ILSI Research Foundation

How Biology-Based Technologies can Contribute to Achieving the Sustainable Development Goals

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PLANT BIOLOGICALS NETWORK ANNUAL SYMPOSIUM

13-14 NOVEMBER 2019 · COPENHAGEN

ILSI Research Foundation

Our Work

All our programs are for public benefit and focus on contributing to long-term solutions. Our primary areas of activity include:

Biosafety Capacity Building

Environmental Risk Assessment

Sustainable Nutrition Security

Food and Feed Safety Assessment

Highlights from Around the World

In the past year, the ILSI Research Foundation's work contributed to the following sustainable development goals (*SDGs*). Icons attached to each pin help signal how our work ties to the SDGs.

- **Zero Hunger**
- **Good Health and Well-Being**
- **Sustainable Cities and Communities**
- **Responsible Consumption and Production**
- **Climate Action**
- **Partnerships for the Goals**

This is only a sample of events for which the ILSI Research Foundation was either a co-organizer (*org.*) or delivered presentations (*pres.*).

ILSI Research Foundation

Vancouver, Canada
2018 Entomology Society of America Annual Meeting (*pres.*)

Washington, DC, USA
Addressing Water Variability and Scarcity: The Role of Agricultural Research (*org.*)

Parma, Italy
2018 EFSA Scientific Conference (*pres.*)

Langfang, China
Safety Assessment of Foods and Feeds Derived from Genetically Engineered Plants: Phase I Technical Workshop (*org.*)

Paris, France
OECD Working Group on the Harmonisation of Regulatory Oversight in Biotechnology (*pres.*)

New Delhi, India
7th Training Workshop for Institutional Biosafety Officers (*org.*)

Gangneung, Korea
2nd Asia Forum on Genome Editing (*pres.*)

Ashland, OH, USA
Safety Assessment of Foods and Feeds Derived from Genetically Engineered Plants: Phase II Technical Workshop (*org.*)

Tarragona, Spain
Genetic Biocontrol of Invasive Species (*org.*)

Dhaka, Bangladesh
SAARC Regional Expert Consultation Meeting on the Progress and Prospects of Agricultural Biotechnology and Biosafety in South Asia (*org.*)

Addis Ababa, Ethiopia
Kick-off Meeting of the *Ad-hoc* Expert Group for Developing the OECD Consensus Document on the Biology of Mosquito *Anopheles gambiae* (*org.*)

Urbana-Champaign, IL, USA
3rd Annual Workshop for the Climate Adaptation and Mitigation in Fruit and Vegetable Supply Chains Project (*org.*)

Manila, The Philippines
Science Policy Forum on Science-Based Regulation of Breeding Stacks (*pres.*)

Tokyo, Japan
Workshop on Application of Data Transportability in the Environmental Risk Assessment of GE Plants (*org.*)

