



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



Climate change is everywhere and at anytime





Impact of Climate Change on Plant Health is in Every Aspect





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 farmers' livelihoods* by **increasing** farmers' incomes recovered from effective pest quarantine and control: **Safe Trade**



International
Plant Protection
Convention

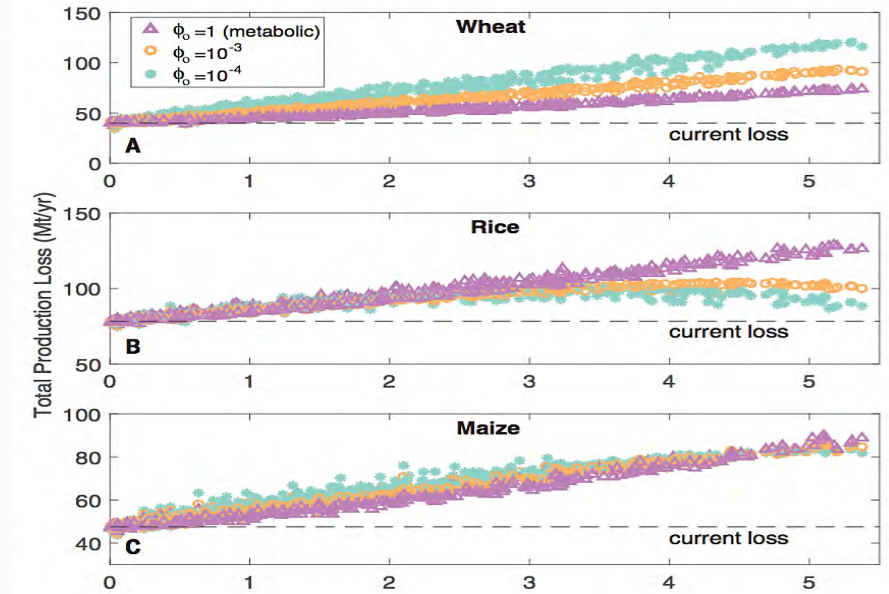


Presentation Outline

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)*

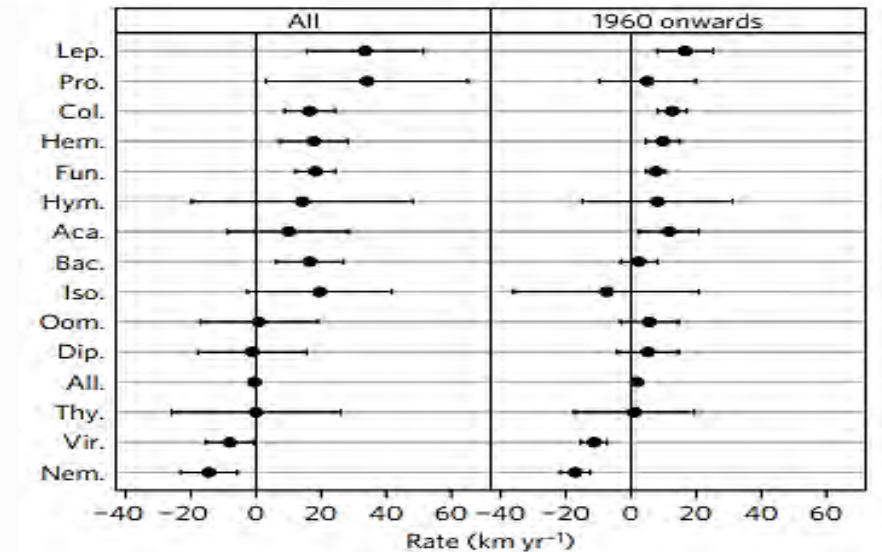
- **Higher temperatures:**
 - Higher developmental rate, resulting shorter pest life cycle; earlier establishment; more generations
 - Increased winter survival at higher latitudes, resulting in elevated population abundance and pesticide resistance
- **Higher atmospheric CO₂ concentration:**
 - Slower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



