附件4

Food and Agriculture Organization of the United Nations

Impact of Climate Change on Plant Health

Dr. Jingyuan Xia, Director
FAO Plant Production and Protection Division (NSP)

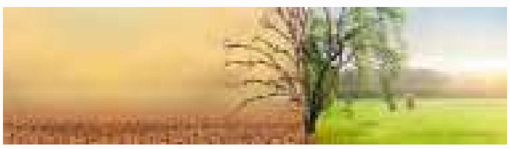
The First International Plant Health Conference (IPHC)
London, UK; 21-23 September 2022

Food and Agriculture Organization of the United Nations

Climate change is everywhere and at anytime





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Impact of Climate Change on Plant Health is in Every Aspect

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Plant Health's Contribution to Supporting UN SDGs

Among **17 UN SDGs** for 2030 Agenda, plant health directly contribute to **6 SDGs**:

- ❑ *SDG 1:* No Poverty
- ❑ *SDG 2:* Zero Hunger
- ❑ *SDG 8:* Decent work and economic growth
- ❑ *SDG 12:* Responsible consumption and production
- ❑ *SDG 13:* Climate action (Climate change)
- ❑ *SDG 15:* Life on land (Biodiversity)

Plant Health's Roles in Supporting Sustainable Agriculture

- ***Ensure food security*** by **reducing** crop loss through effective IPM) and ***promote food safety*** by **reducing** pesticide residue in food: **Food Security**
- ***Protect environment*** by **reducing** pesticide application through effective IPM, and ***preserve biodiversity*** by **reducing** spread of invasive alien plant pests through effective phytosanitary measures: **Environment Protection**
- ***Facilitate trade*** by **implementing** effective phytosanitary measures and ***support famers' livelihoods*** by **increasing** farmers' incomes recovered from effective pest quarantine and control: **Safe Trade**

CODEX ALIMENTARIUS

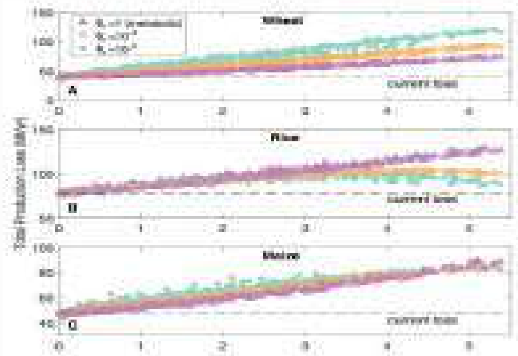
International Plant Protection Convention

Presentation Outline

1. Impact of Climate Change on Plant Health
2. Strategies for Mitigating CC Impact on Plant Health
3. FAO Action on Mitigating CC Impact on Plant Health
4. The Way Forward

1. Impact of Climate Change: ***Alter pest and pathogen bionomics*** *(1/5)*

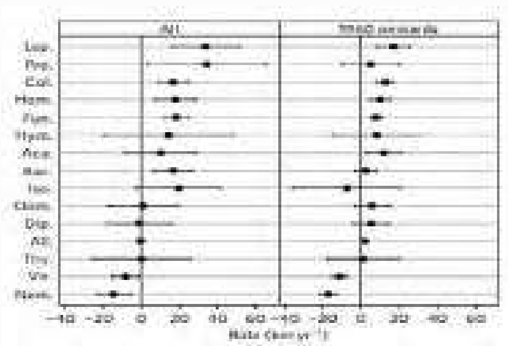
- ***Higher temperatures:***
  - Higher developmental rate, resulting shorter pest life cycle; earlier establishment; more generations
  - Increased winter survival at higher latitudes, resulting in elevated population abundance and pesticide resistance
- ***Higher atmospheric CO2 concentration:***
  - Slower developmental rate and lower population abundance



Projected yield losses (megatonnes per year) as a result of increased insect metabolic activity for wheat (A), rice (B) and maize (C) under increased temp. (Deutsch et al., 2018; Science)

1. Impact of Climate Change: ***Broaden pest population distribution*** *(2/5)*

- ***Latitude:*** 66% of tropical pests projected to achieve global distribution; latitudinal range increases linearly with longitudinal range – with a more rapid expansion for pests with initially small ranges
- ***Elevation:*** Some distribute towards higher elevation, while others move towards lower elevation
- ***Migration:*** Change of migration pattern, e.g. FAW between Asia and Near East
- ***Overall outcome:*** Alter pest status due to responses mediated by species-level evolutionary adaptation, host distribution, and migration patterns



Mean latitudinal shift (km yr−1) for pest taxonomic groups in the Northern Hemisphere for all years, and for 1960 onwards (Bebber et al., 2013. Nature Climate Change)

1. Impact of Climate Change: **Disrupt plant-pest-natural enemy food webs** (3/5)

- ***Host plants:*** Abiotic stressors e.g., drought can alter tolerance or resistance to pests or diseases
- **Herbivores*:*** Mobile, polyphagous, multi-voltine and pesticide-resistant species likely to thrive in conventional systems
- ***Natural enemies:*** Climate-induced mismatches in spatio-temporal distribution of natural enemies vs pests can compromise natural biological control - particularly in simplified agro-ecosystems

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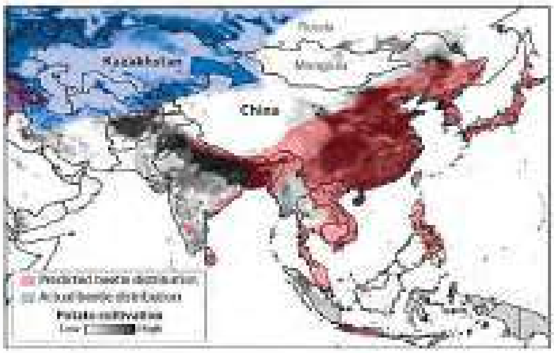
1. Impact of Climate Change: **Effect pest population prediction** (4/5)

- ***Complicate monitoring and prediction*** due to the climate-induced shifts in behavior and population dynamics, especially for adaptable species with short life cycles e.g., aphids, whitefly, pathogens
- ***Fail to predict geographical distribution and voltinism*** by using climate-based niche models e.g., for the Colorado potato beetle in Asia
- ***Solution:*** Improve predictive models to build on advances in biogeography and ecological niche theory



The actual distribution of Colorado potato beetle (blue zone) as compared with its model-based predicted distribution (red) (Bebber et al., 2015. Annu Rev Phytopathol).

Plant Production and Protection Division (NSP)

1. *Impact of Climate Change:* ***Reduce pest control effectiveness*** *(5/5)*

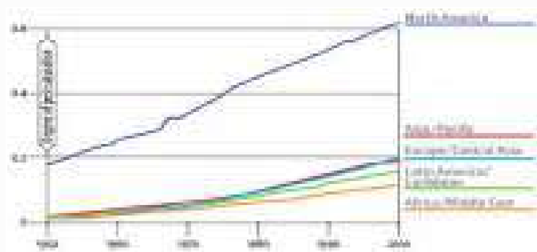
- ***Causes:*** Elevated temperatures and atmospheric CO2 are associated with increased in conditional resistance towards pesticides among pest/weed species
- ***Outcomes:*** Rapid decline in the effectiveness of traditional pest control – especially in simplified, genetically-uniform and pesticide-reliant production systems

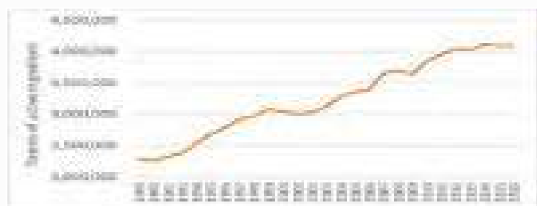
Pest/Weed Species	Active ingredients	Environmental factors	References
Frankliniella occidentalis	Avermectin	Reduced efficacy under elevated temperatures	Li et al. 2014
Nilaparvata lugens	Triazophos	Reduced efficacy under enriched CO2	Ge et al. 2013
Amaranthus palmeri	Mesotrione	Reduced efficacy under elevated temperatures	Godar et al. 2015
Chenopodium album	Glyphosate	Reduced efficacy at enriched CO2	Ziska et al. 1999

(Matzrafi et al. 2018)

1. *Impact of Climate Change:* ***The consequences of the impact***

- ***On food security:*** It is estimated that Yield losses of cereals projected to increase by 10-25% Per degree of global warming
- ***On environment protection:*** Application of pesticide have increased steadily due to increased pest incidence, infestation and invasion
- ***On safe trade:*** In the past 40 years, invasive pest incursions have grown by 40% and have cost countries at least USD 70 billion



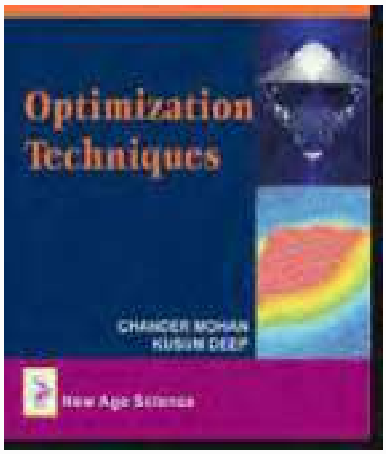


2. Strategy for Mitigation: ***Transform to One Health Approach*** (1/5)

- ***FAO's priority programme for one health approach with five pillars:*** 1) early warning and inform; 2) national biosecurity strategy; 3) preparedness, anticipatory action and response for food chain emergencies; 4) capacities in antimicrobial resistance risk management; 5) One Health systems at regional, national and global levels
- ***NSP's plant health contributing One Health with three key components:*** Harmonized phytosanitary measures, effective IPM, and sound pesticide management with support of seed health, soil health and pollinator health

2. Strategy for Mitigation: ***Mainstream optimization and minimization*** (2/5)

- *Narrative:* Sustainable plant pest management system should be developed and adopted by using a holistic approach **through Optimization and Minimization**
- *Optimization for the positive aspects of plant management system being:* **more diversified** in structure; **more harmonious** in function; and **more resilient** to stress
- *Minimization of the negative aspects of plant pest management system with:* **less loss** of crop yield and biodiversity; **less residue of chemical** pesticides **in food; less harmful effects** of chemical pesticides in environment



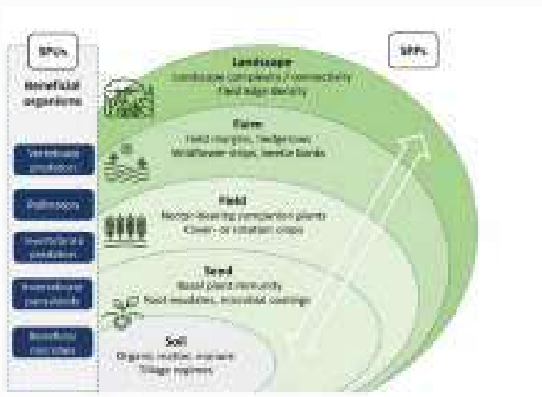
2. Strategy for Mitigation: ***Adapt Climate-smart pest mgt. system*** *(3/5)*

- ***Concept of Climate-smart pest management (CSPM):*** A cross-sectoral approach is to intensity per unit of food produced and strengthen the resilience of agricultural systems in the face of climate change by reducing pest-induced crop losses, enhancing ecosystem services, and decreasing the greenhouse gas emission
- ***Key features of CSPM:*** **More** efficient, **more** inclusive and **more** resilient with **low** yield loss, **low** agri-input, and **low** carbon emission

Climate-smart pest management toolbox: examples of underlying approaches (Luca Heeb et al, 2019; J. Pest Science)

2. Strategy for Mitigation: ***Innovate climate-smart pest mgt. technology*** *(4/5)*

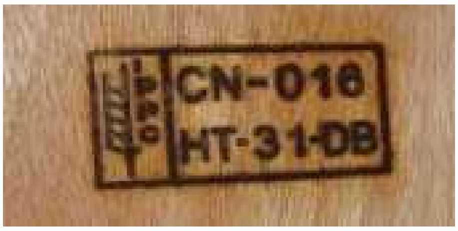
- ***Precision pest forecasting:*** Mitigate climate effect on all components using digital technology, e.g., field data collection, data analyzing, and prediction models
- ***Bio-ecological-based pest management:*** Fortify natural tri-trophic defenses by optimizing the functions of various beneficial organisms in the ecosystem, e.g., beneficial microbes in the soil and plants, parasitoids and predators, and pollinators
- ***Rationalization of pesticide application:*** Adhere to the use of economic thresholds, biocontrol, and precision application of pesticides



Wyckhuys et al., 2022. Current Opinion in Environmental Sustainability

2. Strategy for Mitigation: **Develop enablers for climate-smart pest mgt.** (5/5)

- ***Policies:*** Promote cooperation among various stakeholder; support technical synergy among various disciplines; provide incentive support
- ***Regulation*:** Registration of bio-pesticides and other non-chemical pesticides
- ***Standards:*** ISPMs of IPPC; Pesticide Residues of FAO; PIC Procedures of Rotterdam Convention



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CERTIFIED
PESTICIDE RESIDUE FREE

3. FAO Action on Mitigation: **IPPC work on climate change** (1/5)

- ***IPPC Strategic Framework 2020-30:*** One of eight development agenda "Assessment and management of climate change impacts on plant health" (#6)
- ***CPM FG-CCPI (Climate Change and Photosanitary Issues) Action Plan 2022-25:*** Raising awareness of climate change effects on plant health; Enhancing evaluation and management of climate change risks to plant health; Increasing recognition of phytosanitary matters in international climate change discussions
- ***Legacy of IYPH (2020):*** The scientific review assesses the potential effects of climate change on plant pests and consequently on plant health

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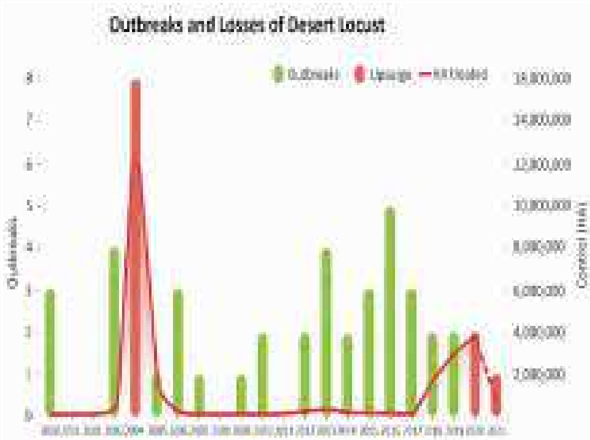
3. FAO Action on Mitigation: ***End of desert locust crisis (2019-22)*** *(2/5)*

Breaking News: The end of the Desert Locust Crisis in the Horn of Africa and Yemen was announced in 2022

DL upsurge in HoA and Yemen declined:

- **5.7 Ha** controlled;
- **USD 243** million mobilized
- **1.4 million tones** crop losses saved for securing food for over **13 million** people



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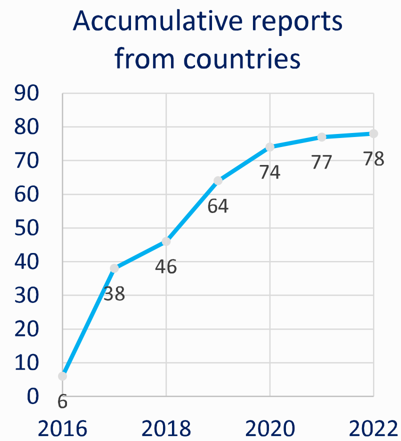
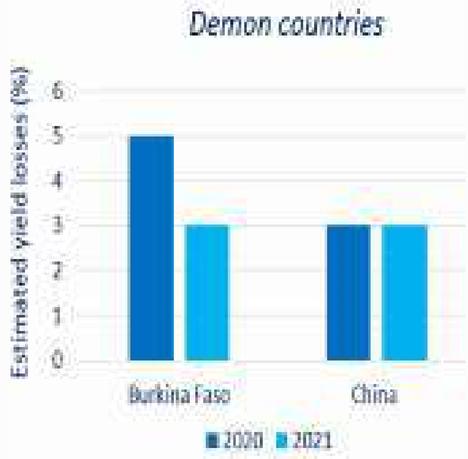
3. FAO Action on Mitigation: ***Global action on FAW control (2019-23)*** *(3/5)*

One of fastest migratory plant insect pests in history



Coordination, IPM and Prevention (Launched in 2019)



3. FAO Action on Mitigation: **Global programme on TR4 control** (4/5)

- ***Situation:*** Present in over 20 countries in Asia & Pacific (Australia), Near East (Jordan), Africa (Mozambique), and Latin America & the Caribbean (Colombia)
- ***Damage:*** Cause 100% loss, with 100,000 ha abandoned for production; By 2040, TR4 has potential to spread to 17% of current banana area producing fruits worth $10 billion
- ***Action:*** FAO TR4 Network (EST); Technical Working Group (NSP); Diagnostic, Surveillance and Prevention (IPPC)

3. FAO Action on Mitigation: ***Sound pesticide management*** (5/5)

- ***Enhancing*** national capacity of sustainable pesticide management through their lifecycle to minimize risks to human health and the environment
- ***Promoting*** biopesticides and IPM to reducing reliance on chemical pesticide use
- ***Protecting*** pollinators from pesticides and mainstreaming biodiversity in agriculture

Pesticide lifecycle management approach

4. The Way Forward: ***Awareness raising*** (1/4)

- ***Milestone events:*** First-ever IYPH (2020-21); first-ever IDPH (12 May 2022); first-ever IPHC (21-23 September 2022)
- ***Awareness-raising***: Importance of plant health and its contribution to supporting UN SDGs
- ***Consensus-reached***: Impact of climate change on plant health and strategies for its mitigation
- ***Active communication:*** Policy dialogues; Technical forum; Stakeholders conference; Farmers field day
- ***Inclusive outreach:*** Website; Social media; Newspapers; Press releases; Newsletters; Posters

4. *The Way Forward:* ***Technical innovation*** *(2/4)*

- ***Green innovation for plant health management***
  - **Targets:** Low yield loss; Low GHG emission; Low agriculture input
  - **Technologies:** Bio-ecological based
- ***Digital innovation for plant health management***
  - **Precision monitoring and forecasting** e.g. remote sensing
  - **Precision application of pesticides** e.g. drones
  - **Efficient and safe trade** e.g. IPPC-ePhyto solution

ePhyto
Improving Safe Trade in Plant and Plant Products

Currently electronic exchange between **70+** countries makes trade safer, faster and cheaper while preventing spread of pests and diseases and protecting the ecosystems with average number of **50 000** ePhytos per month.

5. *The Way Forward:* ***Enabling environment*** *(3/4)*

- *Incentivize* **the use of sustainable pest management** techniques and technologies
- ***Remove*** **perverse incentives** that perpetuate reliance on harmful pest control technologies
- ***Strengthen*** **extension and advisory systems** in rural areas
- ***Develop*** capacities for **pesticide risk assessment and registration**

5. The Way Forward: **International cooperation** (4/4)

- ***Strengthen FAO regional and global commissions, conventions and platforms:*** Serve as a linkage between Advanced Research Institutions with National Research Institutions; Research with Advisory/Training; Regulatory Institutions with Public and Private Sector institutions
- ***Strengthen cross-sectoral collaboration:*** Collaboration with actors in environmental conservation and international trade
- ***Strengthen technical network/platform:*** Pest monitoring; global actions (initiatives and programmes), and technical working groups

Acknowledgments

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NSPRD: *Gerold Wyrwal*

NSPDO: *Haekoo Kim; Hafiz Muminjanov*

FAW Secretariat: *Buyung Hadi; Maged El-Kahky; Kris Wyckhuys*

IPPC Secretariat: *Osama ElLissy; Arop Deng; Zdravka Dimitrova*

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Department for Environment Food & Rural Affairs

Plant Health and Climate Change

London, 21 - 23 September 2022

International Plant Health Conference

USDA APHS Plant Protection and Quarantine Climate Change Response

USDA APHIS PPQ , USDA APHIS PPQ, Bugwood.org

Climate Change Effects on Plant Pests

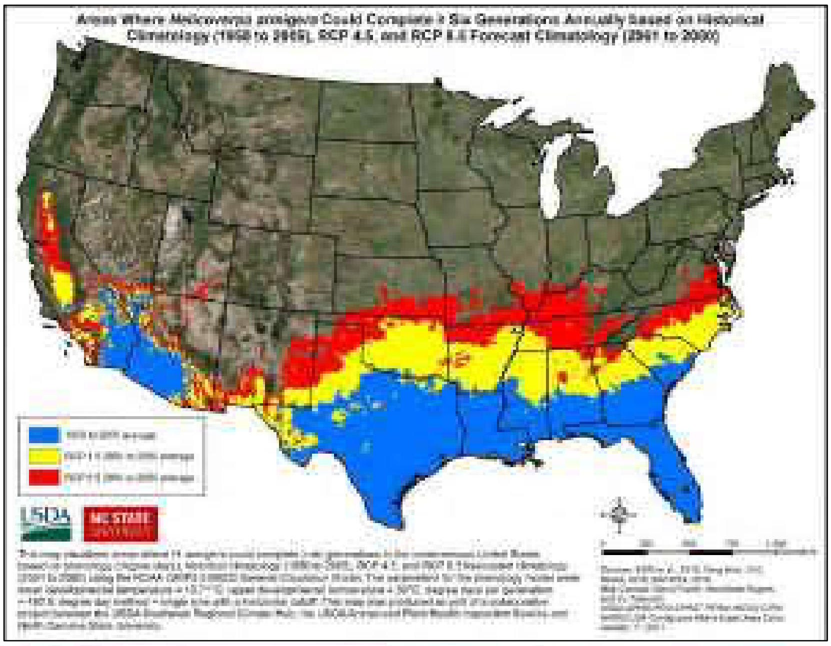
Kerry Britton, USDA Forest Service, Bugwood.org

Better Pest Forecasting to Address Changes in Pest Risk

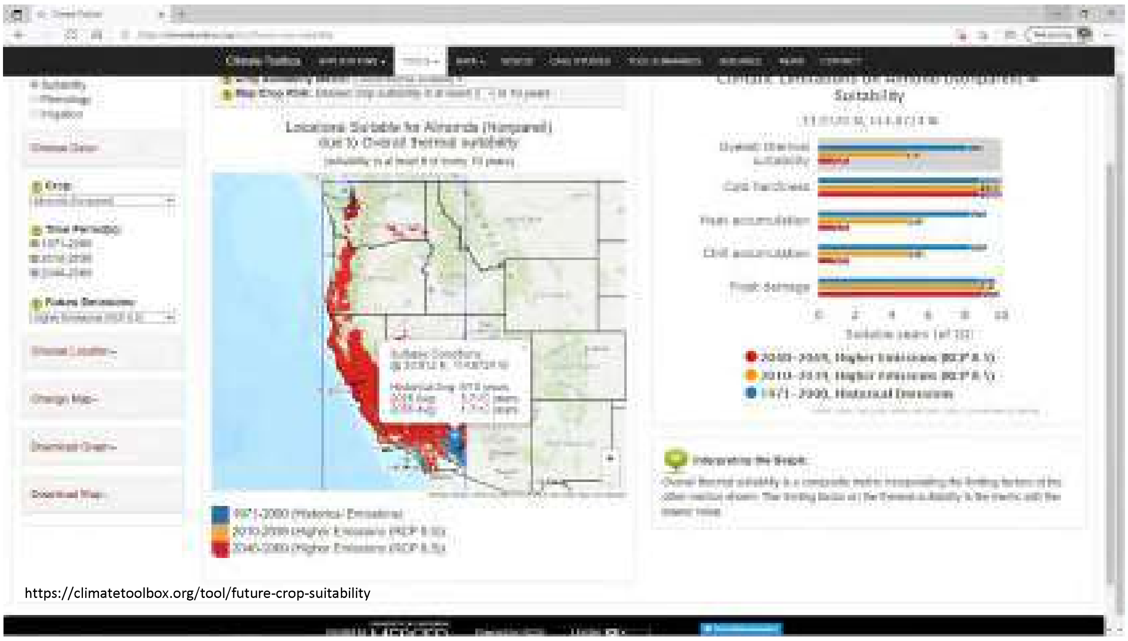
Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org

Spatial Analytic Framework for Advanced Risk Information Systems (SAFARIS)

Climate Change Forecasts



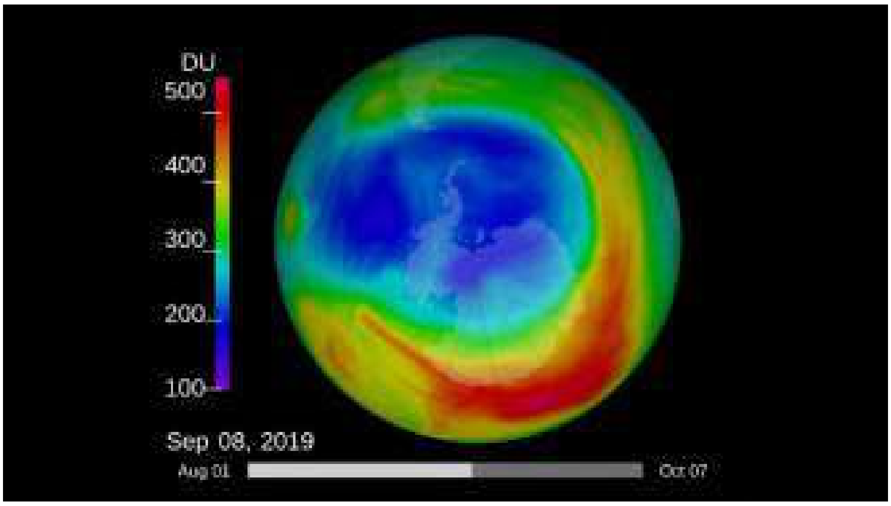
Potential Climate Change Forecasts Applications



https://climatetoolbox.org/tool/future-crop-suitability

Working to Reduce Methyl Bromide Use with Climate Friendly Alternatives

Scott Myers, Forest Pest Methods Laboratory



The 2019 ozone hole reached a peak extent of 6.3 million square miles on Sept. 8, 2019, the lowest maximum observed in 40 years of record. This NASA visualization depicts ozone concentrations on Sept. 8 in Dobson Units, the standard measure for stratospheric ozone. Credit: Katy Mersmann/NASA Goddard

Vacuum Steam Treatment of Hardwoods

Source: Mack (2021)

Phytosanitary Irradiation

Small canister X-ray irradiator Sources: Jeffers (2021a,b, 2022)

Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Reducing Unnecessary Treatments with Molecular Diagnostics

