

The Scientific Significance of Plant Health for One Health

Sunday Ekesi

Deputy Director General – Research for Development, *icipe*

CPM-19 (2025) Science Session: The importance of Plant Health for One Health.
15:00-17:30 (CET), Plenary Hall, FAO Headquarters, Rome, Italy.
20th March 2025



**19th Session of the Commission
on Phytosanitary Measures**

#Planthealth for food security, environmental protection and safe trade

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Outline

01

About *icipe*

02

Global developmental challenges impacting plant health within one health (OH)

03

Importance of plant health for one health (OH)

04

Impact of plant health within one health (OH)

05

Solutions & economics of plant health for one health (OH)

06

Take home message / concluding remarks



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icipe – General Facts

- **Center of Excellence in Africa** for research and capacity building in insect science and its application
- **Intergovernmental organization** - charter signed by 13 countries worldwide
- **>571 staff (>30 nationalities)** and several contracted workers
- **150-180 graduate students** annually
- **>300 partners**



World Organisation
for Animal Health
Founded as OIE



WHO-AFRO Partner
for Vector
Management



STOCKHOLM
CONVENTION



FAO Reference Centre for
Vectors and Vector-borne
Animal Diseases

Collaborating Centre
for Bee Health in
Africa



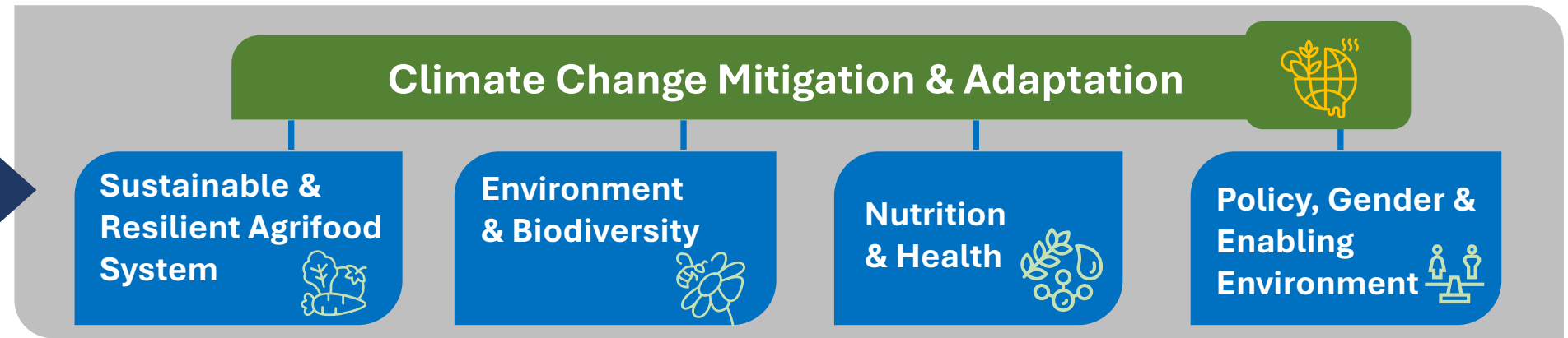
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Themes & Platforms contribute to 5 Impact Domains

icipe Impact Domains



Themes & Integrated Platforms

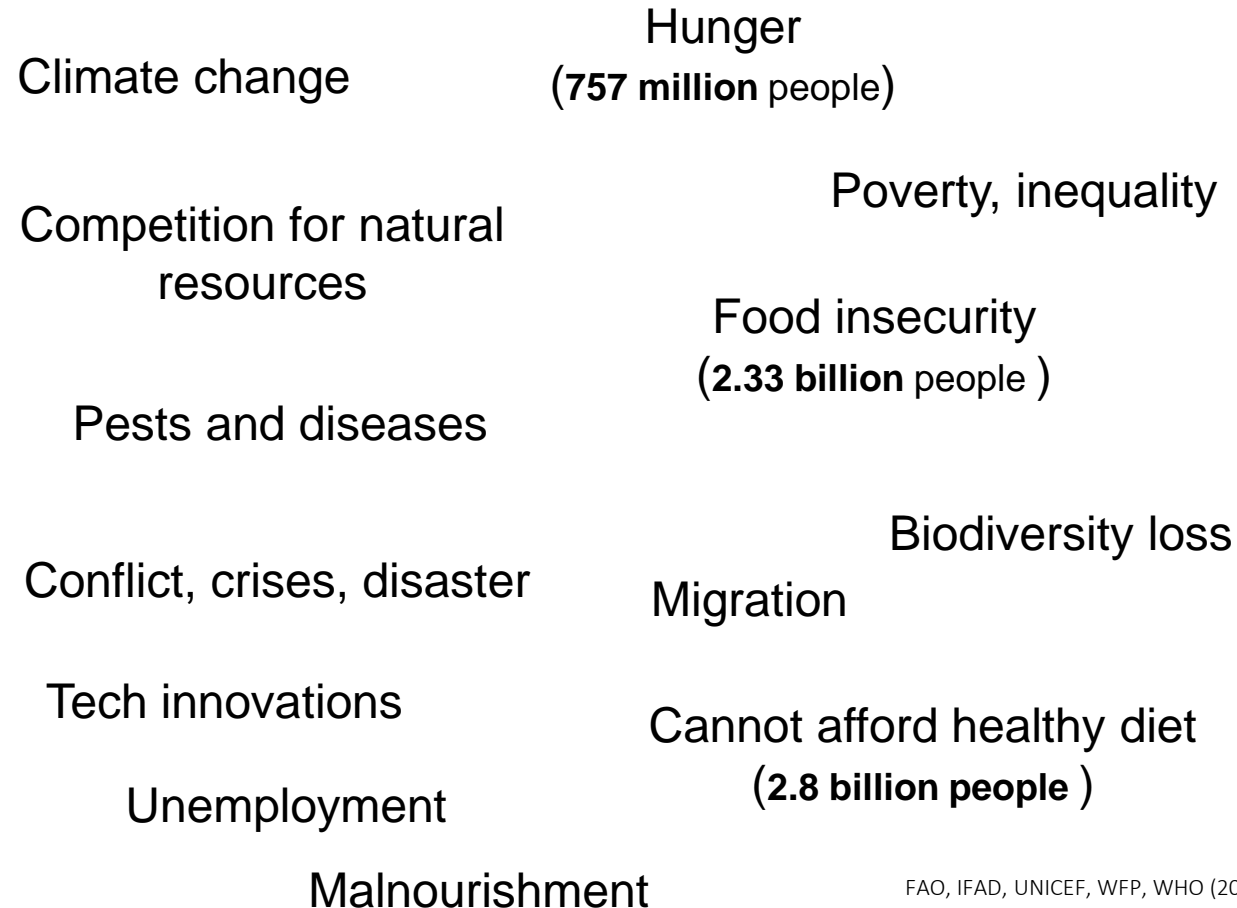


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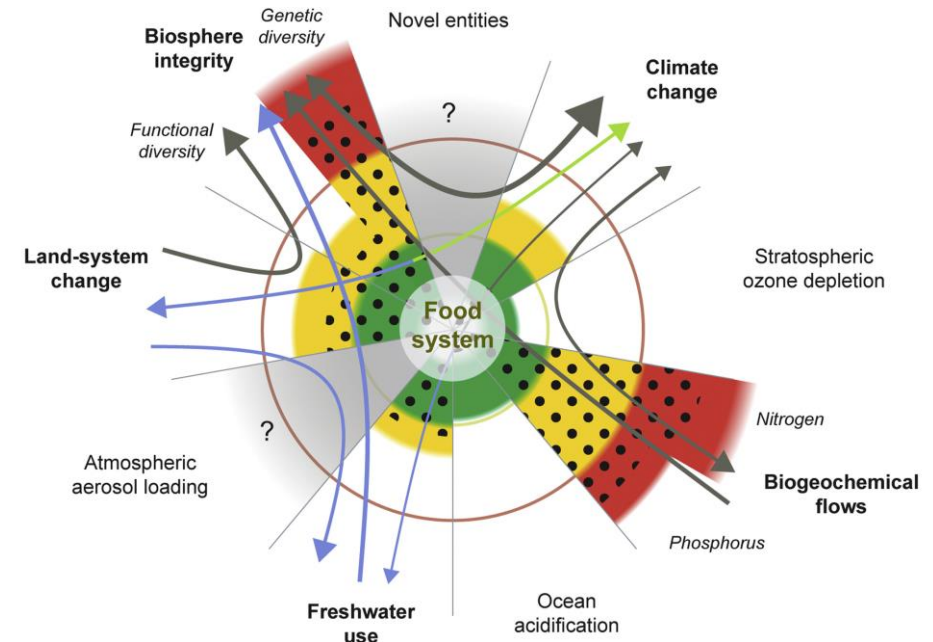
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MEGA-TRENDS impacting Plant Health within OH



...agriculture/plant health is also pushing planetary boundaries



FAO, IFAD, UNICEF, WFP, WHO (2024) Campbell et al (2017)