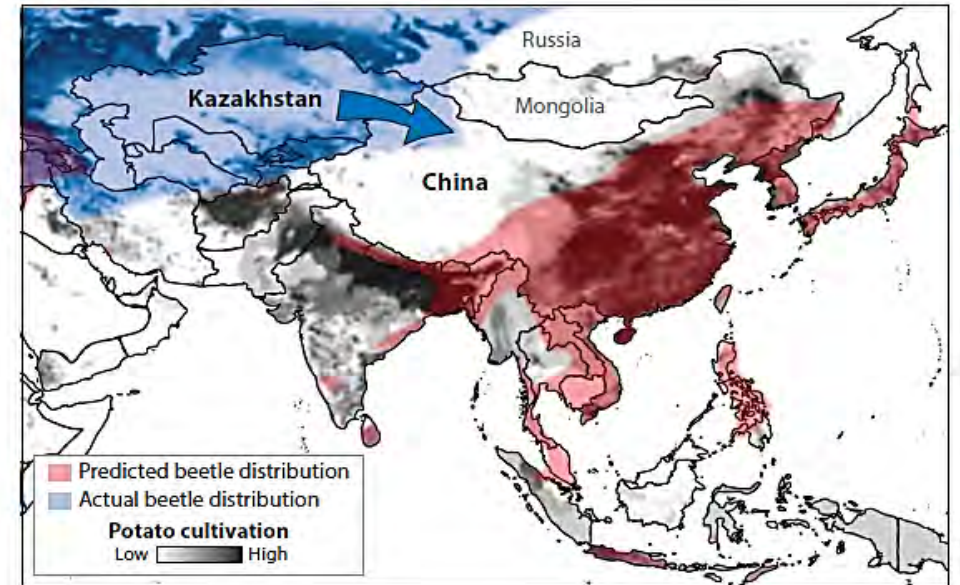
1. Impact of Climate Change: **Disrupt plant-pest-natural enemy food webs** (3/5)

- **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



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*).



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

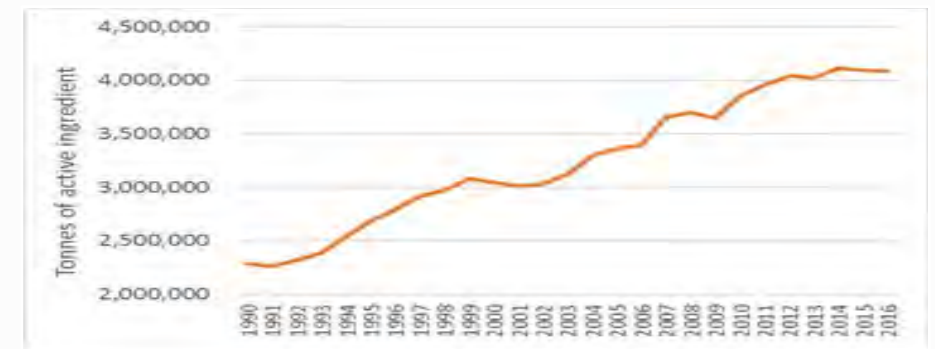
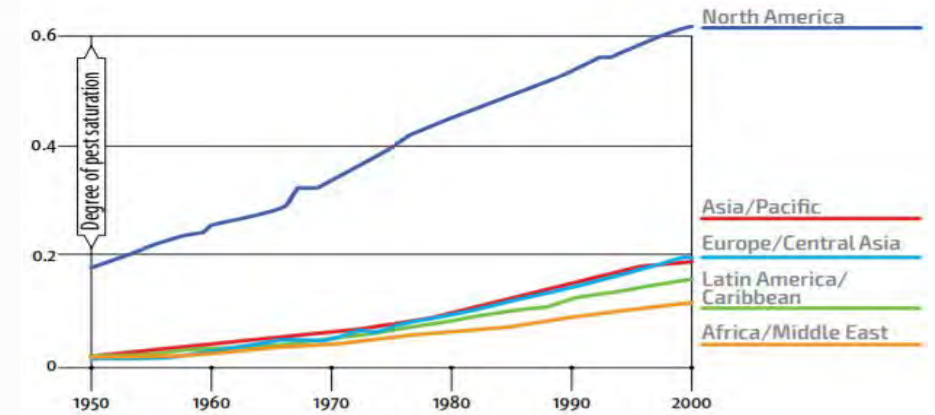
Pest/Weed Species	Active ingredients	Environmental factors	References
<i>Frankliniella occidentalis</i>	Avermectin	Reduced efficacy under elevated temperatures	Li et al. 2014
<i>Nilaparvata lugens</i>	Triazophos	Reduced efficacy under enriched CO ₂	Ge et al. 2013
<i>Amaranthus palmeri</i>	Mesotrione	Reduced efficacy under elevated temperatures	Godar et al. 2015
<i>Chenopodium album</i>	Glyphosate	Reduced efficacy at enriched CO ₂	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