Real-Time PCR Detection System

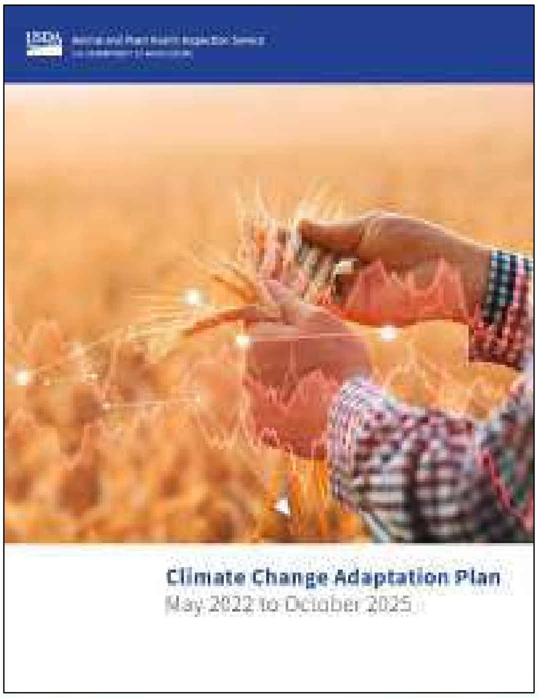
Central Science Laboratory, Harpenden, British Crown, Bugwood.org

Bruce Watt, University of Maine, Bugwood.org

Sources: Ruiz-Arce and Farris (2021), Farris (2021)

Reducing Unnecessary Treatments with Risk Analysis

Communication and Collaboration



International Efforts

Summary and Conclusions

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- ✓ Deirdra Chester
- ✓ Ernie Hain

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London, 21 – 23 September 2022

International Plant Health Conference

Thank you

Glenn Fowler
Risk Analyst, USDA, APHIS, PPQ

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II Plenary Session

Climate Change and the Impacts on Plant Health

Pacific Plant Protection Organisation (PPPO)

London, 21 - 23 September 2022

International Plant Health Conference

PACIFIC PLANT PROTECTION ORGANISTION REGION (PPPO)

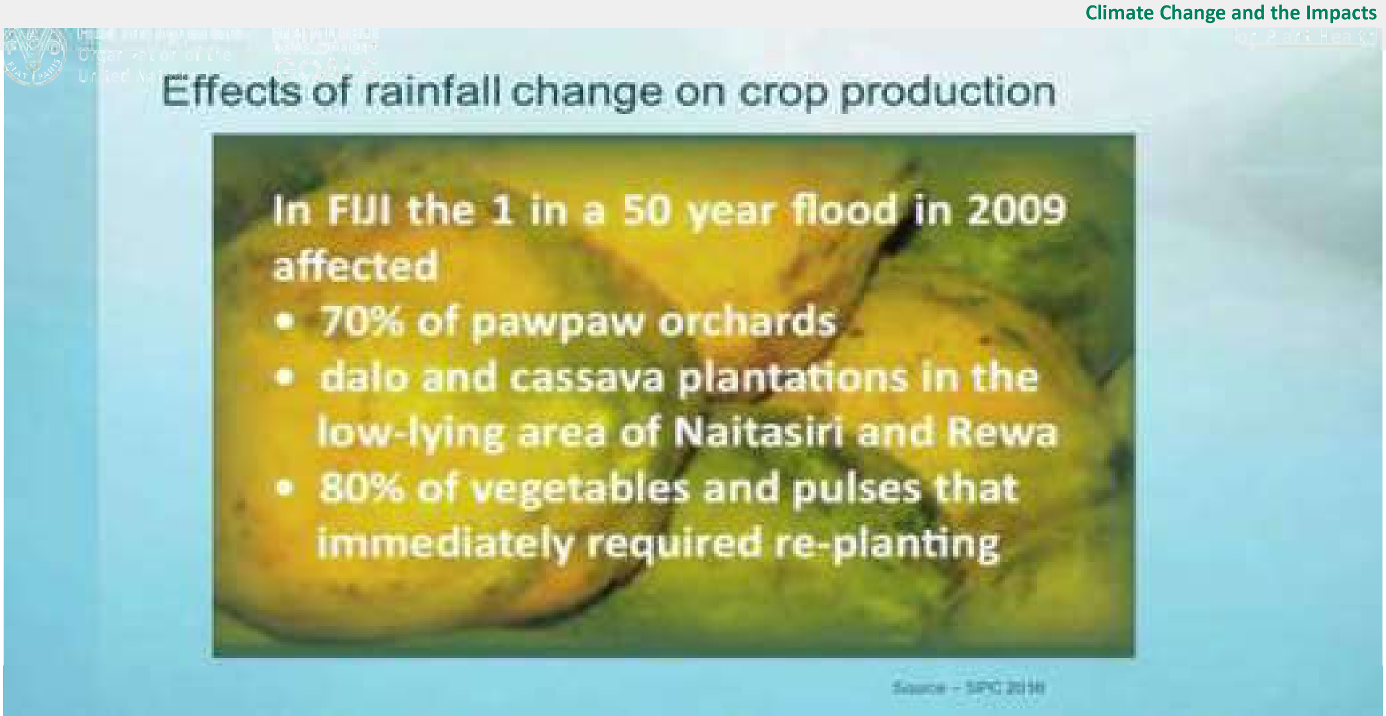
- Southwest Pacific comprises of 22 Pacific Island countries and territories scattered over 40 million sq kms ocean.
- Populations range from 1400 – Tokelau to 25 million plus - Australia.
- Areas range from 10 sq km (Tokelau) to 7.7 million sq km Australia.
- Over 50 languages + 200 dialects.
- Grouped 3 sub regions - Melanesia, Micronesia, Polynesia regions

Climate Change in the PPPO region

- El nino – Prolonged droughts
- Heavy Rainfall – Floods

Impacts

- Stressed plants
- Major Pest outbreaks – due to reduced population/absence of natural enemies
- Huge decline in agricultural production
- Huge decline in fresh produce exports



Example of a disrupted ecology in Fiji

- "2016 Fiji Ant-Mealybug Bioinvasion" (Thaman 2018)
- Not likely a new invasion (too widespread over a sudden time period)
- Likely driven by extreme weather event, Cyclone Winston
- Cyclone caused biological control insects to decline → "Enemy release" enabled sap-sucking insect outbreak → More resources led to outbreak of white-footed ants

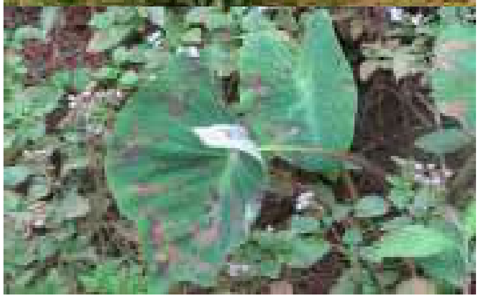
White-footed ants. Image ©Mario David Bazan, CCL

Cont'd

- Outbreak of more than 20 sap-sucking insect species
- Affected 292 plant species including crops, ornamentals and native plants
- Likely to see more examples like this due to climate change with more extreme adverse weather events

Taro leaf blight in Papua New Guinea (PNG)

- Taro leaf blight caused by *Phytophthora colocasiae* was introduced in PNG during the 2nd World War on Bougainville in the 1940s.
- It spread to the mainland PNG in early 1979 It then spread to other parts of the coastal areas of the country.
- The disease has not been recorded in the central highlands region with cool, temperate-like weather conditions.
- The first record of TLB in the highlands was on wild taro at Kuk Agricultural Research Station in Western Highlands Province in 1986.
- The spread of TLB and the increased in commercial taro cultivation in the highlands region since the mid-1990s is attributed to change of climate in the highlands of PNG.



A taro leaf plant severely infected by TLB fungus and severe shot-hole symptoms.

Banana Associated Wilt Phytoplasma in PNG

- Banana Wilt Associated Phytoplasma (BWAP) is a phytoplasma disease. It was first observed on Buka Island of Bougainville in 2006.
- In 2009 field samples were collected from banana pseudo stem tissues in Madang Province.
- The disease mainly affects a particular the local cooking banana variety of the ABB genome.
- Initially, the disease was confined to hot and humid weather conditions in the coastal provinces of PNG.
- The disease in recent years seem to have spread into areas bordering the coastal and highland provinces most likely due to the impact of climate change.

Disease causes yellowing and browning of leaves and eventually the whole plant dies. Affected plants do not bear normal size fruits.

How is climate change affecting Nauru?

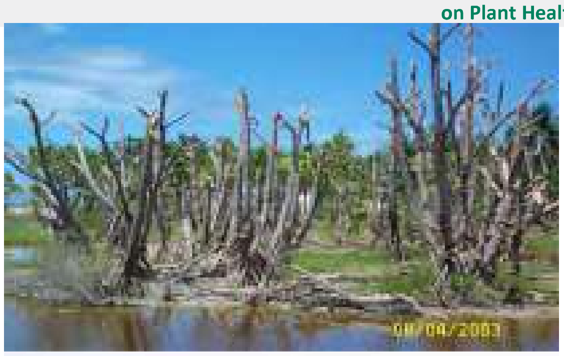
- Sea-level rising – With only one island to occupy the 11,000 occupants we have seen the many residential areas on the fringe of the island been affect. Houses are torn apart due to the water intrusion

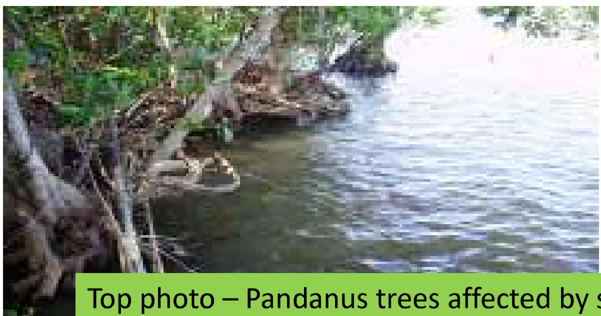
- Sea-level rising also affects the water security of people, especially those living at the low-lying areas, saltwater intrusion have caused problems with drinking water

- Ocean acidification also affects the food security of the people of Nauru, most people rely heavily on the ocean for food. With the warming of the ocean causing less fish, coral bleaching limiting the Nauruan people access to food

Saltwater intrusion

- Although the Pacific Islands have done little to contribute to global warming, they are facing some of the most dire consequences of rising seas.
- Intrusion of seawater threatens biodiversity along with crop yields

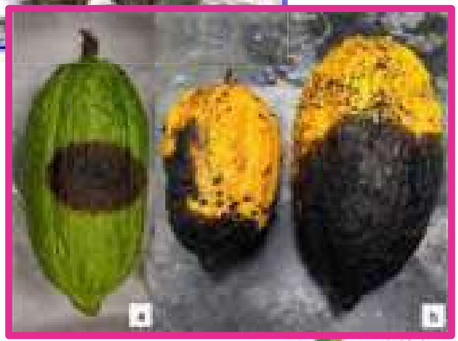




Top photo – Pandanus trees affected by sea water in Kiribati
Bottom photo's – Taro farm affected by sea water in Chuuk, FSM

Prolong wet seasons

- **Prolong wet seasons contributes to the spread of black pods in Cacao.**
- **Black pod is caused by a fungus (Phytophthora) that spreads rapidly on the pods under conditions of excessive rain and humidity, insufficient sunshine, and temperatures below 21 °C.**
- **Phytophthora spp**. are responsible for pod loss of 20 to 30% of the total cacao crop annually, in Fiji.



Global warming

- Increased temperatures have impact on a crop's optimal growth period. While some crops may show increased yields, most food crops will experience negative effects on the amount and quality of yields.
- In Tuvalu, a breadfruit variety is fruiting almost year around compared to the usual seasonal fruiting, thus ensuring the continuous supply of food that is high in complex carbohydrates, low in fat, and cholesterol and gluten free.

Some impacts of Climate change on crops in the Pacific

On atolls

- More frequent extreme weather events → tidal waves, seawater inundation and rising water table → direct crop loss, soil salination, reduced agricultural land, loss of freshwater reserves

On high islands

- More frequent extreme weather events → direct crop damage, landslides lead to soil erosion, reduced agricultural land, leaching and tree cover loss increasing susceptibility to weeds

All islands

- Increased habitat for pest insects, ecological changes causing pest outbreaks
- More frequent droughts
- Sea level rise

Climate Change

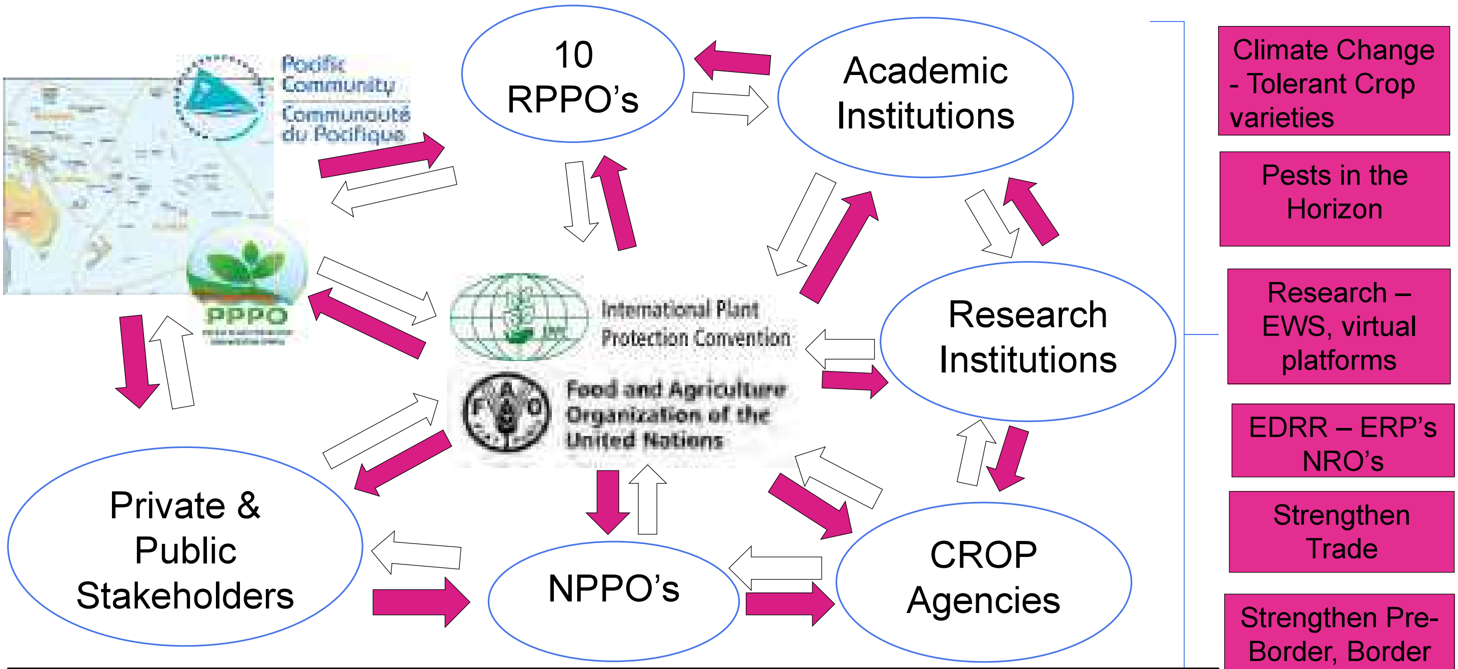
Along with the Pacific region, Australia is on the front line of climate change impacts.

Through the NPPO (Australian Government Department of Agriculture, Fisheries and Forestry - DAFF), Australia is working to use science and innovation to support climate change preparedness and recovery.

The department has a number of initiatives such as;

- **The National Environmental Science Program (NESP) - National Environmental Science Program | Department of Agriculture, Fisheries and Forestry**
- **Agriculture Biodiversity Stewardship program - Agriculture Stewardship Package - Department of Agriculture**
- **National Landcare and regional Land Partnerships programs - National Landcare Program - Department of Agriculture**

Connected, Informed & Prepared – Leaving no one behind



CPM Recommendation: Safe Provision of food and other aid to prevent the introduction of plant pests during an emergency situation (2018-026)

SAFE FOOD AID – FACT SHEETS

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Department for Environment Food & Rural Affairs

London, 21 – 23 September 2022

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THANK YOU

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PACIFIC PLANT PROTECTION ORGANIZATION (PPPO)

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International Plant Protection Convention

Department for Environment Food & Rural Affairs

Coordinating Climate Change and Phytosanitary Issues at a Global Level

CPM Focus Group on Climate Change and Phytosanitary Issues

London, 21 - 23 September 2022

International Plant Health Conference

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Climate Change Impacts on Plant Health 'A Global Issue'

- Available science suggests that **climate change has a significant impact on plant health**, through the actual and potential expansion of pest distribution and intensity, and changes in pest epidemiology and life cycle.
- **Mitigation of these impacts** will present a major challenge to the national, regional and international plant protection organizations.

Climate Change and Phytosanitary Issues 'A Global Opportunity'

- The International Plant Protection Convention (IPPC) Strategic Framework 2020-2030 includes the ***"Assessment and management of climate change impacts on plant health"*** as one the eight development agenda items to be addressed by the global plant health community over the current decade.
- Strategic Framework for the International Plant Protection Convention (IPPC) 2020–2030: https://www.fao.org/3/cb3995en/cb3995en.pdf

IPPC Development Agenda Item
Strategic Framework 2020-2023

Assessment and management of climate change impacts on plant health

GOAL

By 2030, the **impacts of climate change on plant health** and the safe trade of plants and plant products are evaluated, especially in relation to pest risk assessment and pest risk management issues, and phytosanitary issues are represented and highlighted within the international climate change debate.

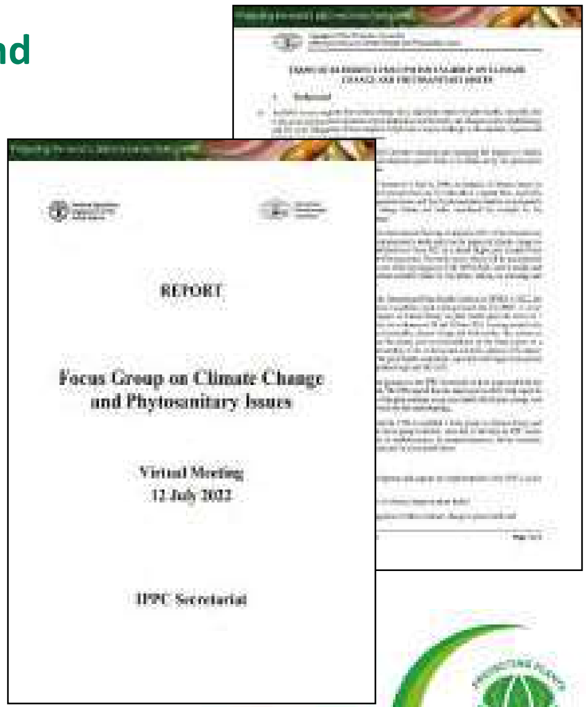
CPM Focus Group on Climate Change and Phytosanitary Issues (FG-CCPI)

- The Commission on Phytosanitary Measures (CPM) **Focus Group on Climate Change and Phytosanitary Issues** (FG-CCPI) was formally endorsed by the CPM Bureau in July 2021 and became active in September 2021.

- The primary role of the FG-CCPI will be to support the implementation and delivery of the IPPC's 'Action Plan on Climate Change Impacts on Plant Health' over the 2022-2025 period.

CPM Focus Group on Climate Change and Phytosanitary Issues (FG-CCPI)

- The Focus Group is composed of ten members with regional representation and specialized skills and experience in climate change and phytosanitary issues, and knowledge of the IPPC and its activities.
- The Focus group meets on a monthly basis to coordinate the delivery of the FG-CCPI Action Plan and develop key materials and resources to support the Action Plan.
- The Focus Group will remain effective until CPM-19 (2025), and the composition of the focus group is presented in: https://www.ippc.int/en/publications/90486/.



FG-CCPI Key Outcomes and Core Action Areas

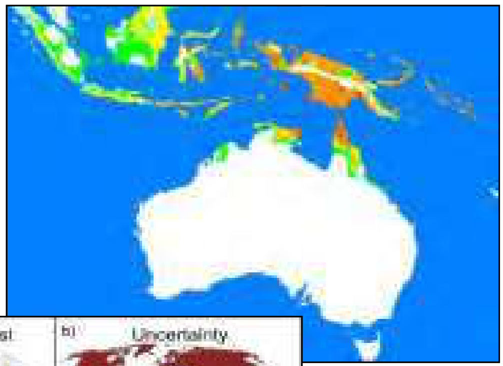
Outcome 1:

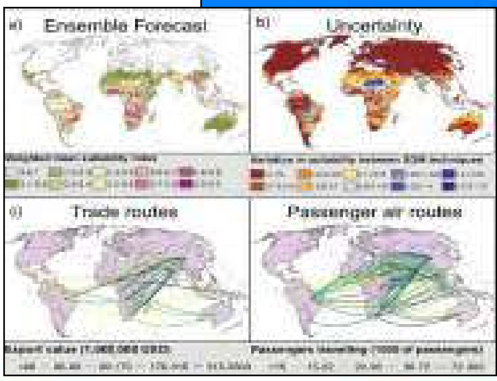
Raising awareness of the impacts of climate change on plant health

Core action areas:

- Convene and participate in meetings and side events related to the impacts of climate change on plant health.
- Facilitate discussions within IPPC subsidiary bodies, regional workshops as well as other IPPC technical groups.
- Assist Contracting Parties (CPs) to meet their National Reporting Obligations (NRO)established by IPPC.

FG-CCPI Key Outcomes and Core Action Areas





Outcome 2:

Enhancing the evaluation and management of risks of climate change to plant health

Core action areas:

- Support countries to collect, analyse and use climate change impacts-related information in decision-making
- Support countries in building capacity to help mitigate the impacts of climate change on plant health

FG-CCPI Key Outcomes and Core Action Areas

Outcome 3:

Enhancing the recognition of phytosanitary matters in the international climate change debate

Core action areas:

- Strengthen collaboration with relevant international, regional and national organizations
- Facilitate, promote and support phytosanitary issues - related policy dialogue at the global level

FG-CCPI Action Plan Priorities 2022-2023

1. Raising awareness of the impacts of climate change on plant health through increasing CPM wide understanding of how climate change may increase of the potential movement and spread of pests through **webinars and special sessions** involving CPM, RPPOs and NPPOs.

CPM Focus Group on Climate Change and Phytosanitary Issues (FG-CPPI)

FG-CCPI Action Plan Priorities 2022-2023

2. Exploring opportunities to **enhance IPPC National and Regional reporting systems** to **identify and share climate change information** relating to changes in pest distributions, host range, and adaptability of pests and host plants.

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FG-CCPI Action Plan Priorities 2022-2023

3. Developing a **'Climate Change Impacts on Plant Health' webpage** on the IPP as a repository of all FG-CCPI related materials and resources.

FG-CCPI Action Plan Priorities 2022-2023

4. Enhancing the evaluation and management of risks of climate change to plant health to incorporate climate change factors into the traditional Pest Risk Analysis (PRA) processes and investigating opportunities to incorporate climate change considerations in existing pest surveillance systems and practices.

FG-CCPI Action Plan Priorities 2022-2023

5. **Developing an IPPC Guide** to assist NPPOs in identifying, assessing, mitigating and managing climate change impacts on plant health.

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Thank You

Dr Gabrielle Vivien Smith
Australian Chief Plant Protection Officer

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Biodiversity and genetic resources for food and agriculture

Irene Hoffmann, Secretary, Commission on Genetic Resources for Food and Agriculture

Regulatory Symposium : Addressing climate change and biodiversity issues in plant health policies

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Content

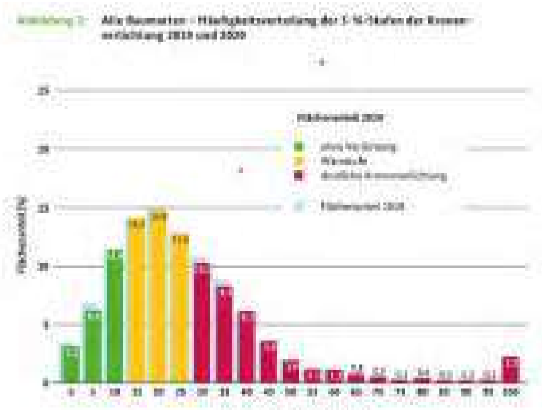
Climate change

Policy areas

- Pesticides
- Invasive alien species (IAS)
- Access and benefit sharing (ABS) / Digital sequence information (DSI)

Climate change, biodiversity and plant health

- CO_2 fertilization vs nutrient and water availability, N-fixation, Increased heterogeneity of nutrient supply
- Yield loss, reduced quality (protein, micro-nutrients)
- Geographical distribution range shifts of plants, animals and pests/pathogens (and pesticides)
- Changes to seasonal phenology, population dynamics and ecosystem function
- Higher movement and establishment of invasive species (+globalization, trade and travel)
- Longer growing seasons, more P&P generations
- Modified ecotoxicological potency of pesticides
- Food safety, e.g. aflatoxins, deoxynivalenol (DON)



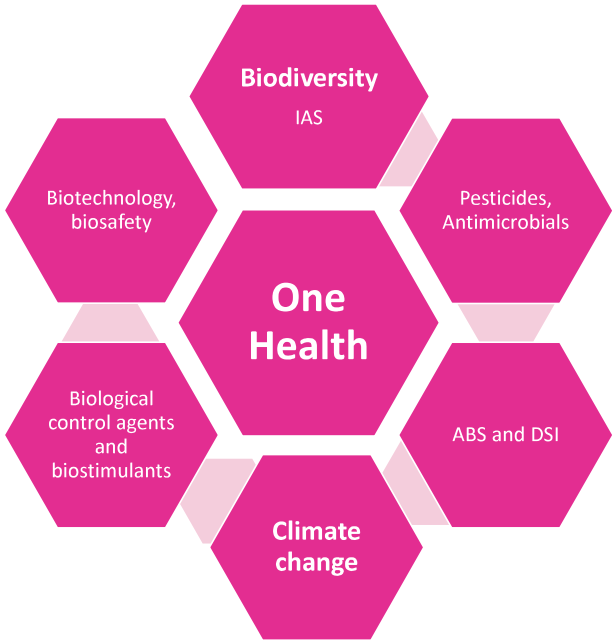
Main drivers of loss of biodiversity in production landscapes

1. habitat loss and conversion to intensive agriculture (field size, landscape heterogeneity)
2. *pollution, mainly by synthetic pesticides and fertilizers*
3. *biological factors, including pathogens and introduced species*
4. climate change

(Sanchez-Bayo and Wyckhuys 2019; FAO 2019)

Policy areas for plant health vis-à-vis biodiversity and climate change

Maintaining **ecosystem services** is **key to protecting plant health**, sustaining the environment and ensuring food security



Multi-sectoral and **multidisciplinary** approaches

Practices

General

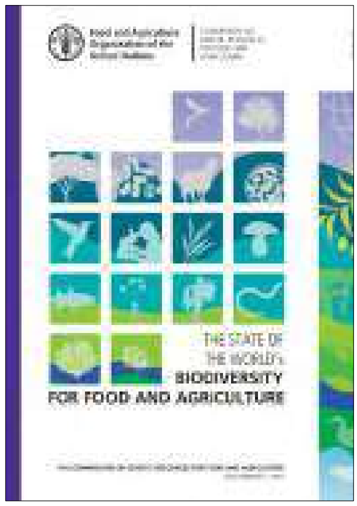
- Biodiversity friendly practices, e.g. Biological control, agroecology
- Replace external inputs by supporting ecosystem services
- Esp. in forestry and aquatic: managed and unmanaged ecosystems

