnoses performed by official laboratories ➢ A national reference laboratory is also required when there is a need to promote uniform practices of analytic methods or diagnostic tests across a number of laboratories
Challenges in establishing NRLs	➢ Shortage of skilled staff - use suitably qualified staff with adequate training in diagnostic techniques required - good knowledge of international standards and practices ➢ Keeping up to date - take into account the latest developments in research at national and international level ➢ Accessing and maintaining reference material - e.g. viruses, phytoplasmas and nematodes on living plant material ➢ Lack of suitable infrastructure - have the infrastructure, equipment and products necessary to carry out the required tasks
Networks of the future	Recognising challenges in establishing NRLs countries could cooperate to avoid duplication of effort. Highly regarded NRLs with strong technical ability could be designated as a regional reference laboratory. In the EU, five regional reference laboratories have been established (EURLs). Each EURL focuses on particular taxa: - Viruses, viroids, and phytoplasmas (NL, IT, SI) - Insects and mites (FR, AT) - Fungi and oomycetes (FR) - Nematodes (FR, BE) - Bacteria (NL, BE, IT, SI)

Table: A summary of some of the national and international plant disease diagnosis networks

Network Name	Coverage
Plantwise (Centre for Agriculture and Biosciences International, CABI)	More than 3,100 plant clinics in 12 African, 11 Asian, 7 South American and 3 Central American countries
National Plant Diagnostic Network (NPDN)	USA
European and Mediterranean Plant Protection Organization (EPPO)	Europe and other countries; curated database on expertise diagnostics
International Plant Diagnostic Network (IPDN)	Central America, East and West Africa
Pest Information Platform for Extension and Education (PIPE)	USA, Australia
European Union virtual biosecurity framework	A virtual biosecurity research and diagnostic network for Europe
Foundation for Technological Development of Agriculture, Livestock and Forestry of Nicaragua (FUNICA)	Nicaragua
Plant Health Australia (PHA)	Online plant biosecurity toolbox available for Australian and Southern Asian farmers
Plant Pest Management Network (PPMN)	Taiwan
XS Growth plant health clinic	An online diagnosis system in India
European Reference Laboratories in Plant Health	Institute from EU countries
National Horticulture Mission	More than 120 plant clinics in India

(Source) Report of the Discussion group on Cross-cutting issues "G20 Transboundary and emerging plant pests: Crosscutting issues discussion group - A global overview"

(b) Suggestions from the Workshop

The role of the reference laboratory is more important nowadays and will become increasingly important in the future. It is crucial to establish a national reference laboratory and for it to contribute at a regional level.

One participant of the workshop announced a plan to establish a national reference laboratory in their own country.

Regional reference laboratories have been established for plant pests in the EU.

A regional reference laboratory can work on capacity building and diagnosis services.

In establishing a reference laboratory and network, support from IPPC is highly appreciated.

(2) Network, research collaboration

(a) Main suggestions from the Discussion Group

Research collaboration	➢ Countries / regions can face similar pest problems

	➢ Sharing resources to study problems in common allows more efficient use of limited resources ➢ Seek to avoid overlap in research activities ➢ The European Phytosanitary Research and Coordination network (EUPHRESCO) is an example ➢ EUPHRESCO is a network – an 'ecosystem' of organisations, each with their own mandate but working together on common research problems - established to facilitate knowledge and information sharing - organises joint research calls on phytosanitary topics - increased the efficiency of resources available for plant health research
EUPHRESCO system ※	➢ Members propose topics for research, ideas shared with others. Usually around five members in each project ➢ EUPHRESCO hosts an inventory of national pest-linked research. Inventory updated ➢ Has funded approximately 100 transnational research projects ➢ Current strategy has 18 objectives including to: - support taxonomic research for the unambiguous identification of pests - improve knowledge on the biology, epidemiology and ecology of priority invasive and emerging pests - explore the use of remote sensing technologies to support surveillance and detection activities - test and validate the use of volatile organic compounds for early detection and pest management - test and validate the use of environmental DNA (eDNA) analysis in inspection and surveillance activities
Future direction	➢ Ten members of the G20 are already included in the EUPHRESCO network ➢ IPPC identified the need for global phytosanitary research coordination as one of eight key development programmes in its Strategic Framework 2020-2030 ➢ Such coordination will accelerate development of science to support phytosanitary activities and plant protection ➢ EUPHRESCO system provides a model framework on which such a global network could be developed, or on which other regional systems for research collaboration could be based ➢ EUPHRESCO could contribute to the development of similar networks in other regions of the world

(*) https://www.euphresco.net/media/sra/euphresco_sra.pdf

Table: Participation of G20 members in RPPOs and EUPHRESCO

AREA	Regional Plant Protection Organization	EUPHRESCO
All member states of the European Union	EPPO	✓
G20 members		
Argentina	COSAVE	
Australia	APPPC/PPPO	✓
Brazil	COSAVE	
Canada	NAPPO	✓
China	APPPC	
France	EPPO	✓
Germany	EPPO	✓

India	APPPC	
Indonesia	APPPC	
Italy	EPPO	✓
Japan	O	
Mexico	NAPPO	✓
Russia	EPPO	✓
Saudi Arabia	O	
South Africa	O	
South Korea	APPPC	
Turkey	EPPO	✓
United Kingdom	EPPO	✓
USA	NAPPO	✓

○：G20 member with no participation in any RPPO

(Source) Presentation material on the Discussion group on Cross-cutting issues (Dr. Alan MacLeod, Defra, UK)

(b) Suggestions from the Workshop

Research collaboration in technical development for controlling target pests is important.

Considering the success of joint research funding & delivery network such as EUPHRESCO, each country should consider engaging or co-establishing similar regional networks.

G20 members should contribute to capacity development in research collaboration with developing countries. In that regard, close coordination between the agricultural ministries and competent authority of Official Development Assistance (ODA) such as the Ministry of Foreign Affairs, is needed.

Facilitation of networks among researchers and stakeholders for sustainable discussion groups as well as expansion of networks is important. (Potential for online discussion forums for each pest, hosted by an organization's website such as FAO, was also raised.)

Exchange of reference materials such as germplasm and associated data between research institutes is often critical, but sometimes constraints are observed in expeditious acquisition even for research purposes, due to procedural impediments based on the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and the Nagoya Protocol, which stipulate access to genetic resources and fair and equitable sharing. For the sake of prompt countermeasures against pests, it is necessary to ensure that researchers are provided with an adequate enabling environment to pursue research objectives, such as uncomplicated access to reference materials and to have mutual recognition among the IPPC and member countries on this. Likewise, sharing useful information such as diagnosis results and traits assessment with developing countries is important, in return to the acquisition of research materials for research.

<Ref. >NAGOYA PROTOCOL on Access to genetic resources and the fair and equitable sharing of benefit arising from their utilization to the Convention on Biological Diversity (CBD) Article 8 Special Conditions

In the development and implementation of its access and benefit-sharing legislation or regulatory requirements, each party shall:

(a) Create conditions to promote and encourage research that contributes to the conservation and

sustainable use of biological diversity, particularly in developing countries, including through simplified measures on access for non-commercial research purpose, taking into account the need to address a change of intent for such research;

(b) Pay due attention to cases of present or imminent emergencies that threaten or damage human, animal or plant health, as determined nationally or internationally. Parties may take into consideration the need for expeditious access to genetic resources and expeditious fair and equitable sharing of benefits arising out of the use of such genetic resources, including access to affordable treatments by those in need , especially in developing countries;