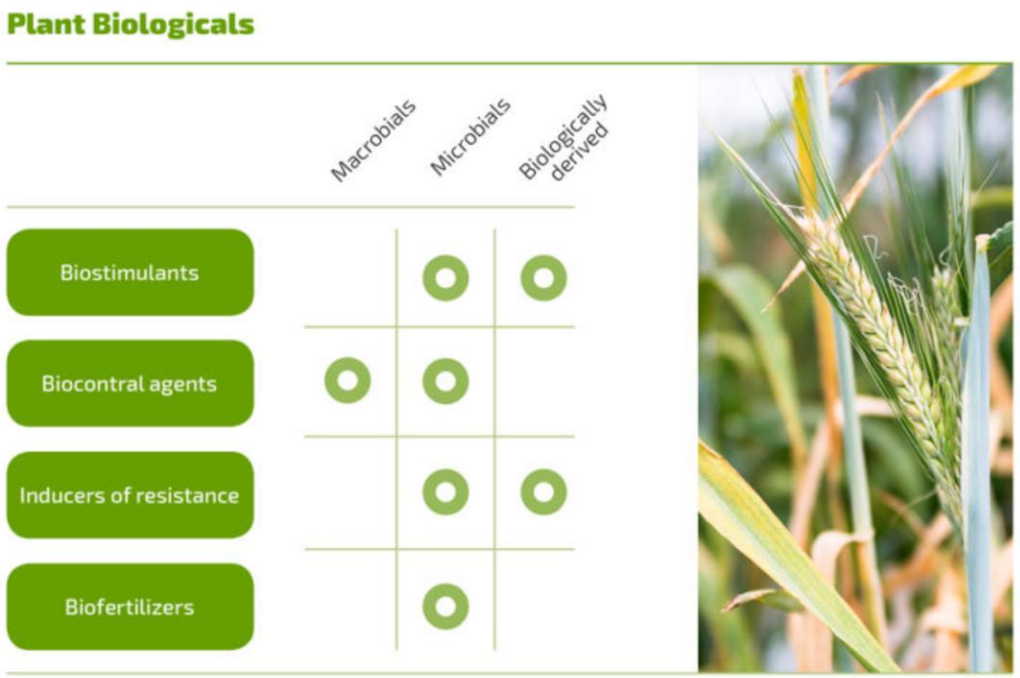
In the past 12 months, our team engaged with an audience of **1900+ people** in **12 countries** through meetings, presentations, seminars, conferences, workshops, and symposia. The ILSI Research Foundation website reached **24,100 users**.