Emerging P&P

- Prevent invasion
- Contain P&Ps based on the knowledge of the biology of the P&P

Chronical, endemic P&P

- Breeding of resistant varieties
- Management strategies that include (below-ground, endophytic) microbiota



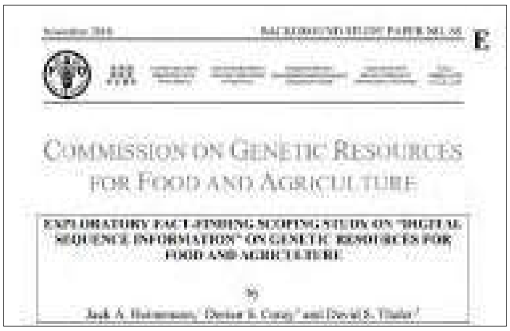
Breeding

Climate change increases the interdependency of countries for GRFA, including BCAs

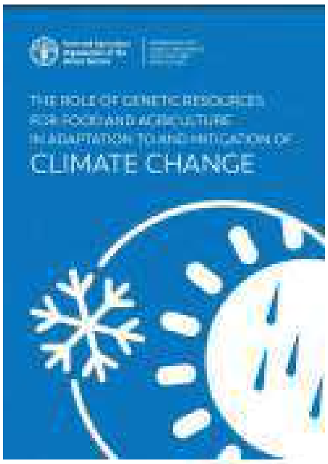
Climate adaptation and disease resistance breeding (commodity plants)

Genomic tools for characterization and breeding

- Digital sequence information
- CRISPR/CAS gene editing


COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

EXPLORATORY FACT-FINDING SCOPING STUDY ON "DIGITAL SEQUENCE INFORMATION" ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE



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Policy area – ABS and DSI

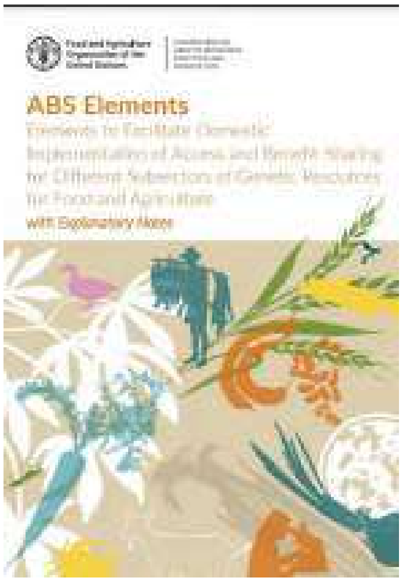
Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the CBD

International Treaty on Plant Genetic Resources for Food and Agriculture

Commission on Genetic Resources for Food and Agriculture

Ongoing negotiations

- UNCLOS BBNJ conservation and sustainable use of biodiversity beyond national jurisdiction - marine genetic resources
- CBD, incl. in the Post-2020 GBF - DSI



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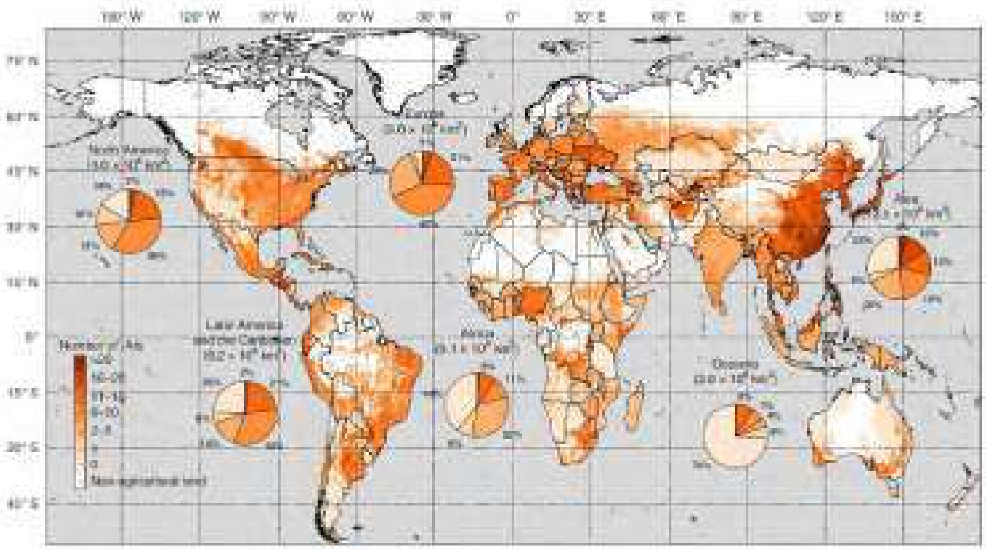
- CBD, incl. in the Post-2020 GBF - DSI

Issues

- how to access these genes or DSI?
- how to share benefits if a product is made from them?
- Is a gene edited organism a GMO?
- Is DSI part or not of a GRFA?

64% of global agricultural land is at risk of pesticide pollution by >1 AI



31% of area at high pollution risk. Of which 34% in high biodiversity regions

Tang et al., 2021

Policy area - Pesticide

Rotterdam Convention

FAO/WHO International Code of Conduct on Pesticide Management, e.g.

- *Guidelines on Highly Hazardous Pesticides 2016*
- *Guidelines on pesticide legislation 2020*
- *Guidance on pesticide licensing schemes 2021*

Codex Alimentarius - Codex Committee on Pesticide Residues (CCPR)

- Maximum Residue Limits (MRLs)

CBD draft Post-2020 GBF contains a target on pollution

Policy area - Pesticide

Rotterdam Convention

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Codex Alimentarius - Codex Committee on Pesticide Residues (CCPR)

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CBD draft Post-2020 GBF contains a target on pollution

Issues

- risk-based assessments
- consider direct and indirect ecosystem impacts
- Consider longer term and accumulative effects, also of herbicides, incl. on aquatic systems
- address HHPs

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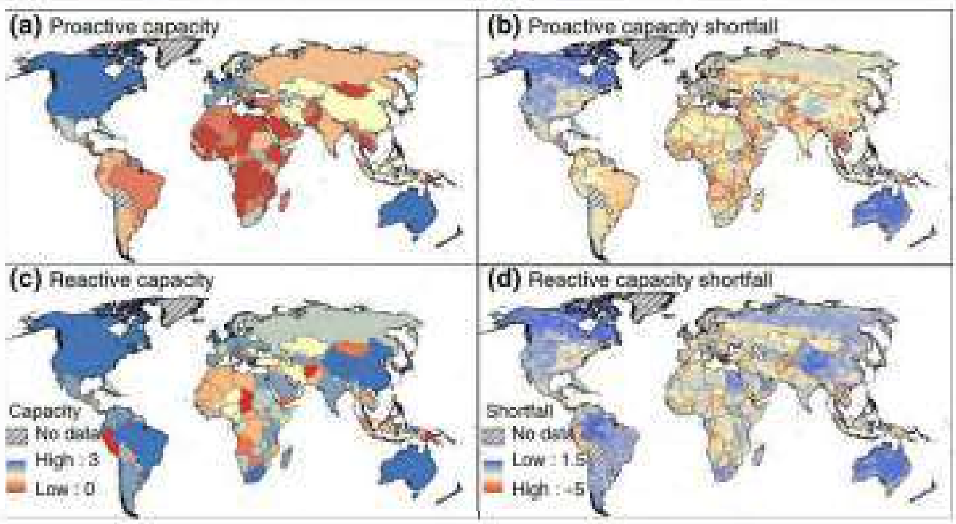
National capacities to respond to IAS threats



Early et al 2016

Intentional introduction of plants

- 46% thru horticulture / nursery trade
- 21% thru agriculture
- 8% thru land reclamation / erosion control

Turbelin et al 2017

Policy area - IAS

IPPC

- ISPMs e.g. sea containers, pallets
- 2020–2030 Strategic Framework

Convention on Biological Diversity

- https://www.cbd.int/invasive/cop-decisions.shtml
- Supplementary Voluntary Guidance for Avoiding Unintentional Introductions of IAS Associated with Trade in Live Organisms 2018

- (Cartagena Protocol on Biosafety (LMOs))

IPBES Invasive alien species assessment 2022

Policy area - IAS

IPPC

- ISPMs e.g. Sea containers, pallets
- 2020–2030 Strategic Framework

Convention on Biological Diversity

- https://www.cbd.int/invasive/cop-decisions.shtml
- Supplementary Voluntary Guidance for Avoiding Unintentional Introductions of IAS Associated with Trade in Live Organisms 2018

- Cartagena Protocol on Biosafety (LMOs)

IPBES Invasive alien species assessment 2022

Issues

- prevent IAS leaving the country
- consider IAS when restoring ecosystems (UN decade on ESR)
- proactive invasion strategies in areas with high poverty levels, high biodiversity and low historical levels of invasion
- post-introduction eradication and control of IAS
- adjustments to plant protection protocols

What needs to be done

R&D

- on plant health and ecosystem management on & beyond the farm and
- on the impact of climate change on P&P (and plant health measures/ pesticides)

Policies

Policy coherence - Link plant health to biodiversity, ag-sector, health and climate policies

invest in strengthening national (phytosanitary) systems

eliminate gaps between international and national regulation

cooperation in: Surveillance, monitoring and information exchange

ecosystemic risk assessment (P&P and pesticides)

consider ABS for GRFA , incl. BCA (+information)

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https://www.fao.org/cgrfa/en/

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Phytosanitary Treatment Standards

Evaluating Phytosanitary Treatments for International Standards

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Technical Panel for Phytosanitary Treatments (TPPT)

- Established to draft ISPMs for phytosanitray treatments IPPC
- Subject matter experts that have been nominated by IPPC contacting parties based on their level of expertise in developing phytosanitary treatments.

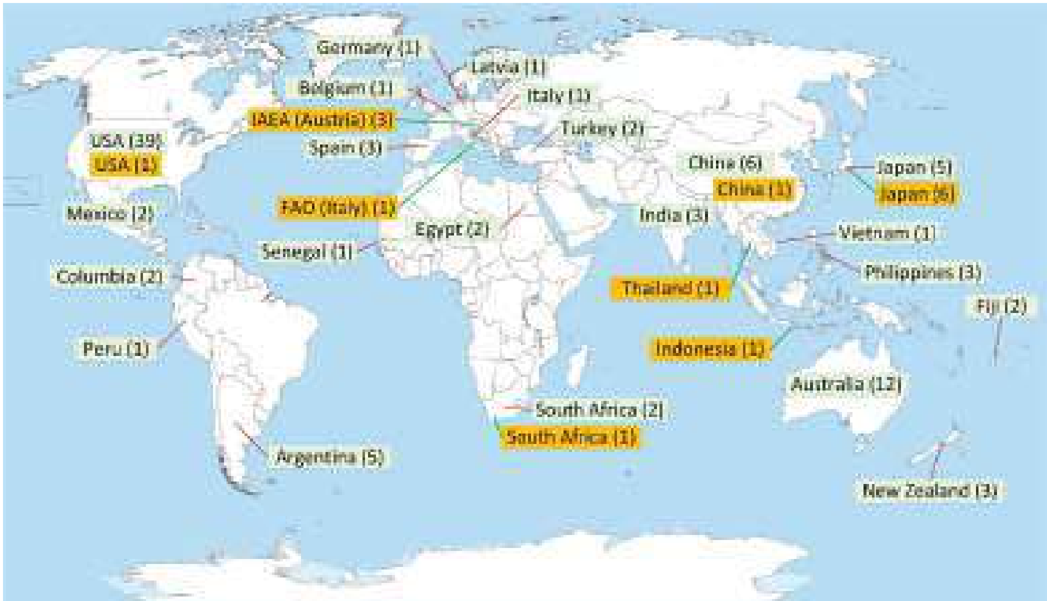
Background

The TPPT first met in 2004, and has since had 15 face-to-face meetings and 42 virtual meetings.

The panel has evaluated 110 submissions made by 22 countries.

(green = submissions)

(orange = meetings)



ISPM 28 for Phytosanitary Treatments

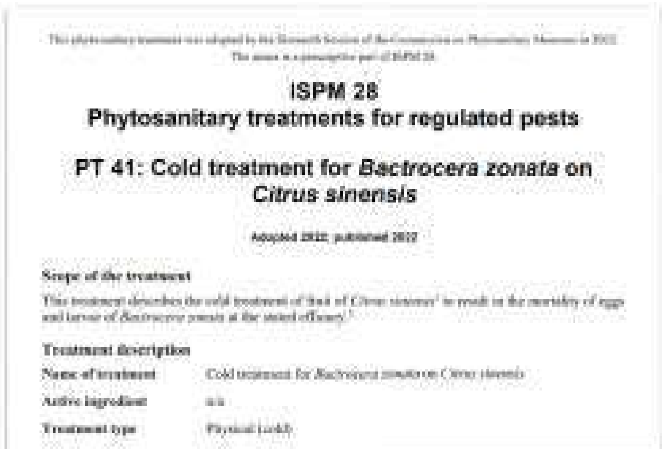
- The TPPT drafted ISPM 28, Phytosanitary treatments for regulated pests.
- This ISPM (ISPM 28) was adopted under the IPPC in 2007 and provides the criteria for PTs
- PTs are annexes to ISPM 28, there are 44 adopted PTs

Treatment Evaluation

The TPPT evaluates treatments against the requirements in ISPM 28.

The Procedure Manual for Standard Setting:

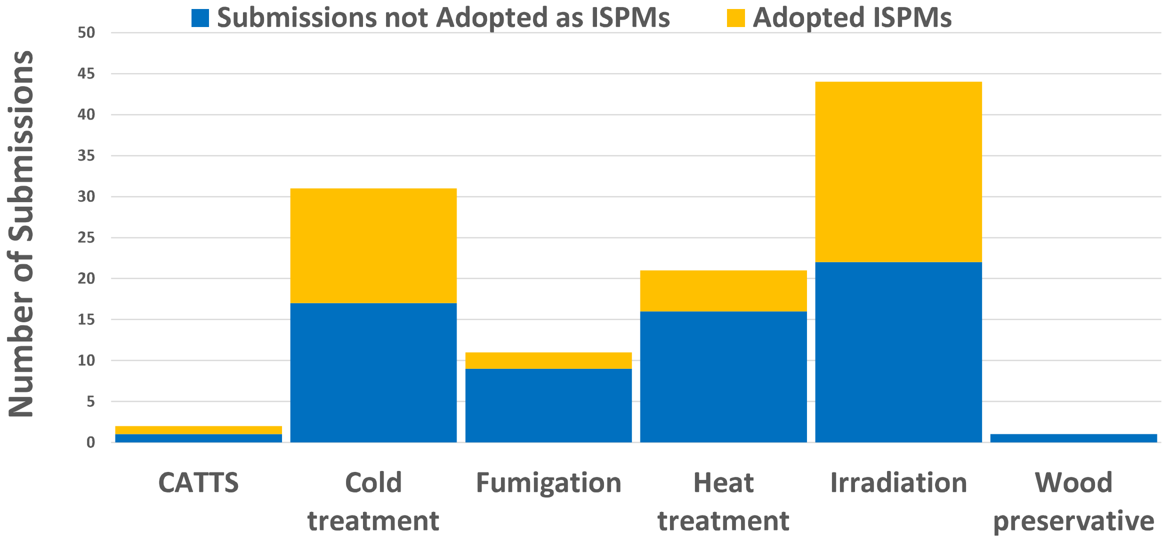
https://www.ippc.int/en/core-activities/ippc-standard-setting-procedure-manual/



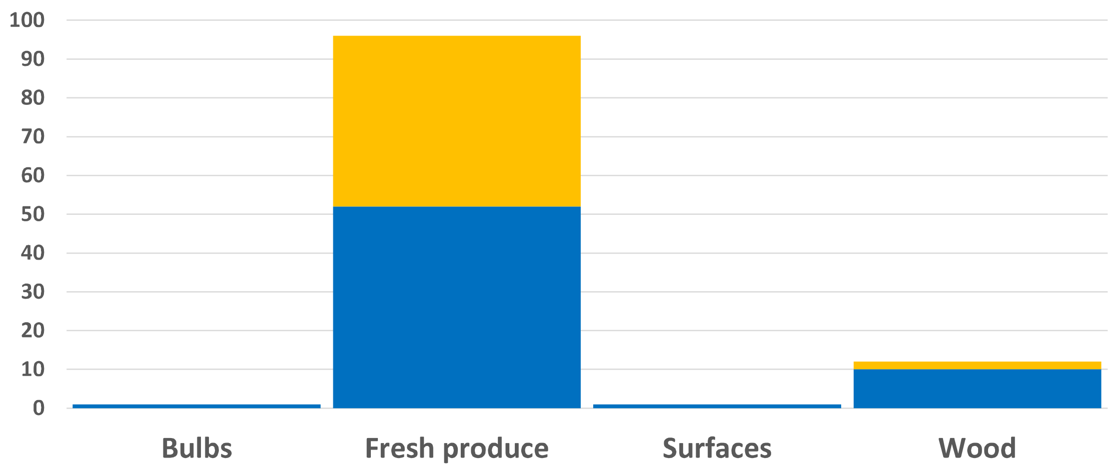
ISPM 28
Phytosanitary treatments for regulated pests

PT 41: Cold treatment for *Bactrocera zonata* on *Citrus sinensis*

TPPT Outputs



TPPT Outputs: Commodity Types



TPPT Drafted Standards

- ISPM 42 - Requirements for the use of temperature treatments as phytosanitary measures
- ISPM 43 - Requirements for the use of fumigation as a phytosanitary measure
- ISPM 44 - Requirements for the use of modified atmosphere treatments as phytosanitary measures

Future Work of the TPPT

- Encourage new high-quality submissions
- 2000+ phytosanitary treatments used in international trade
- NPPOs and RPPOs are encouraged to submit phytosanitary treatments for evaluation

Case Study: Generic Irradiation for Tephritidae

- PT 07 (2009): 150 Gy
- Fast-tracked bilateral negotiations involving PI phytosanitary irradiation.
- ISPM 28 can simplify trade negotiations.
- Australia has negotiated 20+ bilateral protocols.

Case Study: Generic Irradiation for Tephritidae

- A generic treatment provides protection from new incursions.
- Less reliance on industry and NPPOs to fund research.
- Generic treatments will be essential to support the adoption of the **Commodity-specific standards for phytosanitary measures** which is a high priority in the IPPC strategic framework

Proposing New Phytosanitary Treatments

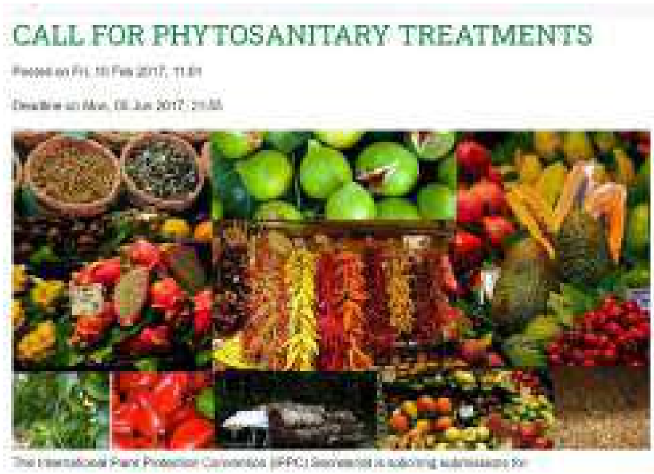
TPPT Drafted Research Guidelines

- Accurate pest identification
- Infestation technique
- Determining endpoint/ measure of mortality
- Most tolerant stage
- Appropriate controls (untreated)
- Number of treated pests: large-scale testing
- Utility of the PT, including commodity quality

A streamlined process for developing PTs – only one consultation if there are no significant concerns

Facilitating New Treatment Submissions

- NPPO and RPPOs can encourage new submissions
- Support researchers submitting new PTs
- IPPC resources
- TPPT support



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Thank you!

Scott Myers

Assistant Director
Forest Pest Methods Laboratory
USDA – Plant Protection and Quarantine – Science & Technology

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Environmental pests – Australian Context

Importance of biodiversity and future approaches to minimise pest risks associated with imported inanimate pathways

Rama Karri - ***Australian Department of Agriculture, Fisheries and Forestry***

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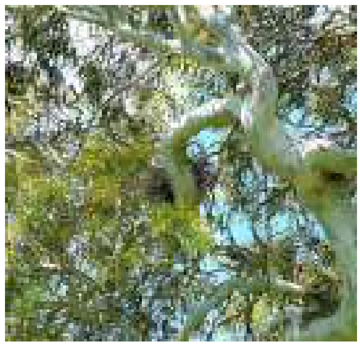
Contents

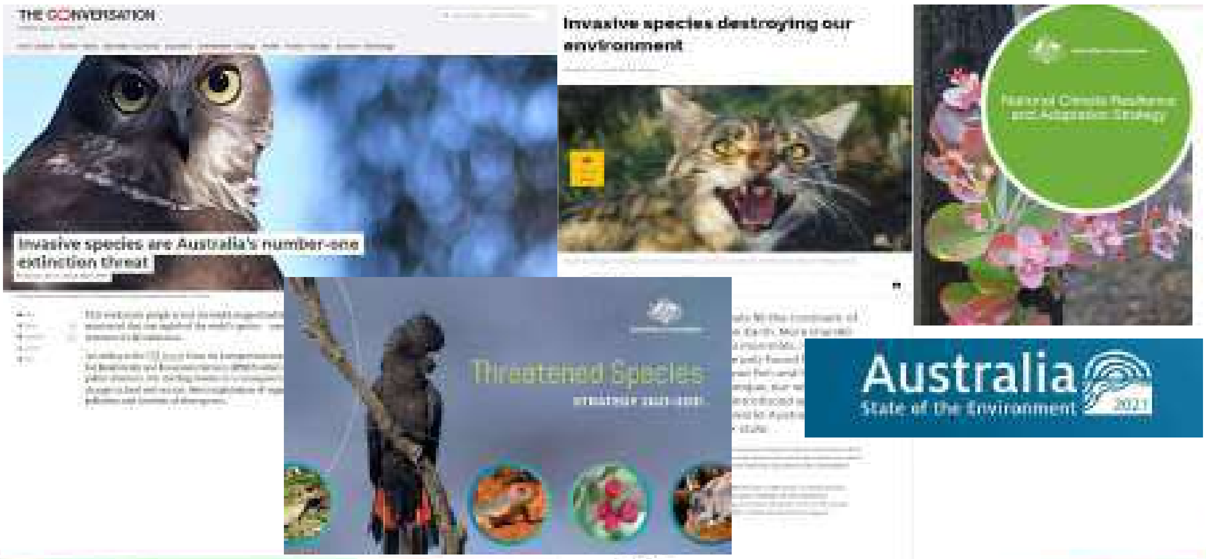
- Importance of biodiversity
- Climate change and invasive species – impacts on biodiversity
- National Priority List of Exotic Environmental Pests, Weeds and Diseases
- Examples of biosecurity issues in Australia
- Biological characteristics of successful hitchhiker pests
- Hitchhiker pest risk assessment – preliminary findings
- Innovative technology trials

Why is biodiversity important to Australia?

- Abundance of **unique biodiversity**
- Home to between **600,000 and 700,000 species**, many of which are found nowhere else in the world.
- About 84% of plants, 83% of mammals, and 45% of birds are **only found in Australia**.



How are climate change and invasive species affecting biodiversity in Australia?



National Priority List of Exotic Environmental Pests, Weeds and Diseases

- **168** pests, weeds and diseases that are considered the greatest biosecurity risks to the Australian environment
- Species must be a risk to one or more of the following:
  - Environment (native species, ecosystems, natural resources etc)
  - Social amenity (recreation opportunities, way of life etc)
- May be a species, set of species or genus-level entries
- Eight biological or ecological groupings – including vertebrates and wildlife diseases

Examples of biosecurity issues in Australia

- Red imported fire ant
- Smooth newt
- Asian black spined toad
- Argentine ant (Norfolk Island)

- Asian honey bee
- Jack Dempsey cichlid
- Emerald furrow bee
- Mexican feathergrass

- Myrtle rust
- Pigeon paramyxovirus
- Red-eared slider turtle
- Yellow crazy ant

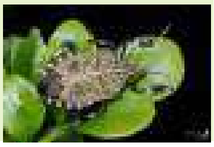
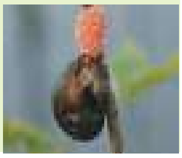
Biological characteristics of successful hitchhikers

1. Entry onto inanimate cargo, shipping containers and/or conveyances
   - ✓Attracted to inanimate goods, conveyance areas, overwintering sites, industrial lights, lays eggs on substrates, areas of refuge etc.

2. Reaching the destination country
   - ✓Survive transport conditions (temperature, humidity)
   - ✓Able to survive periods without food source and/or water
   - ✓Overwinters/Aestivates/Hibernates/Functional diapause etc.
   - ✓Scavengers

3. Ability to distribute and establish
   - ✓Ability to spread to hosts upon arrival
   - ✓Forms aggregations/nests

How many hitchhikers?!

Overwintering	Egg laying	Nesting	Sheltering	Internal
Brown marmorated stink bug Yellow spotted stink bug Western conifer seed bug Green polished stink bug Mottled shield bug Harlequin ladybeetle Seven spotted ladybeetle Asian giant hornet Asian hornet	Spongy moth Nun moth *Hylesia nigricans* Spotted lantern fly Joro spider	Asian honey bee Giant honey bee Dwarf honey bee Red imported fire ant Little fire ant *Nylanderia fulva* Browsing ant Asian needle ant	Giant African snail Korean round snail Golden apple snail Chocolate banded snail White-lip garden snail	Khapra beetle Trogoderma spp.
				