【Ref.】 Examples of international platforms and projects

Target Pest	Information site	Projects
Fall armyworm	➢ CABI - Pest Risk Information Service (PRISE) forecasts the risk of FAW outbreaks for timely large scale alerts ➢ CABI – Open FAW Research Collaboration Platform ➢ FAO - FAW Monitoring and Early Warning System (FAMEWS) serves as a global platform for mapping and analyzing the collected data based on field monitoring & pheromone traps	➢ CABI has proposed & received funding from DFID for a pilot project to bring together FAW researchers and encourage open working and collaboration across the global research community ➢ CGIAR (CIMMYT/IITA) – FAW International Research for Development (R4D) as a FAW consortium with 45 global institutes ➢ CGIAR Research Program on Maize (CIMMYT works on native genetic resistance) ➢ EUPHRESCO project FAW-spedcom (2019-2022: Botswana, Bulgaria, France, Germany, South Africa, CABI) ➢ FAO/IPPC – Global Action for Fall Armyworm Control (2020-2022)
Fruit flies		➢ Horizon 2020 FF-IPM project
Red palm weevil		➢ FAO platform – Action plan for Red Palm Weevil control
Xylella fastidiosa	https://www.cabi.org/isc/datasheet/57195 https://gd.eppo.int/taxon/XYLEFA	➢ Horizon 2020 *Xylella fastidiosa*_ACTORS project ➢ EUPHRESCO-PROMODE project ➢ Horizon 2020 RISE : Cure-*Xylella fastidiosa* project ➢ H2020-MSCA-RISE-2016 CURE-XF 734353 Capacity Building and Raising Awareness in Europe and in Third Countries to Cope with *Xylella fastidiosa* ➢ XF-Actors, a Horizon 2020 research project to improve prevention, early detection and control of *Xylella fastidiosa* through the establishment of a multidisciplinary research program. ➢ POnTE, a Horizon 2020 project researching the risk of introduction and impact of emerging pests, including *Xylella fastidiosa*, threatening EU agriculture and forestry.
Citrus greening		
Tomato brown rugose fruit virus		➢ EUPHRESCO project (Validation of molecular diagnostic methods for the detection of ToBRFV in seeds of tomatoes, chilies and eggplants)
Wheat blast	➢ CIMMYT – Mobile and Web platform for disease monitoring	➢ CGIAR Research Program on Wheat (CIMMYT works on native genetic resistance)

Fusarium wilt (TR 4)	http://www.fao.org/world-banana-forum/fusariumtr4	➢ FAO: The Global programme on Banana Fusarium Wilt Disease 2018-2013

(3) Biovigilance

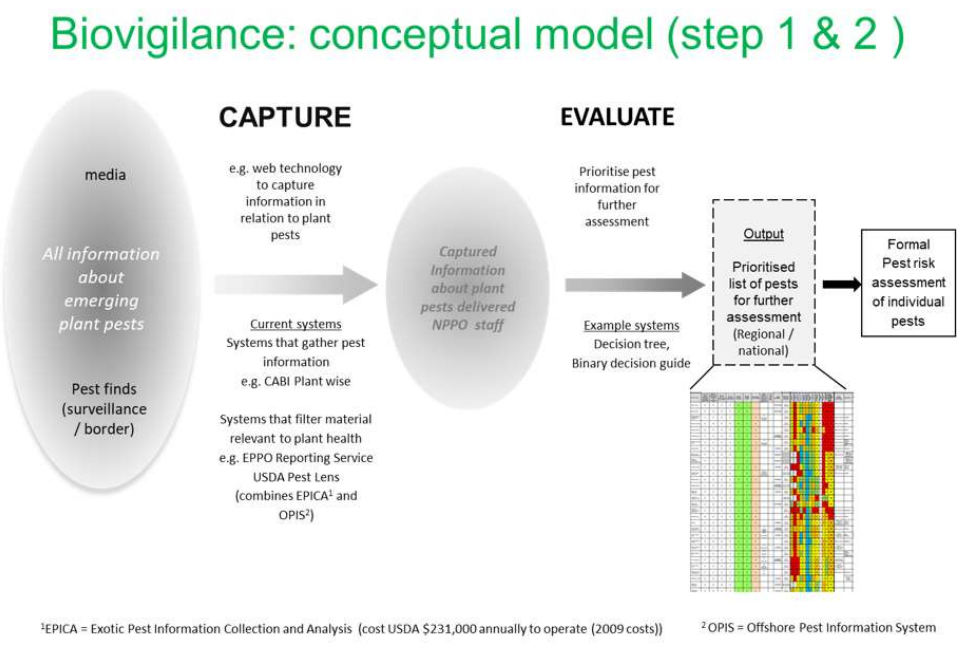
(a) Main suggestions from the Discussion Group

Biovigilance: A definition	➢ A multi-step, multidisciplinary forward-looking system of plant protection and research with the objective to prevent potential threats before they impact the agricultural sector (Carisse et al., 2017) ➢ Enables increased preparedness = better mitigate threats
Biovigilance: Directions for the future	➢ Ideas for collaborative research ranged from straightforward, joint developments: - survey methodology - traps and lures - diagnostic protocols ➢ More ambitious - global pest alert system (Carvajal-Yepes et al.,2019) - integrating and adding to existing methods currently in use - similar aims in draft IPPC Strategic Framework for 2020-2030 - also recognised in the EUPHRESCO Strategic Research Agenda

Table: Steps in a biovigilance program (modified from Carisse et al., 2017)

#	Step	Content
1	Awareness and detection/ identification	Be on the lookout for relevant changes, know what to look for; check for presence.
2	Understanding and assessment /prioritization	Gather information to create knowledge and understanding of the changing pest risk, evaluate the risk, compare against other risks.
3	Appropriate mitigation	Based on 2, design and apply mitigation measures and check that measures applied do not have unintended consequences.

(Source) Presentation material from the Discussion group on Cross-cutting issues (Dr. Alan MacLeod, Defra, UK)



(b) Suggestions from the Workshop

For the sake of better preparedness against major pests, rapid information sharing of pest occurrence is most important.

In case of pest occurrence, IPPC member countries are obliged to report it to the IPPC secretariat immediately (Art.VIII 1a of the IPPC). This rule should be respected.

There are several platforms used by organizations to store and share information. If they were better aligned they could be utilized more widely via cooperation with specialized international organizations to improve efficiency in transferring and sharing information.

It is expected that countries will continue their efforts in information exchanges and discussion to develop bio-alert schemes and pest occurrence at the international and regional level.

【Ref.】 International collaborative initiatives proposed by CGIAR & partners

Proposed initiatives	Remarks
Global Surveillance System (GSS)	➢ GSS would comprise existing surveillance systems worldwide, with a deliberate coordination of people, compilation and analysis of disease diagnostic data patterns, and a forward-looking goal of improved risk management at a global scale. ➢ GSS would function through five interconnected networks: (i) diagnostic laboratories, (ii) risk assessment modeling teams, (iii) data standardization & management specialists, (iv) regular expert communications, (v) a distributed operations management system and (vi) all sharing a cross-cutting capacity-development component to: ✓ Create linkages between general and specific surveillance entities across countries to increase coordination in high-consequence disease detection ✓ Allowing optimization of early response and control ➢ A pilot phase would focus on high-risk diseases, causing high economic impact in some of the world's most important crops in Low Income Countries (LIC), to strengthen their capacity and link critical components of existing response networks
CGIAR-wide Rapid Response Preparedness (RPP)	➢ Key steps in building RPP against food/ feed crop pests, as a contribution to regional and international partnerships and networks, are: ✓ To assess CGIAR and other actor's successful, rapid response interventions, and recognize factors leading to success or failure – also by learning from other institutions and networks in the same/ similar research domains ➢ Develop a business model for rapid response services and preparedness supporting such services

(Background) GSS: https://science.sciencemag.org/content/364/6447/1237
RPP: https://storage.googleapis.com/cgiarorg/2018/10/SC7-F_Rapid-Response.pdf

(4) International Year of Plant Health（IYPH2020）

(a) Main suggestions from the Discussion Group

IYPH 2020 provides an ideal opportunity to raise global awareness on how protecting plant health can help

- end hunger
- reduce poverty
- protect the environment
- boost economic development

IYPH allows all plant health stakeholders to come together and commit to improving awareness of plant health.