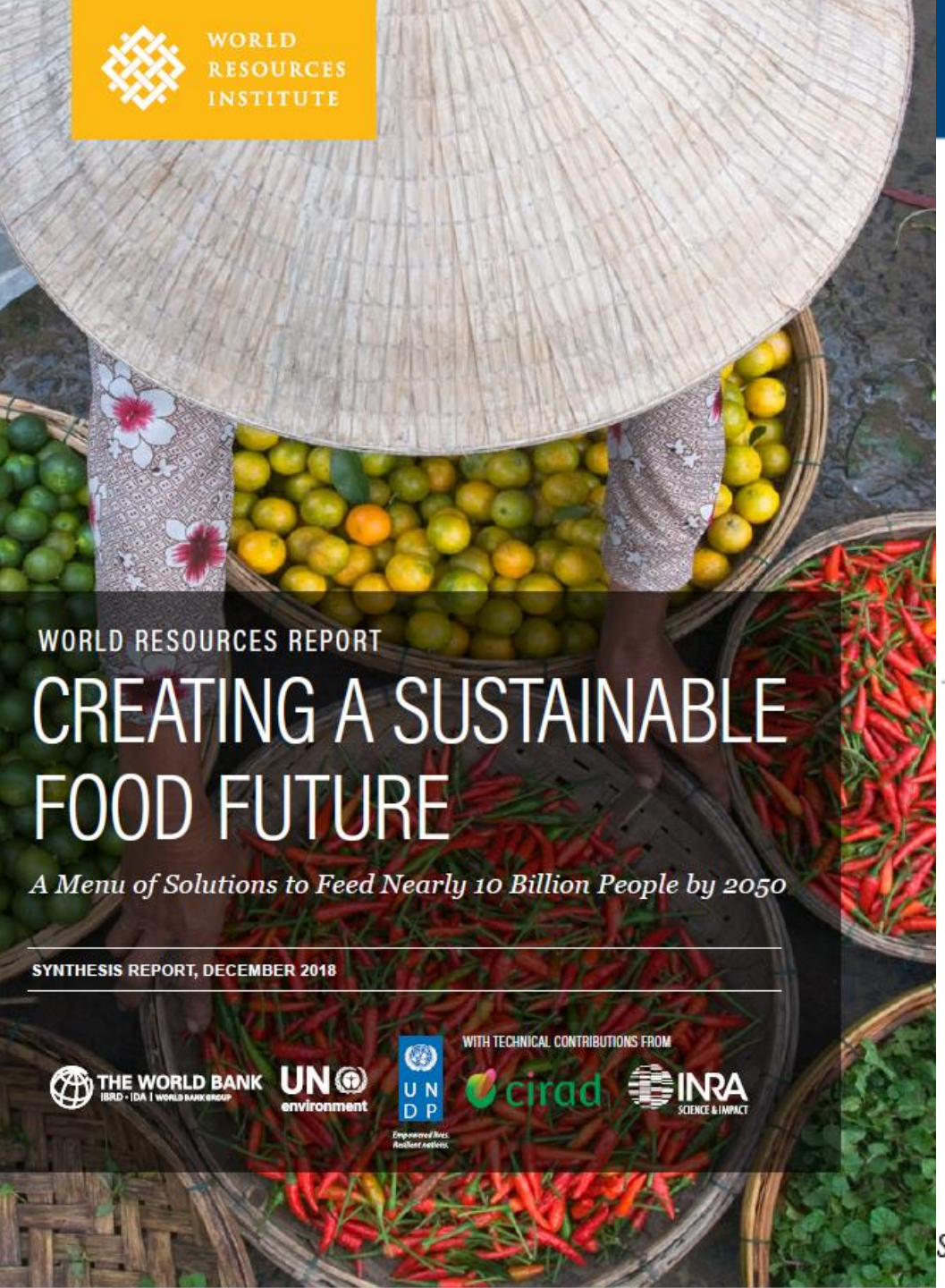
31 July 2019

Today's presentation

Sustainable Development Goals + plant biologicals

Regulation of biology-based technologies in agriculture

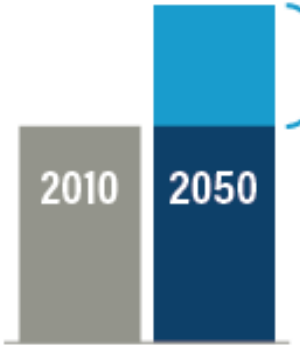




CREATING A **SUSTAINABLE FOOD FUTURE BY 2050**

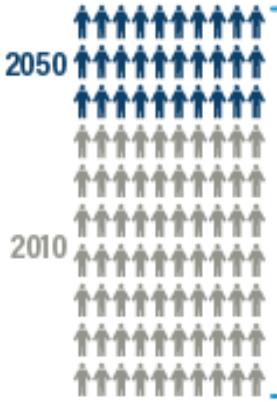
How do we feed 10 billion people...

WE WILL NEED



56% more food

TO FEED NEARLY



10B people in **2050**

...without using more land...

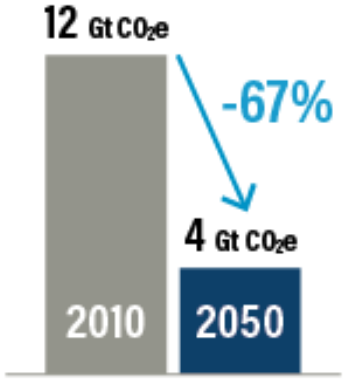
WE NEED TO PREVENT AGRICULTURE FROM EXPANDING

we currently use **~50%** of the world's vegetated land for agriculture

TO SAVE AN AREA OF FORESTS NEARLY **2X** the size of India

...while lowering emissions?

WE CAN LOWER EMISSIONS



WITH INNOVATIVE TECHNOLOGY LIKE

Improved feeds

Plant-based burgers

Resilient crop breeds

Source: wri.org/sustfoodfuture

WORLD RESOURCES INSTITUTE

Sustainable Development Goals

The Sustainable Development Goals (SDGs) set out quantitative objectives across the social, economic, and environmental dimensions of sustainable development — all to be achieved by 2030.

"The SDGs offer an opportunity to address the major challenges facing humanity in ways that will not make things worse in trying to make things better"

Grace, D. 2017. Food safety and the Sustainable Development Goals. Nairobi, Kenya: ILRI.

SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS

2 ZERO HUNGER

2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.

Global Burden of Food Borne Disease

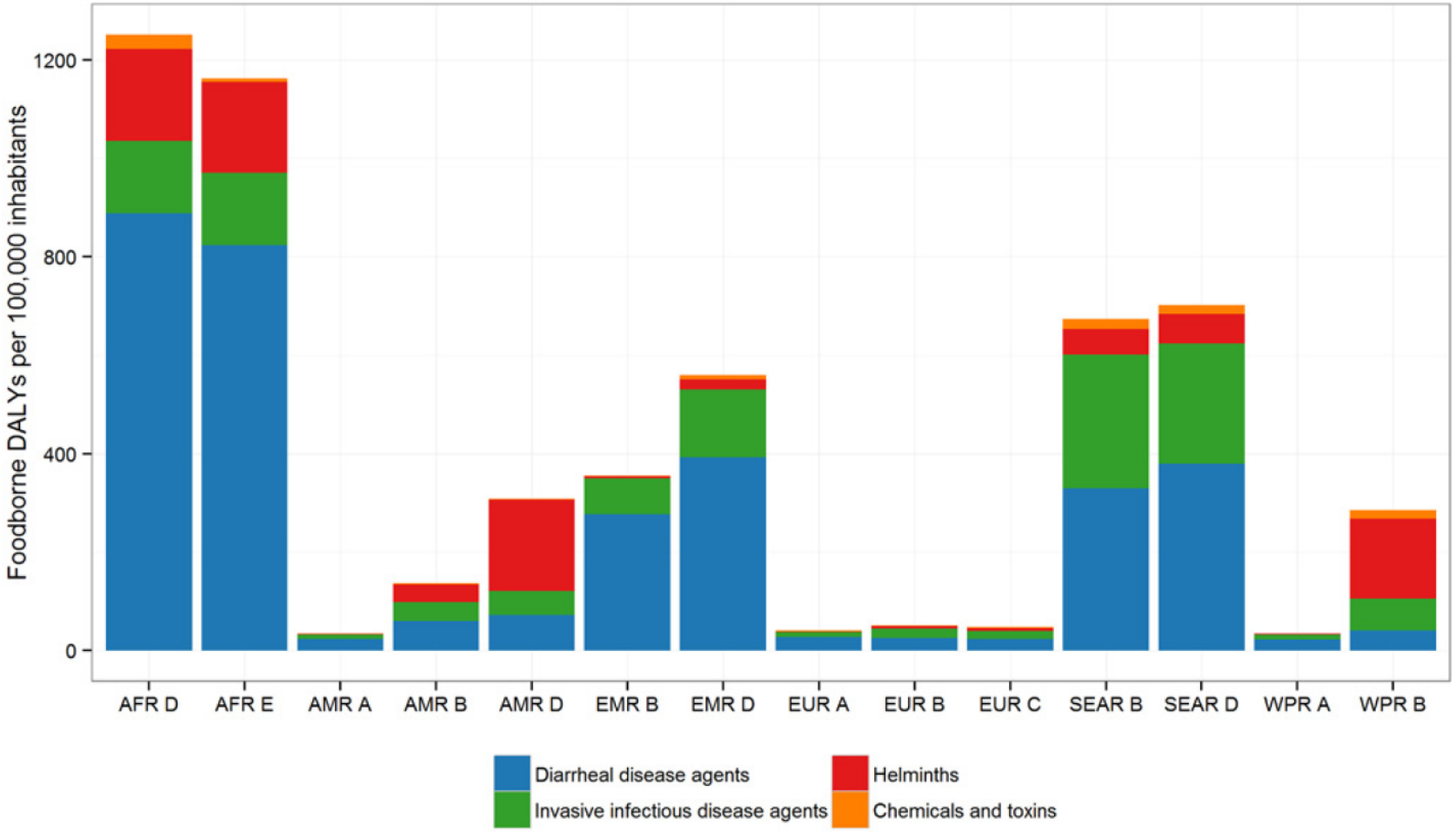
31 foodborne hazards caused 600 million foodborne illnesses and 420,000 deaths in 2010