Environmental pests – Australian Context

Hitchhiker functional groups and high-level pathways

Hitchhiker Functional Group	Container external surfaces	Container internal areas	Non-commodity goods
Overwintering pests (stinkbugs, ladybeetles, hornets)			✓
Bees and Ants	✓	✓	✓
Snails	✓		✓
Egg masses (*Lymantria*)	✓		✓
Scavenging Pests (khapra)		✓	✓

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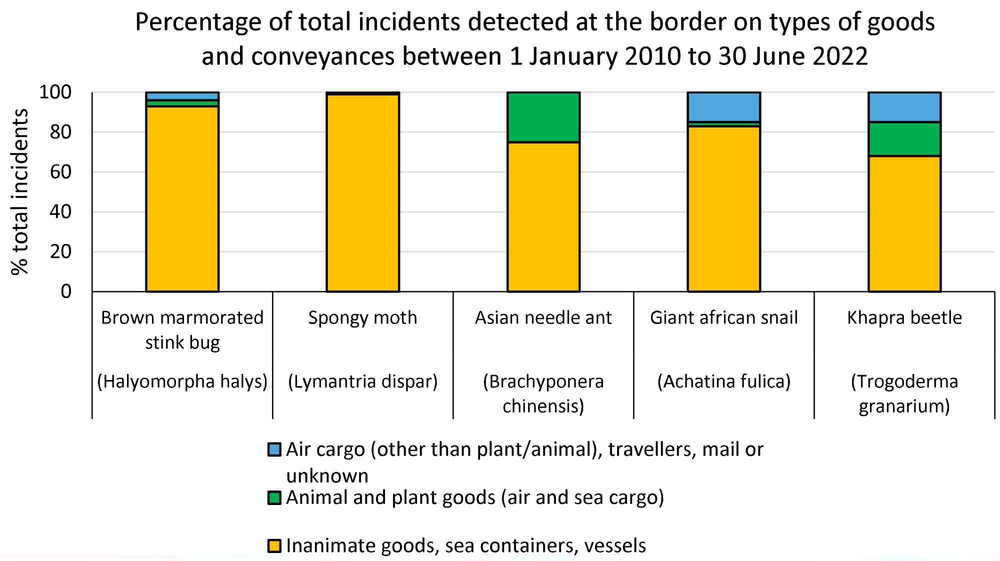
Successful hitchhikers are biologically associated with inanimate pathways



Detection Capability (RingIR)

Pest detection

Phase 1 of this project confirmed that the RingIR technology can detect all 3 fumigants of concern - methyl bromide, sulfuryl fluoride and phosphine.

Phase 2 has commenced and is split into 2 sub-projects.

The first project aimed to develop a portable prototype to detect all 3 fumigants that could be trialed in our operations.

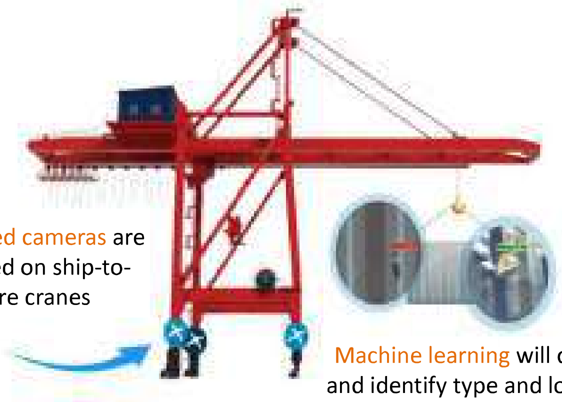
The second project aims to test whether RingIR technology can be expanded to identify hitchhiker pests associated with containers.

Biosecurity Automated Threat Detection System

Trialing a camera system (BATDS) installed on ship-to-shore cranes to improve our surveillance capability at container ports.

The system combines automated cameras and real-time machine learning to scan the external surfaces of sea containers for pests and contaminants as they are discharged from cargo ships.

Early detections of exotic pests at the border provides greater protection and capacity to respond to immediate biosecurity threats.



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Thank you

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Rama Karri
Director, The Australian Department of Agriculture, Fisheries and Forestry

follow
@RJABuggs

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Plant Health, Climate and Biodiversity: Seeking solutions for Ash Trees

Professor Richard Buggs

Royal Botanic Gardens Kew & Queen Mary University of London

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Biodiversity Crisis ↔ Climate Crisis

Biodiversity Crisis ↔ Plant Health Crisis

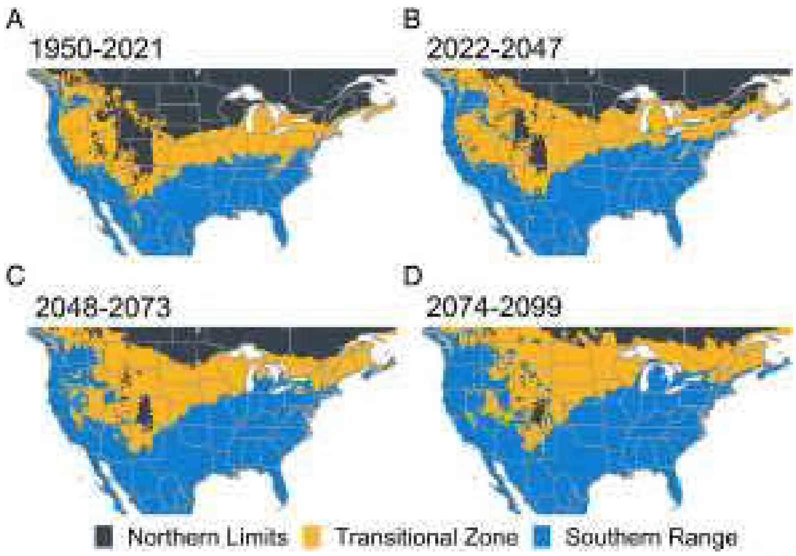
Climate Crisis ↔ Plant Health Crisis

Climate

↕

Plant Health

Corn earworm overwintering zone area 1950-2099



Lawton et al. (2022) PNAS

Climate

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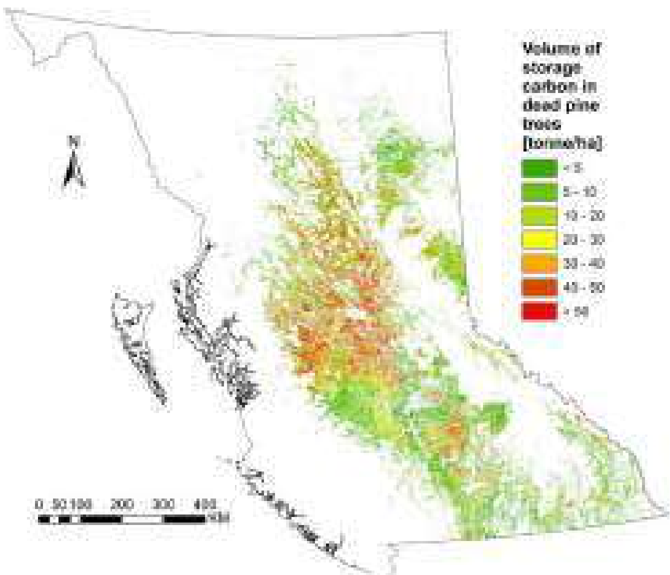
Plant Health

Mountain pine beetle (MPB) outbreak in Canada



Release of 263.73 Mt carbon to the atmosphere.

Comparable to 5.8 years of emissions from Canada's transport sector

Dhar et al. (2018) Scan. J .For. Res

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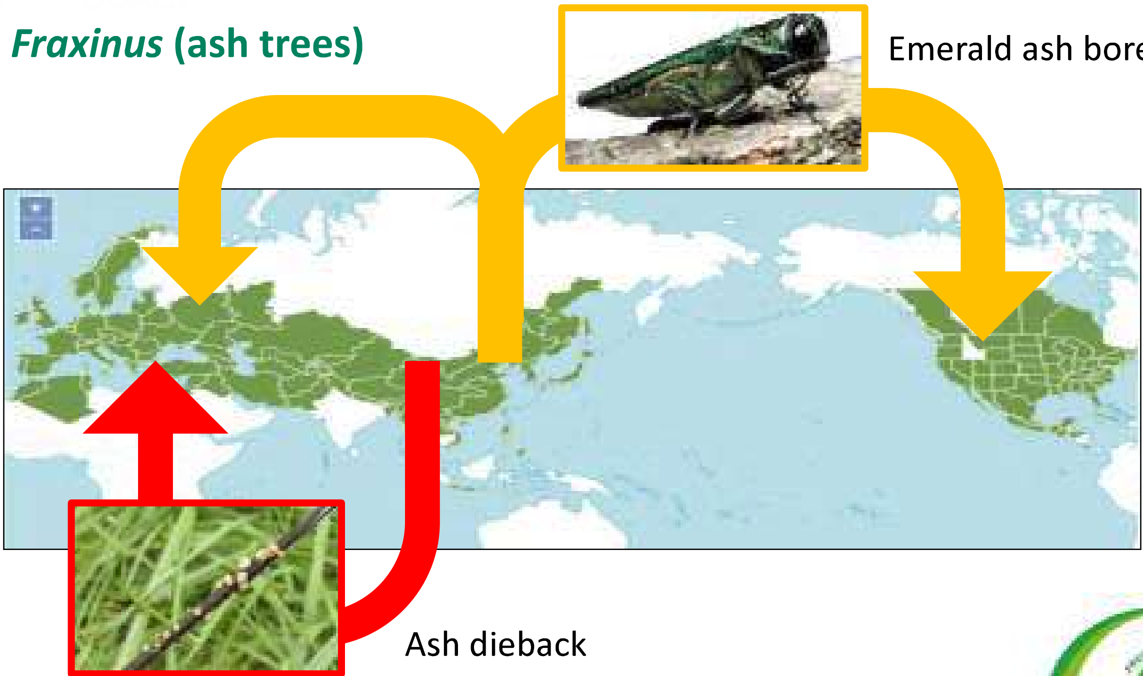
Examples of plant pests and pathogens introduced by humans

- Ash dieback
- Emerald ash borer
- Myrtle rust
- Fall army worm
- Red turpentine beetle
- Tomato leaf miner
- Chestnut blight
- Dutch elm disease
- *Phytophthora* spp.
- Brown marmorated stink bug
- Butternut canker
- Colorado potato beetle
- Cotton Bollworm
- Spotted wing *Drosophila*
- Asian longhorn beetle
- Asian citrus psyllid
- Papaya mealybug
- Potato psyllid
- Box tree moth
- European wood wasp
- Beech bark disease
- European gypsy moth
- Hemlock woolly adelgid
- Laurel wilt disease

The genus *Fraxinus* (ash trees)



Biodiversity: 955 species associated with UK ash

Table 2. Number of species and level of association with ash for six types of organism

Organism	Level of Association: Obligate	High	Partial	Cosmopolitan	Uses	Total
Birds			7	5	2	12
Mammals			1	2	25	28
Bryophytes		6	30	10	12	58
Fungi	11	19	38			68
Lichens	4	13	231	294	6	548
Invertebrates	30	24	37	19	131	241
Total	**45**	**62**	**344**	**330**	**174**	**955**

Level of association – five different categories of association describing the strength of dependency of species that use ash on ash trees. Five levels are: 'Obligate' – Unknown from other tree species; 'High' – Rarely uses other tree species; 'Partial' – Uses ash more frequently than expected; 'Cosmopolitan' – Uses ash as frequently, or less frequently than expected; 'Uses' – Uses ash but the importance of ash for this species is unknown.

Broome et al. (2014) Quart. J. For.

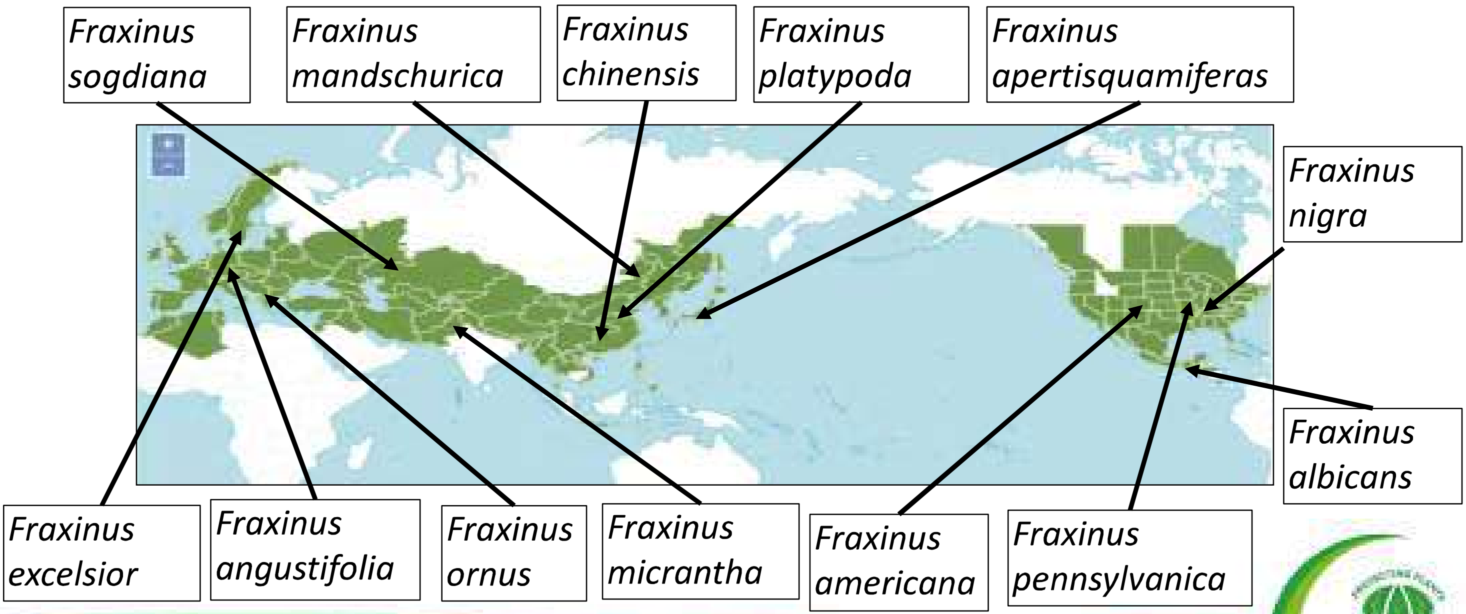
Future ash trees

We need ash trees adapted to:

1. A changing UK climate
2. An invasive Asian fungus
3. An invasive Asian insect
4. The support of UK native species

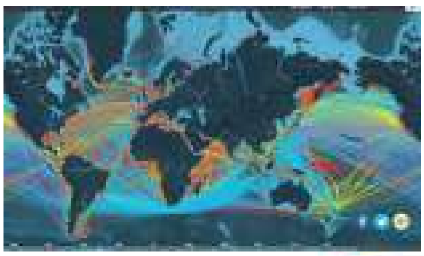
How can we do this?

We can draw on the global diversity of ash trees



Suggestion

The solution to the blending of worldwide pests and pathogens by trade is the blending of worldwide host genomes

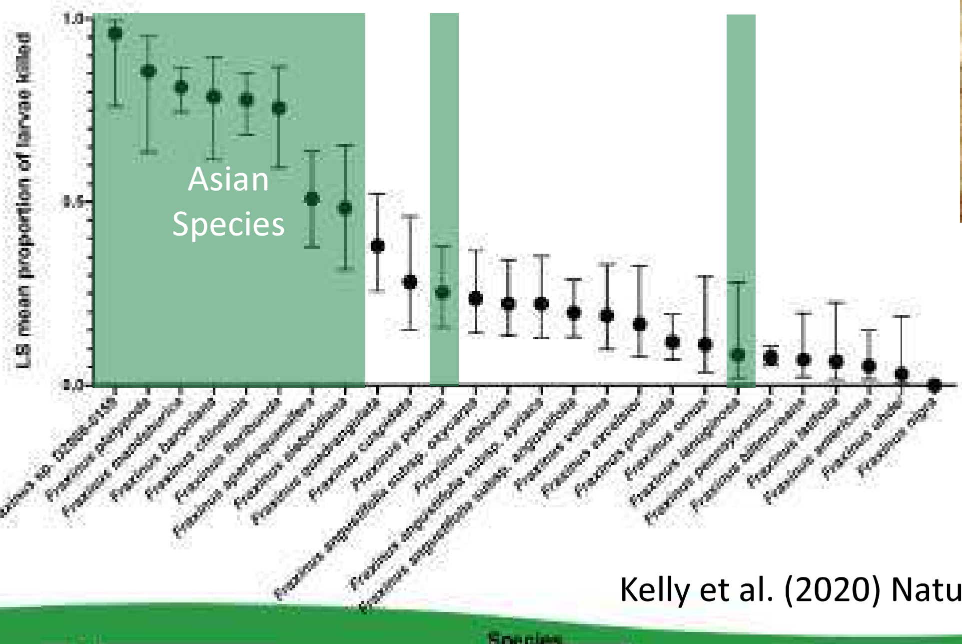


Worldwide ash genomes

- We sequenced the genomes of 29 species of ash from around the world
- Mainly using collections in Botanic Gardens
- We made a phylogenetic tree
- We tested the susceptibility of different species to emerald ash borer
- We compiled data about their susceptibility to ash dieback

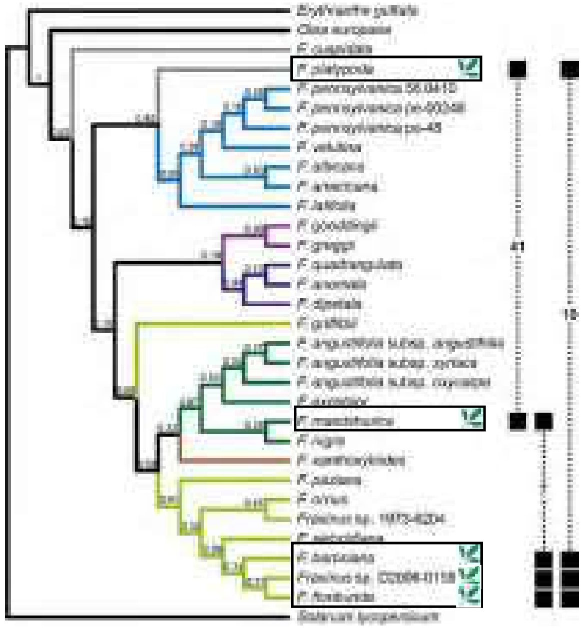
Kelly et al. (2020) Nature Eco. Evo.

Emerald ash borer resistance in global ash species

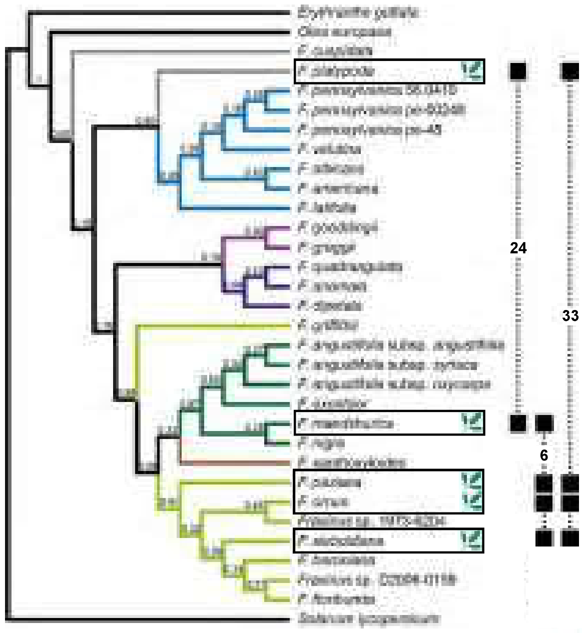


Kelly et al. (2020) Nature Eco. Evo.

Emerald ash borer



Ash dieback



Candidate genes

Emerald ash borer resistance

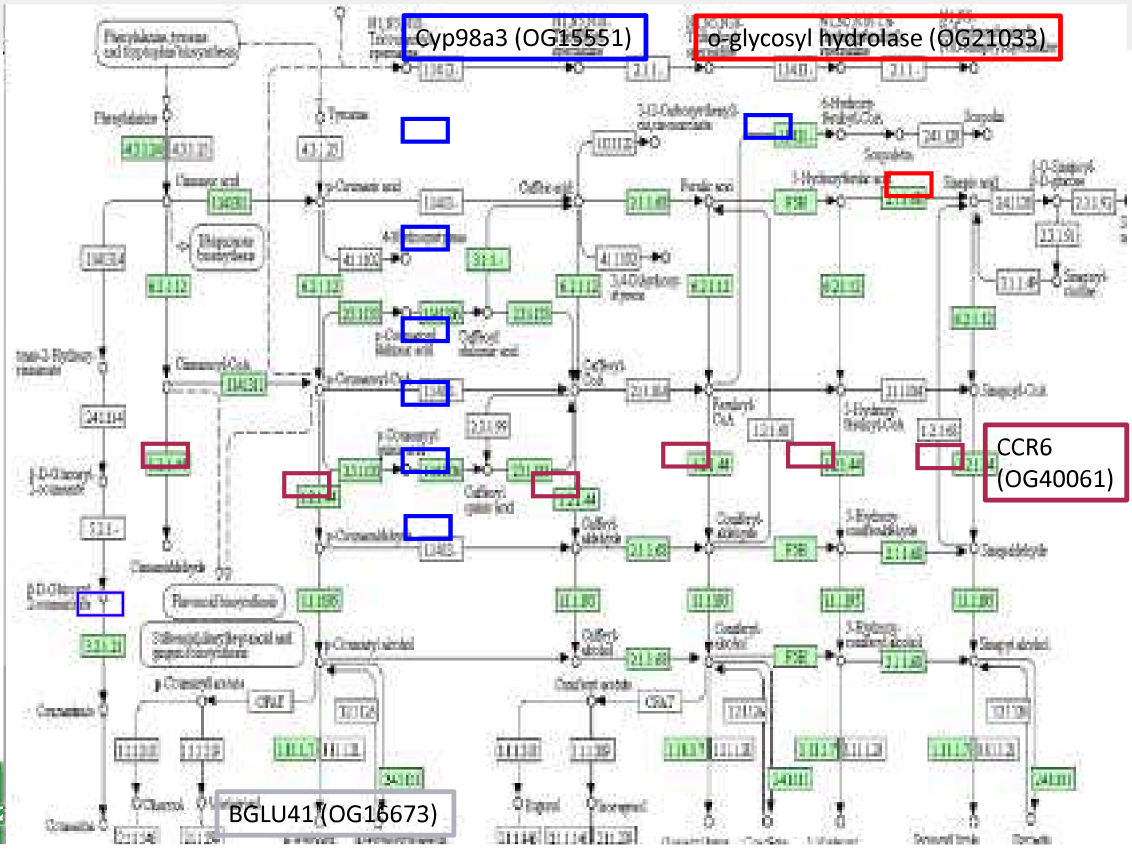
- 64 amino acid variants in 53 genes
- Putative gene functions include herbivore perception, defence signaling and programmed cell death

Ash dieback resistance

- 69 amino acid variants in 62 genes
- 16 genes with putative function in immunity/defence response; 8 linked specifically to fungi
- 1 gene in common with EAB candidate loci (involved in calcium ion binding)

Kelly et al. (2020) Nature Eco. Evo.
Kelly et al. in preparation

Genes from EAB study in Phenyl-propanoid biosynthesis pathway



How do we use this knowledge?

1. Grow Asian species of ash in Britain
   - Would they be adapted to our climate?
   - Would they support local species?
   - Danger of other pests and pathogens?
2. Hybrid breeding programme
   - Need to overcome reproductive barriers
   - Adaptation to climate & local species
3. Genetically engineer UK ash trees
   - Protocols now developed at Rothamsted Research
   - Public acceptability issues

This is all difficult and expensive
BETTER TO PREVENT PESTS AND PATHOGEN INTRODUCTION IN THE FIRST PLACE


Dr Laura Kelly

Postdocs

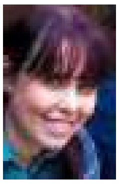

Dr Endymion Cooper


Dr Tim Coker

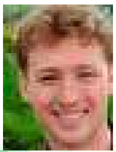
PhD students

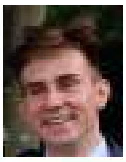

Lizzy Sollars


Jonathan Stocks


Carey Metheringham


Jasmin Zohren


Josiah Seaman


Will Plumb

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Mary Mason, US Forest Service
David Carey, US Forest Service

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NERC SCIENCE OF THE ENVIRONMENT
MARIE CURIE ACTIONS
The Scottish Government
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL
Forestry Commission
Kew
BBSRC bioscience for the future

follow

@RJABuggs

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Understand the ecology of biocontrol microbes for effective deployment

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PROTECTING PLANTS PROTECTING LIFE

Outline

- Disease management is context-dependent
- Biocontrol agents (BCAs) differ from synthetic pesticides
- Using strawberry disease management as an example

Managing strawberry diseases

A biopesticide-based management is effective against mildew and grey mould in strawberry **under protection**

Summary of fungicides, biopesticides, biostimulants applied to strawberry at NIAB in 2019 and the programme material costs (£/ha)

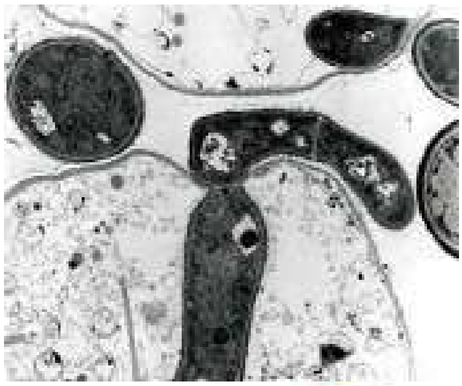
Products used	Management programmes	
	Routine	Managed
Total fungicides	29	2
Biopesticides	0	10
Biostimulants	0	4
Total programme cost	2,006	1,082
Mildew only cost	*889*	*1,082*
Botrytis only cost	*1,361*	*184*

Disease management – context dependent

- Epidemiology primarily dictates interventions
  - Timing depends on risks (past/present/future weather)
  - The actual intervention is context dependent
- For example, for *Botrytis cinerea*
  - Infection of flowers leads to latent infection
  - Regular removal of unmarketable fruit minimises inoculum
  - Rotting fruit are rarely seen before harvest under protection, in contrast to under the open-field conditions
- Post-harvest cool-chain management is sufficient to delay the onset of latent grey mould development
  - Pre-harvest use of fungicide/BCA not needed

Biocontrol organisms

- Biocontrol mechanisms differ from pesticides
  - Competition
  - Antibiosis
  - Induced resistance
  - Mycoparasitism
- BCA are living organisms
  - Spread to other sites/areas
  - Survival/reproducing
- BCA ecology has not received sufficient attention



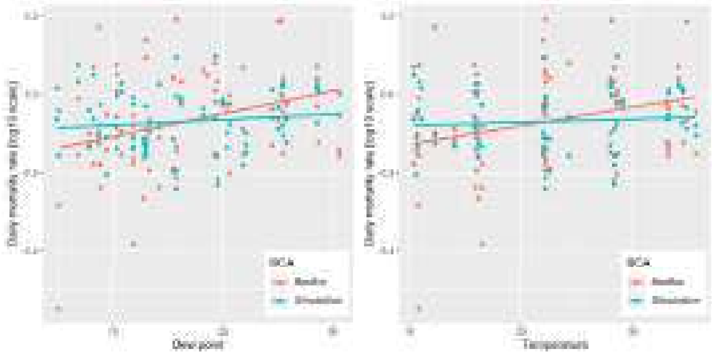
BCA dispersal/spread

- Applying *B. subtilis* increased its population density on leaves
  - Can vary greatly with specific strains
- *B. subtilis* may remain on treated strawberry leaves for many days
- Limited spread of *B. subtilis* among leaves, particularly under protected conditions
  - True for several other biocontrol strains

B. subtilis sequence counts on strawberry leaves			
Treatment	4 hours after treatment	8 Days after treatment	
		Old treated leaves	New leaves not directly treated
Open field:			
Untreated	2	1	5
Treated	3011	1559	459
Protected			
Untreated	2	2	1
Treated	1017	1151	70

BCA survival

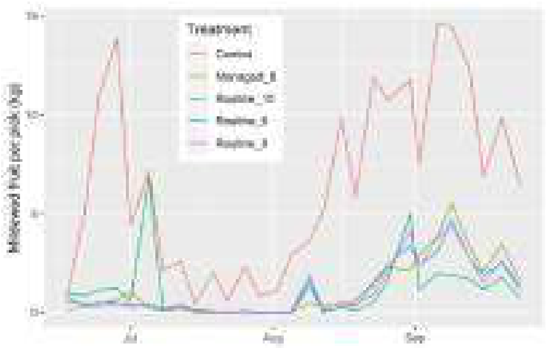
- Both *B. subtilis* and *G. catenulatum* can survive on strawberry and lettuce leaves for many days
- Factors limiting biocontrol efficacies are, thus, likely to be
  - Host growth dilution
  - Lack of dispersal among host tissues
- Biocontrol efficacy is expected to be reduced during the period of host rapid growth



Disease pressure

- Under high disease pressure
  - High inoculum level
  - Highly susceptible genotypes
  - Rapid host growth
  - Favorable weather conditions

  achieving effective disease control is nearly impossible unless the intervention interval is significantly shortened
- Hence the importance of integrated management



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Thanks you for your attention

Xiangming Xu
Head of Science, NIAB

Protecting Plants Protecting Life

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Area-wide Management of Plant Pests Using the Sterile Insect Technique (SIT)

Rui Cardoso Pereira

London, 21 - 23 September 2022

International Plant Health Conference

Protecting Plants Protecting Life

Outline

1. Introduction
2. Area-wide Integrated Pest Management (AW-IPM)
3. Sterile Insect Technique (SIT)
   - Concept
   - Strategic options
   - Examples
4. Set of International Standards for Phytosanitary Measures (ISPMs) for Fruit Flies


Bactrocera dorsalis

1. Introduction

Plant Pests Problems

- Reduce production yields and the quality of the fruits
- Increase the production costs
- Affects the environment
- Cause problems to international trade

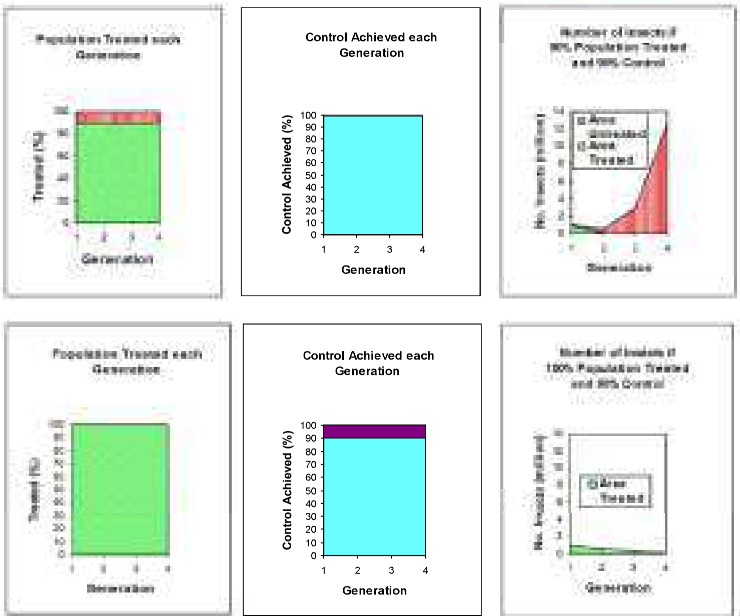
2. Area-Wide Concept

Area-wide is an integrated pest management (IPM) applied against an entire target pest population within a delimited geographical area.