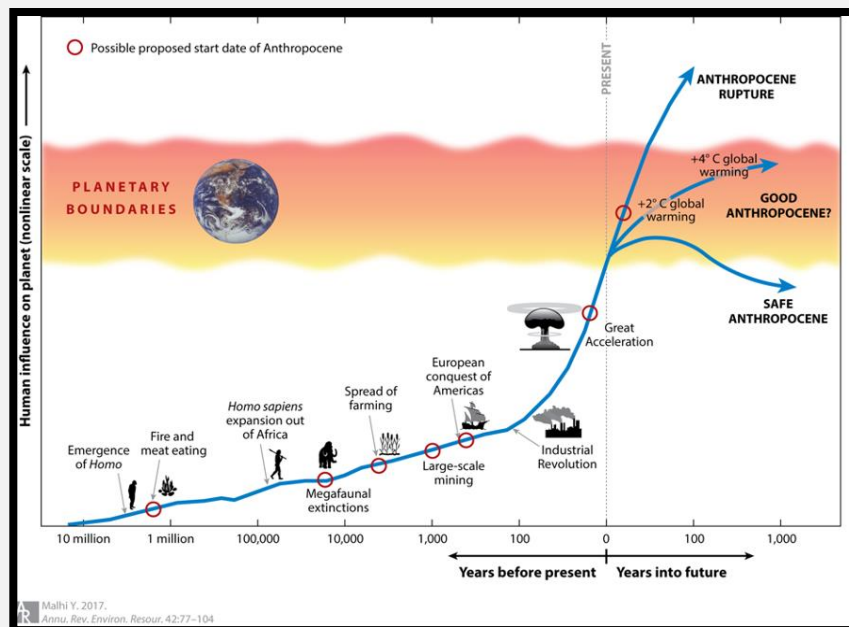


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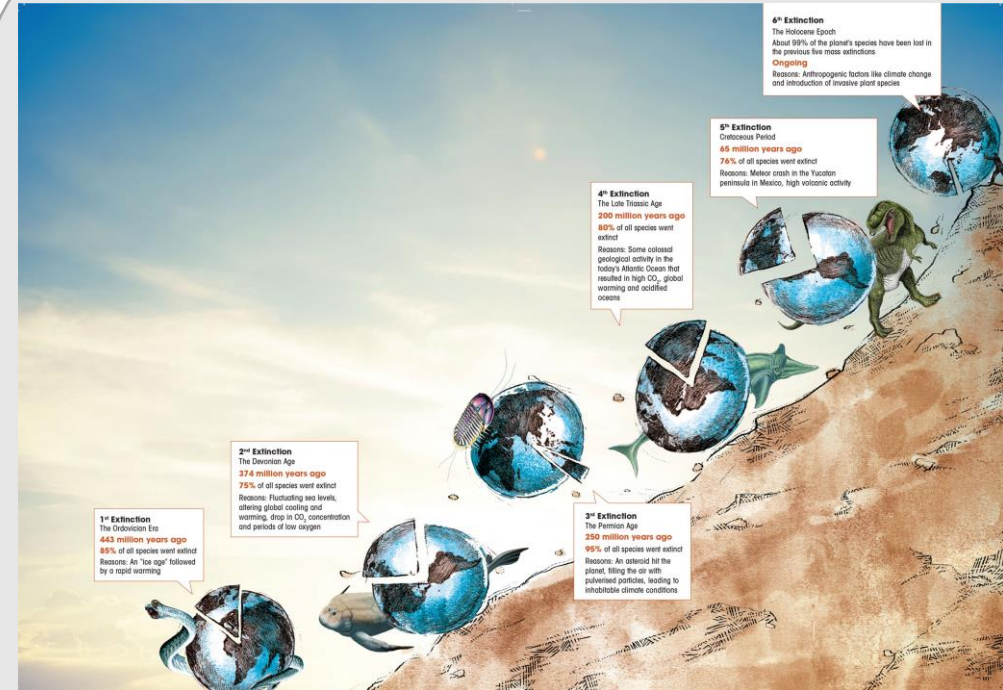
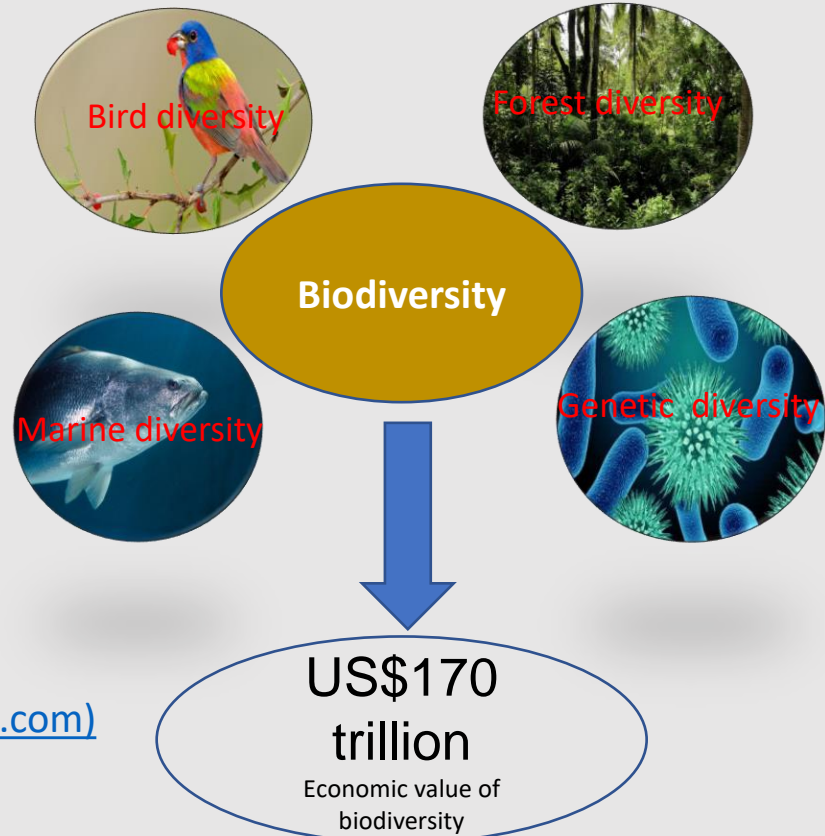
Anthropocene: Predation or Preservation?



- **Stage 1:** 1800 to 1945, is called the “Industrial Era”;
- **Stage 2:** which extends from 1945 to ca. 2015, is called the “**Great Acceleration**”;
- **Stage 3:** which may now be starting, is a stage when people have become aware of the extent of the human impact and may thus start stewardship of the earth system. – Shall we call it the “**Big Consternation**”?

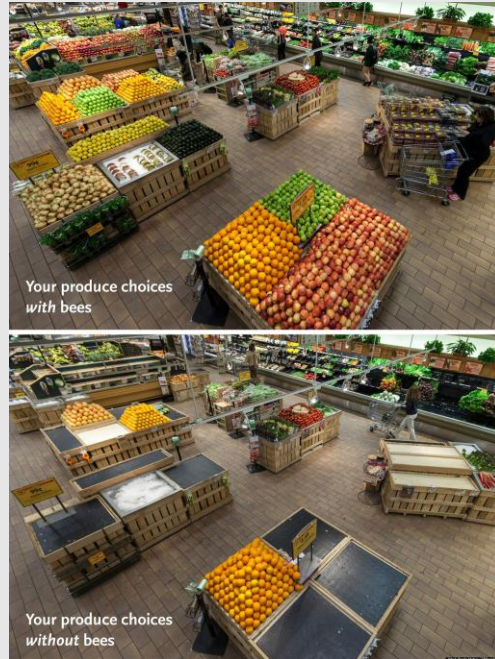
Human domination has profoundly shaped the planet and its biodiversity

Sixth Extinction?



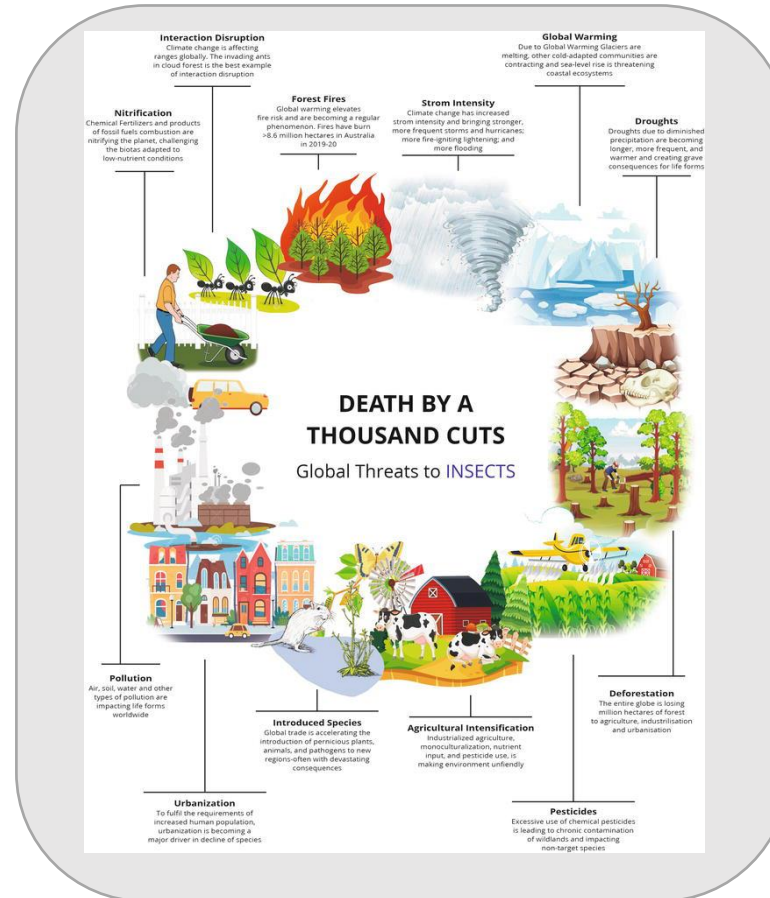
<https://www.downtoearth.org.in/>

Biodiversity loss



Product choices with
OR
without bees

www.farmprogress.com



Global burden of pests and pathogens



Pest images by G. Goergen

Disease plant images by S. Sevgan



Annually up to 40% of global crop production is lost to pests and pathogens.



Annual agricultural trade losses amount to \$220 billion.



Economic cost due to invasive pests alone - \$70 billion.

IPPC (2021); Savary et al (2019); Carvajal-Yepes et al., (2019)

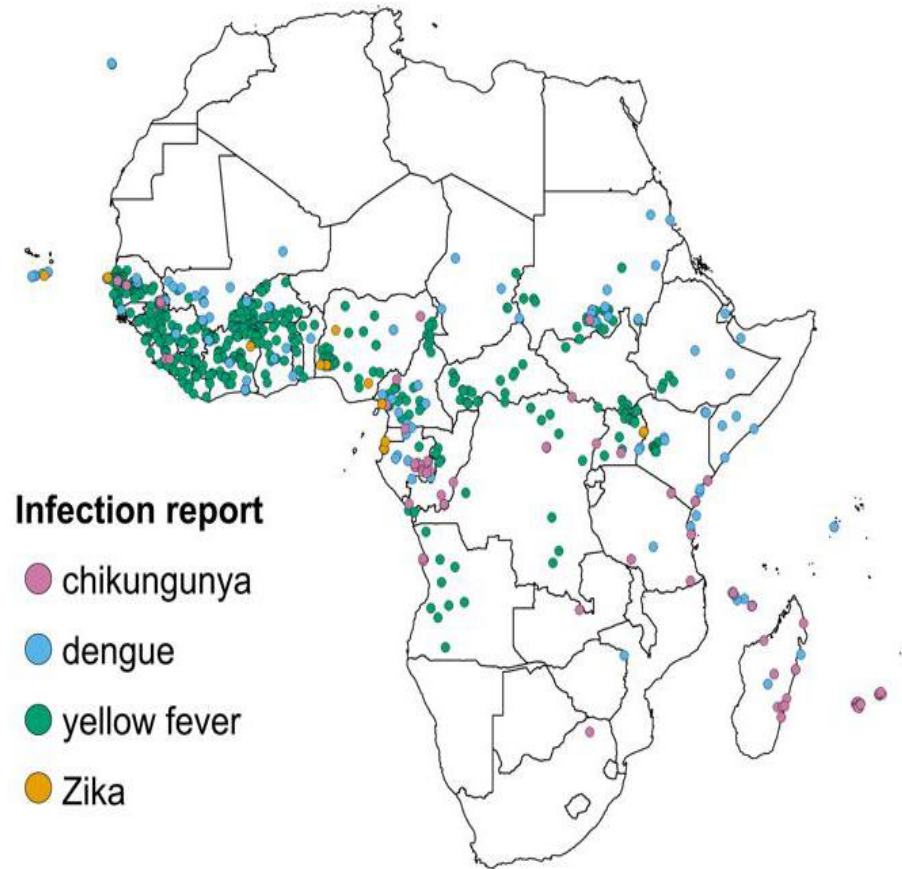


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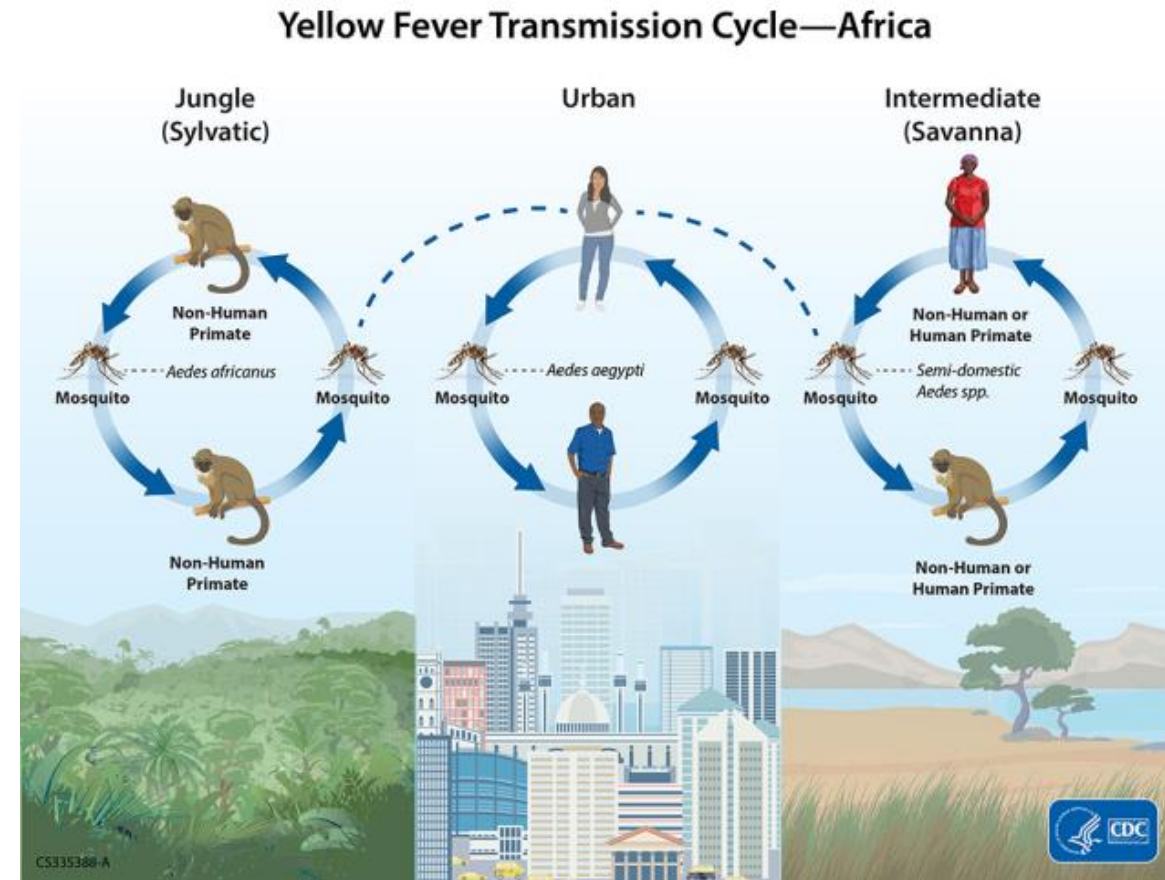
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Increasing menace of zoonotic viral diseases