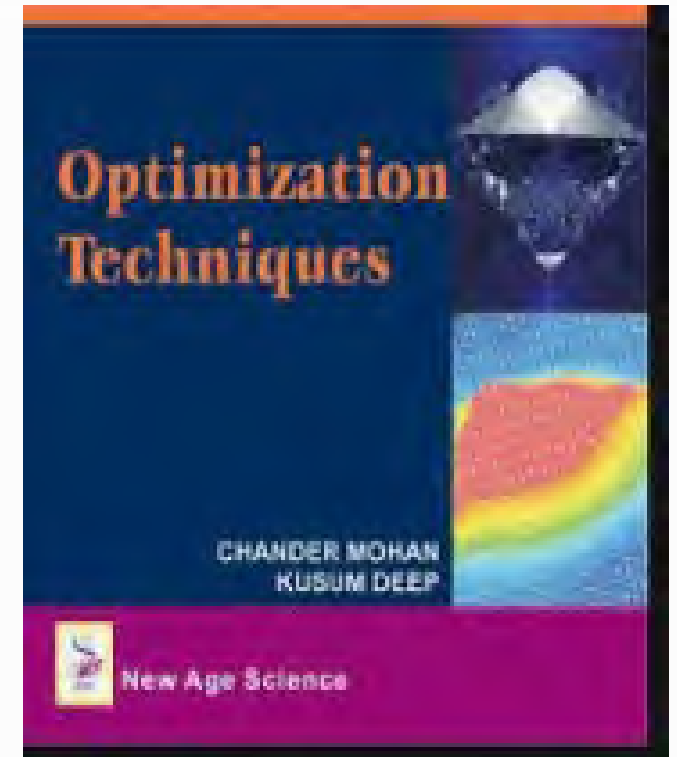
2. Strategy for Mitigation: *Transform to One Health Approach (1/5)*

- **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



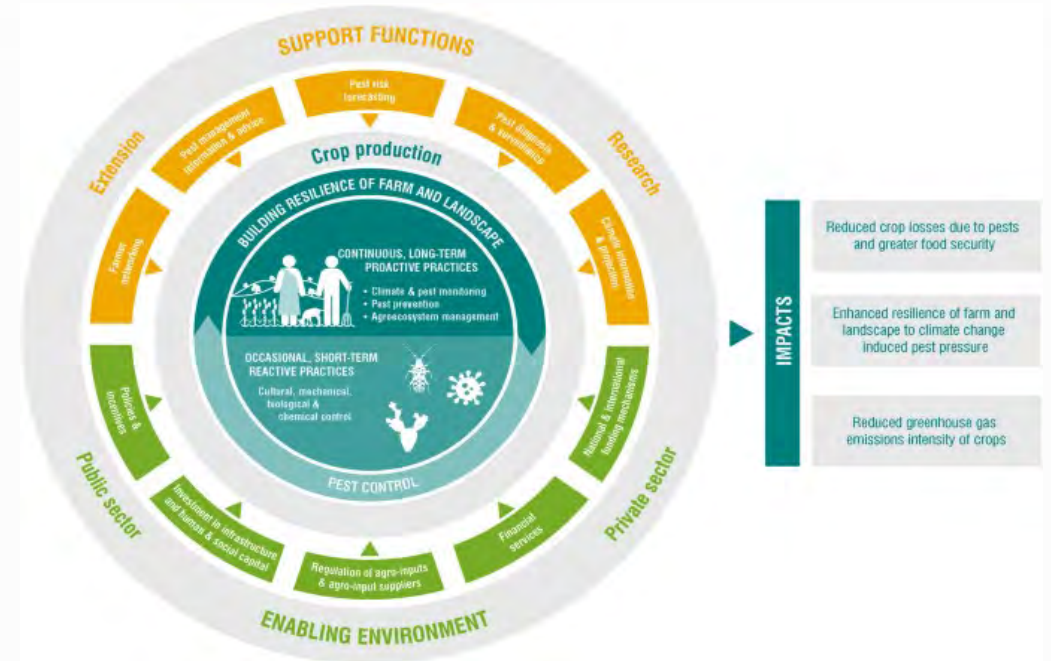
2. Strategy for Mitigation: **Mainstream optimization and minimization (2/5)**