Translates to 33 million Disability Adjusted Life Years in 2010 (one DALY corresponds to one lost year of healthy life)

Children under five years old bore 40% of this burden, although they comprised only 9% of the global population

Havelaar AH et al. (2015) World Health Organization Global Estimates and Regional Comparisons of the Burden of Foodborne Disease in 2010. PLoS Med 12(12): e1001923. doi:10.1371/ journal.pmed.1001923

The global burden of foodborne disease (DALYS per 100,000 population) by hazard groups and by subregion for 2010



Havelaar AH et al. (2015) World Health Organization Global Estimates and Regional Comparisons of the Burden of Foodborne Disease in 2010. PLoS Med 12(12): e1001923. doi:10.1371/ journal.pmed.1001923

Microbial biocontrol of mycotoxins

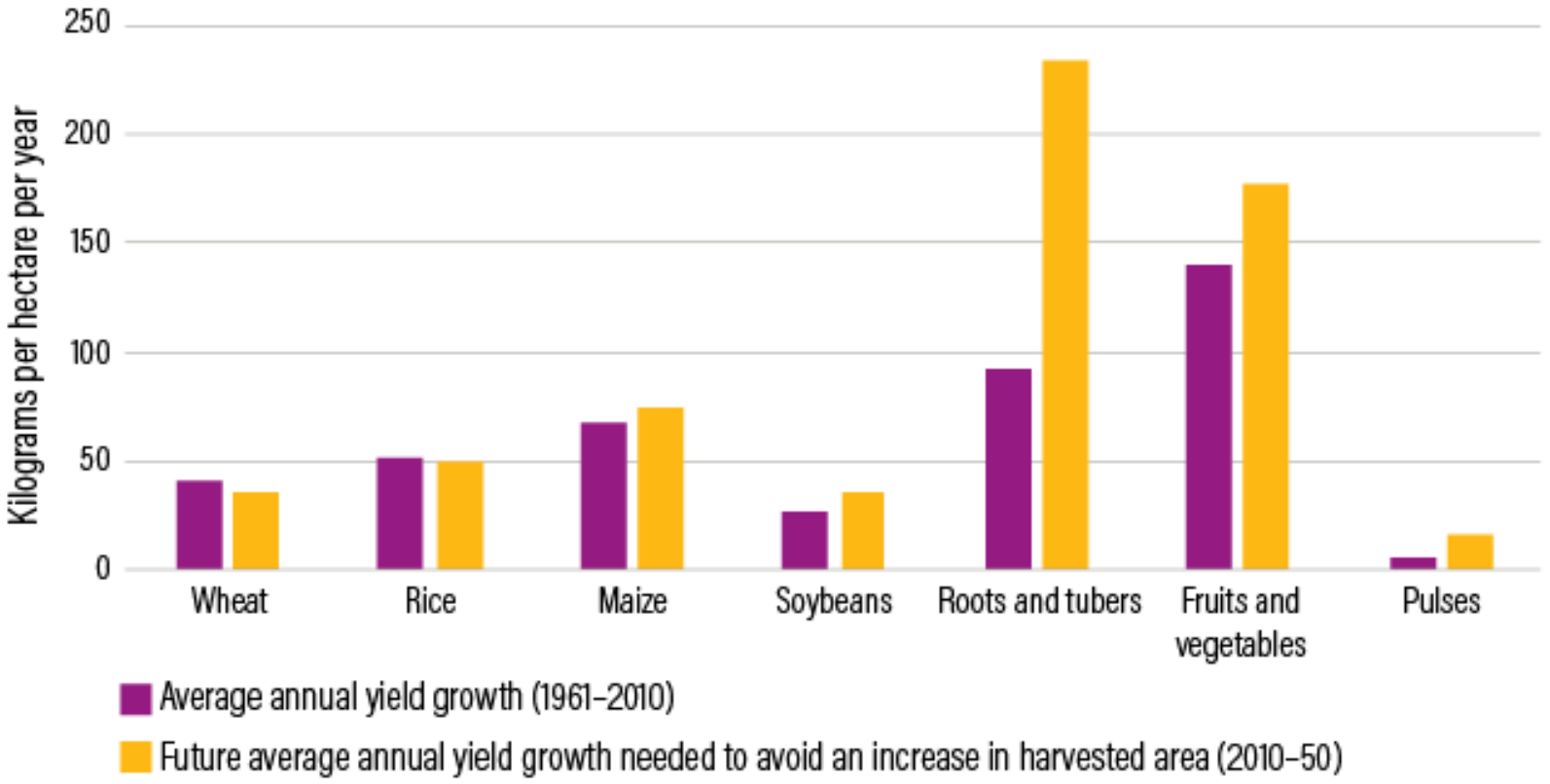
About 25% of the global food and feed output is estimated to be contaminated with mycotoxins, resulting in human health and market losses