Weetman et al 2018; Int J Environ Res Public Health, 15(2)



Unprecedented convergence of multiple disruptors

1

Climate change

2

Environmental
degradation

3

Growing
population

4

Conflict & geo-
political stability

Lack of coordinated responses impact Plant Health

5

Global health
crises

6

Consumption
patterns and
change diet

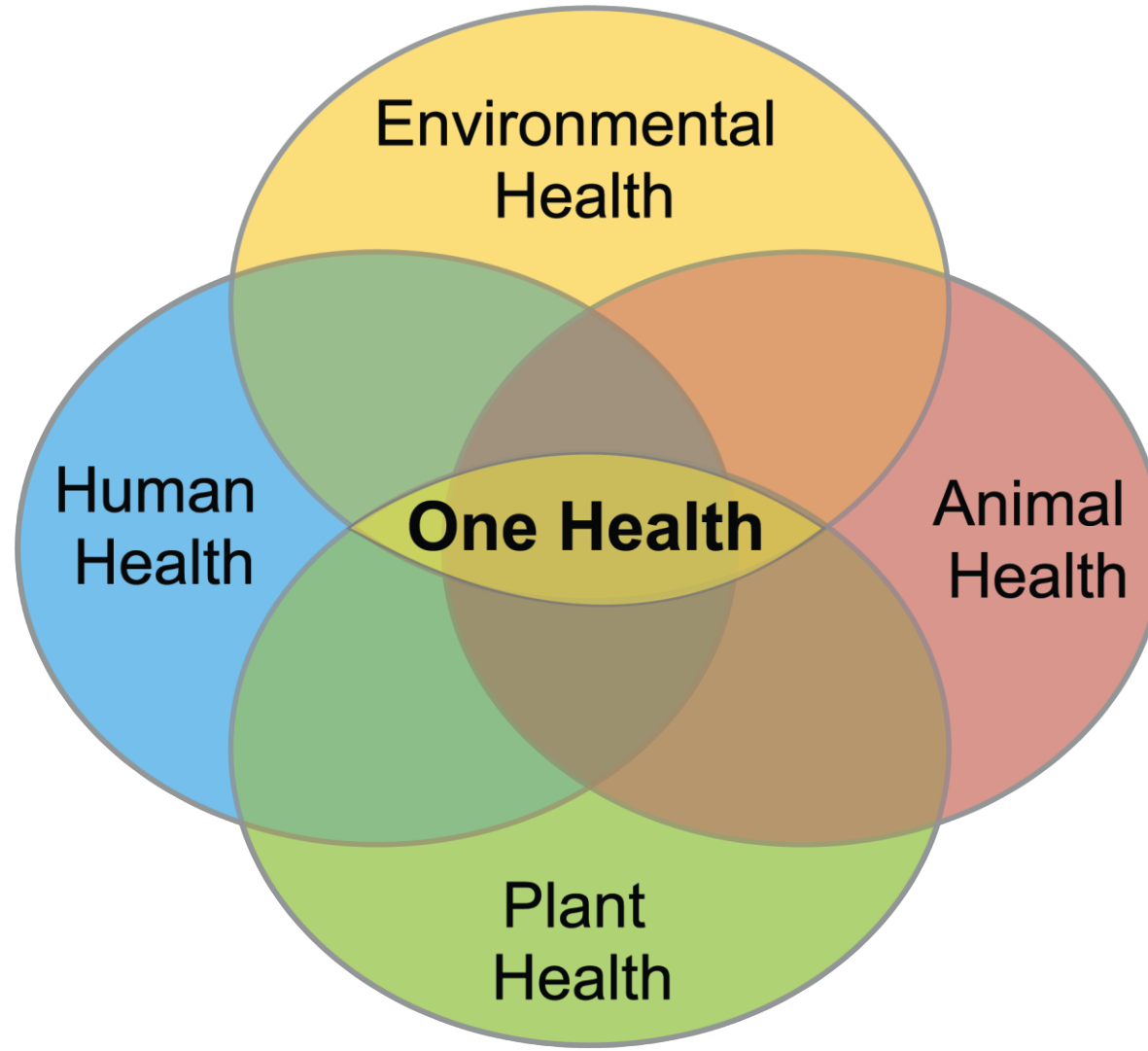
7

Rural & urban
poverty

8

Transboundary
pest &
biodiversity loss

Plant Health as key quadrant of One Health



One Health definition

- The joint quadripartite advisory panel of the the FAO, WOA, UNEP and WHO defined “**One Health as an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems**”

FAO, WOA, WHO, UNEP (2021)



Joint Tripartite (FAO, WOA, WHO) and UNEP Statement Tripartite and UNEP support OHHLEP's definition of “One Health

- The definition recognizes that the health of **humans, animals, plants, and the environment** (including ecosystems) are closely linked and inter-dependent.



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Significant role of Plant Health within OH – Undernutrition (1)

1.6 billion

people suffering iron- or
vitamin B₁₂-deficiency
anemia

0.8 billion

people with insufficient
dietary energy/ intake

15%

Global % of pregnant women
at risk of vitamin A
deficiency

33%

Global % of pre-school age
children at risk of vitamin A
deficiency

- Micronutrient deficiency such as Vit A and Fe are linked to undernutrition and disease severity and morbidity
- Undernutrition due to inadequate plant-based diet can reduce development and effectiveness of immune responses to infectious diseases

Immune responses due to undernutrition are energetically costly

Lochmiller & Deerenberg (2003) Oikos



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Significant role of Plant Health within OH – Undernutrition (2)

nature
sustainability

REVIEW ARTICLE

<https://doi.org/10.1038/s41893-019-0293-3>

Emerging human infectious diseases and the links to global food production

Jason R. Rohr^{1,2*}, Christopher B. Barrett³, David J. Civitello⁴, Meggan E. Craft⁵, Bryan Delius², Giulio A. DeLeo⁶, Peter J. Hudson⁷, Nicolas Jouanard⁸, Karena H. Nguyen², Richard S. Ostfeld⁹, Justin V. Remais¹⁰, Gilles Riveau⁸, Susanne H. Sokolow^{6,11} and David Tilman¹²

Malaria, respiratory infections, diarrhea and measles kill **1 million** people/yr and are much higher in children who are undernourished than those who are not



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Importance of Plant Health within One Health

Global Food Security 41 (2024) 100750

Contents lists available at ScienceDirect

Global Food Security

journal homepage: www.elsevier.com/locate/gfs



Climate change and plant health: impact, implications and the role of research for mitigation and adaptation

Thomas Dubois^a, Buyung A.R. Hadi^{b,m,1}, Sonja Vermeulenⁿ, Peter Ballantyne^c, Achim Dobermann^d, Shenggen Fan^e, Karen A. Garrett^f, Xenina Ibabao^g, Abdelbagi Ismail^g, Juliana Jaramillo^h, Ana Maria Loboguerreroⁱ, Steven McCutcheon^j, Jemimah Njuki^k, Tilak Raj Sharma^l, Henri E.Z. Tonnang^{a,o}, Valerien Pede^{g,4}

40 million

No of people consuming crops with enriched
Fe, Zn and Vit A

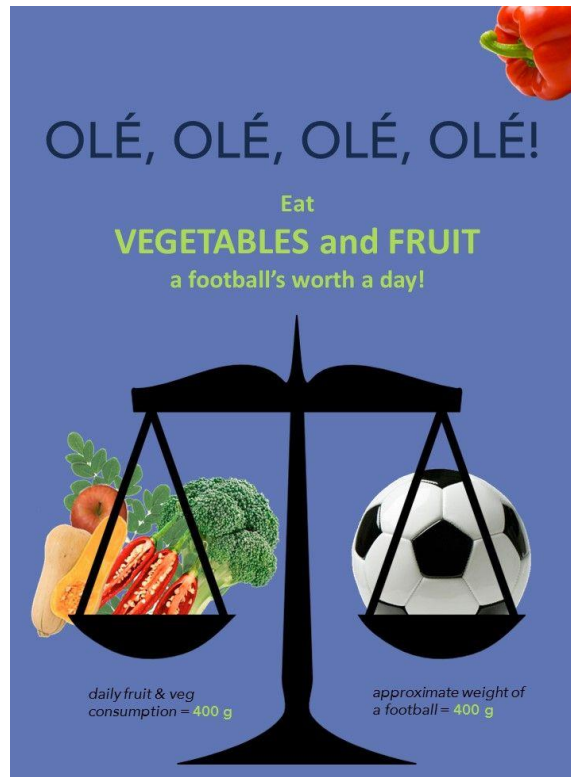


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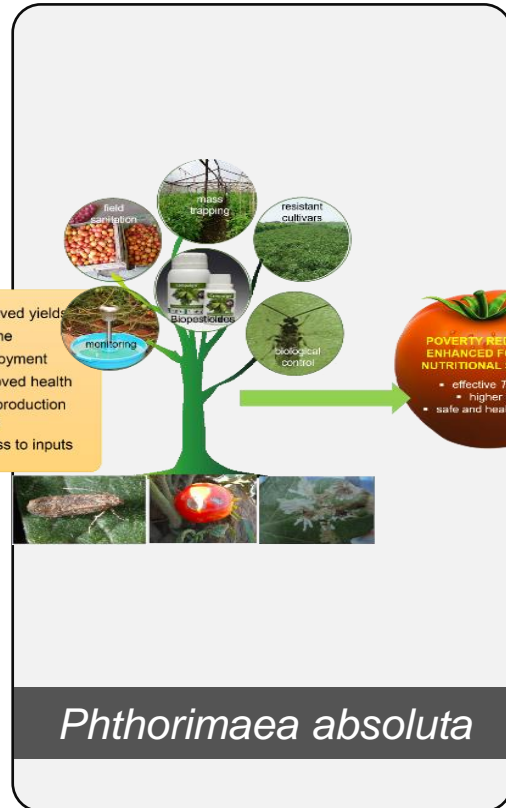
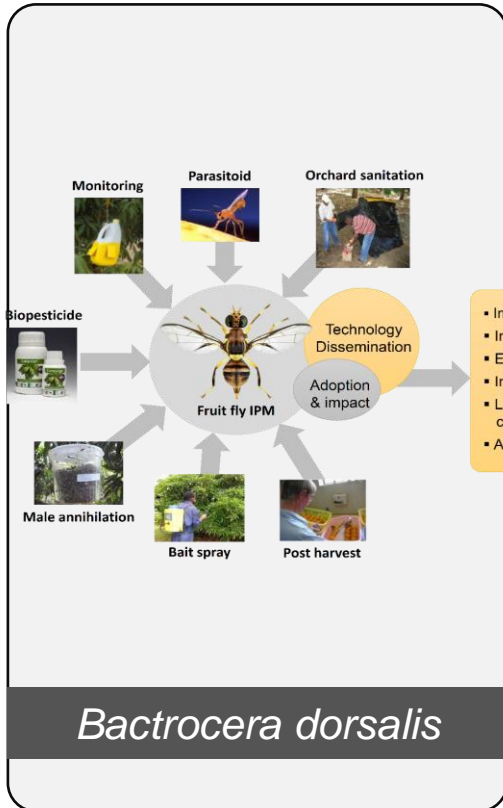
Importance of Plant Health within One Health



www.worldveg.org

Strengthening of Plant Health systems can improve nutrition with pronounced benefits for combating infectious and noncommunicable diseases

IPM is central to Plant Health and benefits One Health



Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in
Insect Science

Integrated Pest Management (IPM) and One Health — a call for action to integrate
Timo Falkenberg^{1,2}, Sunday Ekesi³ and Christian Borgemeister¹