- **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)**

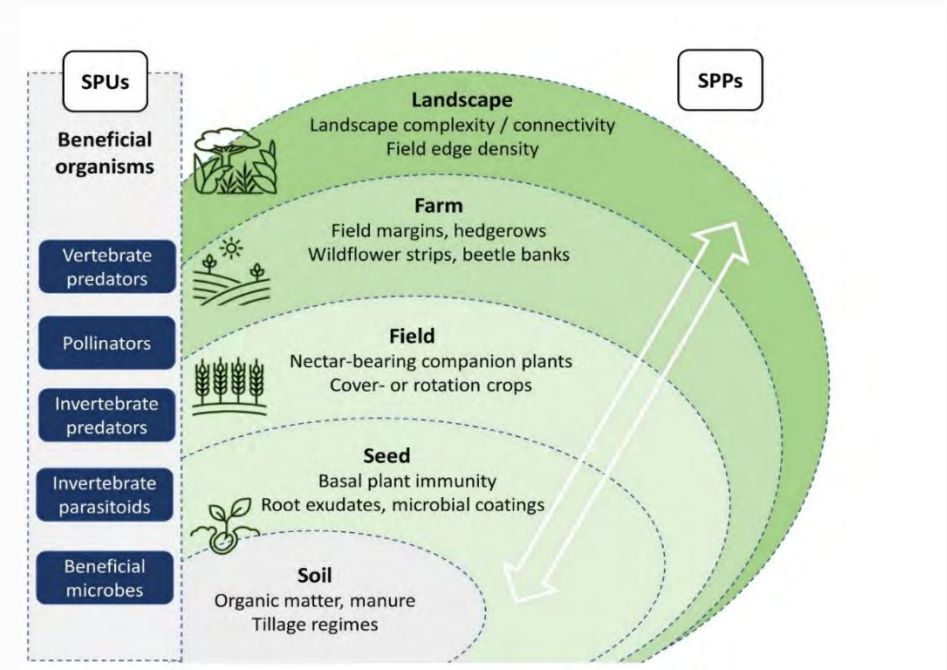
- **Concept of Climate-smart pest management (CSPM):** A cross-sectoral approach is to intensity per unit of food produced and strengthen the resilience of agricultural systems in the face of climate change by reducing pest-induced crop losses, enhancing ecosystem services, and decreasing the greenhouse 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





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 Phytosanitary 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





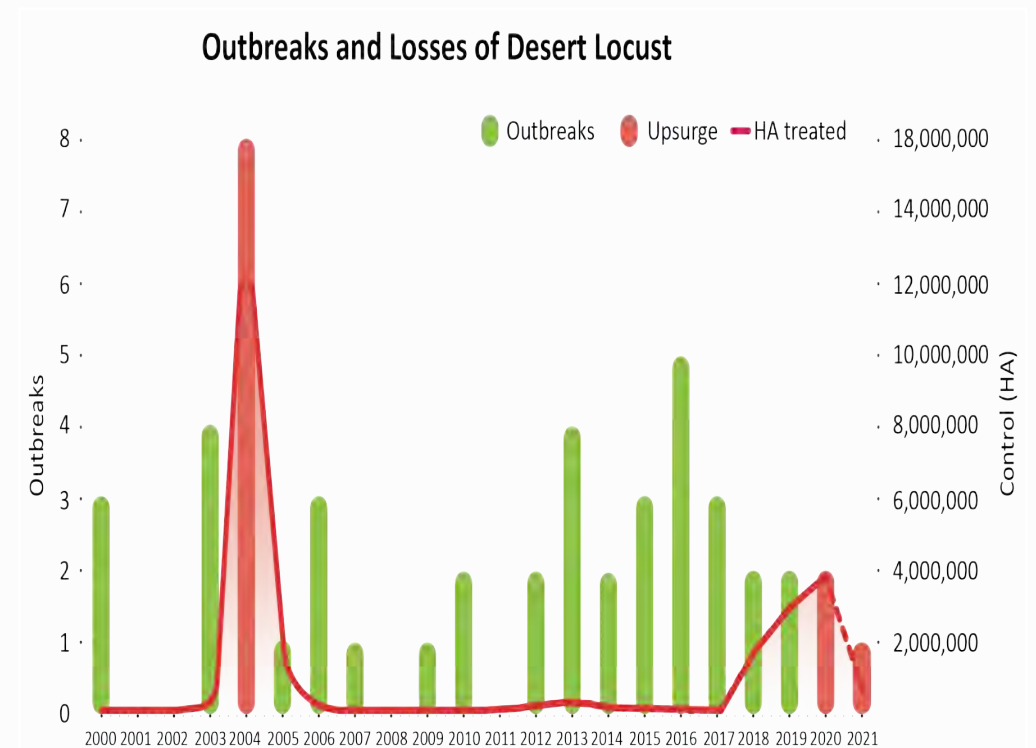
3. FAO Action on Mitigation: *End of desert locust crisis (2019-22) (2/5)*