G20 members and stakeholder organisations are planning a broad range of scientific, industry focussed, educational, public, media and cultural events that are designed to capitalize on this unique opportunity and to make IYPH a success with a lasting legacy.

Examples of Activities during IYPH 2020	
Science events	➢ Regular conferences to include IYPH event as part of programme - Specific IYPH special event during the Asian Conference on Plant Pathology in Tsukuba, Japan (September 2020) - 7th International Congress of Nematology (ICN) links to the IYPH - 7th International Conference on "Phytopathology in Achieving UN Sustainable Development Goals" (New Delhi, India, January 2020) - International Conference on Banana Fusarium wilt TR4 (Status, challenges and prospects for prevention and long-term management) (TBC) aim to agree on and support a long-term global strategy to combat TR4 ➢ Helsinki Conference October 2020 ➢ Plant Health, Agriculture & Bioscience Conference (PHAB 2020), 9-11 September 2020, The Hague, Netherlands
Stakeholder awareness raising events	➢ USDA APHIS - Plant Health Safeguarding and Safe Trade Conference in 2020 - aims for cross-sector dialogue and collaboration among government, industry, academia, NGOs, and science and research organizations - will seek to identify areas where targeted actions, research, investments, or other interventions may be needed over the next 5-10 years to better safeguard plant health and facilitate safe trade. ➢ Canada will promote IYPH at Canadian Biopesticides and Minor Use Pesticides Workshops (March 2020) to industry stakeholders, grower groups, provincial specialists, researchers, manufacturing companies, federal regulators & international partner organizations.
Events for children / youth	➢ CABI planning an animated video about IYPH, 2 minutes aimed at pre-teen school children ➢ FAO planning - animated videos in different languages - children's activity book themed around plants and health ➢ Canada will host an IYPH2020 themed booth at STEM 2020 Expo at Canadian Science Fair to increase awareness of IYPH2020 and promote careers in STEM to youth. ➢ In Japan, plant protection officers plan visits to schools. ➢ UK planning IYPH event for youth groups

(b) Suggestions from the Workshop

Raising public awareness about the importance plant health, especially during the International Year of Plant Health (IYPH) is critically important.

Development of publicity about phytosanitary related events using the appropriate media to target key audiences is recommended as part of the contributions by researchers toward IYPH2020. Cooperation by researchers in raising public awareness regarding the risk of plant pests is important.

Information sharing to tourists on phytosanitary matters is vitally important – there should be careful consideration of the methods and communication tools used.

Besides the ministries for agriculture and foods, authorities related to international cooperation in phytosanitary matters (Ministry of Foreign Affairs for example) should recognize the importance of IYPH 2020 to facilitate research collaboration with developing countries.

III Findings and Future Opportunities

Damage caused by plant pests is worsening year by year and it requires not only adequate countermeasures by competent authorities in respective countries but also utmost efforts by national and international research institutes through efficient resource mobilization, for which further collaboration among international community in research is crucial. In addition, the latest information on pest occurrence, exchange of research materials and support to developing countries are necessary in order to take effective measures against pests.

The findings and opportunities identified below may be useful to inform future national and regional activities, voluntary international collaboration or consultation going forward. They were identified and validated during the workshop in Tsukuba, Japan (November 27 to 29, 2019).

Finding 1
The most important countermeasure against pests is information sharing about incursion as a part of appropriate preparedness.
➢ CABI, CGIAR, FAO,EPPO and other international and regional organizations operate information sharing mechanisms/websites on important pests, and expanded or new initiatives are planned. ➢ IPPC member countries are obliged to report new pest occurrence immediately to be shared with all member countries. ➢ Major pests selected by G20-MACS participants are the most prioritized by their researchers from G20 members, however, ISPMs by IPPC such as a diagnosis model or protocol are yet to be accomplished. Further work on this is expected.

Finding 2
International collaboration is increasingly important to tackle pests causing serious damage to regional economies.
➢ Networks among stakeholders to be developed to facilitate international research collaboration. ✓ Discussion groups organized for the workshop were quite meaningful in terms of information exchange on the latest pest occurrence, future challenges and perspectives among interested researchers from countries and organizations. The presentation materials and related information are available at the following URL. https://www.affrc.maff.go.jp/kokusaikenkyu/transboundary_plant_pests_e_2019.html ✓ In accordance with respective objective, not only researchers but seed companies, farmers, distributors and officials from competent government agencies are eligible as members of the network. ✓ EUPHRESCO is currently in operation as a coordinating network for international joint research. 11 out of the G20 countries are members, together with countries outside the G20. ✓ Roles of reference laboratories and networks are increasingly important.

Some G20 countries have, or are about to establish, national reference laboratories and regional reference laboratories have recently been set up in the EU.

✓ It is necessary to ensure that researchers are provided with a sound environment to pursue research objectives by smooth access to research materials.

Finding 3
Concerns about transboundary pests and their impacts are growing globally.
In the International Year of Plant Health (IYPH2020), many side events are proposed by researchers to share their concern over threats caused by transboundary pests. IYPH provides the ideal opportunity to raise public awareness in cooperation with the private sector. In addition to the competent ministries for agriculture and food, other agencies involved in ODA should recognize the importance of phytosanitary matters to facilitate research cooperation with developing countries.

Opportunity 1
➢ In order to strengthen research collaboration to develop effective measures against transboundary pests, proactive participation in and use of existing international and regional initiatives and frameworks would enhance the opportunities.
➢ There are several platforms of information existing or to be established by international organizations. In order to make best use of them by the researchers, participants in the workshop sought possibilities in which CAB, CGAIR, FAO and IPPC may consider alignment of relevant websites (as a clearinghouse). The Global Surveillance System (GSS) proposed by CGIAR & partners could be referred to in this regard. A discussion forum on the website for each pest would allow researchers to share information with 'threads' around particular topics (similar to PestNet or Reddit). ➢ Participation in joint funding networks enables expansion of research collaboration opportunities. Bearing in mind the EUPHRESCO experience to date, global collaboration should be discussed. ➢ Information exchange and discussion about establishing strategic surveillance systems covering broad areas by developing models of pest occurrence under international and regional initiatives mentioned above are also important.

Opportunity 2
Improvement of compliance of each country in line with existing international and regional rules will enhance opportunities for timely information sharing, research collaboration and rapid response.
➢ In order to ensure proper preparedness against pest incursion, information exchange is crucial in timely manner. IPPC members are obliged to report to IPPC on occurrence immediately. The participants of the workshop, therefore, strongly reminded all IPPC members to fulfill their responsibilities. In addition, they have expressed an urgent need for more diagnostic protocols to be developed by IPPC to add to the existing international standard for pest diagnosis. More than 20 pest specific diagnostic protocols are Annexes to ISPM 27 : https://www.ippc.int/en/core-activities/standards-setting/ispms/ Diagnostic protocol for *Thrips palmi* : https://www.ippc.int/en/publications/586/ ➢ For the sake of prompt countermeasures against pests, it is necessary to ensure that researchers are provided with an adequate enabling environment, as stipulated in the Nagoya Protocol, to pursue research objectives by smooth access to research materials and to have mutual recognition among IPPC and member countries on this. Likewise, sharing the benefit of useful information such as diagnosis results and traits assessment with developing countries is important in return to the acquisition of research materials for research. With respect to countermeasures, the CGIAR is developing a Rapid Response Preparedness

concept linked to the Global Surveillance System initiative.

Opportunity 3

Establishment of networks among researchers and stakeholders from respective countries as well as a reinforcement of collaboration between reference laboratories through the framework of the discussion groups organized for this workshop.

- The participants in the workshop recognized the importance of continuous efforts within the discussion groups as well as networks among researchers and stakeholders to interact with other relevant networks.

For example, the discussion group on "Citrus greening" is considering taking part in the initiative on "International Grand Challenge on Citrus" run by the USA with joint cooperation by producers, private sectors and government entities.