2. Area-Wide IPM

Top: 10% of the population is untreated, and in four generations it produces a large number of individuals, while the 90% of the population that is treated declines.

Bottom: Entire pest population in the agroecosystem is suppressed uniformly, and its numbers decline from generation to generation.



Adapted from Knipling (1972)

2. Area-Wide IPM Requirements

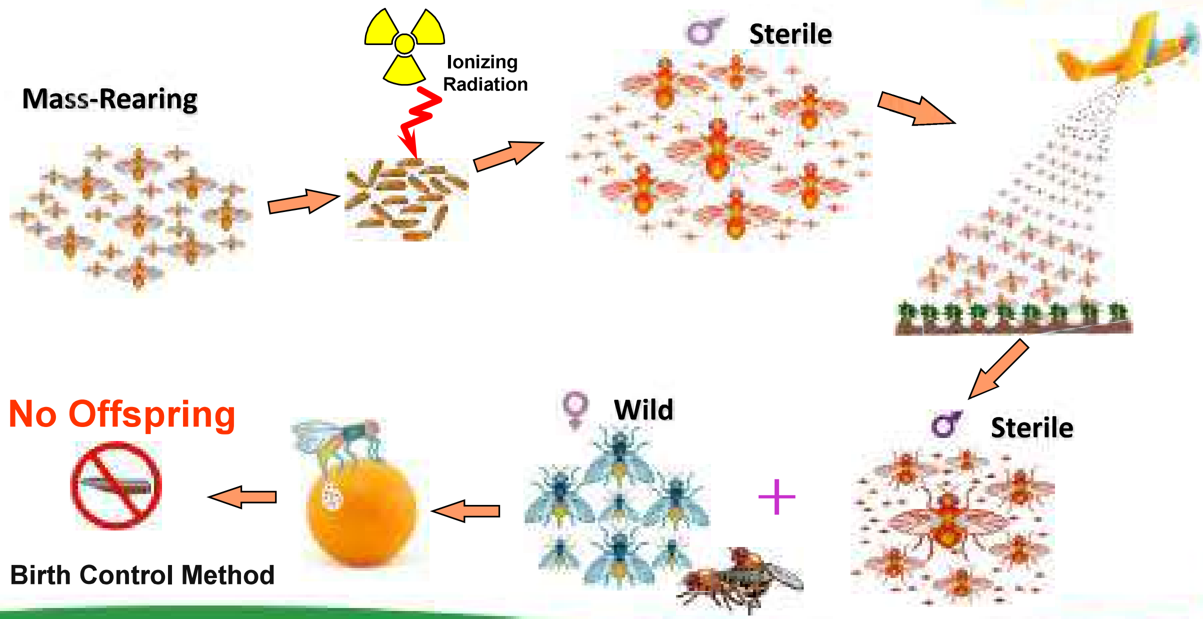
- Treatment of entire target pest population
- Coordination among all stakeholders
- Long-term commitment and multiyear planning
- Centralized organization dedicated exclusively to its implementation

3. Sterile Insect Technique (SIT)

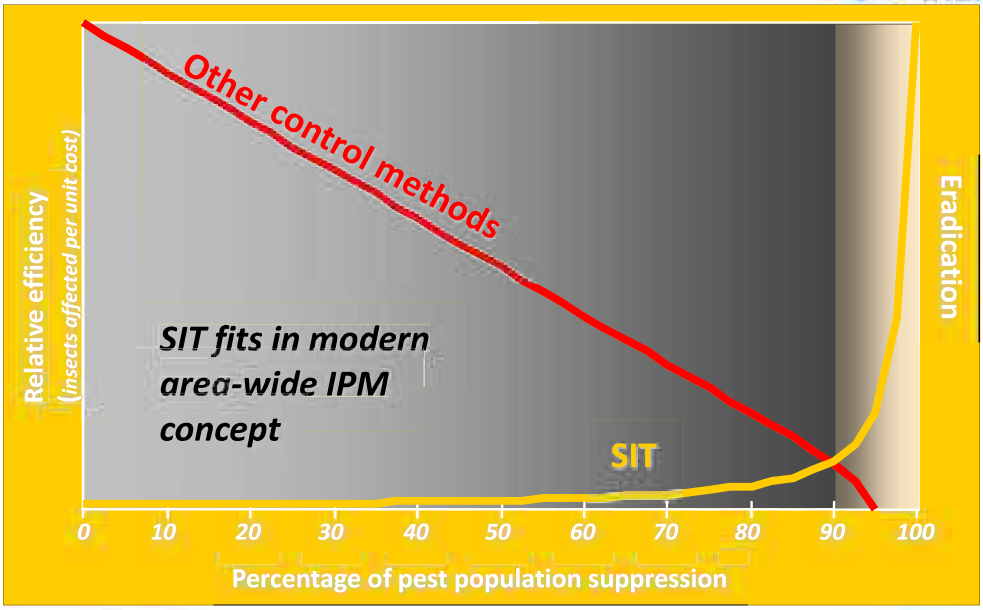
Plant pests
- **Fruit flies**
- **Moths**

Pests of medical and veterinary importance
- **Mosquitoes**
- **Screwworm**
- **Tsetse flies**

3. Sterile Insect Technique (SIT)



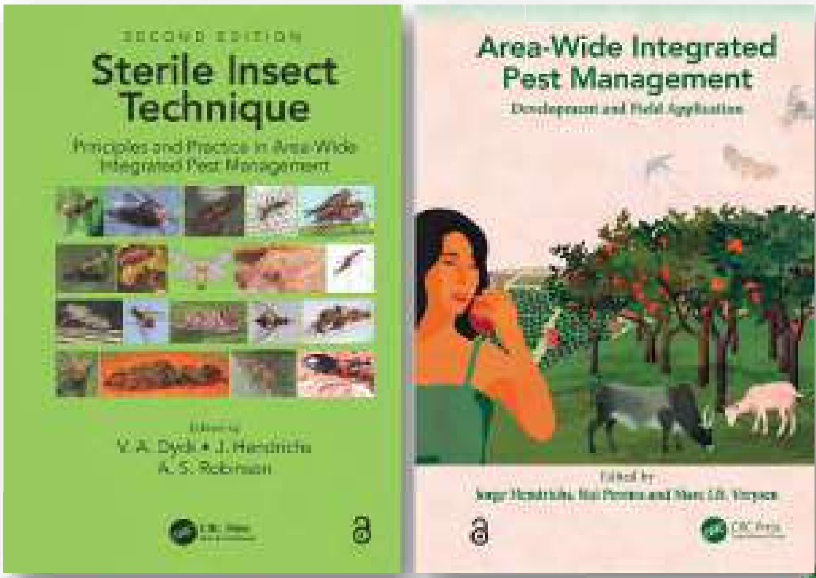
3. Sterile Insect Technique (SIT)



3. SIT & AW-IPM publications (2021)

Joint FAO/IAEA Programme

- Books with more that 1000 pages each published in 2021 and freely available on digital format
- *https://doi.org/10.1201/9781003035572* *(SIT)*
- *https://doi.org/10.1201/9781003169239* *(AW-IPM)*



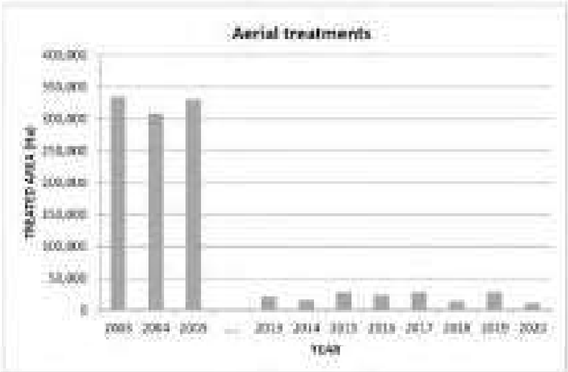
3. SIT Strategic Options

Joint FAO/IAEA Programme

- **Suppression:** To reduce insecticide use and crop losses, and to develop low pest prevalence areas
- **Containment:** To avoid the spread of invasive pests
- **Prevention:** To avoid establishment of invasive pests
- **Eradication:** To establish pest free areas to facilitate international trade and address outbreaks of invasive pests

3. Examples: SIT Suppression

Mediterranean fruit fly Suppression in Valencia, Spain



Area treated with insecticide bait sprays (Pla et al., 2021).

False Codling Moth in Citrusdal, South Africa

Rearing of the false codling moth *Thaumatotibia leucotreta*.

3. Examples: SIT Containment

Mediterranean fruit fly in Mexico-Guatemala

State-of-the-art Mediterranean fruit fly mass-rearing and irradiation facility with the capacity of producing **one billion** sterile males per week, Chiapas, Mexico.

3. Examples: SIT Prevention

Mediterranean fruit fly Preventive Release Programme in California and Florida

Mediterranean fruit fly preventive releases in Chile and Argentina

Argentina and Chile are piloting the implementation of a preventive SIT approach in their pest free areas.

3. Examples: SIT Eradication

Cactus Moth in Isla Mujeres and Isla Contoy, Mexico (2009)

Pink Bollworm in Mexico and USA (2018)

Included planting transgenic cotton, using insect pheromones to disrupt mating, releasing sterile insects to prevent reproduction, and extensive survey.

3. Examples: SIT Eradication

Dominican Republic

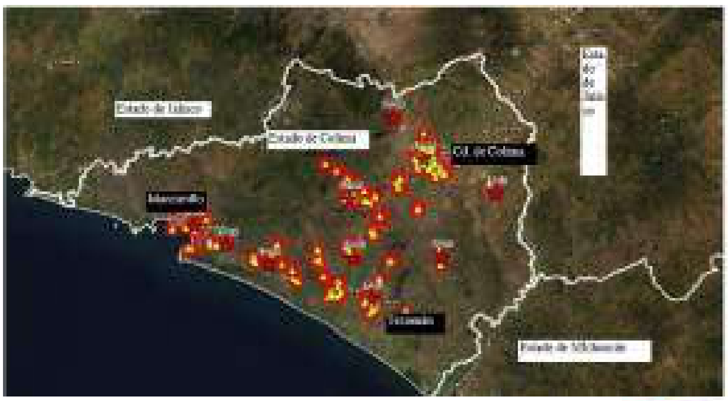
Invasion of Mediterranean fruit fly in 2000 Km^2 (1st detection in March 2015, last detection Jan. 2017). 4000 million sterile flies released between Oct. 2015-May 2017.

Dominican Republic Fruit Exports.

3. Examples: SIT Eradication

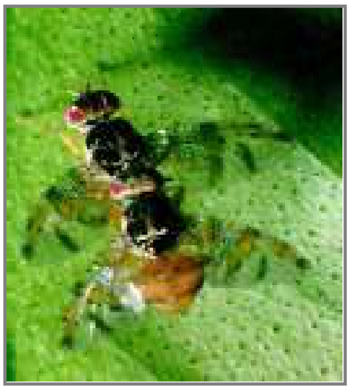
Colima, Mexico

- Outbreak of Mediterranean fruit fly in April 2021
- 4436 traps deployed for pest delimitation purposes
- Extensive suppression and eradication activities, including release of 1170 million of sterile flies
- Official declaration of eradication by the Mexican Government on 2 Aug. 2022



4. Set of ISPMs for fruit flies

- ISPM 26: Establishment of pest free areas for fruit flies (Tephritidae)
- ISPM 35: Systems approach for pest risk management of fruit flies (Tephritidae)
- ISPM 37: Determination of host status of fruit to fruit flies (Tephritidae)
- Fruit Fly Standards can Help Gain Market Access | IAEA



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Thank You

Rui Cardoso Pereira
Head of Insect Pest Control, Joint FAO/IAEA Programme

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PROJECT HLB BioMath

Sentinel Routes and ARMs (Areas of Regional Management)

A surveillance system for Citrus Greening (HLB) in Brazil

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Sentinel routes are an effective way of detecting HLB invasions

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Areas of Regional Management (ARMs) can be used and improved to monitor vector dynamics and inform its control

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Both SRs and ARMs could and should be used as tools for strengthening the farmer knowledge to support the implementation of IPM technology regarding HLB

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Preventing HLB invasion protects the way of life of thousands of families and avoids losses ~US$ 40 million per year, only in the state of Bahia

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The pathosystem

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Huanglongbing

- The yellow shoot disease
- Eradication of millions of trees

Mottling

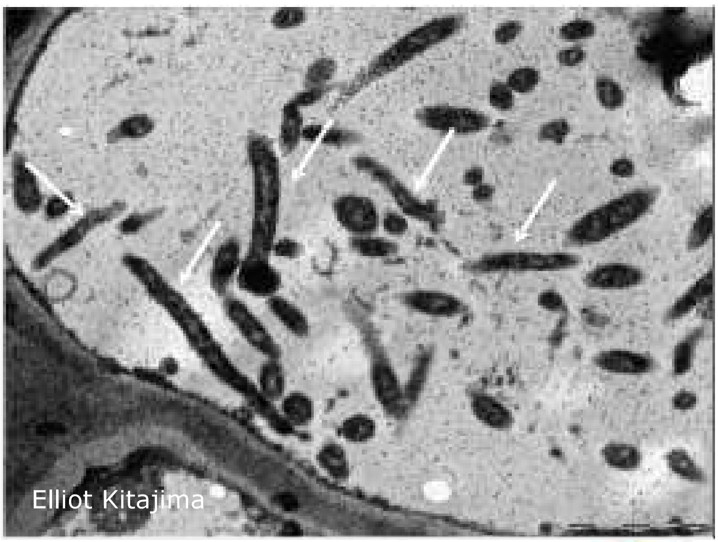
Fruit drop

- Small and bitter fruits
- Up to 100% of crop losses

Candidatus Liberibacter spp

Phloem-limited bacteria

- *Ca.* Liberibacter asiaticus is prevalent in Brazil



Diaphorina citri

Widespread in Brazil

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The context

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HLB BioMath

Americas: almost all citrus regions

Citrus HLB: Sentinel Routes and Areas of Regional Management (ARMs)

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Since 2004 in Brazil...

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...but still restricted to the Center-South

Due to strict control policies

Citrus HLB: Sentinel Routes and Areas of Regional Management (ARMs)

Citrus all over Brazil

88% of its microregions have commercially grown citrus

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Complex landscape

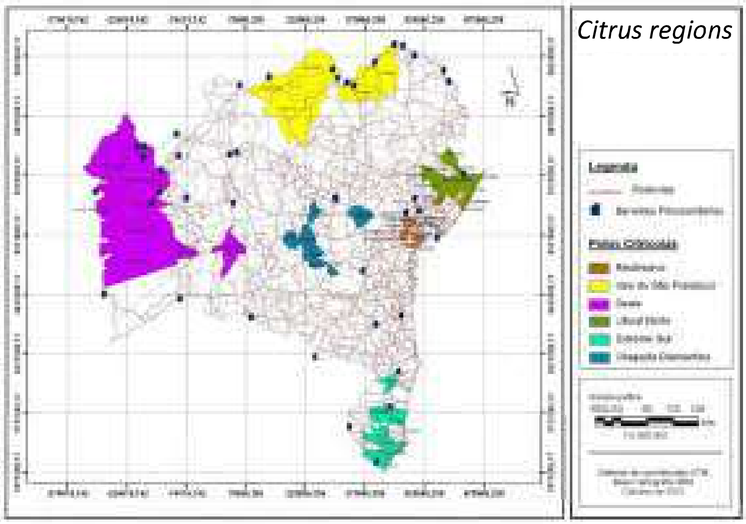
Multiple smallholder family properties

HLB BioMath

Low technological level

- Low plant health literacy
- Low access to credit

Bahia: an HLB-free region



Citrus regions in Bahia

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ARMs

Areas of Regional Management

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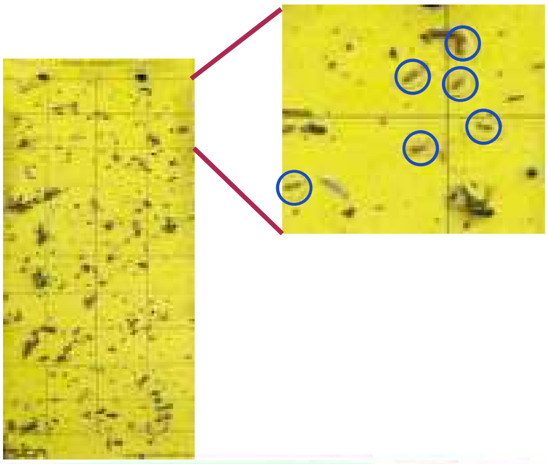
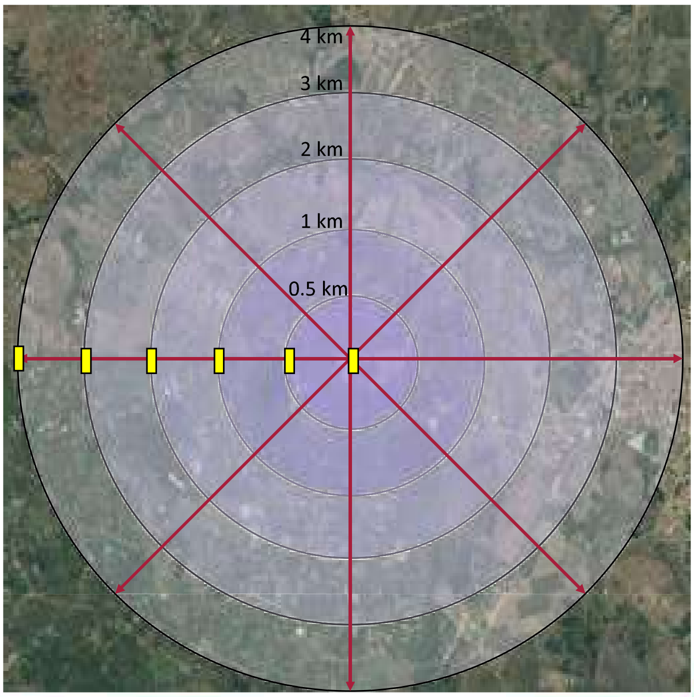
Monitoring sites at interceptions

Perimeter: 25.1 km

Area: 50.3 km²



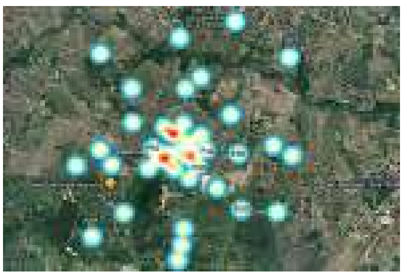


Vector Abundance

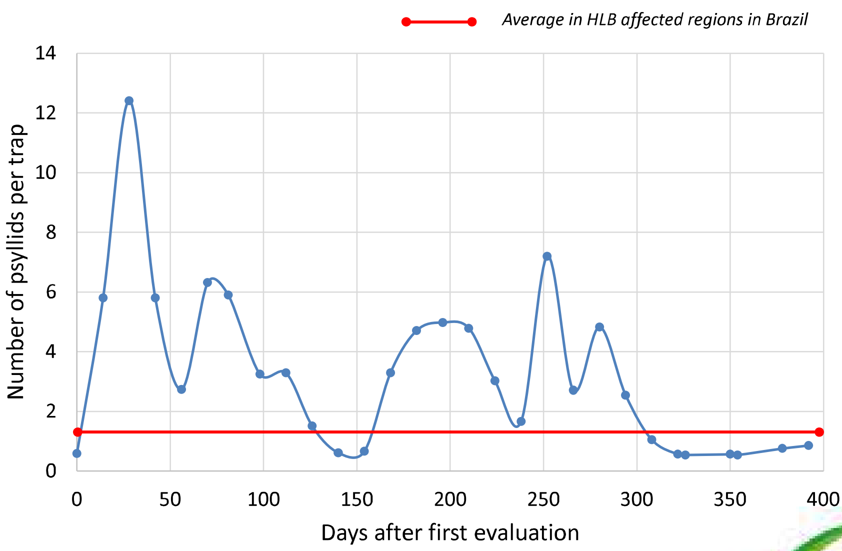
Very high psyllid populations

Higher in traps near urban areas

No Vector Control



Heatmap of trapped psyllid

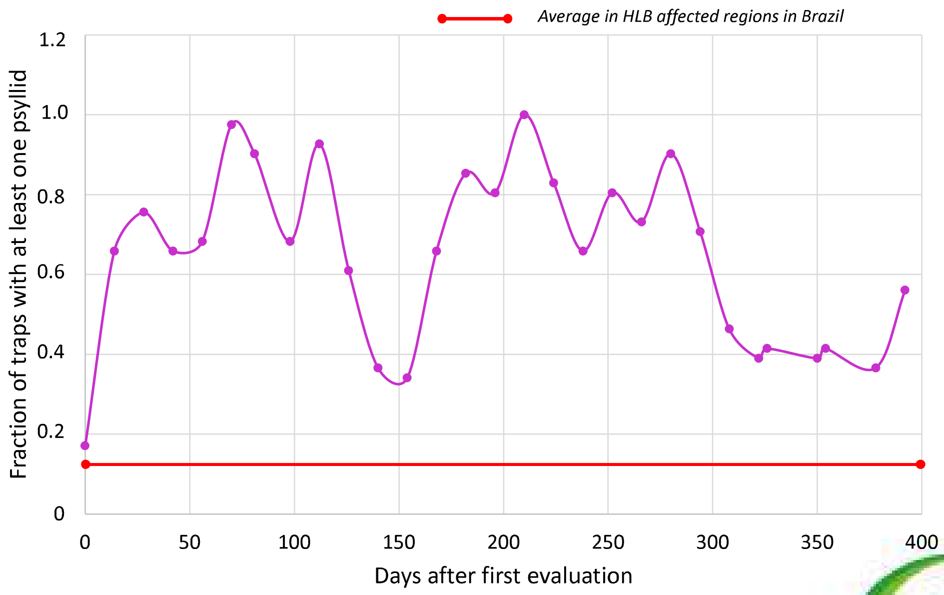


Vector Occupancy

Proportion of traps with at least one vector

Very high occupancy

No Vector Control



Sentinel Routes

Transects for capturing and test HLB vectors

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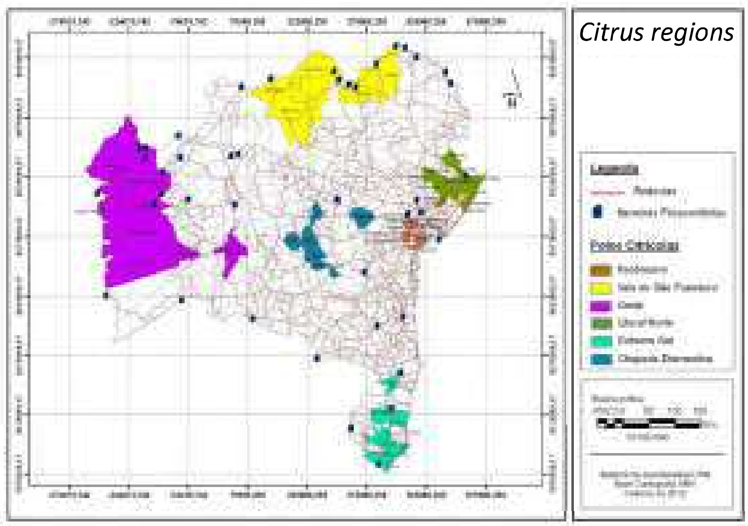
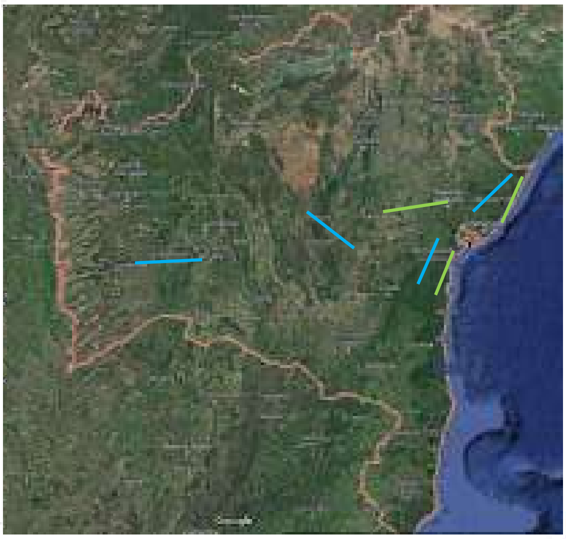
Sentinel Routes in Bahia



Citrus regions in Bahia



Citrus HLB: Sentinel Routes and Areas of Regional Management (ARMs)

HLB BioMath

Sentinel Routes in Bahia

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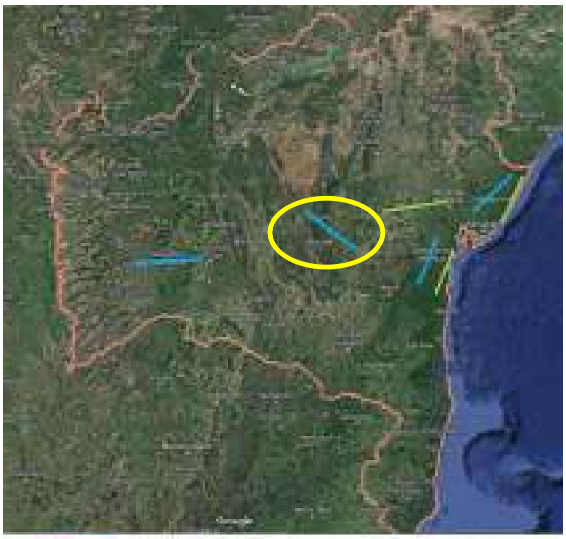
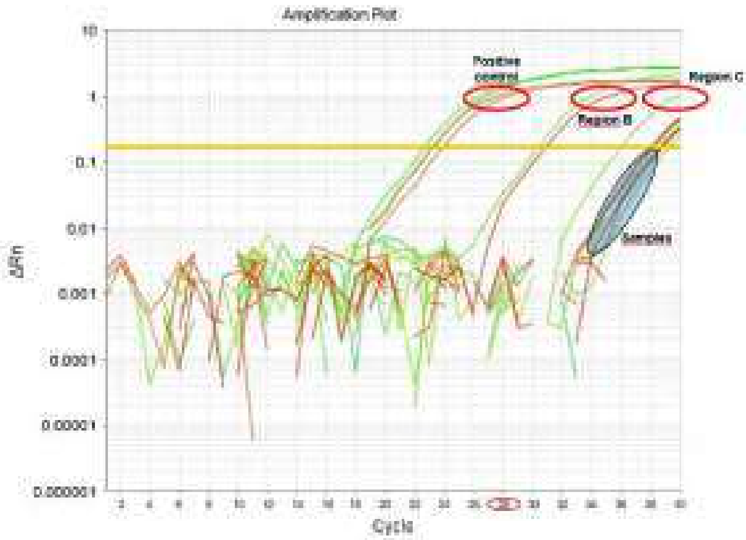
Oeste 2012: Phytoplasm group IX. Negative for HLB

(A) Orange leaves with HLB-like symptoms. (B) PCR, primers P1/P7 nested rU3/fU5. (C) PCR, primers P1/P7 nested D7f2/D7r2.