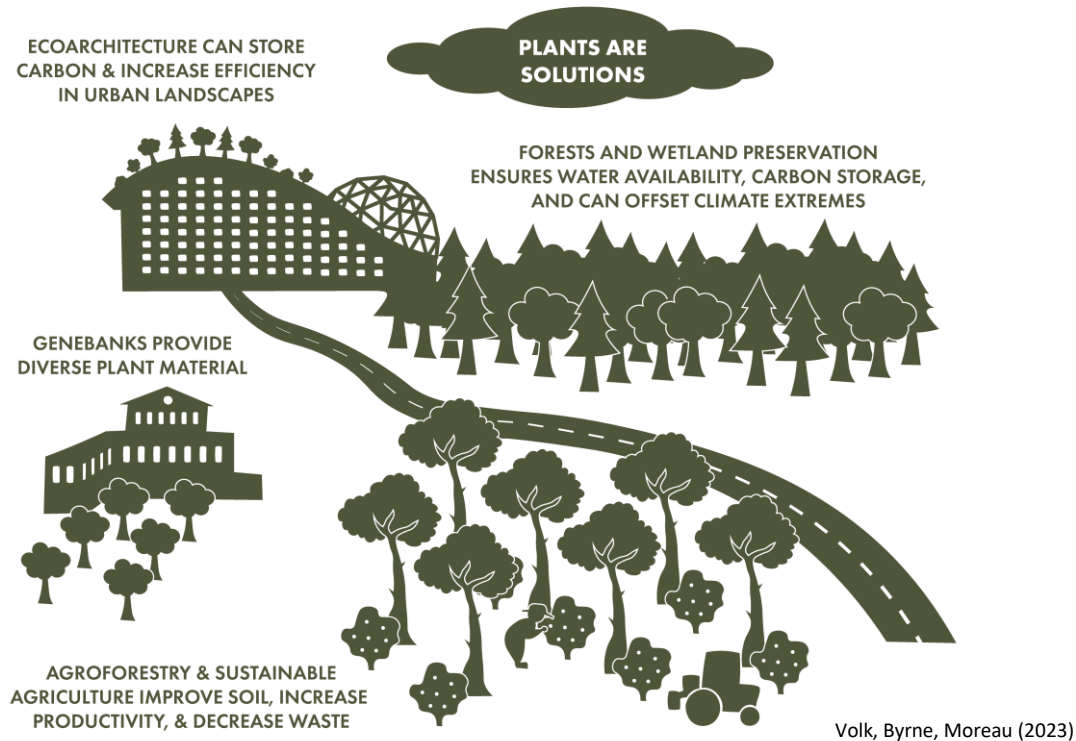


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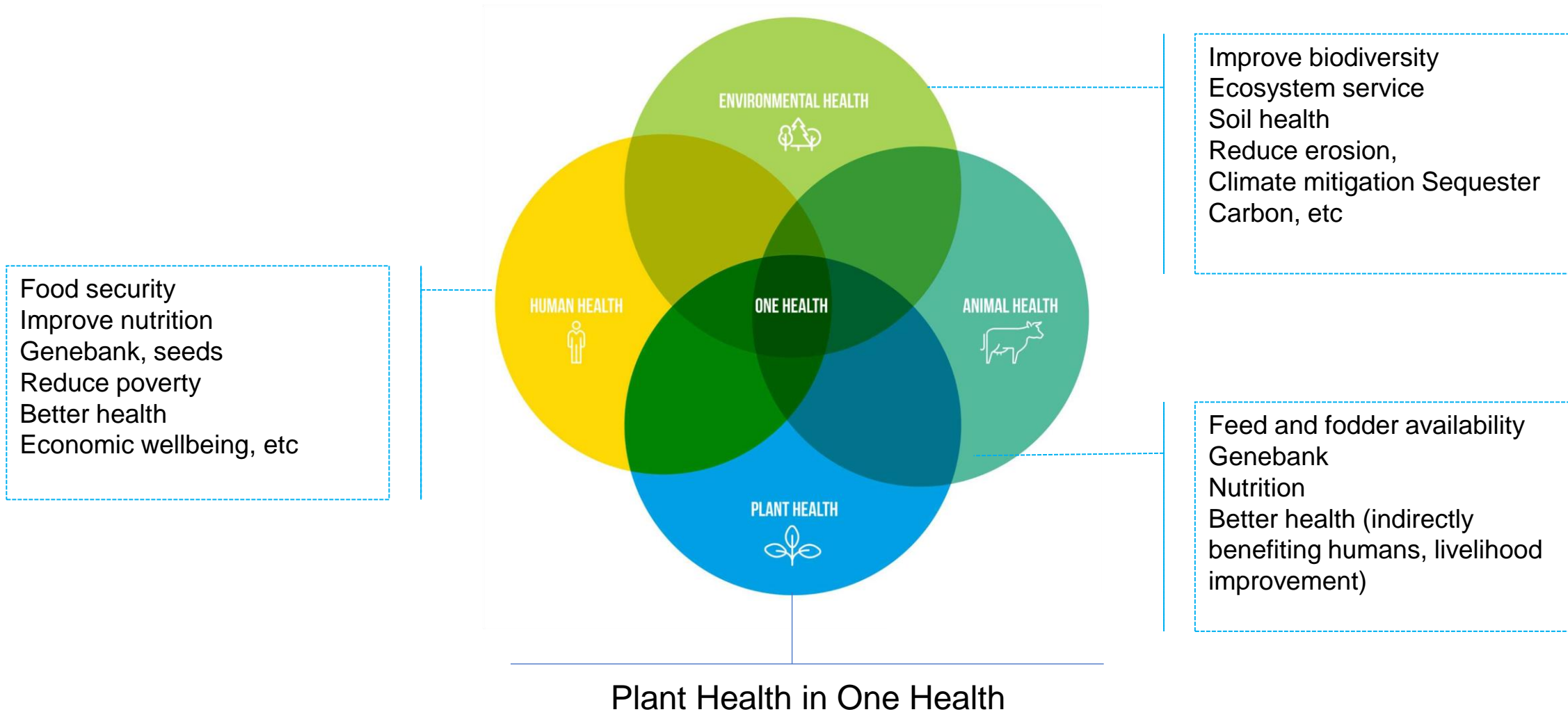
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Importance of Plant Health within One Health in Mitigating Climate Change

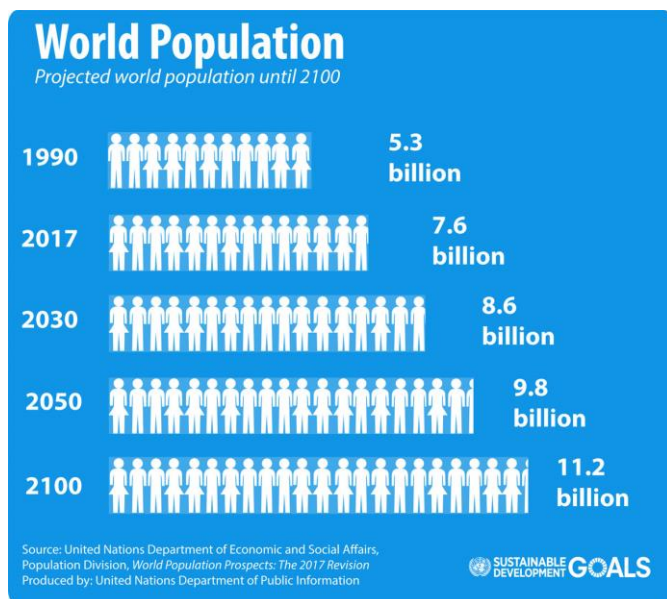


- Eco-architecture for carbon sequestration
- Forests and wetlands preservation ensure water availability and C storage
- Genebanks provide diverse plant materials for food and nutrition security that benefits human and animal health
- Agroecology and agroforestry improve soil health, increase productivity, decrease waste and benefits human, animal and environmental health

Plant Health is a central tenet of One Health



Plant Health must contribute to feeding a growing world population



..... food production must increase by 70% to feed the growing population.

The world's population will be at ~11 billion by 2100.



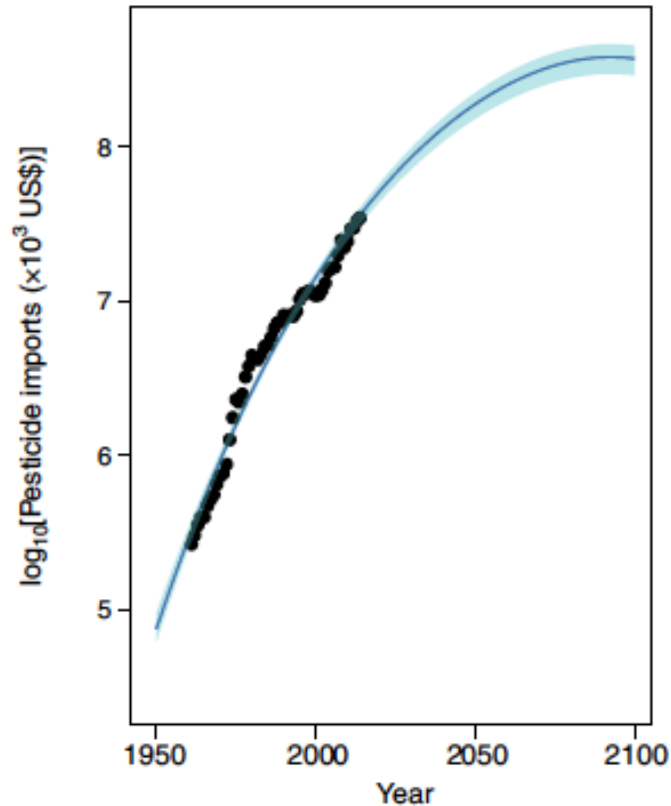
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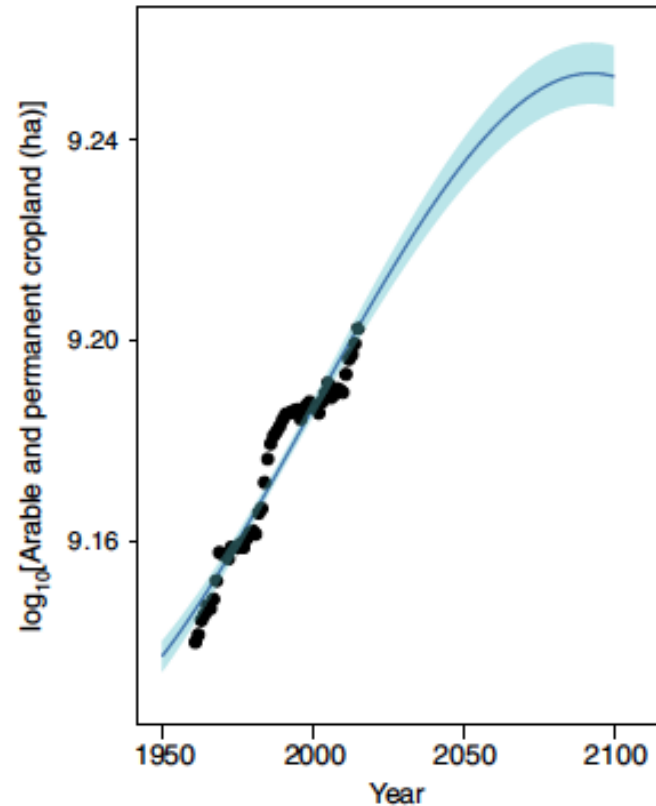
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...meeting food demand through present ag production & plant health systems will require:

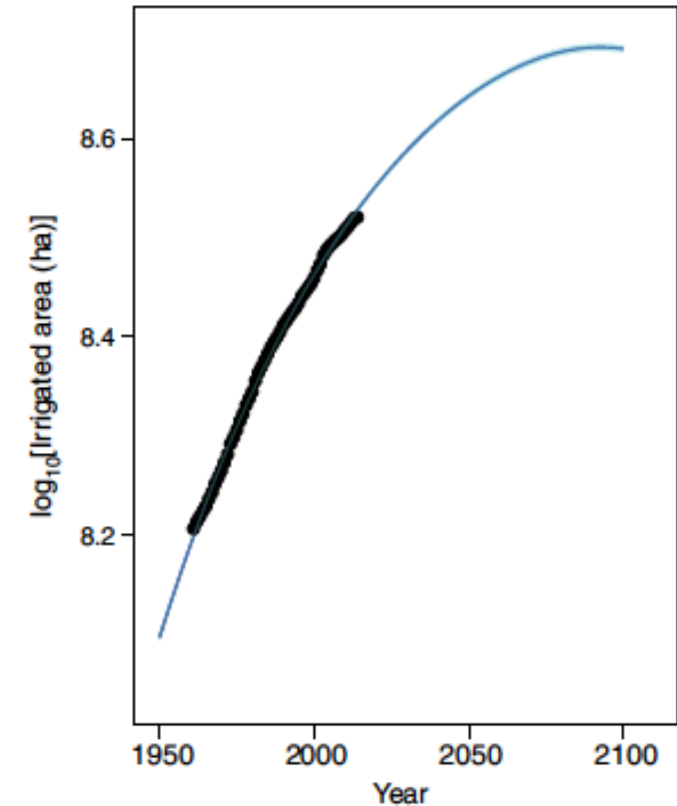
Rohr et al (2019) Nature Sustainability



...replacing $>10^9$ hectares of natural ecosystems with agricultural production

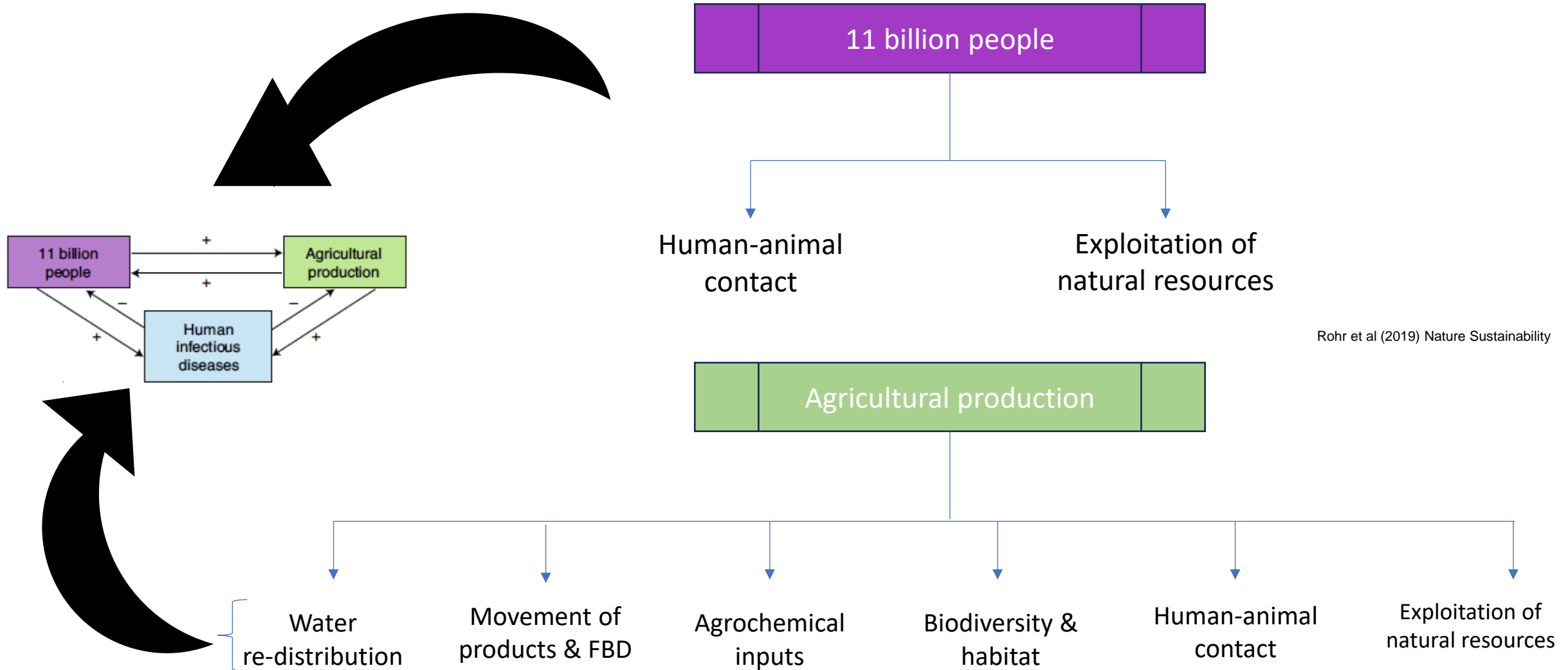


...~2.7-fold increase in fertilizer and 10-fold increase in pesticide use

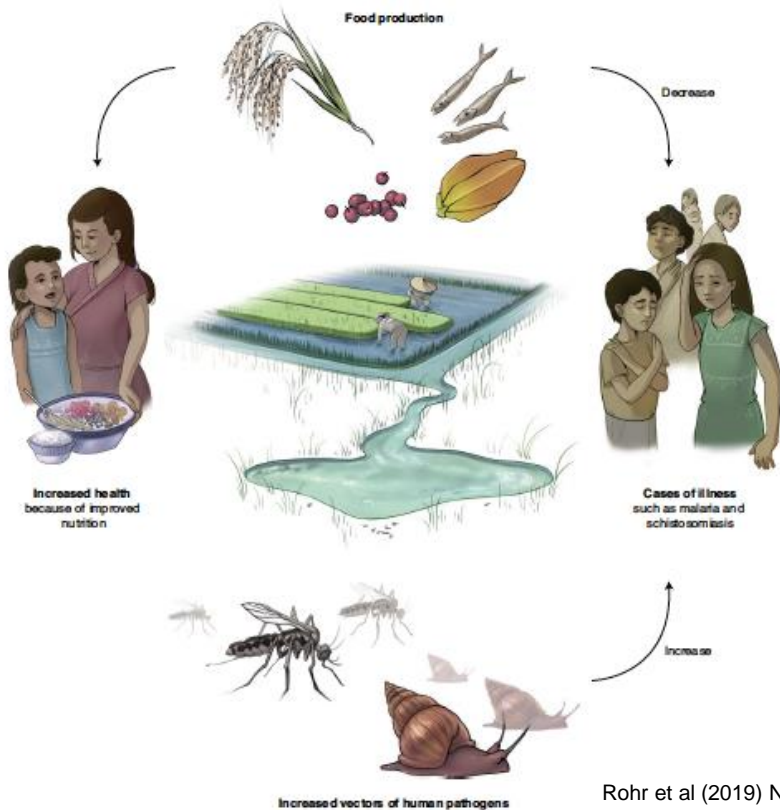


...result in an estimated ~2-fold increase in irrigation

...Ag intensification is a key driver & system is complex



Redistribution of freshwater for ag & Plant Health have consequences for infectious diseases in human



Rohr et al (2019) Nature Sustainability

- World total land area equipped for irrigation is approx. 352 million ha (22% of total cropland area).
- Irrigation and redistribution of fresh water for irrigation has well-known consequences for the transmission of infectious diseases.

Irrigation and associated plant health activities and proliferation of infectious diseases

Postirrigation Breeding Patterns of Surface Water Mosquitoes in the Mahaweli Project, Sri Lanka, and Comparisons with Preceding Developmental Phases

F. P. AMERASINGHE AND N. G. INDRAJITH

Department of Zoology, University of Peradeniya,
Sri Lanka

J. Med. Entomol. 31(4): 516–523 (1994)

The resurgence of lymphatic filariasis in the Nile delta

M. Harb,¹ R. Faris,² A.M. Gad,³ O.N. Hafez,⁴ R. Ramzy,⁵ & A.A. Buck⁶

Journal of Arid Environments (1997) 36: 541–555



Outbreak of *falciparum* malaria in the Thar Desert (India), with particular emphasis on physiographic changes brought about by extensive canalization and their impact on vector density and dissemination

B.K. Tyagi & R.C. Chaudhary

Desert Medicine Research Centre (ICMR), Post Box 122, New Pali Road,
Jodhpur 342005, India

Incidence of malaria among children living near dams in northern Ethiopia: community based incidence survey

Tedros A Ghebreyesus, Mitiku Haile, Karen H Witten, Asefaw Getachew, Ambachew M Yohannes, Mekonnen Yohannes, Hailay D Teklehaimanot, Steven W Lindsay, Peter Byass

Construction of dams and the accompanying irrigation network are associated with a rise in schistosomiasis and mosquito vectors of elephantiasis and malaria
(up to 7-fold increase in Ethiopia)

Biodiversity loss, ag intensification and infectious diseases of OH significance

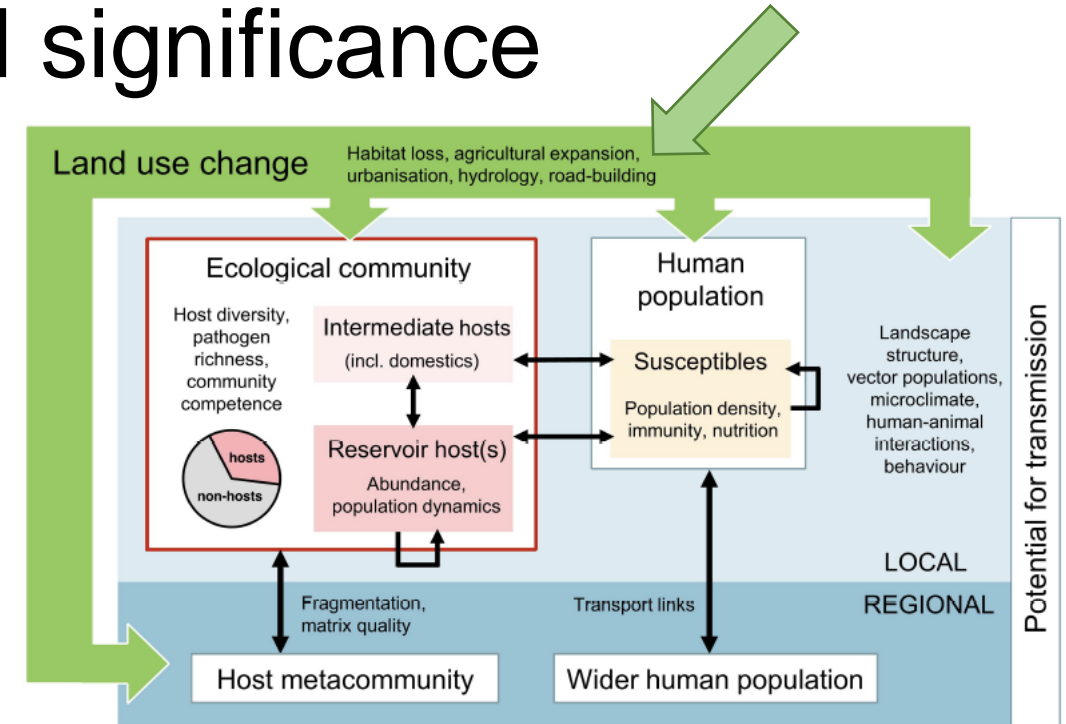
Nature | www.nature.com |

Zoonotic host diversity increases in human-dominated ecosystems

<https://doi.org/10.1038/s41586-020-2562-8>

Received: 28 January 2019

Rory Gibb^{1,5}, David W. Redding^{1,5,6}, Kai Qing Chin¹, Christl A. Donnelly^{2,3}, Tim M. Blackburn^{1,4}, Tim Newbold¹ & Kate E. Jones^{1,4,6}



Conversion of natural habitat to agriculture can lead to biodiversity loss and generally increase infections of wildlife and zoonotic infections of humans



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Human diseases from domestic and wild animals



Encroachment into wild habitat leads to interactions between Animal, Environment, Human and Plants increasing pathogen transmission from a reservoir host to a novel host
(65% of all human diseases are of animal origin)

Examples of zoonotic disease with agriculture as drivers of expansion

- Avian influenza, salmonellosis (poultry humans)
- Newcastle disease (poultry)
- Nipah virus (plants, pigs humans)
- Bovine Brucellosis (cattle, humans)
- Rabies (dogs and humans)
- Severe acute respiratory syndrome (SARS) (humans)