As for the discussion group on "Tomato brown rugose fruit virus", since the first detection in 2014 there are many unknown factors about this disease and relevant data is still insufficient, it was pointed out that joint work with researchers, seed companies, producers, retailers and regulatory authorities is important.

Regarding the establishment of reference laboratories and networks, the workshop participants reaffirmed that it is crucial to discuss the establishment of reference laboratories taking the resources and role of each country at the regional level into consideration, while referring to the precedence of regional quarantine organizations such as EPPO. Also, one of the workshop participants announced a plan to establish a reference laboratory in their own country for which the participant emphasized the importance of assistance by IPPC in the establishment and network development.

International Workshop on Facilitating International Research Collaboration on Transboundary Plant Pests

－Agenda－

Date: November 27th – 29th, 2019

(Workshop Sessions on 27th and 29th, Welcome Reception on 27th and Field Trips on 28th)

Venue: Tsukuba International Congress Center (Epochal Tsukuba), Tsukuba, Ibaraki 305-0032 Japan (https://www.epochal.or.jp/eng/)

Organizer: Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF)

Working Language: English

Background:

- At the 8th Meeting of G20 Agricultural Chief Scientists (MACS-G20) in Japan in April 2019, G20 members agreed to hold an international workshop to share the experiences of G20 members and invited guests and the latest information on the occurrence and management of transboundary plant pests, as well as to facilitate international research collaboration to help develop effective countermeasures for major plant pests. This workshop also aims to encourage diagnostic laboratories, research institutes and universities to establish networks among themselves and to promote voluntary interactions with stakeholders.
- In order to facilitate the preliminary work for the international workshop, Japan has requested colleagues from MACS-G20 and guests to establish and participate in discussion groups on (a) Fall armyworm, (b) Fruit flies, (c) Wheat blast, (d) *Xylella fastidiosa*, (e) Tomato brown rugose fruit virus, (f) Citrus greening (Huanglongbing), (g) Fusarium wilt tropical race 4, (h) Red palm weevil, and (i) Cross-cutting issues. Each group started holding discussions for the workshop by email with the participation of interested experts in September 2019.

Target Participants:

- G20 members and other selected countries and organizations with expertise in transboundary plant pests (such as the countries and organizations that participated in the 8th MACS-G20) will be invited to participate in the workshop on a voluntary basis (i.e., the travel and accommodation expenses should be

borne by the participating countries and organizations). Other countries and organizations that wish to participate in the workshop may be invited at the discretion of the Chair.

- G20 members or organizations that nominated discussion group leaders will be requested to send their leaders to the workshop to give presentations on the results of their groups' works. If any leaders are not able to attend the workshop, acting leaders from the groups should participate in their place and give the presentations at the workshop.
- In addition to those affiliated with public organizations (e.g., researchers at national research institutions, as well as government officials and specialists) of G20 members and invited countries and organizations, specialists in private corporations related to plant pests (e.g., agricultural chemical manufacturers, seed and plant suppliers and developers of diagnostic equipment) and universities may participate if recommended through a MACS-G20 contact in their country or organization. Specialists affiliated with international organizations, local organizations and NGOs, etc. may also be invited by the Chair. However, scientific expertise in plant pests is a prerequisite for attending the workshop.
- Participating countries and organizations are requested to limit their number of participants up to three attendees.

Deliverables:

- The report will be reviewed and finalized with comments from the participants of the workshop by email in and after December 2019.
- The report is planned to be submitted to MACS-G20 in 2020. In addition, the Secretariat of the International Plant Protection Convention (IPPC) may be consulted on how the report could be shared with and used by the IPPC contracting parties.

Schedule:

Wednesday, November 27th, 2019 (Workshop Sessions at Room 201 A/B)	
9:00 – 9:30	Registration/ Morning Coffee
9:30 – 10:00	**Opening Session** - Opening Remarks (Dr. Masa Iwanaga, Workshop Chair) - Welcoming Address (Mr. Kazuhiko Shimada, Deputy Director-General, Agriculture, Forestry and Fisheries Research Council Secretariat, MAFF) - Introduction
10:00 – 11:10	**Session 1: Reports by leaders of discussion groups on selected major transboundary plant pests** - Presentation on Fall armyworm (25 min.), Q&A (10 min.) - Presentation on Fruit flies (25 min.), Q&A (10 min.)

11:10 – 11:30	Coffee Break
11:30 – 12:05	- Presentation on Wheat blast (25 min.), Q&A (10 min.)
12:05 – 12:15	Group Photo
12:15 – 13:30	Lunch (Venue: Room 202 A/B)
13:30 – 14:40	- Presentation on *Xylella fastidiosa* (25 min.), Q&A (10 min.) - Presentation on Tomato brown rugose fruit virus (25 min.), Q&A (10 min.)
14:40 – 15:00	Coffee Break
15:00 – 16:45	- Presentation on Citrus greening (Huanglongbing) (25 min.), Q&A (10 min.) - Presentation on Fusarium wilt tropical race 4 (25 min.), Q&A (10 min.) - Presentation on Red palm weevil (25 min.), Q&A (10 min.)
16:45 – 17:00	Coffee Break
17:00 – 18:30	- Panel Discussions by leaders of discussion groups on selected major transboundary plant pests, and with participants
19:00 – 21:00	**Welcome Reception** (Venue: Restaurant "Espoir", Tsukuba International Congress Center)
Thursday, November 28th, 2019 (Field Trips)	
By 8:50	Meeting point: Lobby of the Okura Frontier Hotel Tsukuba Epochal
9:00	Buses depart from the Okura Frontier Hotel Tsukuba Epochal
9:15 – 11:45	Field Trip Site 1: Genetic Resources Center of the National Agriculture and Food Research Organization (NARO) Field Trip Site 2: Natural Resources Inventory Museum of NARO
11:45 – 12:10	Field Trip Site 3: Poster sessions on Japan's experiences and research on certain transboundary plant pests by the MAFF Plant Protection Station and NARO (Venue: Tsukuba Business-Academia Cooperation Support Center, Agriculture, Forestry and Fisheries Research Council Secretariat, MAFF)
12:10 – 13:10	Lunch (Venue: Tsukuba Business-Academia Cooperation Support Center)
13:50 – 14:30	Field Trip Site 4: Kogoro Farm (Introduction of pest management with Ultrasound, UV-B, predator and other control methods in strawberry)
15:10	Arrival and breakup at the entrance of the Okura Frontier Hotel Tsukuba Epochal
Friday, November 29th, 2019 (Workshop Sessions at Room 201 A/B)	
8:30 – 9:00	Morning Coffee

9:00 – 10:10	**Session 2: Report by leader of the discussion group on Cross-cutting issues** - Presentation (1) (25 min.), Q&A (10 min.) - Presentation (2) (25 min.), Q&A (10 min.)
10:10 – 10:40	Coffee Break
10:40 – 11:45	- Discussion
11:45 – 13:00	Lunch (Venue: Room 406)
13:00 – 13:10	**Outlook for MACS-G20 2020** (Saudi Arabia)
13:10 – 14:25	**Session 3: Wrap-up and way forward** - Discussion
14:25 – 14:30	**Closing Remarks** (The Chair)

International Workshop on Facilitating International Research Collaboration on Transboundary Plant Pests
LIST OF PARTICIPANTS