Citrus HLB: Sentinel Routes and Areas of Regional Management (ARMs)

Chapada 2013: CLas positive in vectors





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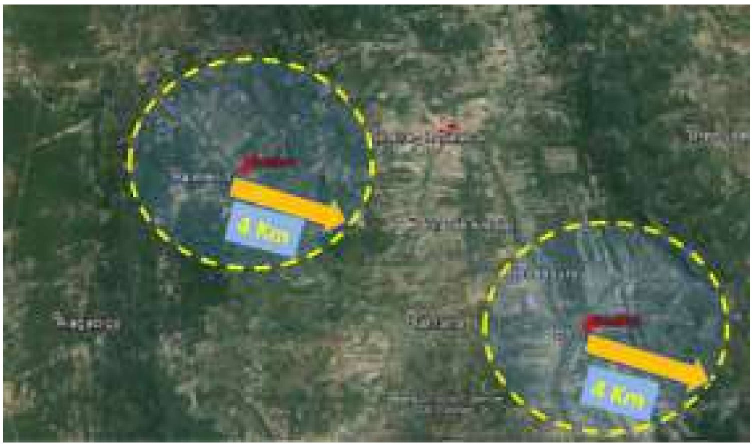
HLB BioMath

Chapada 2013: Clas negative in plants



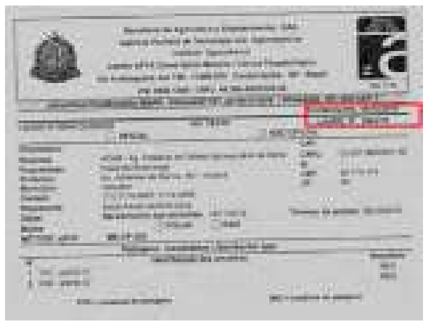
Surveillance perimeters

Eradication of *Citrus* and *Murraya* within the perimeters

Citrus HLB: Sentinel Routes and Areas of Regional Management (ARMs)

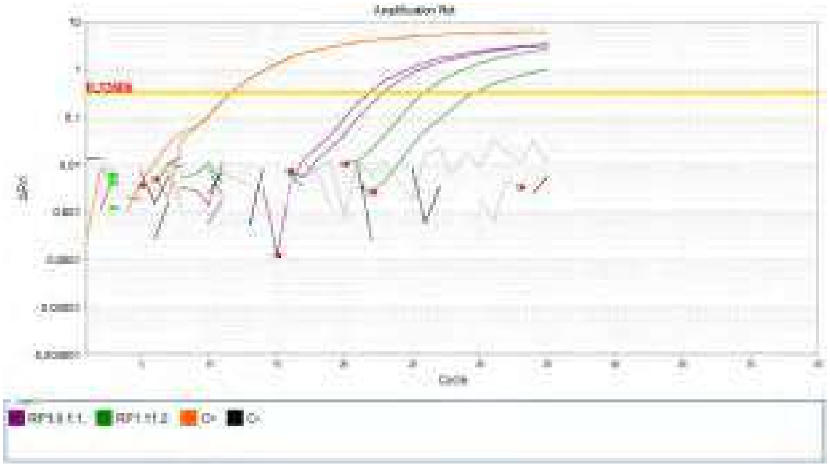
HLB BioMath

Chapada 2018: negative for HLB



HLB BioMath

Oeste 2022: CLas positive in vectors



HLB BioMath

Oeste 2022: CLas negative in plants

4km radius

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PROJECT HLB βioMath

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Sentinel Routes and ARMs are accessible, available and affordable. They are still to be used beyond the regional plant health agencies

Francisco Ferraz Laranjeira
Director General, Embrapa Cassava & Fruits

PROTECTING PLANTS PROTECTING LIFE

Food and Agriculture Organization of the United Nations
International Plant Protection Convention
Department for Environment Food & Rural Affairs

Biocontrol: solving sustainable pest control

Dr R L Gwynn, Vice President, International Biocontrol Manufacturers Association

London, 21 - 23 September 2022

International Plant Health Conference

PROTECTING PLANTS PROTECTING LIFE

The pest control problem

Functioning ecosystem

Biocontrol Technologies

Invertebrates

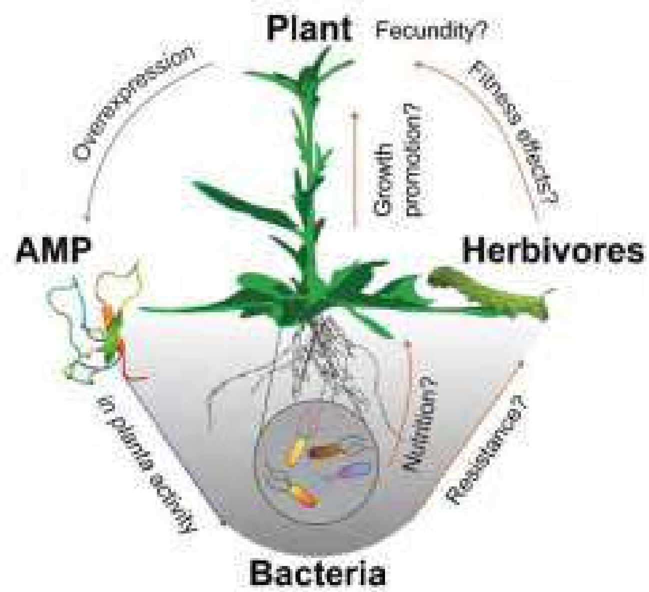
Microbials

Natural substances

Semiochemicals

Good practice IPM

Plants in the agroecosystem



Source: Max Planck Institute for Chemical Ecology 2017

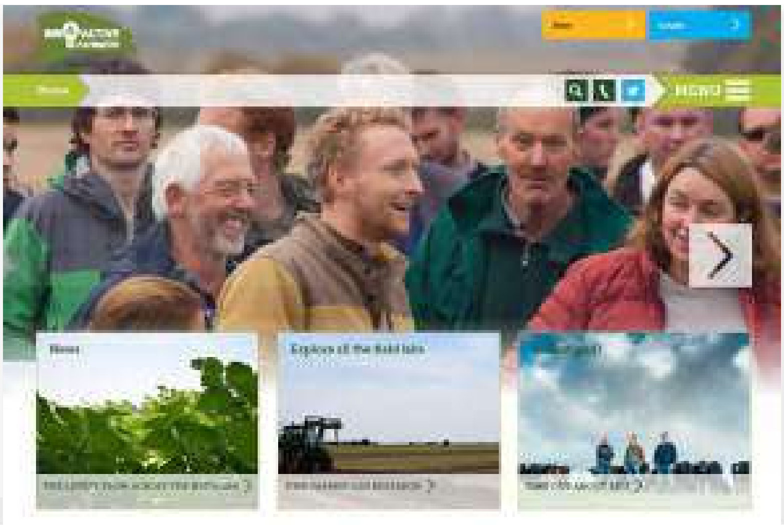
Biocontrol is much more than 'pest control'

High uptake of biocontrol in greenhouses

Uptake of biocontrol in speciality crops

Lower uptake of biocontrol in arable

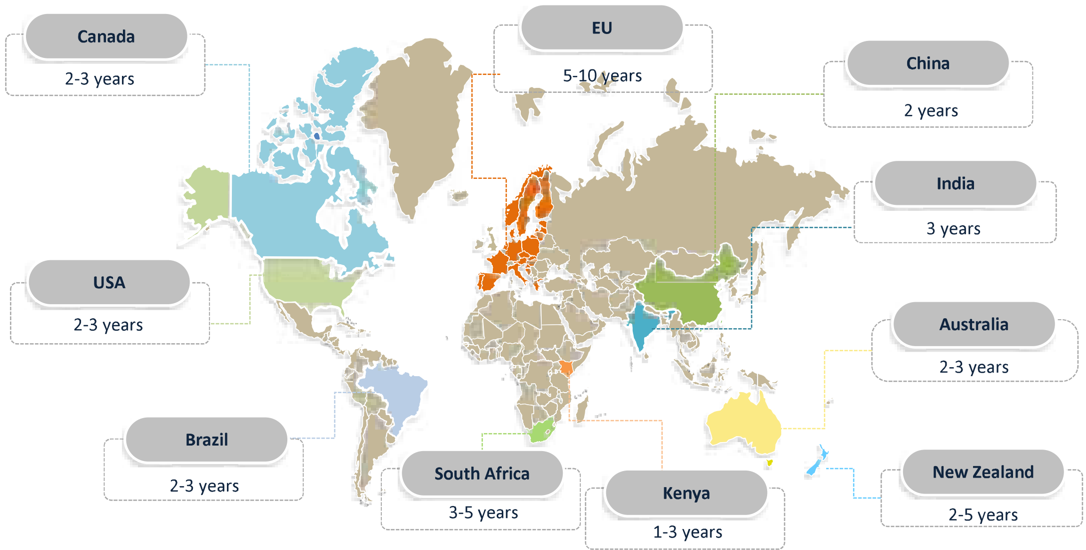
Biocontrol adoption



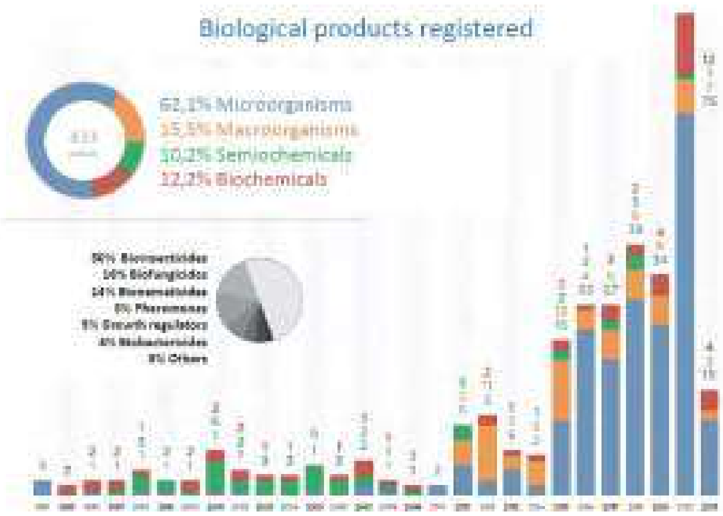
https://www.innovativefarmers.org/case-studies/

Biological based crop protection

Regulation - timelines



Better regulation



Biocontrol is for today's agriculture

Gabe Brown (2018) – Author of from "Dirt to Soil" and North Dakota farmer

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Deliberations?

Dr Roma L Gwynn (roma.gwynn@ibma-global.org)
Vice President, International Biocontrol Manufacturers Association (IBMA)

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IPM in Thailand and Nature based solutions to Fall Armyworm management in Asia Pacific Region

Chonticha Rakkrai, Sarute Sudhi-Aromna
Pruetthichat Punyawattoe and Yubak Dhoj G.C.

London, 21 - 23 September 2022

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PROTECTING PLANTS PROTECTING LIFE

Content

- ❖ Timeline of IPM in Thailand
- ❖ Example successful cases and implementation in Thailand
  1. Fall armyworm
  2. Coconut black-headed caterpillar
- ❖ Award
- ❖ Summary
- ❖ 5 key NBS central to FAW management (FAO)

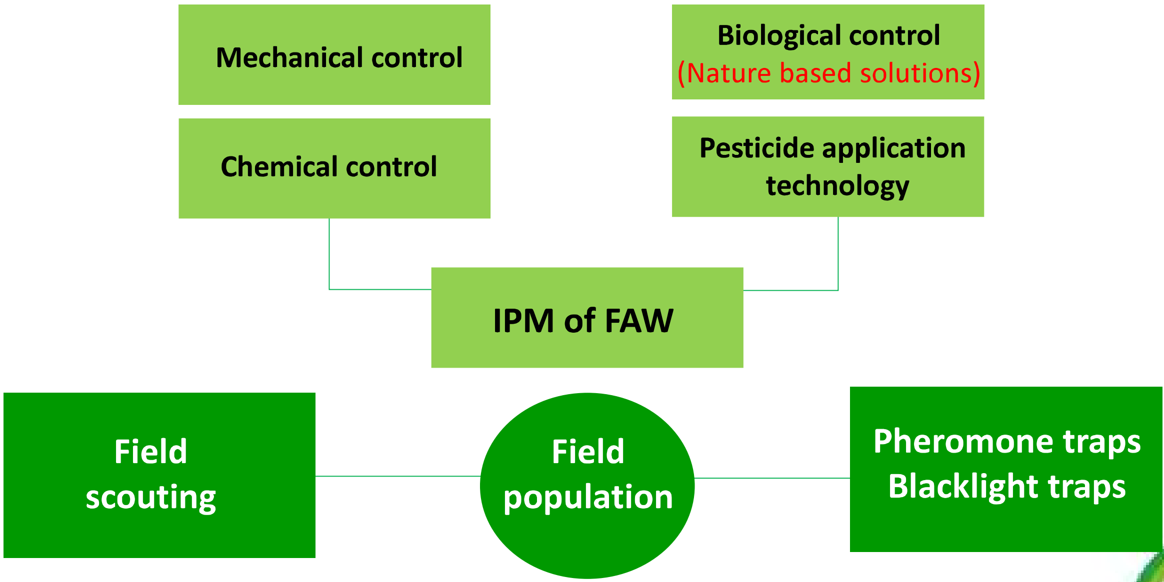
Timeline of IPM in Thailand

- Food and Agricultural Organization (FAO, 1967) defined IPM as "a pest management system, that, in the context of associated environment and population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains pest populations at levels below those causing economic injury"

- In 1989, IPM Task Force was established, and in 1990. IPM Working Group (IPMWG) was constituted to strengthen the implementation of IPM at international level.

- In 1993 first established IPM in Thailand by the Entomology and Zoology Division, Department of Agriculture until now

Example successful cases in Thailand



Mechanical control

Remove the egg masses and neonate larvae (newly hatch larvae that aggregated) in the infested corn fields and destroy

Chemical control

Seed treatment

1) cyantraniliprole 20% SC at 20 ml/1 kg seed (IRAC group 28)
2) clorantraniliprole 62.5 % FS at 7 ml/1 kg seed (IRAC group 28)
3) cyantraniliprole+ thaiamethoxam 24%+24% FS at 7 ml/1 kg seed (IRAC group 28+4A)

Action threshold for foliar application

Maize Crop Stage	V Stage	Action Threshold for Smallholder Farmer	Action Threshold for Village-Level Progressive Farmer
Early Whorl Stage	VE-V6	20% (10-30%)	20% (10-30%)
Late Whorl Stage	V7-VT	40% (30-50%)	40% (30-50%)
Tassel & Silk Stage	R1-R3	NO SPRAY Unless low-toxicity & supportive of conservation biological control	20% (10-30%)

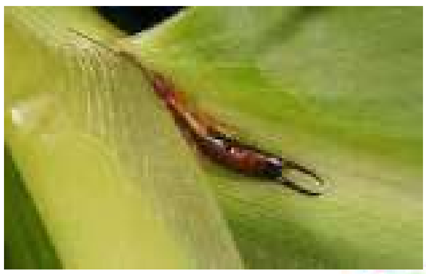
Thresholds: Treat for FAW during the early whorl stage when more than 15% of the plants are infested. During mid-to late-whorl stages, treatment for FAW may be necessary if more than 30% of the plants are infested.

Official recommendation insecticides for foliar application

Insecticide	Rate ml/water 20 l.	IRAC	Duration for control (Days)
1. emamectin benzoate 5% SG	10	6	7
2. emamectin benzoate 1.92% EC	20	6	7
3. spinetoram 25% SG	10	5	10-12
4. spinetoram 12% SC	15	5	10-12
5. spinetoram + methoxyfenozide 30 + 6% SC	30	5+18	7
6. chlorfenapyr 10% S	30	13	7
7. indoxacarb 15% SC	30	22A	7
8. flubendiamide 20% WG	10	28	7
9. chlorantraniliprole 5.17% SC	30	28	7
10. lufenuron 5% EC	30	15	7

Biological control

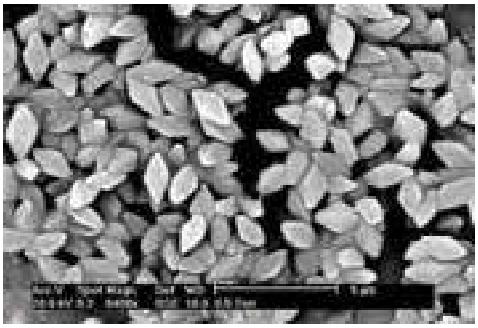
Predator	Period to release after cultivation	Timing	Rate/ha
1. Stink bug	4 weeks	1-3 times	3,250
2. Earwigs	3-5 weeks	2-3 times Egg, 1st and 2nd instar larvae	10,000



Biological control (Cont.)

1) *Bacillus thruringiensis* cv. *aizawai* at 80 g/ 20 litres of water

2) *Bacillus thruringiensis* cv. *kurstaki* at 80 ml/ 20 litres of water

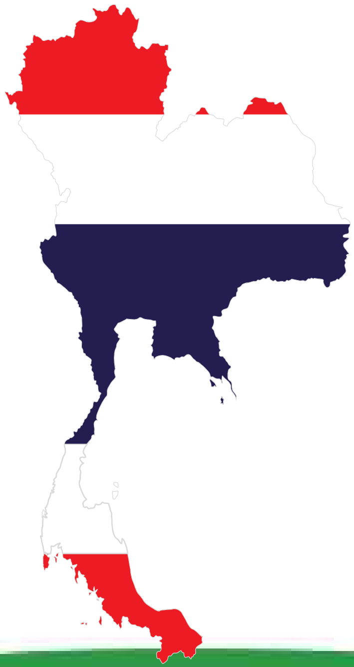


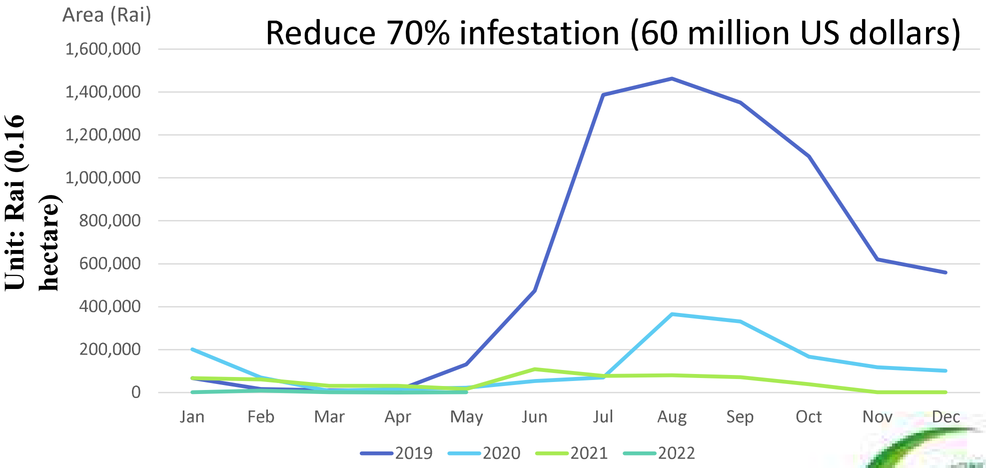
Pesticide application technology

Recommendation

- Spraying at a volume of 8–16 litres/hectare with a single-rotor UAV (helicopter)
- Spraying at a volume of 18.75–31.25 litres/hectare with a multiple-rotor UAV (drone)
- Spraying at a volume of 250-375 litres/hectare with a motorised knapsack sprayer installed with a spray lance (with a hollow cone-type nozzle) or boom sprayer (with a fan-type nozzle)

Summary of the infestation of FAW over the years





Source: Department of Agricultural Extension

Official recommendation for FAW management in Thailand

IPM for Coconut black headed caterpillar

- Removing infested leaves
- Bt
- Trunk injection
- Releasing parasitoid

Application of *Bt.*

Trunk injection by using emamectin benzoate 1.92% EC

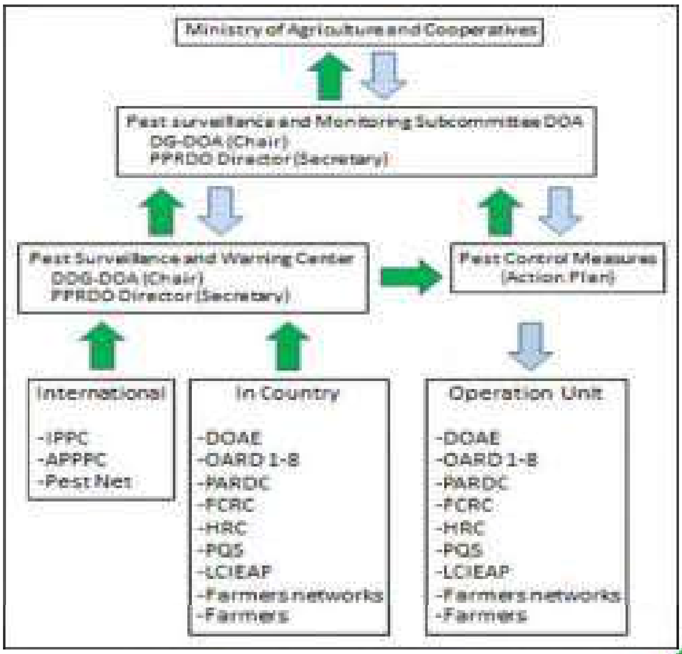
Goniozus nephantidis

Recovery of the palms

Official recommendation for Coconut black-headed caterpillar management in Thailand

Implementation

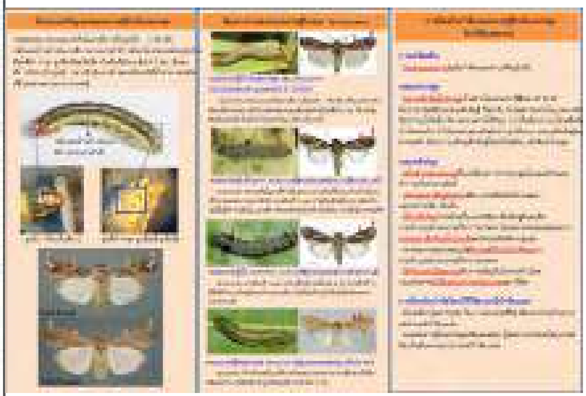
PEST SURVEILLANCE ACTION PLAN OF DEPARTMENT OF AGRICULTURE



Implementation

Short term measures
The information medias are including:

- Manuals for FAW survey and surveillance programs
- Brochures and posters to describe the information of FAW identification guide and its control measures
- Infographics
- Press releases



Implementation

Various official meetings were organized to explicate the information of FAW to relevant agencies including

- Plant quarantine inspectors
- Local government officers of DOAE and DOA officers in the outbreak and endangered areas.
- Seed Industry
- Department of Rice
- Office of the Cane and Sugar Board

Summary

1. Locally and international cooperation and capacity building

1.1 Establish coordination mechanism and information exchange systems at national, regional, and international levels

1.2 Provide adequate financial and technical support from relevant national, regional, and international assistance agencies.

1.3 Initiate assessments of problems and develop early warning and monitoring systems

1.4 Encourage partnership between public and private sectors

1.5 Convening workshops and seminars, as well as conducting publicity events and media campaigns; and

1.6 Ensure the sustainability in the region by developing long-term programs of action

Award

Cassava Pink Mealybug

This, along with releases of local biological control agents (predatory lacewings), and together with ecological pest management training efforts of field extension workers and farmers, provided effective control of the pest and stopped its spread.