- Use of non-aflatoxigenic *A. flavus* isolates to reduce aflatoxin contamination in peanut, maize and cotton
- Control of *Fusarium* mycotoxins using biocontrol microorganisms, application of phenolic plant extracts
- Scaling can be a challenge, esp. in SSA, but the potential benefits are significant

2 ZERO HUNGER

2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.

Future yield growth in many crops will need to be higher than in the past to meet projected food demand on existing agricultural land



Source: GlobAgri-WRR model, WRI and ACE analysis based on Alexandratos and Bruinsma (2012).

WORLD RESOURCES INSTITUTE

From: https://www.wri.org/blog/2018/12/how-sustainably-feed-10-billion-people-2050-21-charts

Biologicals and sustainable production

Macrobials can help manage insect pests and weeds

- Long established use of classical biological control in many countries to manage invasive species

Microbials can help manage insect pests, diseases, and weeds

- Biopesticides can manage plant diseases in the field and post-harvest
- Bioinsecticides have long been used e.g., *Bacillus thuringiensis*
- Bioherbicides used to manage weeds

Resistance inducers can also activate plant defenses to reduce pests and pathogens

- The organism itself or a derivative e.g., harpin protein, salicylic acid

Biologicals and sustainable production

Nitrogen-fixing bacteria

Mycorrhizal fungi

- Enhanced drought tolerance and higher water use efficiency

Microbes associated with plants that improve drought tolerance

- Activate osmotic stress responsive genes
- Improved soil health, such as water holding capacity
- Potential for manipulating the root microbiome to improve crop fitness under water stress

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution

Water pollution from agriculture

Agricultural pressures on water quality come from crop and livestock systems and aquaculture - which have expanded and intensified to meet increasing food demand and changes in dietary patterns

Nitrate from agriculture is the most common chemical contaminant in the world's groundwater aquifers

In the European Union, 38 percent of water bodies are significantly under pressure from agricultural pollution

In the US, agriculture is the main source of pollution in rivers and streams, the second in wetlands and the third in lakes

Mateo-Sagasta et al. 2017. Water Pollution from Agriculture: A Global Review. FAO & IWMI.

Biologicals and water quality

Biofertilizers could replace and/or reduce the use of synthetic chemical fertilizers

Help reduce nitrate and phosphorus run-off, mitigate eutrophication, and improve water quality

Biologicals could improve water use efficiency – more crop biomass with less water