No.	Country/Organization	Organization（Ministry/Institute/Company）	Department	Position	Title	Name
1	Australia	Department of Agriculture and Fisheries	Plant Biosecurity and Product Integrity, Biosecurity Queensland	Principal Entomologist	Ms.	Jane Royer
2	Australia	Grains Research and Development Corporation		Senior Manager (Biosecurity and Regulation)	Dr.	Ken Young
3	Brazil	Brazil Agricultural Research Corporation (Embrapa)		Senior Scientist	Dr.	José Maurício Fernandes
4	China	Chinese Academy of Agricultural Sciences (CAAS)	Laboratory of Agricultural Entomology, Institute of Plant Protection	Director/Professor	Prof.	Zhenying Wang
5	France	National Institute of Agricultural Research (INRA)		Head of Division	Dr.	Christian Lannou
6	France	National Institute of Agricultural Research (INRA)		Director of Research	Dr.	Marie-Agnès Jacques
7	France	Agricultural Research Center for International Development (CIRAD)		Epidemiologist	Ms.	Yolande Chilin-Charles
8	Germany	Julius Kühn Institut	Institute for National and International Plant Health	Senior Researcher/ Entomologist	Dr.	Peter Baufeld
9	Germany	Julius Kühn Institut	Institute for National and International Plant Health	Senior Researcher/ Mycologist	Dr.	Clovis Douanla-Meli
10	Germany	Julius Kühn Institut	Institute for Epidemiology and Pathogen Diagnostics	Senior Scientist	Dr.	Heiko Ziebell
11	India	Indian Council of Agricultural Research (ICAR)	National Research Centre for Integrated Pest Management	Principal Scientist (Agricultural Entomology)	Dr.	Sengottaiyan Vennila
12	Italy	Council for Research in Agriculture and Economical Analysis (CREA-DC)		Senior Researcher	Dr.	Francesco Faggioli
13	Italy	Council for Research in Agriculture and economical analisys (CREA-DC)	National Reference Laboratory for Virology	Researcher	Dr.	Luca Ferretti

14	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)		Chair of 2019 MACS-G20/Advisor to the Minister of Agriculture, Forestry and Fisheries on International Research/President of JIRCAS	Dr.	Masa Iwanaga
15	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Agriculture, Forestry and Fisheries Research Council Secretariat (AFFRCS)	Deputy Director-General (Research Councilor)	Mr.	Kazuhiko Shimada
16	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	International Research, AFFRCS	Director	Mr.	Hiroshi Honjo
17	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	International Research, AFFRCS	Team Leader for G20 MACS	Mr.	Hiroyuki Tanaka
18	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	International Research, AFFRCS	Deputy Director	Mr.	Kazuyuki Ono
19	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	International Research, AFFRCS	International Research Expert	Dr.	Naoki Yanagida
20	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	International Research, AFFRCS	International Research Expert	Mr.	Koichiro Nishihata
21	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	International Research, AFFRCS	Officer	Mr.	Kazuhiro Tamura
22	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Research and Development, AFFRCS	Research Specialist	Dr.	Jun Tabata
23	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Plant Protection Division, Food Safety and Consumer Affairs Bureau	Deputy Director	Mr.	Tomoki Ishikawa
24	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Plant Protection Division, Food Safety and Consumer Affairs Bureau	Officer	Ms.	Momoko Hosoda
25	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Chief Researcher	Mr.	Kiyofumi Abe
26	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Chief Inspector	Dr.	Takayuki Matsuura
27	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Senior Researcher	Mr.	Motonori Sasaki
28	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Senior Researcher	Mr.	Shigehito Nakahara

29	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Researcher	Mr.	Nobuyuki Fujii
30	Japan	National Agriculture and Food Research Organization (NARO)	Strategic Planning Headquarters	Director-General	Dr.	Takashi Nakajima
31	Japan	National Agriculture and Food Research Organization (NARO)	Institute for Agro-Environmental Sciences	Director-General	Dr.	Tomonari Watanabe
32	Japan	National Agriculture and Food Research Organization (NARO)	Segment IV Team, Research Promotion Section, Department of Research Promotion, Strategic Planning Headquarters	Chief	Dr.	Masaya Matsumura
33	Japan	National Agriculture and Food Research Organization (NARO)	Division of Plant Disease Management, Central Region Agricultural Research Center	Director	Dr.	Yasuo Ohto
34	Japan	National Agriculture and Food Research Organization (NARO)	International Research Promotion Team, Strategic Planning Headquarters	Chief	Dr.	Ryoko Machida
35	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Research Strategy Office	Director	Dr.	Miyuki Iiyama
36	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Stable Agricultural Production	Program Director	Dr.	Kazuo Nakashima
37	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Biological Resources and Post-harvest Division	Project Leader	Dr.	Masayasu Kato
38	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Crop, Livestock and Environment Division	Senior Researcher	Dr.	Youichi Kobori
39	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Tropical Agriculture Research Front	Senior Researcher	Dr.	Yoshimichi Fukuta
40	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Biological Resources and Post-harvest Division	Researcher	Dr.	Takeshi Kashiwa
41	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Research Planning and Management Office, Research Planning and Partnership Division	Specialist	Dr.	Baltazar A. Antonio
42	Japan	Japan Crop Protection Association		Director General	Dr.	Takashi Hirooka

43	Japan	Japan Crop Protection Association (Kumiai Chemical Industry Co., Ltd.)	Life Science Research Institute	Senior Research Manager, Head of Agrochemical Research Center	Mr.	Yuki Nakano
44	Japan	Japan Plant Protection Association		President	Mr.	Yasuhiro Hayakawa
45	Japan	Tokyo University of Agriculture	Faculty of Agriculture	Professor	Prof.	Toru Iwanami
46	Republic of Korea	National Institute of Agricultural Sciences (NAS)	Crop Protection Division	Research Scientist	Dr.	Hong-Hyun Park
47	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)		Consultant	Prof.	Hassan Al-Ayied
48	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)		General Director for Plant Production	Prof.	Suliman Al-Kateeb
49	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)		Team Secretary	Ms.	Arwa S. Numan
50	South Africa	Embassy of South Africa in Japan		Counsellor (Agriculture)	Mr.	Sithembele Kelembe
51	South Africa	Embassy of South Africa in Japan		Liaison Officer (Agriculture)	Mr.	Minoru Isohata
52	Turkey	Ministry of Agriculture and Forestry	Department of Plant Health Research, General Directorate of Agricultural Research and Policies	Head	Dr.	Suat Kaymak
53	Turkey	Ministry of Agriculture and Forestry	Plant Pathology Department, Plant Protection Central Research Institute-Ankara, General Directorate of Agricultural Research and Policies	Head	Dr.	Aynur Karahan
54	Turkey	Ministry of Agriculture and Forestry	Fruit and Vineyard Pests Laboratory, Plant Protection Research Institute-Bornova, General Directorate of Agricultural Research and Policies	Researcher	Dr.	Ferhunde Özlem Altindişli
55	United Kingdom	Department for Environment Food and Rural Affairs (Defra)	Risk and Horizon Scanning, Animal and Plant Health Directorate, Department for Environment	Team Leader, Pest Risk Analysis	Dr.	Alan MacLeod
56	United Kingdom	Department for Environment Food and Rural Affairs (Defra)	Plant Health Evidence and Analysis	Plant Health R&D Strategy Manager	Mr.	Michael Sutton-Croft
57	United Kingdom	Fera Science Limited		Senior Plant Virologist	Dr.	Adrian Fox
58	Netherlands	Netherlands Food and Consumer Product Safety Authority (National Plant Protection Organization)		Director	Mr.	Antonie Van Arnhem

59	Netherlands	Embassy of the Kingdom of the Netherlands in Japan		Agricultural Counsellor	Mr.	Evert Jan Krajenbrink
60	New Zealand	Ministry for Primary Industries		Senior Scientist (Molecular Entomology)	Dr.	Rebijith Kayattukandy Balan
61	CABI	Centre for Agriculture and Bioscience International (CABI), Switzerland	Global Operations	Executive Director	Dr.	Ulrich Kuhlmann
62	CABI	Centre for Agriculture and Bioscience International (CABI), China		Regional Director for East Asia	Dr.	Feng Zhang
63	CIAT	International Center for Tropical Agriculture (CIAT)	Digital Genebank	Scientist	Dr.	Mónica Carvajal-Yepes
64	CIMMYT	International Maize and Wheat Improvement Center (CIMMYT)	CGIAR Research Programs on Maize and Wheat	Program Manager	Dr.	Viktor Maurice Kommerell
65	CIMMYT	International Maize and Wheat Improvement Center (CIMMYT)	Wheat Pathology, Global Wheat Program	Senior Scientist/ Head	Dr.	Pawan Kumar Singh
66	FAO	Food and Agriculture Organization of the United Nations (FAO)	Locusts and Transboundary Plant Pests and Diseases, Plant Production and Protection Division (AGP)	Senior Agricultural Officer	Dr.	Shoki Al-Dobai