Summary

2. Research required

2.1 Monitoring and early warning system

2.2 Insecticide susceptibility

2.3 Mating disruption

2.4 Effective natural enemies

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Department for Environment Food & Rural Affairs

London, 21 – 23 September 2022

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Thank you for your attention

Name Miss Chonticha Rakkrai
Position Director of Plant Quarantine Research

Food and Agriculture Organization of the United Nations | International Plant Protection Convention | Department for Environment Food & Rural Affairs

Healthy soils for a healthy life

Soil and plant health: a requisite for sustainable development

Ronald Vargas, Secretary Global Soil Partnership

London, 21 - 23 September 2022

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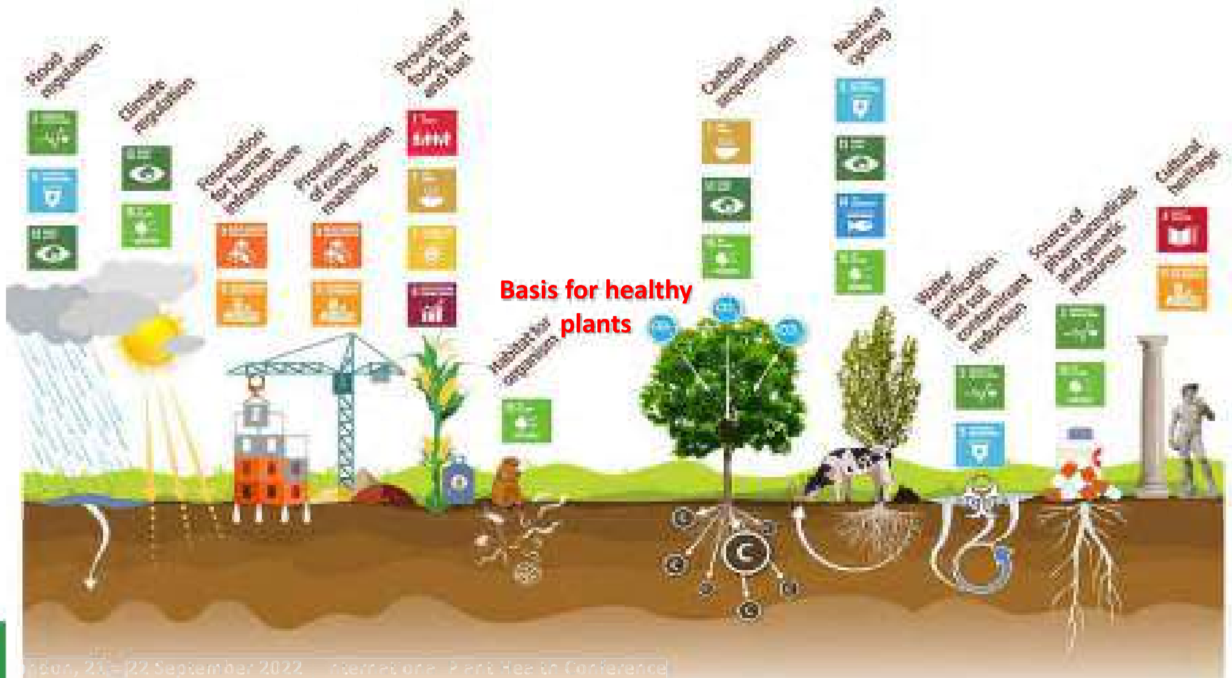
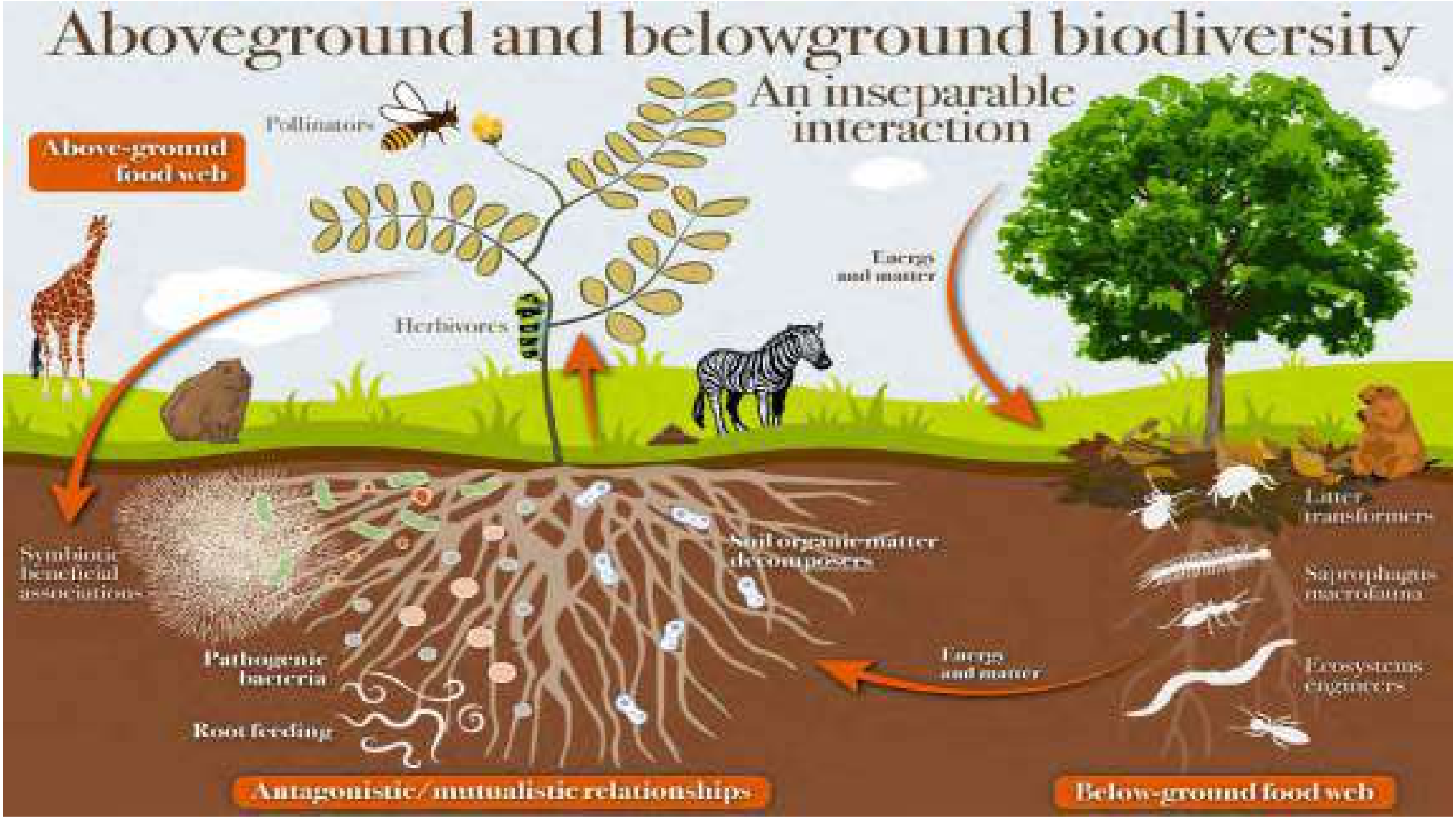
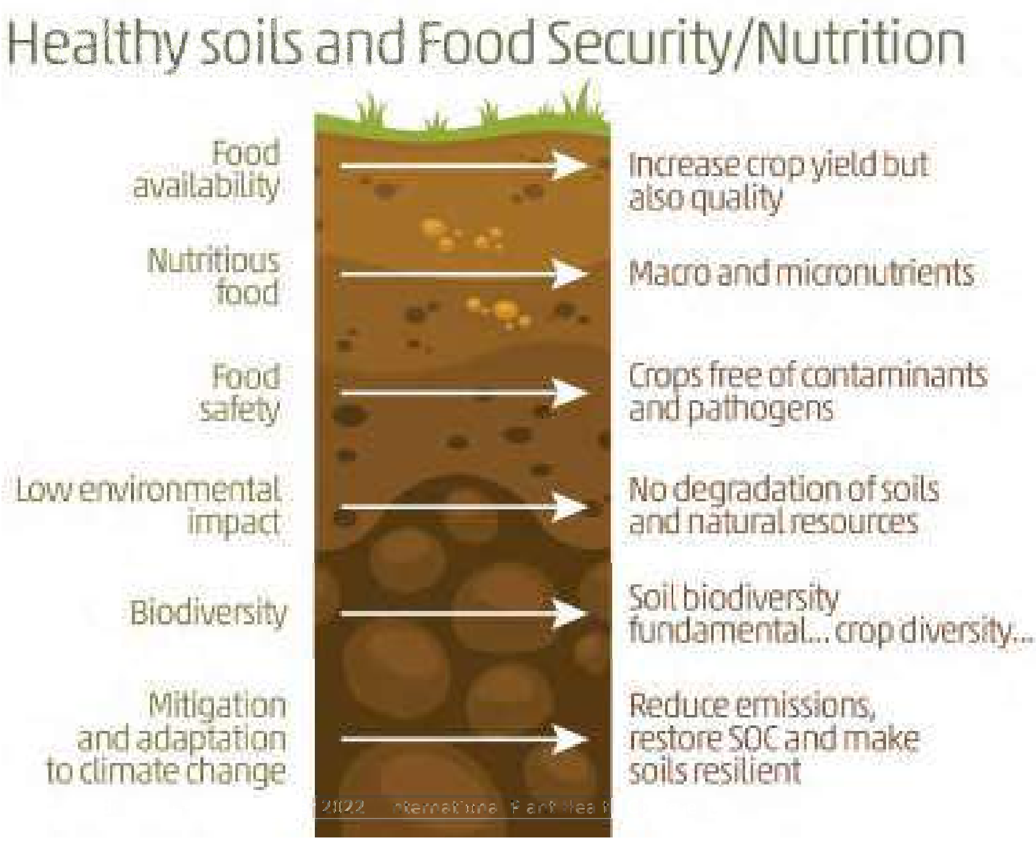
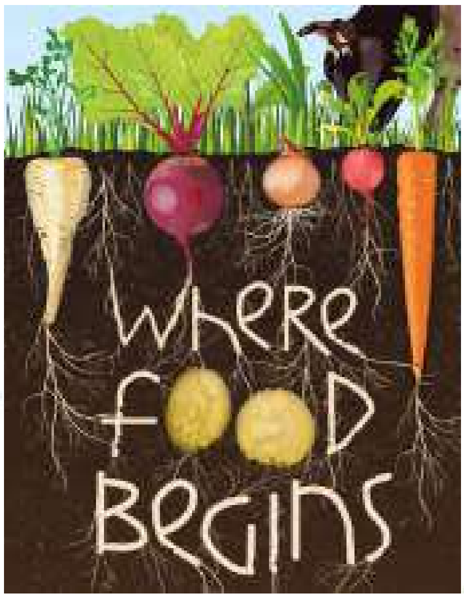
A healthy soil is capable of providing most terrestrial ecosystem services, therefore contributing to achieve the SDGs and human well-being

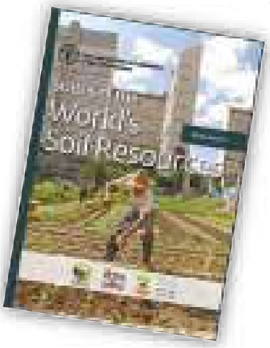



Aboveground and belowground biodiversity
An inseparable interaction
Above-ground food web
Pollinators
Herbivores
Energy and matter
Symbiotic beneficial associations
Pathogenic bacteria
Root feeding
Soil organic matter decomposers
Litter transformers
Saprophagus macrofauna
Ecosystems engineers
Antagonistic/mutualistic relationships
Below-ground food web


Healthy soils and Food Security/Nutrition
Food availability
Increase crop yield but also quality
Nutritious food
Macro and micronutrients
Food safety
Crops free of contaminants and pathogens
Low environmental impact
No degradation of soils and natural resources
Biodiversity
Soil biodiversity fundamental... crop diversity...
Mitigation and adaptation to climate change
Reduce emissions, restore SOC and make soils resilient


Where Food Begins

Yet the world's soils are at risk



The situation will **worsen** if **business as usual** continues

Soil degradation has negative impact son the provission of ecosystem services but also contributes with GHG emissions (CO_2, N_2O y CH_4)

27% of total global emmisions

Gt = gigatonne = 10^{15} g C = billion tonnes

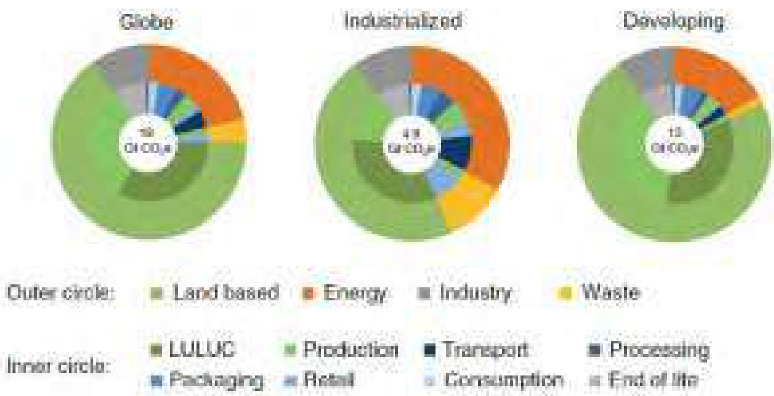
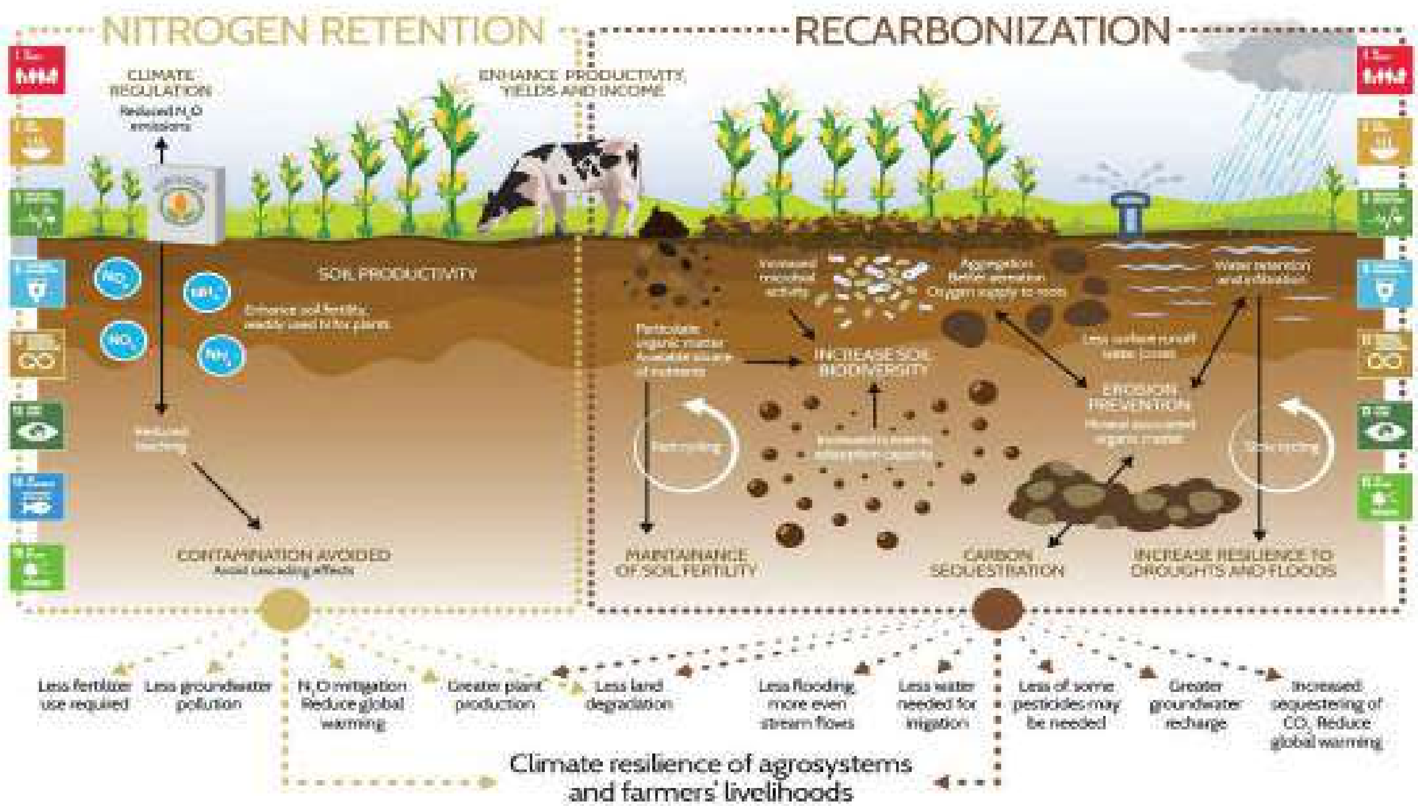


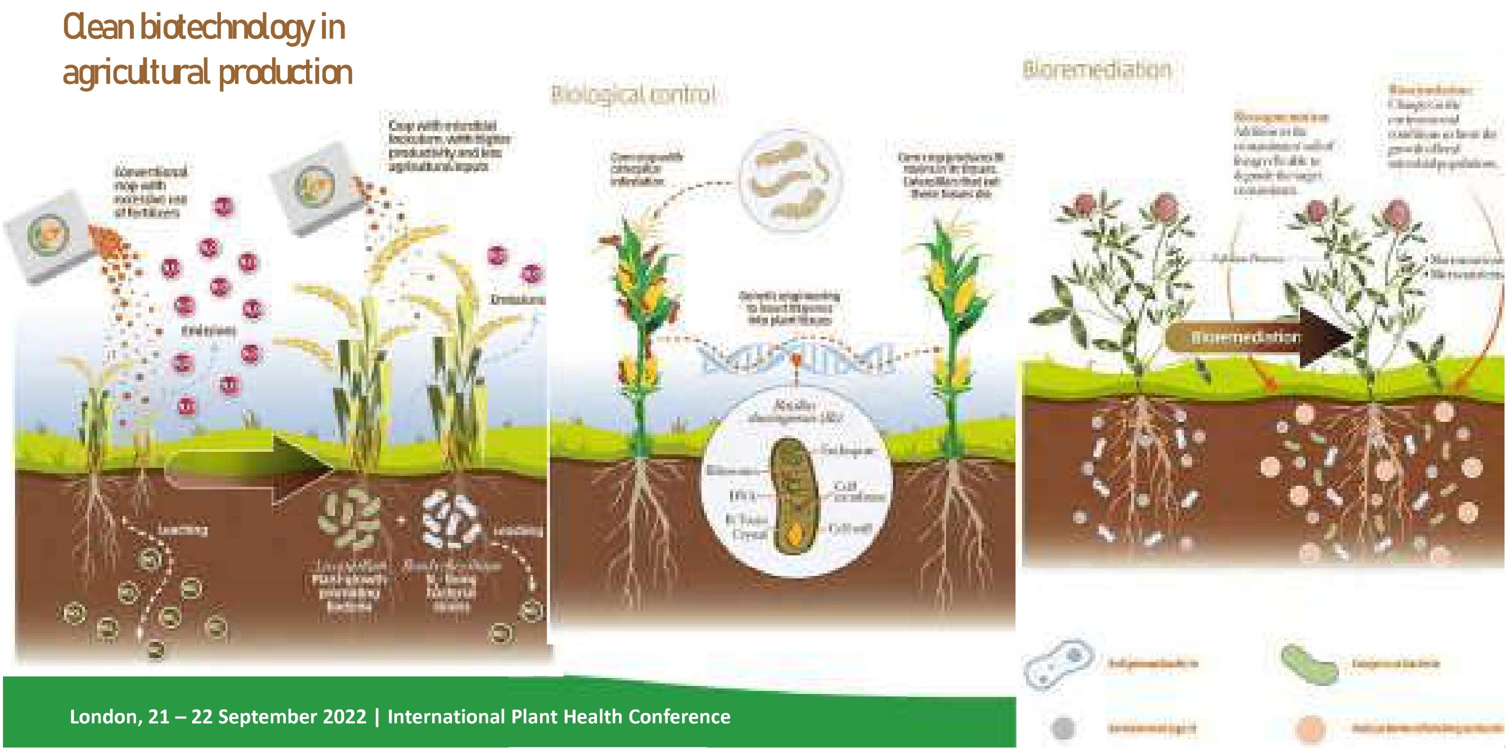
Fig. 1 | GHG emissions from the food system in different sectors in 2015. Total GHG emissions (including CO_2, CH_4, N_2O and F-gases) are expressed as CO_2e calculated using the GWP100 values used in the IPCC AR5, with a value of 28 for CH_4 and 265 for N_2O.

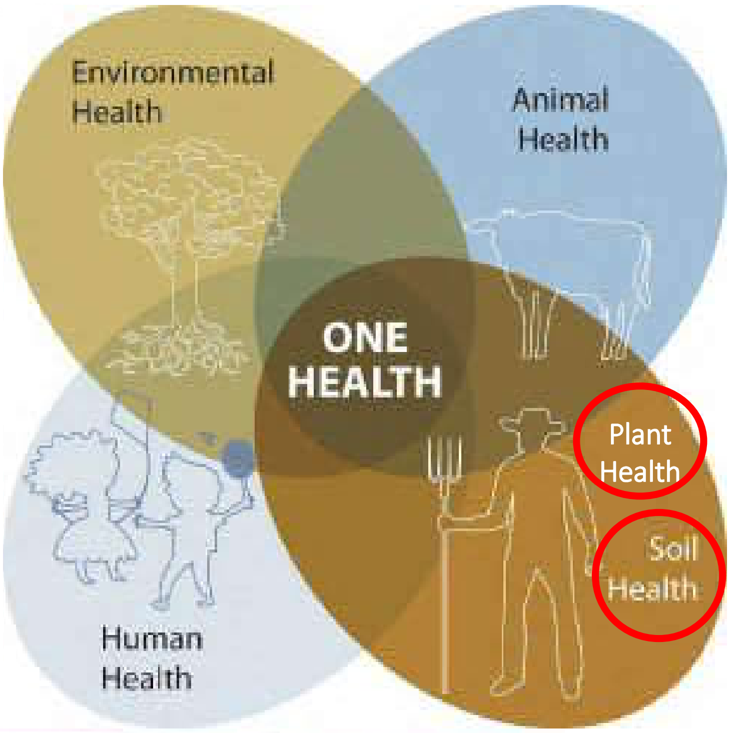

Carbon
Hydrogen
Oxygen
Silicon
Molybdenum
Nitrogen
Sodium
Chlorine
Potassium
Magnesium
Calcium
Sulphur
Phosphorus
Copper
Boron
The rest is obtained from the soil


A nutrient depleted soil cannot produce food that contains those macro and micronutrients necessary for human health
Recommended nutrient intake
NUTRIENT-DEPLETED SOIL

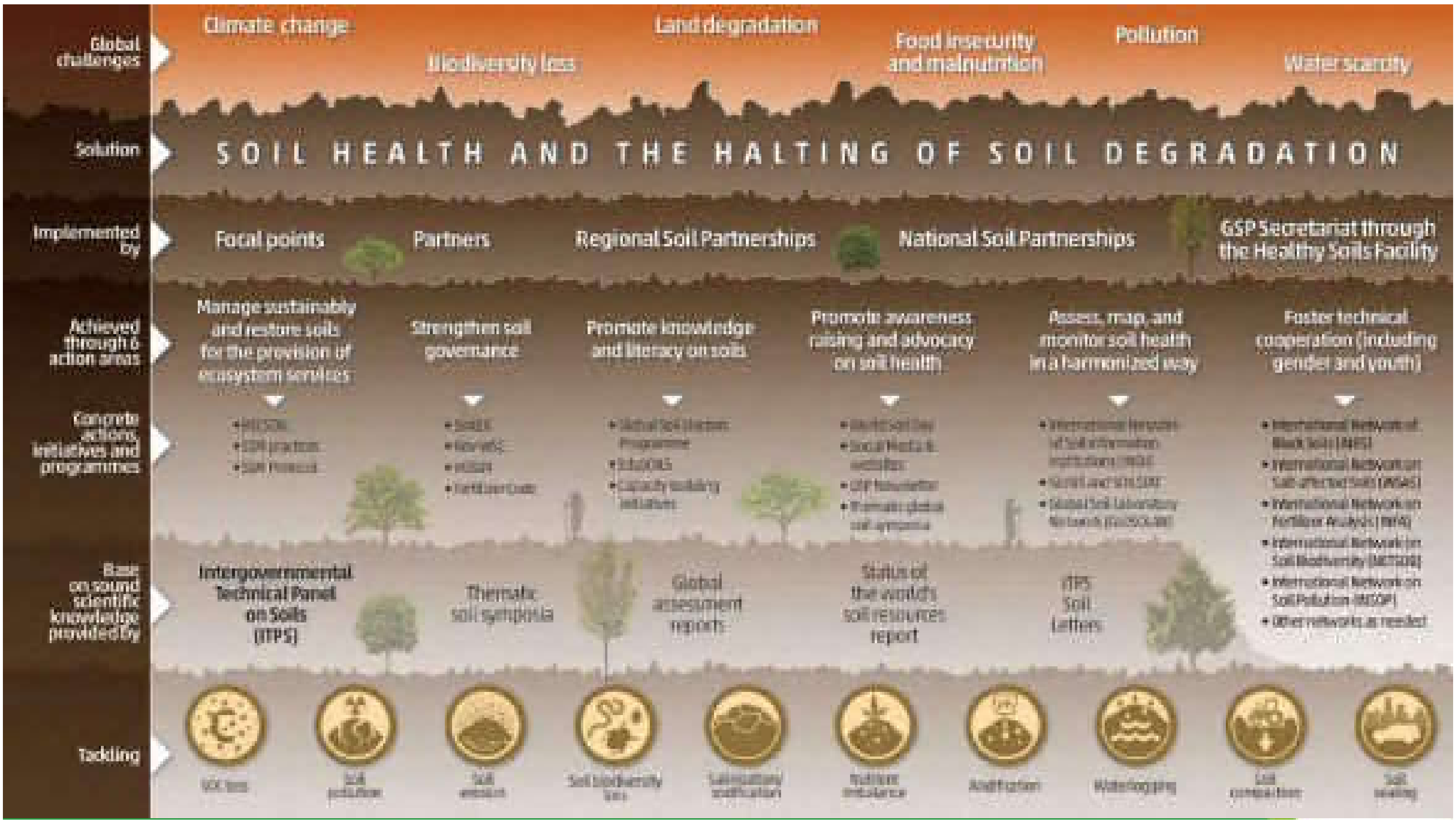

NITROGEN RETENTION
RECARBONIZATION
CLIMATE REGULATION
ENHANCE PRODUCTIVITY, YIELDS AND INCOME
SOIL PRODUCTIVITY
INCREASE SOIL BIODIVERSITY
EROSION PREVENTION
CONTAMINATION AVOIDED
MAINTAINANCE OF SOIL FERTILITY
CARBON SEQUESTRATION
INCREASE RESILIENCE TO DROUGHTS AND FLOODS
Less fertilizer use required
Less groundwater pollution
N2O mitigation Reduce global warming
Greater plant production
Less land degradation
Less flooding, more even stream flows
Less water needed for irrigation
Less of some pesticides may be needed
Greater groundwater recharge
Increased sequestering of CO2 Reduce global warming
Climate resilience of agrosystems and farmers' livelihoods

Opportunities on how a healthy soil can enhance plant health





The One Health approach needs to clearly consider Plant and Soil Health, otherwise, there will be a significant gap.