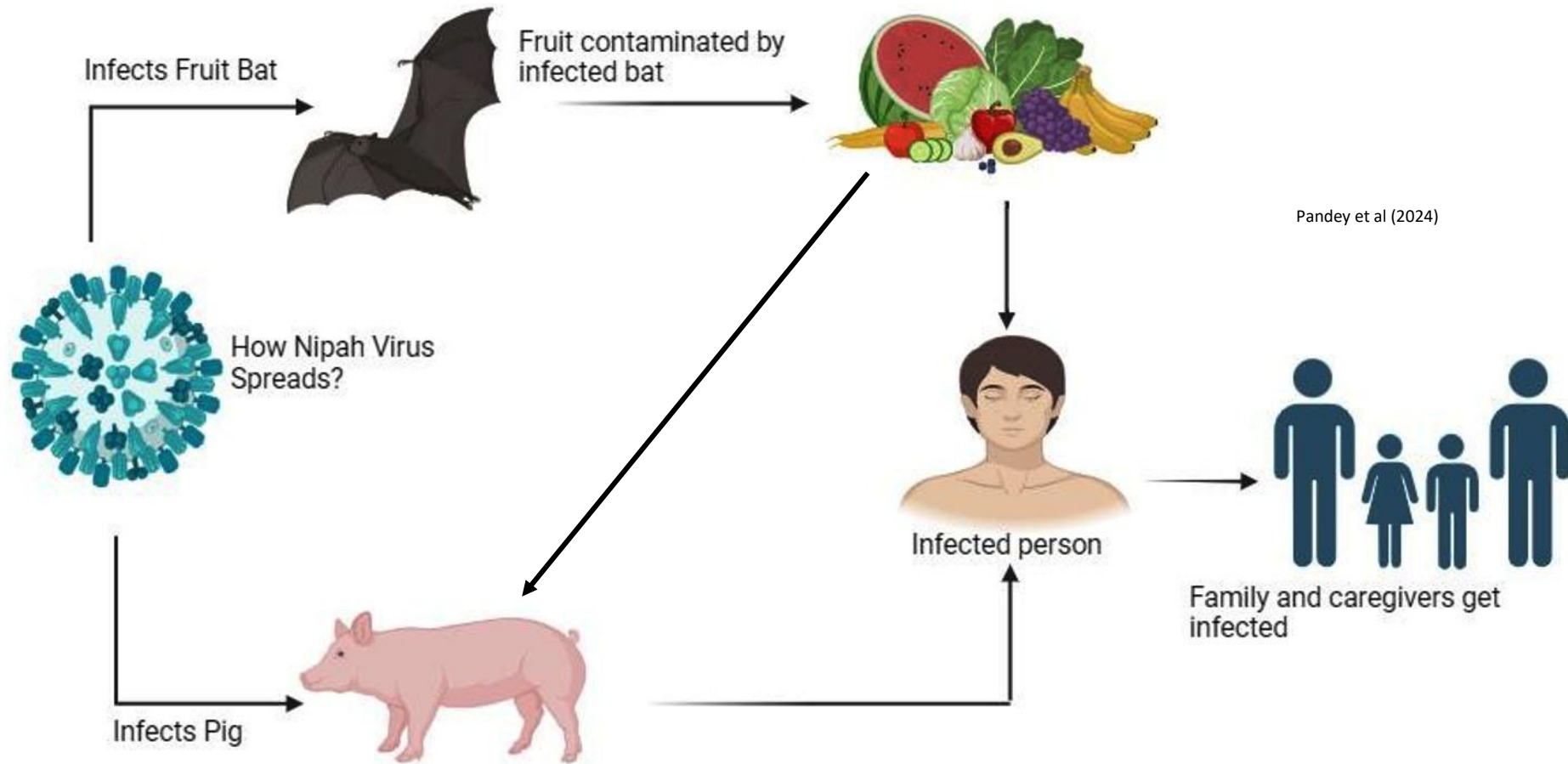


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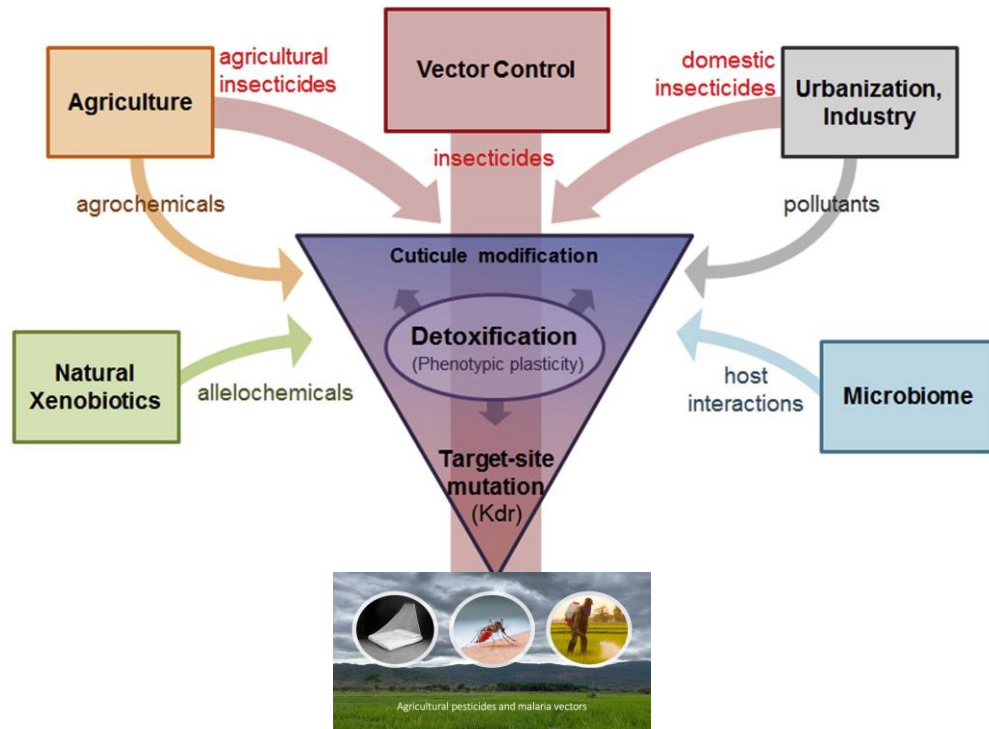
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Nipah virus transmission (plants, pigs, human)



Plant Health agrochemicals drive vector resistance and impact human health



- Pyrethroid, organophosphate and organochlorine insecticides are used for both plant and human health
- Several mosquito vectors of human have already evolved resistance to these compounds.

Nkya et al (2013) Insect Biochem and Mol Biol

If agricultural expansion and intensification is accompanied by an increased use of insecticides, vector resistance may become common and control of vector borne diseases more challenging.

Plant Health fertilizer enrichment benefit malaria and schistosomiasis transmission

Ecological Applications, 20(1), 2010, pp. 16–29
© 2010 by the Ecological Society of America

Linking environmental nutrient enrichment and disease emergence in humans and wildlife

PIETER T. J. JOHNSON,^{1,8} ALAN R. TOWNSEND,^{1,2} CORY C. CLEVELAND,³ PATRICIA M. GLIBERT,⁴ ROBERT W. HOWARTH,⁵ VALERIE J. MCKENZIE,¹ ELISKA REJMANKOVA,⁶ AND MARY H. WARD⁷

¹Ecology and Evolutionary Biology, University of Colorado, Ramaley N122, Campus Box 334, Boulder, Colorado 80309 USA

²Institute for Arctic and Alpine Research, 1560 30th Street, University of Colorado, Boulder, Colorado 80303 USA

³Ecosystem and Conservation Sciences, University of Montana, Missoula, Montana 59812 USA

⁴University of Maryland Center for Environmental Science, Horn Point Laboratory, P.O. Box 775, Cambridge, Maryland 21613 USA

⁵Ecology and Evolutionary Biology, Cornell University, Corson Hall, Ithaca, New York 14853 USA

⁶Department of Environmental Science and Policy, University of California, One Shields Avenue, Davis, California 95616 USA

⁷Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health,

Department of Health and Human Services, Bethesda, Maryland 20892 USA

EcoHealth 4, 384–396, 2007
DOI: 10.1007/s10393-007-0131-3

EcoHEALTH

© 2007 EcoHealth Journal Consortium

Review

Parasitic and Infectious Disease Responses to Changing Global Nutrient Cycles

Valerie J. McKenzie and Alan R. Townsend

- Phosphorous fertilizer enrichment can benefit mosquitoes that transmit malaria and West Nile virus
- Nitrogen- and phosphorous-based fertilizer use can increase the number of snails that transmit flatworms that cause human schistosomiasis



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Human infectious disease impact on plant health, food production and economic development



American Economic Review

ISSN 0002-8282 (Print) | ISSN 1944-7981 (Online)

American Economic Review 2015, 105(1): 382–410
<http://dx.doi.org/10.1257/aer.20130604>

The Effect of the TseTse Fly on African Development[†]

By MARCELLA ALSAN^{*}



Journal of Health Economics

Volume 42, July 2015, Pages 151–164



Health and agricultural productivity:
Evidence from Zambia

Günther Fink^a , Felix Masiye^b

- Malaria-afflicted smallholders lose up to 22 days work through the illness and harvest only 40 percent of their crops.
- In SSA, areas infested with tsetse fly that cause African sleeping sickness in humans and cattle, lag behind in the adoption of plant health and agricultural enterprises hindering agricultural development and economic prosperity



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Plant Health, Food safety and One Health



<https://www.foodsafety.gov/blog/fruit-and-vegetable-safety>

135 million

No. of FBD cases/year in
Africa

180,000

FBD related
deaths/year

US\$20 billion

Productivity losses attributed
to unsafe food in Africa

US\$3.5 billion

The cost of treating FBD
illnesses

Expanded spatial scope and increased frequency, speed and volume of people and movement of agricultural products facilitates spread of pathogens.

(Steven and Delia (2020) IFPRI Report

World Bank (2016)

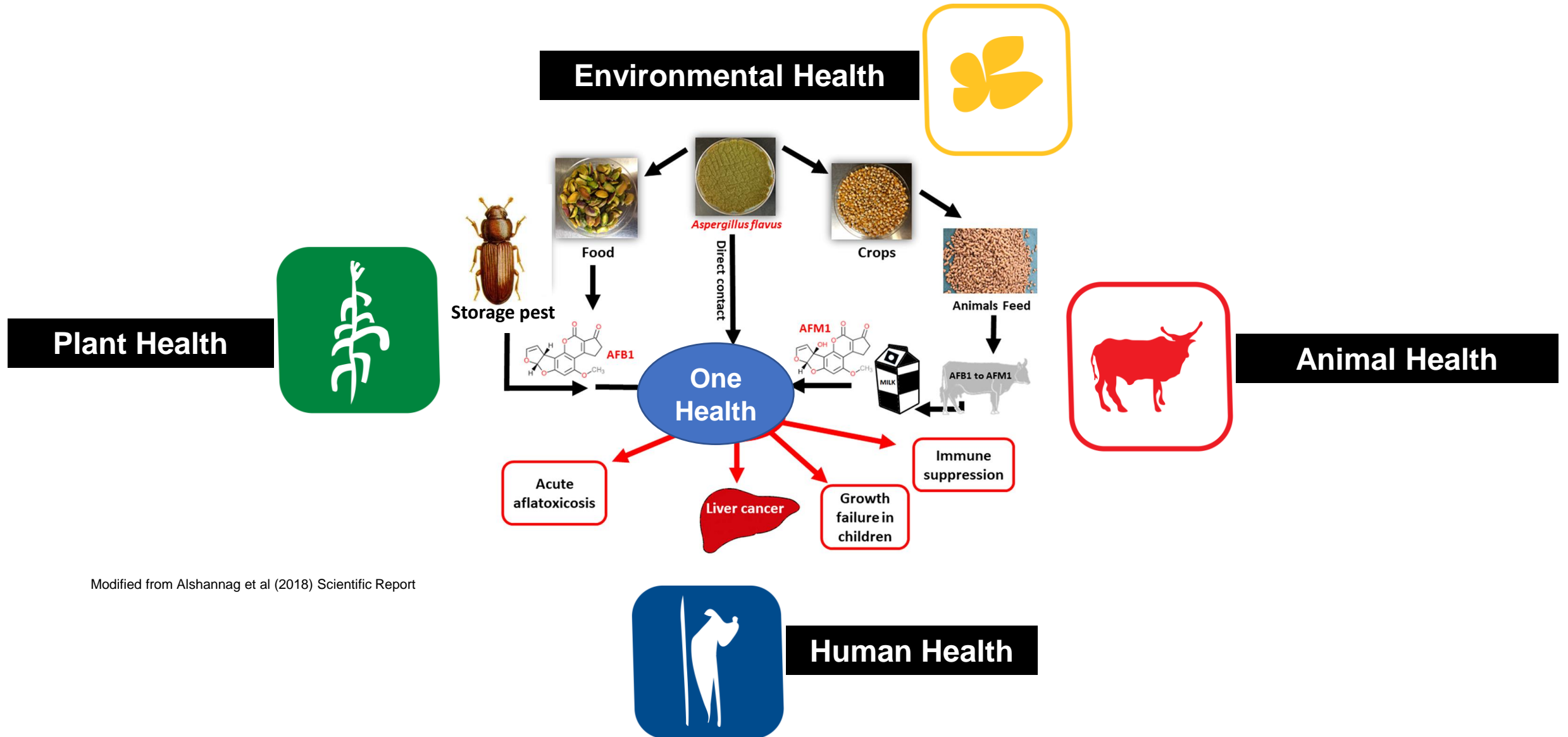


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Aflatoxin contamination & One Health