Lists of participants of each discussion group

List of participants of the discussion group on Fall armyworm

	Country/ Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Co-Leader	China	Chinese Academy of Agricultural Sciences (CAAS)	Laboratory of Agricultural Entomology, Institute of Plant Protection	Director/Professor	Prof.	Zhenying Wang
Co-Leader	India	Indian Council of Agricultural Research (ICAR)	National Research Centre for Integrated Pest Management	Principal Scientist	Dr.	Sengottaiyan Vennila
	Australia	Grains Research and Development Corporation (GRDC)	Applied Research and Development Business Group	Senior Manager Biosecurity and Regulation	Dr.	Ken Young
	Australia	Grains Research and Development Corporation (GRDC)	Applied Research and Development Business Group	Manager Biosecurity	Dr.	Jeevan Khurana

	Brazil	Brazilian Agricultural Research Corporation (Embrapa)	Brazilian Maize and Sorghum Research Center/ Integrated Pest Management/Biological control of maize pest	Senior Researcher	Dr.	Ivan Cruz
	China	Chinese Academy of Agricultural Sciences (CAAS)	Department of International Cooperation Institute of Plant Protection	Director/Professor	Dr.	Julian Chen
	France	Agricultural Research Centre for International Development (CIRAD)	University of La Réunion	Head of the UMR PVBMT	Pr.	Bernard Reynaud
	France	Agricultural Research Centre for International Development (CIRAD)	UMR PVBMT, Biological Systems (BIOS)	Researcher	Dr.	Helene Delatte
	Germany	Julius Kühn-Institute	Federal Research Centre for Cultivated Plants, Institute for National and International Plant Health		Dr.	Peter Baufeld
	India	Indian Council of Agricultural Research (ICAR)	Crop Science Division	Asst. Director General (Plant Protection and Biosafety)	Dr.	Rajan
	Italy	Council for Agricultural Research and Economics (CREA)	Research Centre for Plant Protection and Certification	Centre Director	Dr.	Pio Federico Roversi
	Italy	Council for Agricultural Research and Economics (CREA)	Research Centre for Plant Protection and Certification	Researcher	Dr.	Elisabetta Gargani
	Japan	National Agriculture and Food Research Organization (NARO)	Informatics Unit, Department of Innovative Engineering Research, Institute of Agricultural Machinery	Unit Leader	Dr.	Akira Otsuka
	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Crop, Livestock and Environment Division	Senior Researcher	Dr.	Youichi Kobori
	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Research and Development, Agriculture, Forestry and Fisheries Research Council Secretariat (AFFRCS)	Research Specialist	Dr.	Jun Tabata
	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Senior Researcher	Mr.	Motonori Sasaki

	Republic of Korea	National Institute of Agricultural Sciences (NAS)	Crop Protection Division	Research Scientist	Dr.	Hong-Hyun Park
	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)		Consultant	Dr.	Ahmed Mohammed Al-Jabr
	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)		Consultant	Dr.	Suliman Ali Al-Khateeb
	United States	U.S. Department of Agriculture (USDA)		Research Entomologist		Rob Meagher
	European Commission	Directorate-General for Agriculture and Rural Development	Unit B2 Research and Innovation	Research Programme Officer	Ms.	Patrizia Eleonora Ganci
	New Zealand	Ministry for Primary Industries (MPI)	Plant Health and Environment Laboratory, Biosecurity New Zealand	Senior Scientist	Dr.	Rebijith Kayattukandy Balan
	CABI	Centre for Agriculture and Bioscience International (CABI), United Kingdom	Action on Invasives	Programme Executive	Dr.	Roger Day
	CIMMYT	International Maize and Wheat Improvement Center (CIMMYT), Kenya	Global Maize Program & CGIAR Research Program Maize	Director	Dr.	Prasanna Boddupalli
	FAO	Food and Agriculture Organization of the United Nations (FAO)	Plant Production and Protection Division (AGP)	Senior Agricultural Officer	Dr.	Shoki Al-Dobai
	FAO	Food and Agriculture Organization of the United Nations (FAO)	Plant Production and Protection Division (AGP)	Senior Agricultural Officer	Ms.	Elisabetta Tagliati
	FAO	Food and Agriculture Organization of the United Nations (FAO)	Plant Production and Protection Division (AGP)	Agricultural Officer	Dr.	Maged Elkahky

List of participants of the discussion group on Fruit flies

	Country/ Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Leader	Australia	Biosecurity Queensland, Department of Agriculture and Fisheries	Plant Biosecurity and Product Integrity	Principal Entomologist	Ms.	Jane Royer
	Brazil	Brazilian Agricultural Research Corporation (Embrapa)				Ricardo Adaime

	France	Agricultural Research Centre for International Development (CIRAD)				Bernard Reynaud
	France	Agricultural Research Centre for International Development (CIRAD)				Helene Delatte
	Italy	Council for Agricultural Research and Economics (CREA)				Leonardo Marianelli
	Japan	National Agriculture and Food Research Organization (NARO)	Segment IV Team, Research Promotion Section, Department of Research Promotion, Strategic Planning Headquarters	Chief	Dr.	Masaya Matsumura
	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Senior Researcher	Mr.	Shigehito Nakahara
	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)		Consultant	Dr.	Ahmed Mohammed Al-Jabr
	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)	Organic Faming Administration	Manager		Ayman Saad Al-Ghamd
	Turkey	Ministry of Agriculture and Forestry	Department of Plant Health Research, General Directorate of Agricultural Research and Policies	Head of the Department of Plant Health Research	Dr.	Suat Kaymak
	Turkey	Ministry of Agriculture and Forestry	Plant Protection Research Institute Bornova-İzmır, General Directorate of Agricultural Research and Policies	Senior Researcher	Dr.	Özlem Altindisli
	United States	U.S. Department of Agriculture (USDA)		Research Entomologist		Scott Geib
	United States	U.S. Department of Agriculture (USDA)		Research Entomologist		Kim Hoelmer
	United States	U.S. Department of Agriculture (USDA)		Supervisory Research Biologist		Nicholas Manoukis
	United States	U.S. Department of Agriculture (USDA)		Research Geneticist		Alfred Handler
	European Commission	Directotate-General for Agriculture and Rural Development	Unit B2 Research and Innovation	Research Programme Officer	Ms.	Patrizia Eleonora Ganci
	New Zealand	Ministry for Primary Industries (MPI)	Plant Health and Environment Laboratory,	Senior Scientist	Dr.	Rebijith Kayattukandy Balan

			Biosecurity New Zealand			
	CABI	Centre for Agriculture and Bioscience International (CABI), China			Dr.	Feng Zhang

List of participants of the discussion group on Wheat blast

	Country/ Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Co-Leader	Brazil	Brazilian Agricultural Research Corporation (Embrapa)		Plant Pathologist	Dr.	José Maurício Fernandes
Co-Leader	CIMMYT	International Maize and Wheat Improvement Center (CIMMYT)	Wheat Pathology, Global Wheat Program	Senior Scientist/Head	Dr.	Pawan Singh
	Australia	Grains Research and Development Corporation (GRDC)		Senior Manager Biosecurity and Regulation	Dr.	Ken Young
	Australia	Grains Research and Development Corporation (GRDC)		Manager Biosecurity	Dr.	Jeevan Khurana
	China	Chinese Academy of Agricultural Sciences (CAAS)	Institute of Plant Protection	Professor	Prof.	Zhou Yilin
	China	Chinese Academy of Agricultural Sciences (CAAS)	Institute of Plant Protection		Dr.	Fan Jieru
	Germany	Julius Kühn-Institut	Federal Research Centre for Cultivated Plants, Institute for National and International Plant Health		Dr.	Clovis Douanla-Meli
	Italy	Council for Agricultural Research and Economics (CREA)				Luca Riccioni
	Japan	Kobe University	Graduate School of Agricultural Science	Professor	Prof.	Yokio Tosa
	Japan	Kyoto Prefectural University	Department of Agricultural and Life Science	Professor	Prof.	Hirokazu Handa
	Japan	National Agriculture and Food Research Organization (NARO)	Breeding Unit, Division of Wheat and Barley Research, Institute of Crop Science	Unit Leader	Dr.	Masaya Fujita
	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Tropical Agriculture Research Front	Senior Researcher	Dr.	Yoshimichi Fukuta