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses

Food loss and waste

FAO estimates ~ 30% of all food produced in the world is lost or wasted

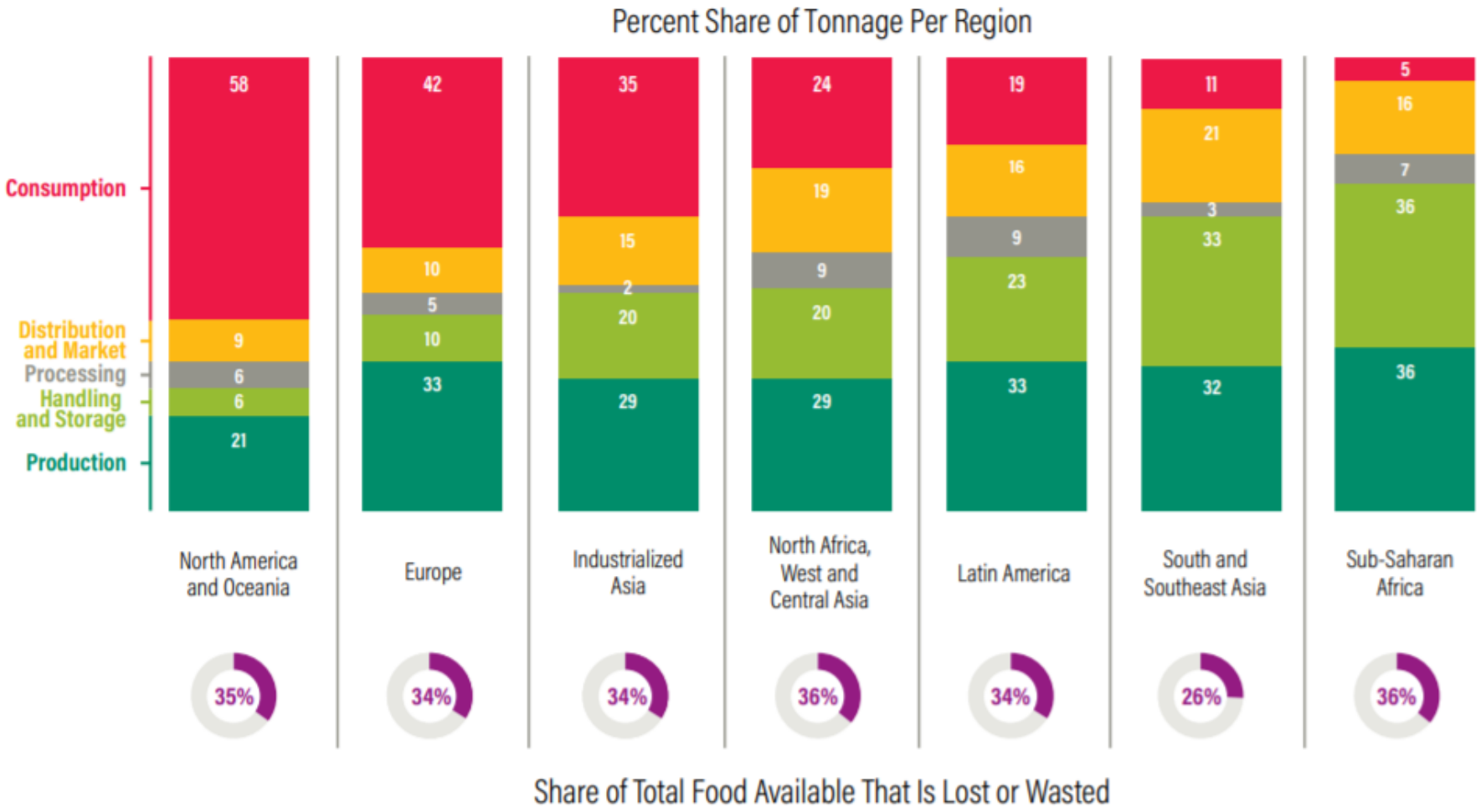
Results in ~ $940 billion in economic losses globally per year

>1 billion metric tons of food is never consumed, exacerbating food and nutrition insecurity

Lost or wasted food uses:

- ~25% of all water used by agriculture annually
- Requires land area greater than the size of China
- Generates about 8% of global greenhouse gas emissions annually

Figure ES-1 | **Distribution of Food Loss and Waste by Region and Stage in the Food Supply Chain, 2007**



Notes: Values displayed are of food loss and waste as a percent of food supply, defined here as the sum of the "Food" and "Processing" columns of the FAO Food Balance Sheet. Numbers may not sum to 100 due to rounding.
Source: WRI analysis based on FAO (2011).