Way forward

- Continue advocating for Soil Governance at national level (all countries of the world should have soil governance in place).
- Awareness raising of general public on the importance of soils (where food begins….) and its importance for plant health.
- Implementation of the new GSP action framework and promote the achievement of the goal: **improve and maintain the health of at least 50 percent of the world's soils by 2030**.
- Promoting soils as a solution in the UN Conventions and integrating Sustainable Soil Management to crosscutting fields.
- Promoting the development and application of solutions to real issues (enhancing soil fertility, addressing soil pollution, carbon sequestration, soil information, etc).
- Advocating for investment on sustainable soil management including targeted research on soils.
- Capacity development and supporting provision of technical guidance to farmers on soils.
- Advocate for **Soil and Plant health** to be clearly recognized and included in the **ONE HEALTH APPROACH**.

Food and Agriculture Organization of the United Nations

International Plant Protection Convention

Department for Environment Food & Rural Affairs

London, 21 – 23 September 2022

International Plant Health Conference

Thank you for your attention!

Ronald Vargas
Secretary Global Soil Partnership

PROTECTING PLANTS PROTECTING LIFE

Food and Agriculture Organization of the United Nations

International Plant Protection Convention

Department for Environment Food & Rural Affairs

Healthy Soil for Healthy Crops: A Role for Regenerative Agriculture in Assembling Disease-Suppressive Soils

Prof. Jonathan R. Leake F.I. Soil Sci. The University of Sheffield, and Science Panel Member of the Sustainable Soils Alliance

London, 21 - 23 September 2022

International Plant Health Conference

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Disease-Suppressive Soils

Increased knowledge of beneficial soil microbiomes

Disease suppressive soils protect plants against soil-borne pathogens including fungi, oomycetes, bacteria and nematodes.

SCIENCE VOL 332 27 MAY 2011

Deciphering the Rhizosphere Microbiome for Disease-Suppressive Bacteria

Rodrigo Mendes, Marco Kruijt, Irene de Bruijn, Ester Dekkers, Menno van der Voort, Johannes H. M. Schneider, Yvette M. Piceno, Todd Z. DeSantis, Gary L. Andersen, Peter A. H. M. Bakker, Jos M. Raaijmakers

frontiers in Microbiology

Current Insights into the Role of Rhizosphere Bacteria in Disease Suppressive Soils

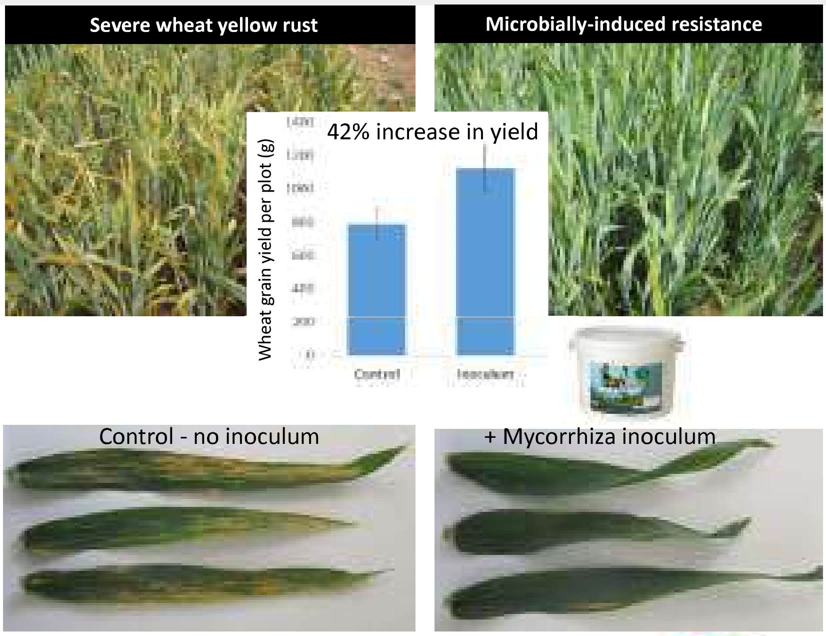
frontiers

Development of plant systemic resistance by beneficial rhizobacteria: Recognition, initiation, elicitation and regulation

Disease suppression by soil microbiomes. Key groups associated with disease-suppression include Proteobacteria, Firmicutes, and Actinobacteria.

Induction of systemic resistance includes root and shoot pathogens.

Suppression of yellow rust in wheat grown in long-term arable soil by addition of commercial mycorrhizal inoculum that contains bacteria and other microbes

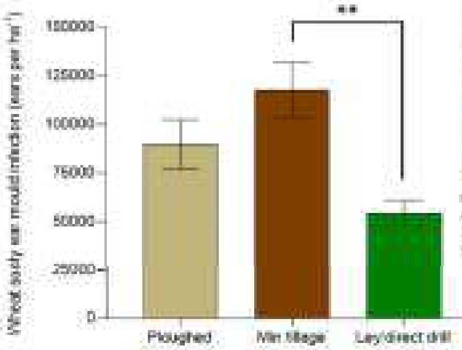


Can disease-suppressive soil be developed from intensively cultivated arable land by regenerative agriculture approaches?

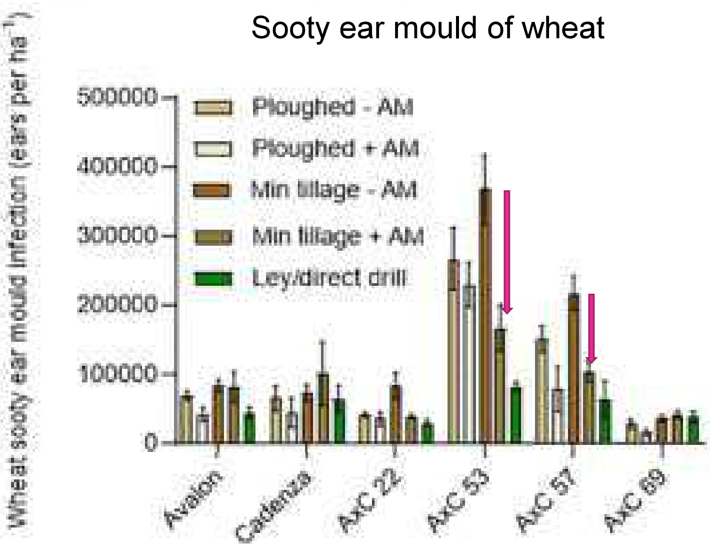
Experimental Evaluation of Biological Regeneration of Arable Soil: The Effects of Grass-Clover Leys and Arbuscular Mycorrhizal Inoculants on Wheat Growth, Yield, and Shoot Pathology.

Michele Austen, Stefania Tille, Despina Berdeni, Leslie Firbank, Martin Lappage, Michael Nelson, Thorunn Helgason, Ewan Marshall-Harries, Bleddyn Hughes, Richard Summers, Duncan D. Cameron, Jonathan Leake

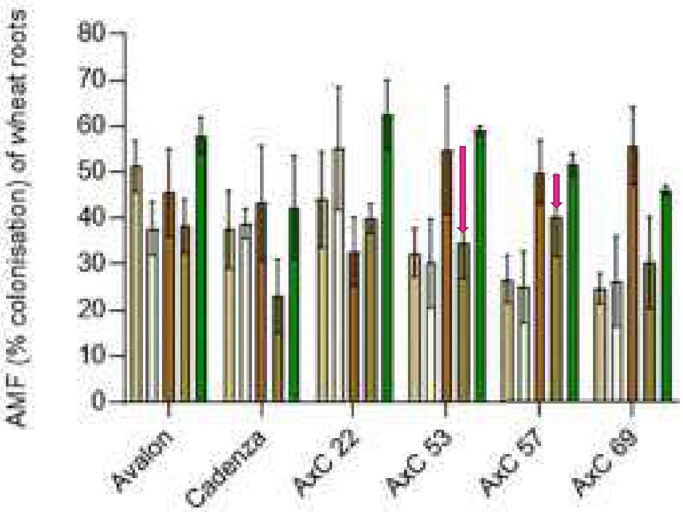
Sooty ear mould of wheat



Sooty ear mould of wheat



Mycorrhization of wheat

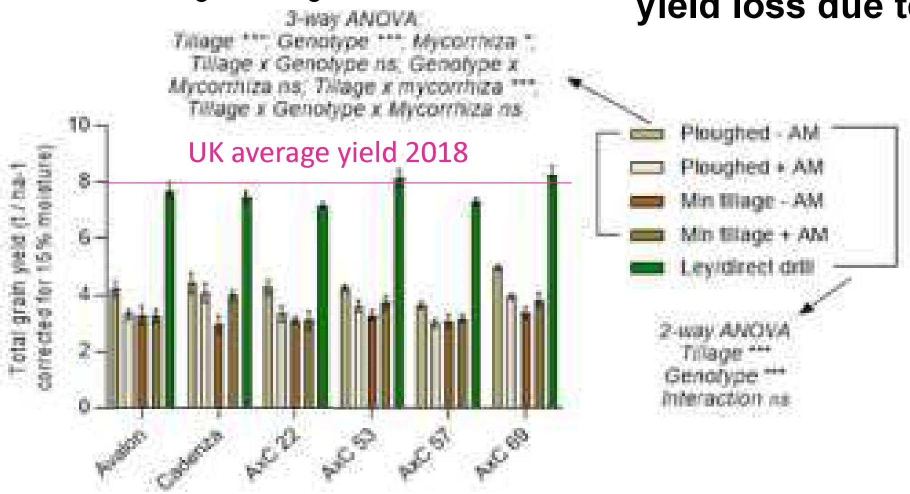


Disease suppressiveness of commercial mycorrhizal inoculum not associated with improved mycorrhization- likely due to bacteria.

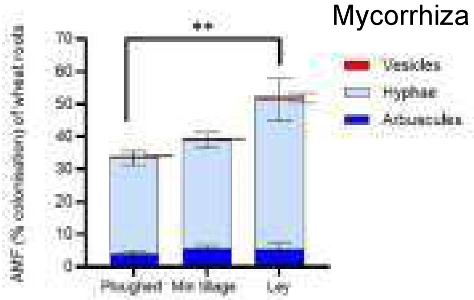
Austen *et al.*, 2022

Wheat yields in ley- no evidence of yield loss due to induced defences.

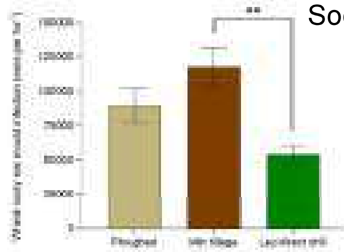
Wheat grown with only 35 Kg N ha^{-1} rather than the average 137 Kg N ha^{-1}



Mycorrhiza



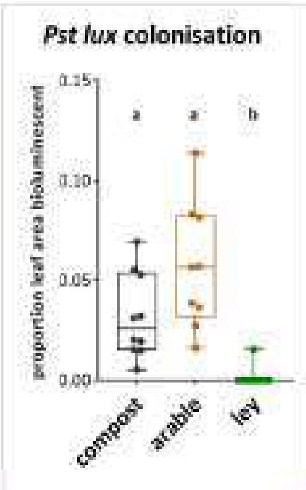
Sooty ear mould

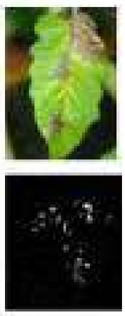


Changing arable to legume-rich ley improves mycorrhization, generates disease-suppressive soil and reduces N fertilizer requirements- regenerative agriculture.

Identifying and transferring resistance-inducing microbes from ley soils

Nancy Muringai, Prof. Jurriaan Ton, Dr. Anna Krzywoszynska*, Prof. Stephen Rolfe,
School of Biosciences, The University of Sheffield, UK, (*now at University of Twente)



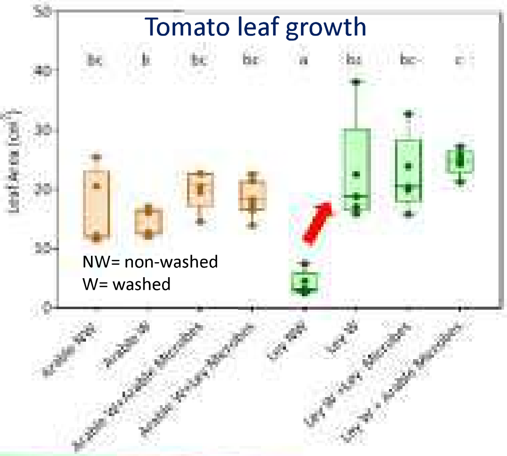


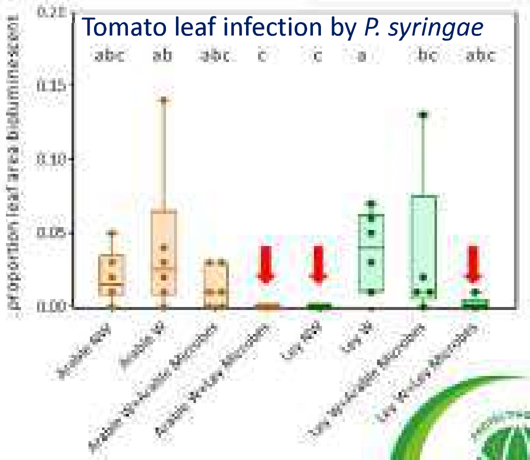
Ley soil induced tomato resistance to *Pseudomonas syringae*, but with lower growth rate.

Extraction and inoculation of disease-suppressive microbiomes from ley soil to arable soil.

Tomato growth on ley soils increased after soil washing (W).
Re-addition of microbes had no further effect on plant growth.

Washing (W) removed resistance-inducing microbes but they could be restored by re-adding ley microbes to washed arable or ley soils.





Take-home messages

Healthy Soil for Healthy Crops:
A Role for Regenerative Agriculture in Assembling Disease-Suppressive Soils

Leys rest soil from disturbance, increase diversity, keep soil covered, and maintain year-round living roots feeding the soil with carbon and nitrogen.

- Arable soil health can be regenerated by reintroducing legume-rich leys.
- Leys can develop soil microbiomes that suppress plant diseases – including shoot pathogens.
- Locally adapted soil microbiomes can be extracted from leys and inoculated into arable soil in pot experiments to deliver disease suppressive soils.
- Regenerative agriculture approaches such as reintroducing leys into arable rotations has the potential to improve soil and crop health and reduce reliance on chemical fertilizers and pathogen controls.

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Practical strategies for managing soil health in temperate agricultural systems

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Threats to agricultural soils

Compaction:

- Livestock and machinery

Erosion:

- Bare ground and compaction

Loss of organic matter:

- Soil disturbance and lack of inputs to cultivated systems

Impacts of poor soil quality

- Lower yield (typically 10-20%; up to 100%)
- More uneven crop
- Higher weed/disease pressure
- Poor drainage
  - ➢ Reduced timeliness (machinery work days)
- Increased fuel use: 50%+
- Gross margins ↓ £600-£1,200/ha or 15-30%
- Increased risks of erosion and surface runoff

(Balshaw *et al*., 2014; Hallet *et al*., 2012; Mouazen & Palmqvist, 2015)

Preventative measures

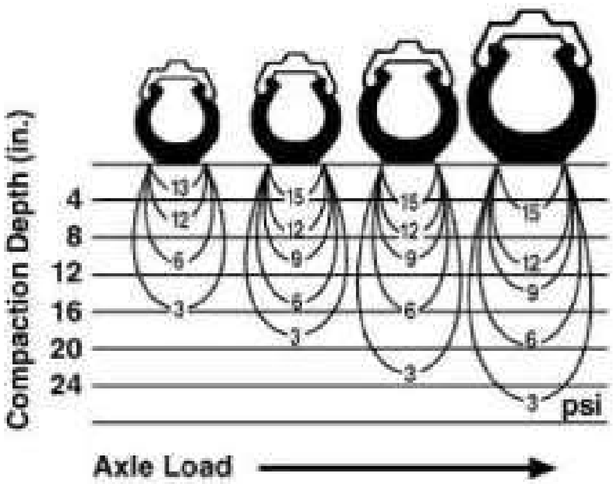
Keep stock off wet ground:
- Manage turn out times and stocking rates
- Move feeders regularly

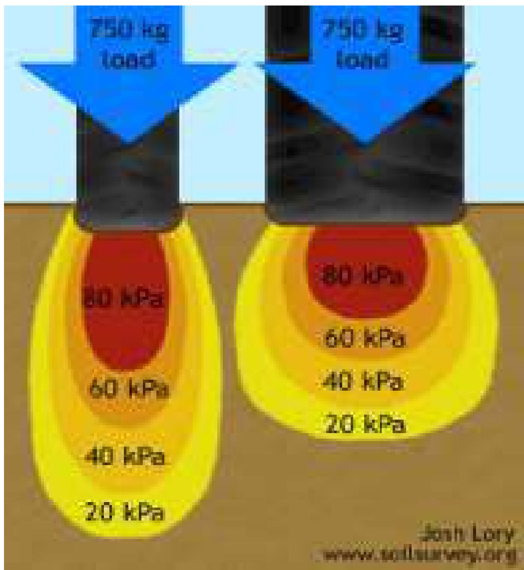
Machinery:
- Balance and ballast machinery to reduce wheel slip
- Low ground pressure tyres
- Reduce the trafficked area (CTF)

Rotation & crop choice
- Minimise bare ground
- Cultivation timing

Enhance soil organic matter levels to build resilience

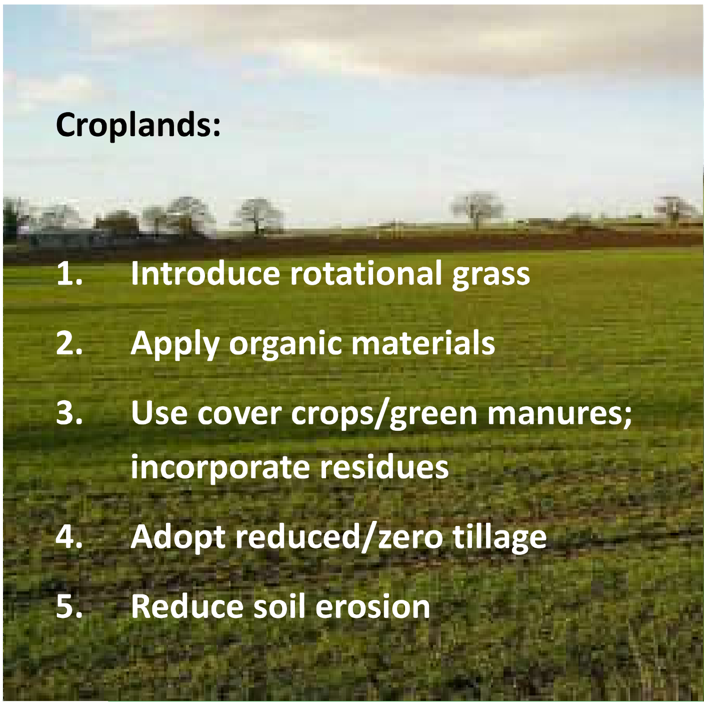
The effect of axle loading and tyres on compaction

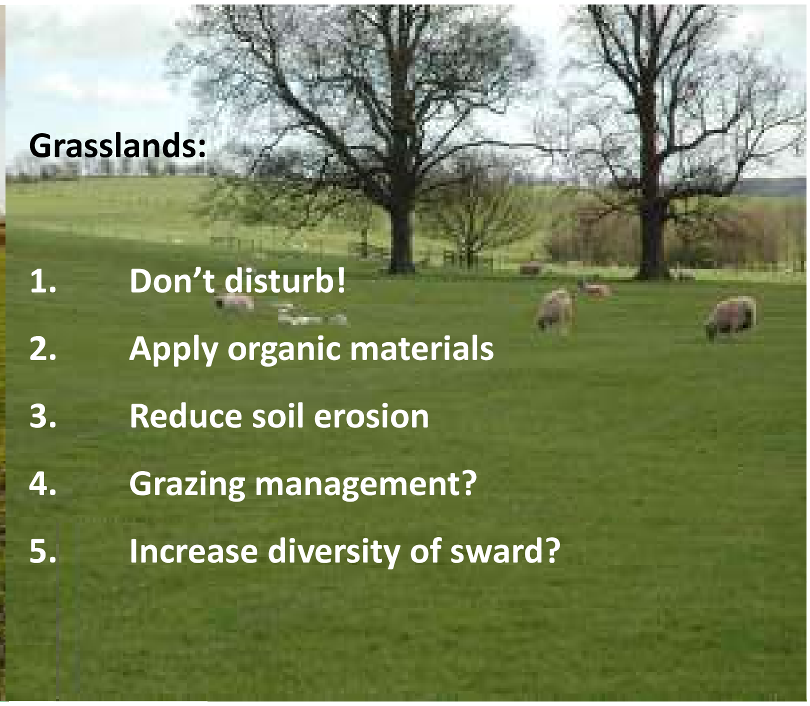




What can we do to maintain/increase SOM?

Defra project: SP08016 (2009)





How to assess soil health – an integrated approach:

Chemistry:
- Soil analysis – pH, P, K, Mg

Physics:
- Soil examination – dig holes
- Compaction, colour, smell

Biology:
- Soil organic matter
- Earthworm counts

AHDB Soil Health Scorecard

Comparison categories	Soil health scorecard indicators		
	Physical	Chemical	Biological
Region (rainfall class)	Visual assessment of soil structure (VESS) most limiting layer	pH, Ext. P Ext. K Ext. Mg	Earthworm count SOM (Microbial activity)
Rotational cropping			
Topsoil character			

Investigate

Review

Continue rotational monitoring

- Tested at long-term experimental sites and with farmer groups; used on AHDB Monitor and Strategic farms
- Video 'walk through', benchmarks and guidance
- www. Testing the soil health scorecard | AHDB

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Thank you for listening

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Soil health, the soil microbiome and plant health

Communication to support change

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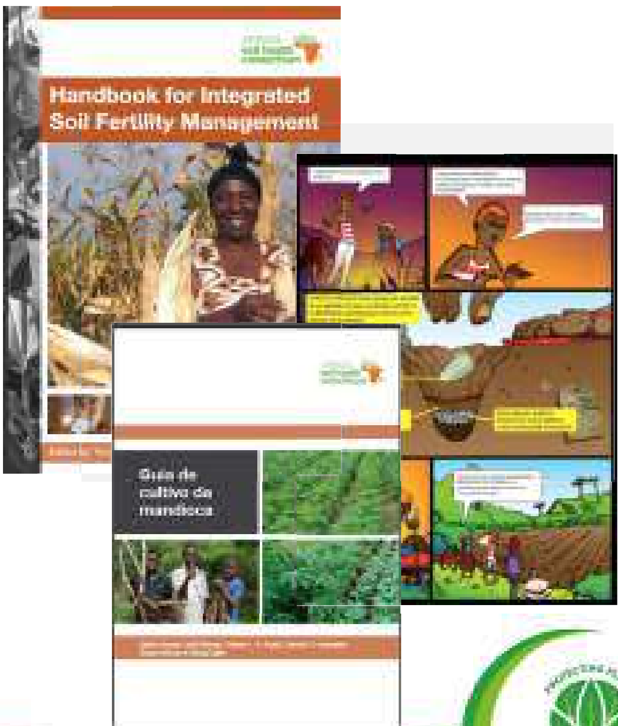
Africa Soil Health Consortium

Project implementation
- Scale-up campaign model developed and tested
- Responsive partnership model used
- Mixed media – video, radio, drama, comics, VBA

Project outputs
- 18 scale-up campaigns were carried out in 4 countries reaching 1.3 million farmers
- Crops included maize, common bean, soybean, cassava, potato and banana
- Online resource of materials

Project outcomes
- Adoption rates increased by ≥20%,

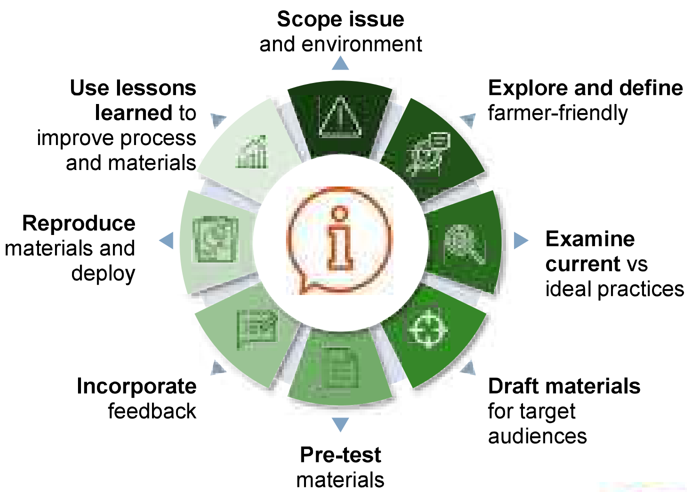


Different approaches for different campaigns

Early warning campaign	New technology campaign	Good Agricultural Practices
Aim Identification, prevention and management of Fall armyworm	**Aim** Promotion of Rhizobium inoculant for legume farmers	**Aim** Good Agronomic Practices for maize, bean, Irish potato and cassava
Communication activities implemented Posters for public awareness; media briefings for journalists; radio interview series; fact sheets for support services; knowledge bank updates	**Communication activities implemented** Radio interview series; print guides for point of sale and extension; farmer posters; training of trainers, film screenings, Village Based Advisors	**Communication activities implemented** Radio expert interviews interspersed with listener feedback using the *Uliza* phone-in system; SMS feedback; follow-up surveys to assess effectiveness

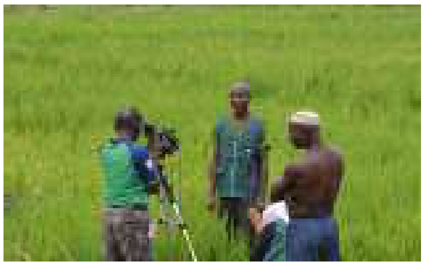
Content development

- Engage National stakeholders to ensure buy-in
- Communication specialists need to
  - Help identify key information
  - Simplify messages
  - Ground-truth practicality
  - Pilot messaging and materials
- Partnership between
  - Knowledge partners
  - Value chain partners
  - Delivery partners



Lessons learnt– information is necessary but not sufficient

- Barriers to changing practice are many e.g. too costly, too time consuming, inputs not available.
- Farmers are looking to address their problems and rarely only on information about the latest research
- Changing to a better version of an existing product or practice is much easier than a completely new product (e.g. rhizobia) – greater support required for the latter
- Stepwise approach to recommendations can encourage adoption
- Different communication approaches work better for different community sectors for example:



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Dannie Romney
Global Director – Development, Communication and Extension

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