	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Senior Researcher	Mr.	Takashi Hirata
	Turkey	Ministry of Agriculture and Forestry	Department of Plant Health Research, General Directorate of Agricultural Research and Policies	Head of the Department of Plant Health Research	Dr.	Suat Kaymak
	United States	U.S. Department of Agriculture (USDA)		Research Molecular Biologist		Kerry Pedley
	Wheat Initiative	University of Sydney	Plant Breeding Institute	Professor	Prof.	Robert Park

List of participants of the discussion group on *Xylella fastidiosa*

	Country/ Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Leader	France	National Institute for Agricultural Research (INRA)		Director of Research	Dr.	Marie-Agnes Jacques
	Brazil	Brazilian Agricultural Research Corporation (Embrapa)			Dr.	Abi Marques
	Brazil	Secretaria da Agricultura e Abastecimento, Cordeiropolis	Centro de Citricultura Sylvio Moreira-CCSM, Instituto Agrono	Senior Researcher	Dr.	Alessandra Alves de Souza
	Brazil	Secretaria da Agricultura e Abastecimento, Cordeiropolis	Centro de Citricultura Sylvio Moreira-CCSM, Instituto Agrono	Senior Researcher	Dr.	Helvecio Della Coletta-Filho
	China	Chinese Academy of Agricultural Sciences (CAAS)	Institute of Plant Protection		Dr.	Guan Wei.
	Italy	Council for Agricultural Research and Economics (CREA)				Stefania Loreti
	Japan	National Agriculture and Food Research Organization (NARO)	Plant Pathology Unit, Division of Fruit Production and Postharvest Science, Institute of Fruit Tree and Tea Science	Principal Scientist	Dr.	Takashi Fujikawa
	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Researcher	Mr.	Yuichiro Takai
	Russia	Lomonosov Moscow State University	Eurasian Center for Food Security	Senior Research Officer	Dr.	Sergey Elansky
	Turkey	Ministry of Agriculture and Forestry	Ankara Plant Protection Central Research Institute, General Directorate of Agricultural Research and Policies	Senior Researcher	Dr.	Aynur Karahan

	United Kingdom	John Innes Centre			Dr.	Gerard Clover
	United Kingdom	Food and Rural Affairs (Defra)	Plant Health Evidence and Analysis		Mr.	Mike Sutton-Croft
	United States	U.S. Department of Agriculture (USDA)	Agricultural Research Service	Research Plant Pathologist	Dr.	Rodrigo Krugner
	United States	U.S. Department of Agriculture (USDA)	Agricultural Research Service	Research Plant Pathologist	Dr.	Lindsey Burbank

List of participants of the discussion group on Tomato brown rugose fruit virus

	Country/ Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Co-Leader	Germany	Julius Kühn-Institut	Federal Research Centre for Cultivated Plants, Institute for Epidemiology and Pathogen Diagnostics	Senior Scientist	Dr.	Heiko Ziebell
Co-Leader	United Kingdom	Fera Science Limited		Senior Plant Virologist	Dr.	Adrian Fox
	Australia	Agriculture Victoria		Plant Virologist	Dr.	Fiona Constable
	Brazil	Brazilian Agricultural Research Corporation (Embrapa)				Alice Nagata
	France	BioGEVES	Molecular Detection Unit	Head of Group	Dr.	Thomas Baldwin
	Germany	Landwirtschaftskammer Nordrhein-Westfalen	Pflanzenschutzdienst	Head of Diagnostics	Dr.	Monika Heupel
	Italy	Council for Agricultural Research and Economics (CREA)			Dr.	Laura Tomassoli
	Italy	Institute for Sustainable Plant Protection		Phytopathologist	Dr.	Massimo Turina
	Japan	National Agriculture and Food Research Organization (NARO)	Horticultural Plant Disease Control Group, Division of Plant Disease Management, Central Region Agricultural Research Center	Senior Scientist	Dr.	Kenji Kubota
	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Senior Researcher	Mr.	Hitoshi Oya
	Russia	Lomonosov Moscow State University	Eurasian Center for Food Security	Senior Research Officer	Dr.	Sergey Elansky
	United Kingdom	Food and Rural Affairs (Defra)	Risk and Horizon Scanning, Animal and Plant Health Directorate, Department for Environment		Dr.	Matthew Everatt

	United States	USDA, ARS, USHRL		Research Plant Pathologist	Dr.	Scott Adkins
	United States	Southwest Florida Research and Education Center	Citrus Pathology	Assistant Professor	Dr.	Ozgur Batuman
	United States	U.S. Department of Agriculture (USDA)	Agricultural Research Service (ARS)	Research Plant Pathologist	Dr.	Kai Ling
	European Commission	Directorate-General for Agriculture and Rural Development	Unit B2 Research and Innovation	Research Programme Officer	Ms.	Patrizia Eleonora Ganci
	Israel	Volcani Centre		Plant Virologist	Dr.	Aviv Dombrovsky
	Netherlands	Netherlands Food and Consumer Product Safety Authority (National Plant Protection Organization)			Mr.	Dirk Jan van der Gaag
	Netherlands	Naktuinbouw		Seed Pathologist	Dr.	Harrie Koenraadt
	Netherlands	Wageningen University and Research	Biointeractions and Plant Health	Senior Scientist	Prof. Dr.	Rene van der Vlugt
	ISF	International Seed Federation (ISF), Switzerland		Technical Director		Radha Ranganathan

List of participants of the discussion group on Citrus greening (Huanglongbing)

	Country/ Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Leader	Japan	Tokyo University of Agriculture	Faculty of Agriculture	Professor	Prof.	Toru Iwanami
	Brazil	Brazilian Agricultural Research Corporation (Embrapa)				Juliana Astúa
	China	Chinese Academy of Agricultural Sciences (CAAS)	Institute of Plant Protection		Dr.	Guan Wei
	France	Agricultural Research Centre for International Development (CIRAD)				Bernard Reynaud
	France	Agricultural Research Centre for International Development (CIRAD)				Helene Delatte
	France	Agency for Food, Environmental and Occupational Health & Safety (ANSES)				Bruno Hostachy
	France	Agency for Food, Environmental and Occupational Health & Safety (ANSES)				Gilles Cellier
	Italy	Council for Agricultural Research and Economics (CREA)				Vincenza Ilardi

	Japan	National Agriculture and Food Research Organization (NARO)	Pest Management Unit, Division of Citrus Research, Institute of Fruit Tree and Tea Science	Principal Scientist	Dr.	Kenta Tomimura
	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Chief Inspecter	Dr.	Takayuki Matsuura
	United States	U.S. Department of Agriculture (USDA)		Research Molecular Biologist		Robert Shatters
	United States	U.S. Department of Agriculture (USDA)		Research Molecular Biologist		Michelle Cilia Heck
	European Commission	Directorate-General for Agriculture and Rural Development	Unit B2 Research and Innovation	Research Programme Officer	Ms.	Patrizia Eleonora Ganci