From: Flanagan et al. 2019. Reducing Food Loss and Waste: Setting a Global Action Agenda. World Resources Institute, Washington DC.

Food loss and waste

Insects cause serious direct postharvest losses of ~ 9% in developed countries and ~ 20% or more in developing countries

Insects also contaminate food products e.g., live and dead insects, excreta, chemical insecticide residues

Biologicals for insect control in on-farm and off-farm storage:

- Pheromone traps for monitoring and IPM, mating disruption, mass trapping
- Macrobial parasitoids and predators

15 LIFE ON LAND

15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species

Biologicals and biodiversity

Biologicals can play an important role in management of grasslands, rangelands, and forests

- Classical biological control and genetic biocontrol to manage invasive species
- Bioherbicides to target specific weedy species

Potential for richer biodiversity in the agricultural ecosystem through multi-modal applications of plant biologicals

Improved productivity takes pressure off land conversion

Rehabilitation of degraded lands through bioremediation

Regulation of biologicals in the US

Biostimulants*
- EPA

Biocontrol agents
- USDA APHIS
- EPA

Inducers of resistance
- EPA

Biofertilizers
- EPA

Plant Biologicals

	Macrobials	Microbials	Biologically derived
Biostimulants		○	○
Biocontral agents	○	○	
Inducers of resistance		○	○
Biofertilizers		○	

Biostimulants in the US

Draft Guidance for Plant Regulator Label Claims, Including Plant Biostimulants

This document is "intended to provide guidance on identifying product label claims that are considered to be plant regulator claims by the Agency, thereby subjecting the products to regulation as pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)"

See: https://www.federalregister.gov/documents/2019/03/27/2019-05879/pesticides-draft-guidance-for-pesticide-registrants-on-plant-regulator-label-claims-including-plant

Biostimulants in the US

2018 Farm Bill: “a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield”

No definition under FIFRA, but EPA is using “naturally-occurring substance or microbe that is used either by itself or in combination with other naturally-occurring substances or microbes for the purpose of stimulating natural processes in plants or in the soil in order to, among other things, improve nutrient and/or water use efficiency by plants, help plants tolerate abiotic stress, or improve the physical, chemical, and/or biological characteristics of the soil as a medium for plant growth.

Biopesticides in the US

US EPA "is committed to encouraging the development and use of biopesticides and considers them inherently reduced-risk pesticides."

"Since biopesticides tend to pose fewer risks than conventional pesticides, EPA generally requires much less data to register a biopesticide than to register a conventional pesticide, and EPA's review times are shorter for biopesticides"

Categories:

- Biochemical pesticides: naturally occurring substances or synthetically derived equivalents that have a non-toxic mode of action to the target pest(s) e.g., pheromones, induced resistance promoters
- Microbial pesticides: microorganisms that produce a pesticidal effect e.g., *Bacillus thuringiensis*,
- Plant-incorporated protectants: transgenic crops with pesticidal traits

What can we learn from the world of GE plants?

- **Regulation should be commensurate with risk**
- Apply problem formulation to risk assessment
- Path to commercialization must be possible for public and private sectors (SMEs as well as MNCs)
- Differentiate research from (commercial) product development
- Harmonization is not easy but it is worth the (patient) effort
- Science is not enough

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2 ZERO HUNGER

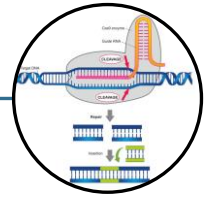
6 CLEAN WATER AND SANITATION

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

14 LIFE BELOW WATER

15 LIFE ON LAND

Plant Biologicals Network



Acknowledgements:

Dr. Rachel Melnick

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