Antibiotics use in Plant Health, potential for AMR and implications for One Health



Phytopathology®
REVIEW

The Use and Impact of Antibiotics in Plant Agriculture: A Review

Ozgur Batuman,^{1,†} Kellee Britt-Ugartemendia,¹ Sanju Kunwar,¹ Salih Yilmaz,¹ Lauren Fessler,¹ Ana Redondo,¹ Kseniya Chumachenko,² Shourish Chakravarty,³ and Tara Wade³

¹ Department of Plant Pathology, Southwest Florida Research and Education Center, University of Florida, Immokalee, FL

² Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL

³ Department of Food and Resource Economics, Southwest Florida Research and Education Center, University of Florida, Immokalee, FL

Accepted for publication 8 March 2024.

Cases of AMR in Plant Health can contribute to AMR emergence in human due to antibiotic overuse.



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List of commonly used antibiotics in plant agriculture & countries with resistance

Antibiotic	Countries with antibiotic use/registration	Crops ^a	Countries with resistance detected (in last 10 years)	Reference(s)
Streptomycin	United States, Argentina, Canada, Chile, China, Iran, Israel, Korea, Mexico, New Zealand	Apples, pears, solanaceous crops, and oranges	United States, Canada, Chile, China, Korea, Mexico	de León Door et al. 2013; Förster et al. 2015; Lee et al. 2020, 2022, 2023; Lyu et al. 2019; Shtienberg et al. 2015; Smits et al. 2014; Soleimani-Delfan et al. 2015; Sundin et al. 2023; Stockwell 2014; Tancos and Cox 2017; Tancos et al. 2016; Valenzuela et al. 2019; Wallis et al. 2021; Xu et al. 2013
Oxytetracycline	United States, Costa Rica, Honduras, Guatemala, El Salvador, Mexico	Citrus, apples, pears, peaches, and palms	United States	Förster et al. 2020; Haynes et al. 2020; Herbert et al. 2022; Rodríguez et al. 2007; Sundin et al. 2023
Kasugamycin	United States, Japan, New Zealand	Apples, walnuts, pears, rice, and cherries	Japan	Yoshii et al. 2012
Oxolinic acid	Israel, Japan, Korea	Apples, pears, and rice	Israel, Japan, Korea	Ham et al. 2022; Kleitman et al. 2005; Shtienberg et al. 2001, 2015
Gentamicin	Mexico, Chile, Costa Rica, Honduras, Guatemala, El Salvador, Thailand	Apples, pears, solanaceous crops, brassica crops	Thailand	Srichamnong et al. 2021; Vidaver 2002

^a Not exclusive.

Batuman et al (2024) Phytopathology

Others

- Ningnanmycin
- Validamycin
- Aureofungin
- Oxolinic acid

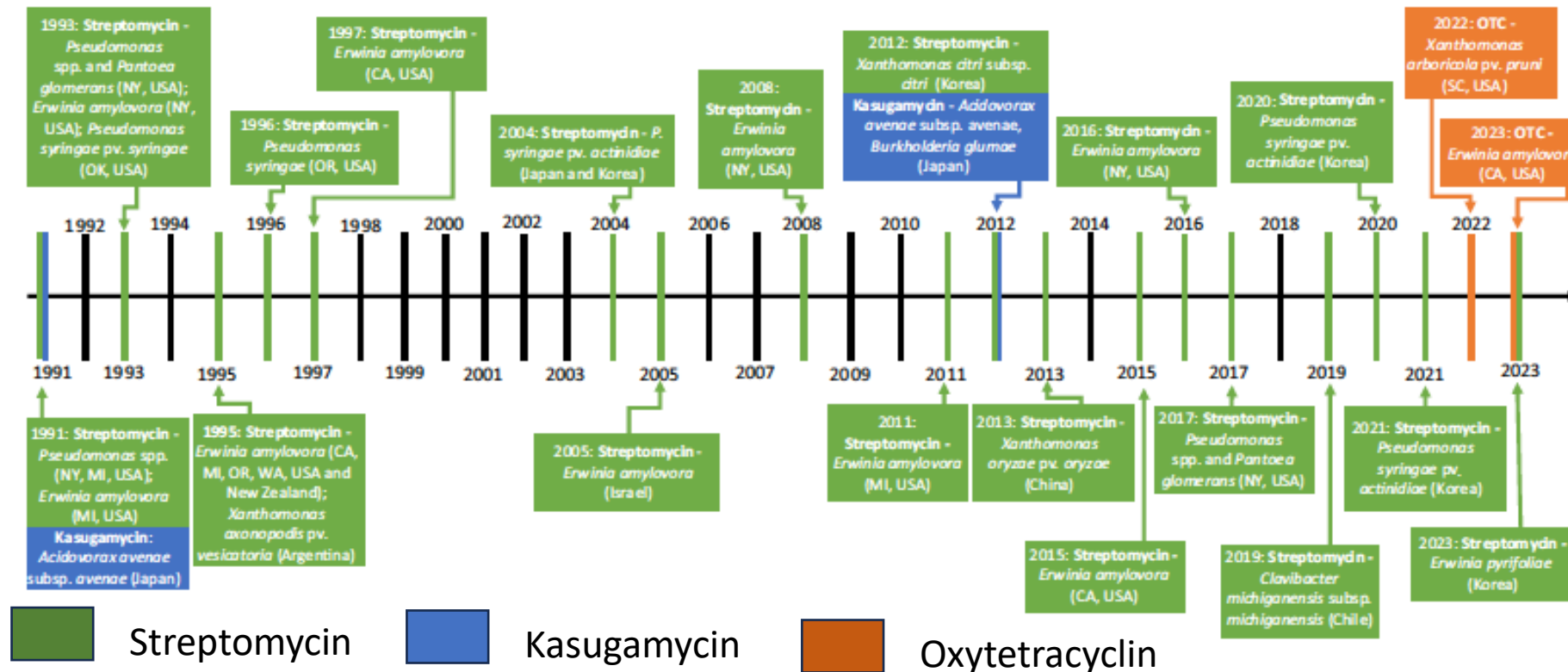


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Timeline of reported incidences of antibiotic resistance



Monitoring AMR in Plant Health in One Health

MONITORING GLOBAL PROGRESS ON ADDRESSING ANTIMICROBIAL RESISTANCE

Analysis report of the second round of results
of AMR country self-assessment survey
2018



- A joint FAO, WOA and WHO report concerning AMR found that few countries that monitor the use of antibiotics in **plant agriculture**
- Only 3% of the 194 countries acknowledged regular assessments on their antibiotic uses in terms of type and amounts.
- This is much lower than the monitoring systems in place for human (26%) and animal (23%) use
- A large majority (83%) of the countries surveyed indicated that they **lacked the ability to monitor antimicrobial use on plants**
- Systems for monitoring the use of antimicrobials in the plant sector exist only in 11 high-income countries

194 WHO member countries



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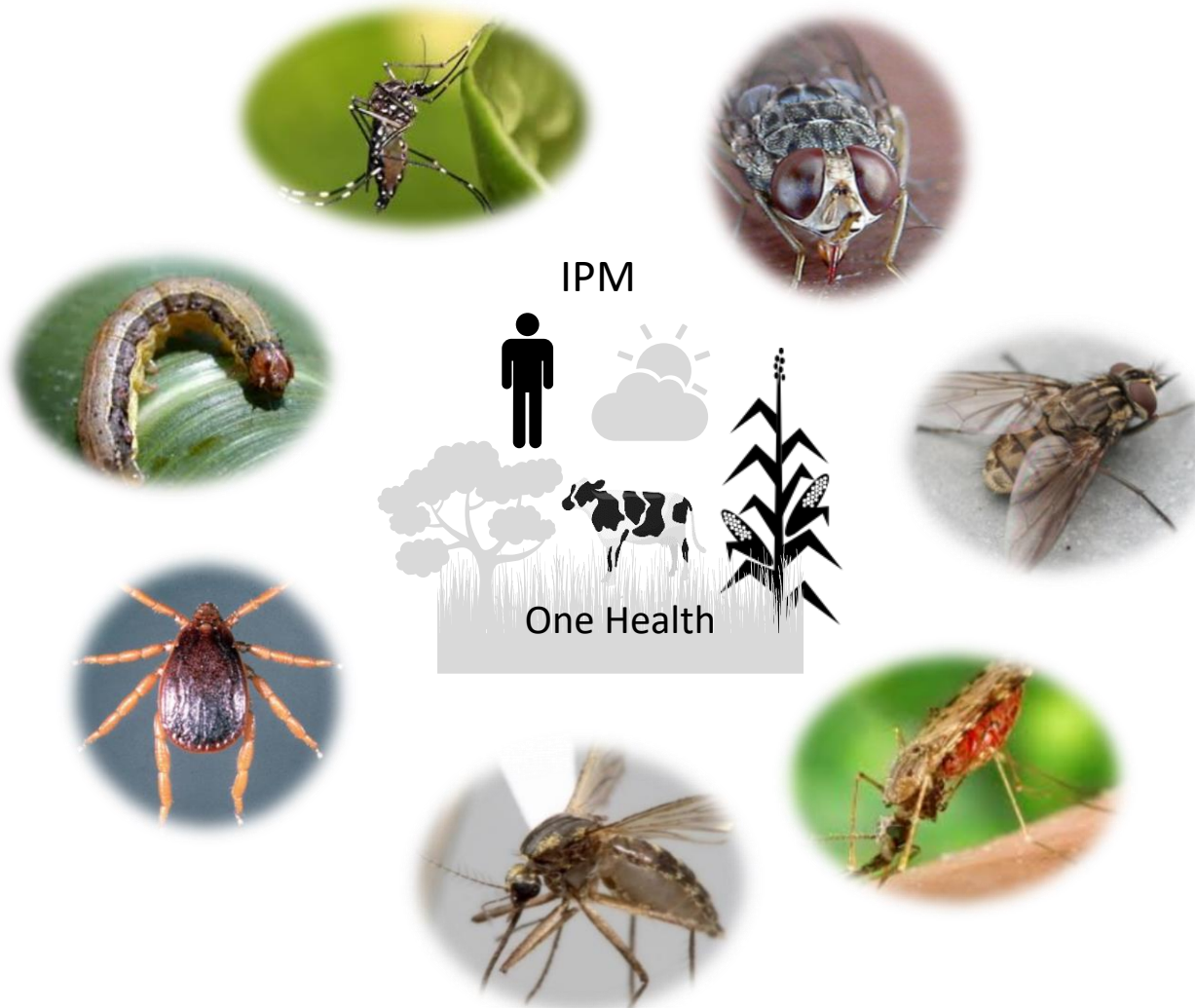
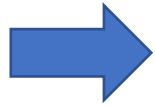
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Solution - Nature- positive solutions for One Health - Biopesticides