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:

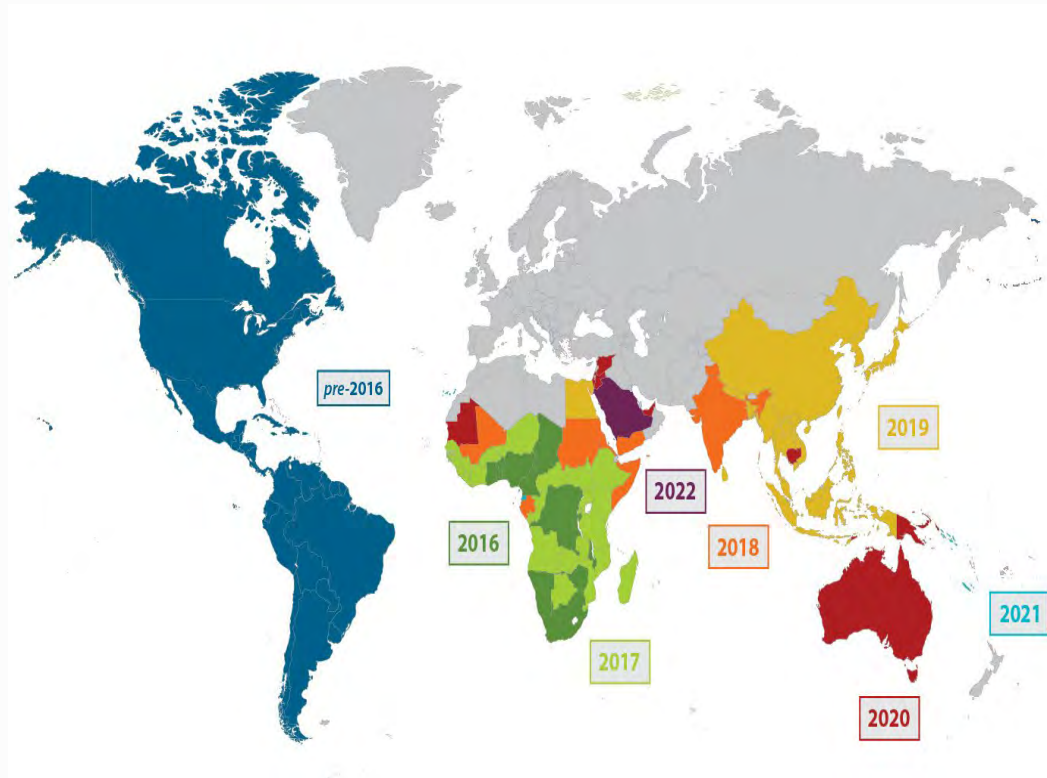
- **5.7 Ha** controlled;
- **USD 243 million** mobilized
- **1.4 million tones** crop losses saved for securing food for over **13 million people**