List of participants of the discussion group on Fusarium wilt tropical race 4

	Country/ Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Co-Leader	France	Agricultural Research Centre for International Development (CIRAD)			Ms.	Yolande Chilin-Charles
Co-Leader	IPPC	International Plant Protection Convention (IPPC) Secretariat		Implementation Facilitation Officer	Ms.	Sara Brunel
	Brazil	Brazilian Agricultural Research Corporation (Embrapa)				Miguel Dita
	France	Agency for Food, Environmental and Occupational Health & Safety (ANSES)				Bruno Hostachy
	France	Agency for Food, Environmental and Occupational Health & Safety (ANSES)				Jaime Aguayo
	France	Agricultural Research Centre for International Development (CIRAD)		Research Population Geneticist	Dr.	Emmanuel Wicker
	Japan	National Agriculture and Food Research Organization (NARO)	Phytopathology Unit, Division of Vegetable Pest Management and Functional Analysis, Institute of Vegetable and Floriculture Science	Senior Scientist	Dr.	Yuichiro Iida
	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Biological Resources and Post-harvest Division	Researcher	Dr.	Takeshi Kashiwa

	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Senior Researcher	Mr.	Koshi Ueda
	Turkey	General Directorate of Agricultural Research and Policies/Ministry of Agriculture and Forestry	Department of Plant Health Research	Head of the Department of Plant Health Research	Dr.	Suat KAYMAK
	European Commission	Directorate-General for Agriculture and Rural Development	Unit B2 Research and Innovation	Research Programme Officer	Ms.	Patrizia Eleonora Ganci
	Bioversity International	Bioversity International, India		Regional Representative	Dr.	Nallur K. Krishna Kumar
	FAO	Food and Agriculture Organization of the United Nations (FAO)	Plant Production and Protection Division (AGP)	Senior Agricultural Officer	Dr.	Shoki Al-Dobai
	FAO	Food and Agriculture Organization of the United Nations (FAO)	Plant Production and Protection Division (AGP)			Fazil Dusunceli
	FAO	Food and Agriculture Organization of the United Nations (FAO)	Plant Production and Protection Division (AGP)			Maged Elkahky

List of participants of the discussion group on Red palm weevil

	Country/ Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Leader	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)		Consultant	Prof.	Hassan Al-Ayedh
Deputy -Leader	FAO	Food and Agriculture Organization of the United Nations (FAO)	Plant Production and Protection Division (AGP)	Senior Agricultural Officer	Dr.	Shoki Al-Dobai
	Brazil	Brazilian Agricultural Research Corporation (Embrapa)				Elio Guzzo
	Italy	Council for Agricultural Research and Economics (CREA)				Giuseppe Mazza
	Japan	National Agriculture and Food Research Organization (NARO)	Tropical Crop Protection Group, Division of Agro-Environment Research, Kyushu Okinawa Agricultural Research Center	Principal Scientist	Dr.	Hiraku Yoshitake
	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station	Plant quarantine officer	Mr.	Takuya Yamaji
	Saudi Arabia	Ministry of Environment, Water and Agriculture (MEWA)	Plant Resources Administration	General Manager	Dr.	Suliman Ali Al-Khateeb

	Turkey	Ministry of Agriculture and Forestry	Department of Plant Health Research, General Directorate of Agricultural Research and Policies	Head of the Department of Plant Health Research	Dr.	Suat KAYMAK
	Turkey	Ministry of Agriculture and Forestry	Plant Protection Research Institute Bornova-İzmır, General Directorate of Agricultural Research and Policies	Senior Researcher	Dr.	Özlem ALTINDİŞLİ
	European Commission	Directorate-General for Agriculture and Rural Development	Unit B2 Research and Innovation	Research Programme Officer	Ms.	Patrizia Eleonora Ganci

List of participants of the discussion group on Cross-cutting issues

	Country/Organization	Organization (Institute/Ministry, etc)	Department	Position	Title	Name
Leader	United Kingdom	Food and Rural Affairs (Defra)	Risk and Horizon Scanning, Animal and Plant Health Directorate, Department for Environment		Dr.	Alan MacLeod
	Brazil	Ministry of Agriculture, Livestock and Food Supply (MAPA)			Mr.	Tiago Lohmann
	Canada	Agriculture and Agri-Food Canada			Dr.	Odile Carisse
	Canada	Agriculture and Agri-Food Canada			Dr.	Cezarina Kora
	France	National Institute for Agricultural Research (INRA)				Christian Lannou
	France	Agency for Food, Environmental and Occupational Health & Safety (ANSES)				Philippe Reignault
	India	Indian Council of Agricultural Research (ICAR)	Crop Science Division	Asst. Director General (Plant Protection and Biosafety)	Dr.	Rajan
	India	Indian Council of Agricultural Research (ICAR)	National Research Centre for Integrated Pest Management	Principal Scientist	Dr.	Sengottaiyan Vennila
	Japan	National Agriculture and Food Research Organization (NARO)	Division of Plant Disease Management, Central Region Agricultural Research Center	Director	Dr.	Yasuo Ohto
	Japan	Japan International Research Center for Agricultural Sciences (JIRCAS)	Biological Resources and Post-harvest Division	Project Leader	Dr.	Masayasu Kato

	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	International Research, Agriculture, Forestry and Fisheries Research Secretariat (AFFRCS)	Director	Mr.	Hiroshi Honjo
	Japan	Ministry of Agriculture, Forestry and Fisheries (MAFF)	Yokohama Plant Protection Station		Mr.	Kiyofumi Abe
	Turkey	Ministry of Agriculture and Forestry	Department of Plant Health Research, General Directorate of Agricultural Research and Policies	Head of the Department of Plant Health Research	Dr.	Suat Kaymak
	Turkey	Ministry of Agriculture and Forestry	Plant Protection Research Institute Bornova-İzmır, General Directorate of Agricultural Research and Policies	Senior Researcher	Dr.	Özlem Altindisli
	Turkey	Ministry of Agriculture and Forestry	Ankara Plant Protection Central Research Institute, General Directorate of Agricultural Research and Policies	Senior Researcher	Dr.	Aynur Karahan
	United Kingdom	Food and Rural Affairs (Defra)	Plant Health Evidence and Analysis		Mr.	Mike Sutton-Croft
	United Kingdom	Fera Science Limited			Dr.	Rebecca Weekes
	United Kingdom	John Innes Centre			Dr.	Gerard Clover
	United States	US Department of Agriculture	APHIS, Plant protection and Quarantine Science and Technology	Coordinator, National Clean Plant Network, USDA, APHIS	Mr.	Erich Rudj
	European Commission	Directorate-General for Agriculture and Rural Development	Unit B2 Research and Innovation	Research Programme Officer	Ms.	Patrizia Eleonora Ganci
	European Commission	European Commission, Directorate-General for Health and Food Safety	Unit G1 Plant Health		Ms.	Panagiota Mylona
	New Zealand	Ministry for Primary Industries (MPI)	Plant Health and Environment Laboratory, Biosecurity New Zealand	Senior Scientist	Dr.	Rebijith Kayattukandy Balan
	CABI	Centre for Agriculture and Bioscience International (CABI), Switzerland	Global Operations	Executive Director	Dr.	Ulrich Kuhlmann
	CIMMYT	International Maize and Wheat Improvement Center (CIMMYT)	CGIAR Research Programs on Maize and Wheat	Manager	Dr.	Victor Kommerell
	FAO	Food and Agriculture Organization of the United Nations (FAO)	Plant Production and Protection Division (AGP)	Senior Agricultural Officer	Dr.	Shoki Al-Dobai

	IPPC	International Plant Protection Convention (IPPC) Secretariat		Implementation Facilitation Officer	Ms.	Sara Brunel
	EPPO	European and Mediterranean Plant Protection Organization (EPPO)		Director-General	Mr.	Nico Horn
	EPPO	European and Mediterranean Plant Protection Organization (EPPO)		Assistant Director	Ms.	Françoise Petter
	EUPHRESCO	EUPHRESCO		Euphresco Coordinator at EPPO	Dr.	Baldissera Giovani
	Consultant			Independent consultant	Dr.	Shashi Bhooshan Sharma

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