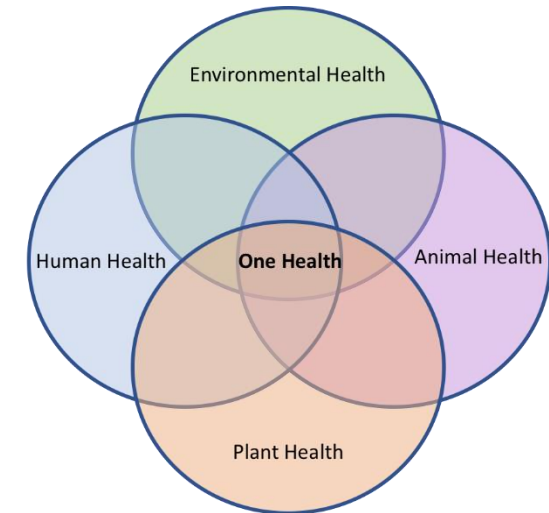
Biopesticide
product



FAW
Ticks
Mosquitoes
Tsetse



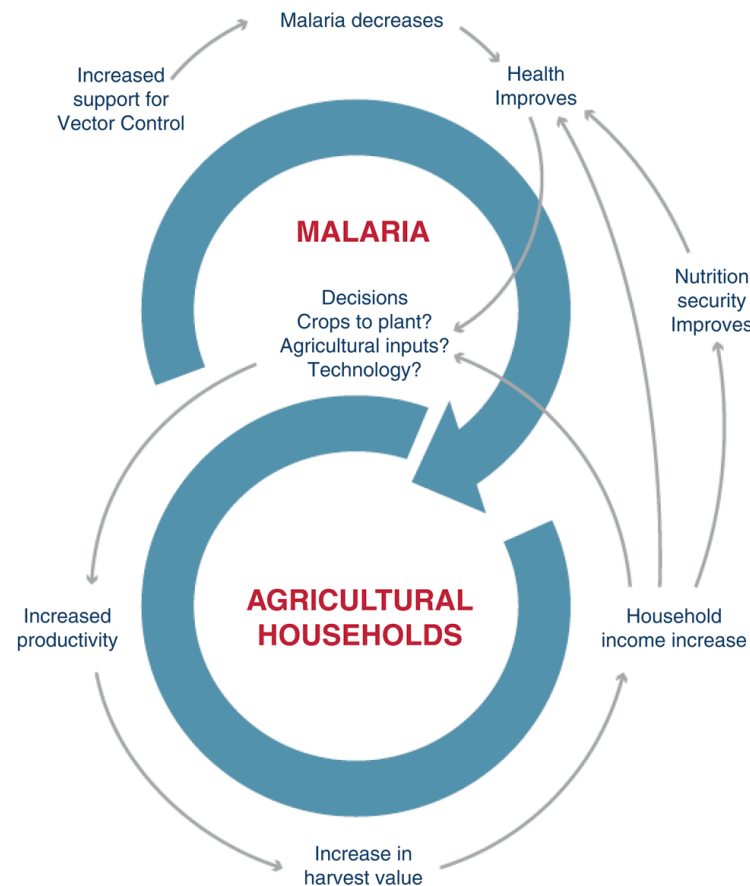
Jointly address, plant, human & animal health; utilizing single, easy to use biopesticide product



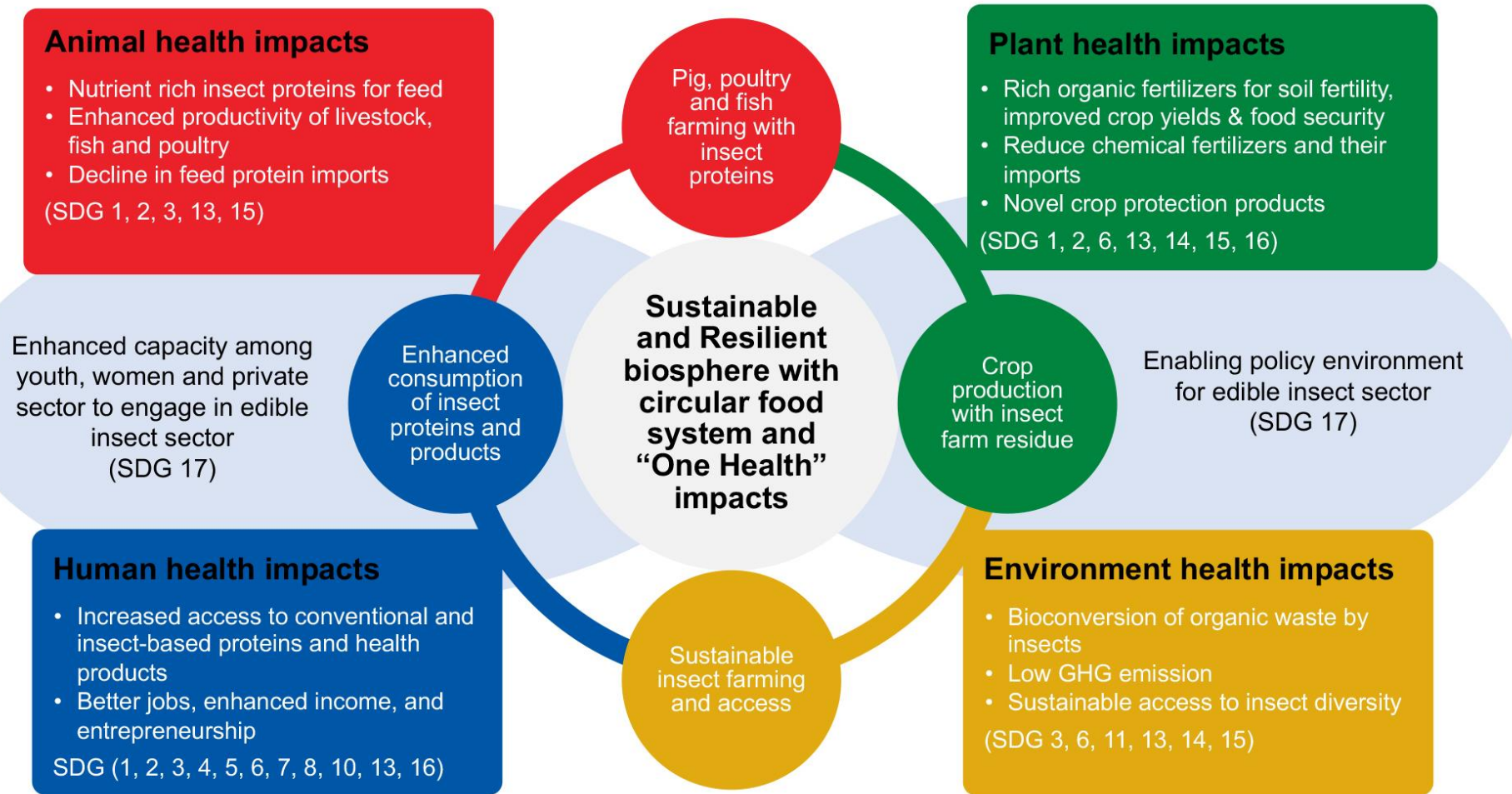
Solution - Plant Health for OH



Willis & Hamon (2024) Gates Open Res



Solution - Insects for Circular Economy & One Health



THE
CURT BERGFORS
**FOOD
PLANET
PRIZE**



**WINNER
2020**



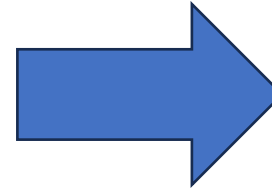
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Solution - Food safety and One Health

- Modernization of food supply in developing countries to high-income consumers in cities and high-income countries, can enhance food safety and quality standards
- Strengthening food safety regulatory standards across food supply chain
- Enhanced monitoring for the spread of pathogens across transportation networks



Economics of Plant Health within OH



Article

Integrated Health Interventions for Improved Livelihoods: A Case Study in Ethiopia

Menale Kassie ^{1,*}, Zewdu Abro ², Tesfamicheal Wossen ³, Samuel T. Ledermann ⁴, Gracious Diiro ¹, Shifa Ballo ² and Lulseged Belayhun ²

Using whole-farm multiperiod mathematical linear programming model results show that higher annual income benefits from combined interventions (35% higher) than gains from each intervention alone



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Sustainable Plant Health for One Health



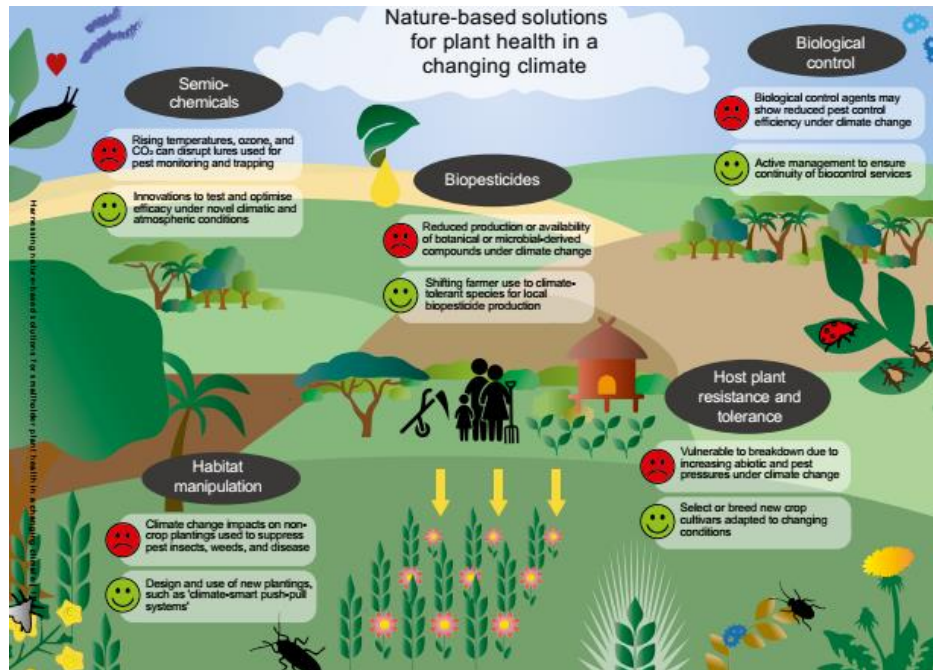
Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in
Insect Science

Integrated Pest Management (IPM) and One Health — a call for action to integrate

Timo Falkenberg^{1,2}, Sunday Ekesi³ and Christian Borgemeister¹



Harnessing nature-based solutions for smallholder plant health in a changing climate



Paul A. Egan (SLU) & David Chikoye (IITA), Editors
| SLU Global 2021

Nature-based solutions, IPM, and One Health – action at the intersection



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Take home message & concluding remarks

- Plant Health systems can play an important role for OH by
 - ✓ Providing genebank for food security, improve nutrition and combatting infectious diseases that impact Human Health within the context of OH
 - ✓ Plant health also contribute to Environmental Health by sustaining biodiversity, ecosystem service, climate change mitigation
 - ✓ An improved plant-livestock integration provides fodder and animal feed and enhance animal health within OH
 - ✓ IPM, agroecological approaches and agroforestry improve soil health, increase crop productivity, decrease waste and benefits human, animal and environmental health



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Take home message & concluding remarks

- Nevertheless, feeding 11 billion people in 2100 will expand plant health use of pesticides and fertilizer, water, and antibiotics, foodborne diseases and contact rates between humans and animals, all with consequences for the emergence and spread of infectious agents
 - ✓ Minimize the conversion rate of natural areas to agriculture – should help curb climate change, human wildlife contact and minimize disease risks – better planning and policy dialogue
 - ✓ More safe nature-based solutions (e.g., biopesticides, frass fertilizers) as alternative to synthetic pesticides
 - ✓ Strengthening food safety regulatory standards including monitoring of pathogens across food supply chain to combat food borne diseases



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Take home message & concluding remarks

- FAO and WHO joint “Code of Practice to Minimize and Contain Foodborne Antimicrobial Resistance,”
 - ✓ Report highlights the importance of utilizing **plant/crop health professionals** as a major resource in making decisions **on antimicrobial use, risk assessments** and strategies
 - ✓ Regulations on antibiotics on plant health, monitoring systems and capacity building needed
 - ✓ National and international policies based on management practices should be developed and implemented that document use, agencies to monitor, reporting mandate and enforcement
- Modeling tools for quantitative analysis of interactions of PH within OH and socioeconomic assessment of benefits are needed
- Strengthen transdisciplinary research, education and capacity on OH
- National and international shifts in investments towards OH are need.



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Thank you

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