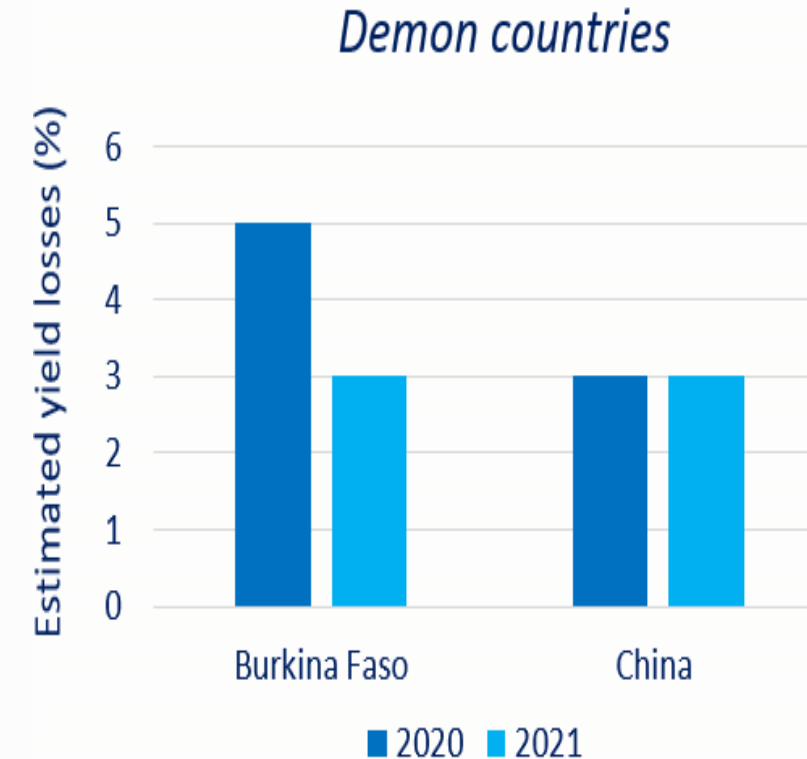
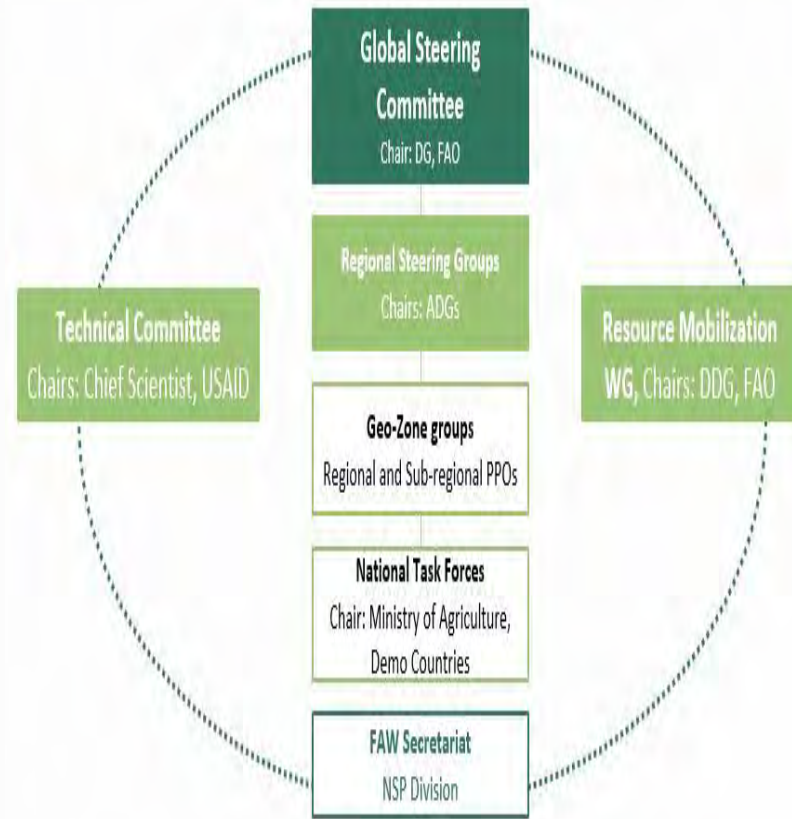
5 million Metric Tonnes of Cereals Protected Each Season

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)



- ! Problem Area (Race 1)
This area is under attack by Race 1 of Panama disease.
- ! Problem Area (Tropical Race 4)
This area is under severe attack of the new Tropical Race 4 (TR4) strain of Fusarium.
- + Banana daily diet area
This area is on risk. The farmers here made the banana their living.



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



INTERNATIONAL YEAR OF
PLANT HEALTH

2020



London, 21 – 23 September 2022

**International
Plant Health
Conference**

REGISTER NOW





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



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

NSPMD: *Shoki AlDobai; Alexandre Latchininsky; Fazil Dusunceli*

NSPCD: *Baogen Gu; Anne-Sophie Poisot; Suzanne Philipps;*

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*



Contact Us

- ***Plant Production and Protection Division (NSP)***

NSP-Director@fao.org

NSP-Deputy-Director@fao.org

Website: <http://www.fao.org/agriculture/plant-production-and-protection/en/>



Food and Agriculture Organization
of the United Nations

Thank you