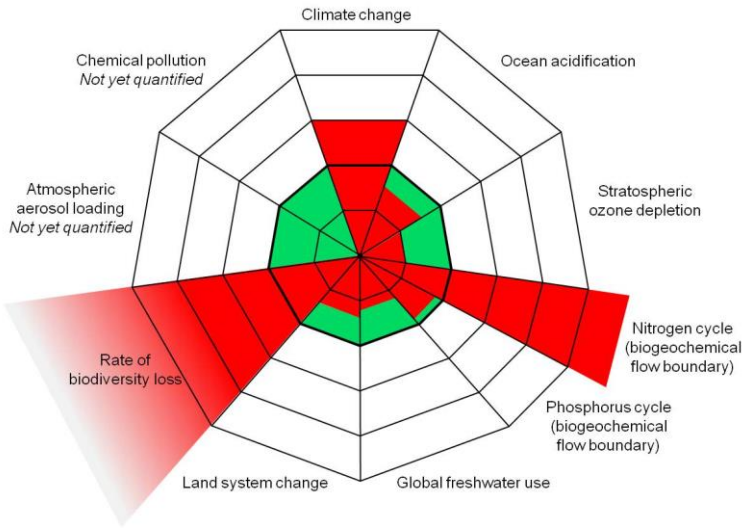
Food Security
and its interactions with Biodiversity

and other aspects of Environmental Change

?



John Ingram
Food Systems Programme Leader
Environmental Change Institute
University of Oxford

Environmental *Change* Institute
eci
UNIVERSITY OF OXFORD

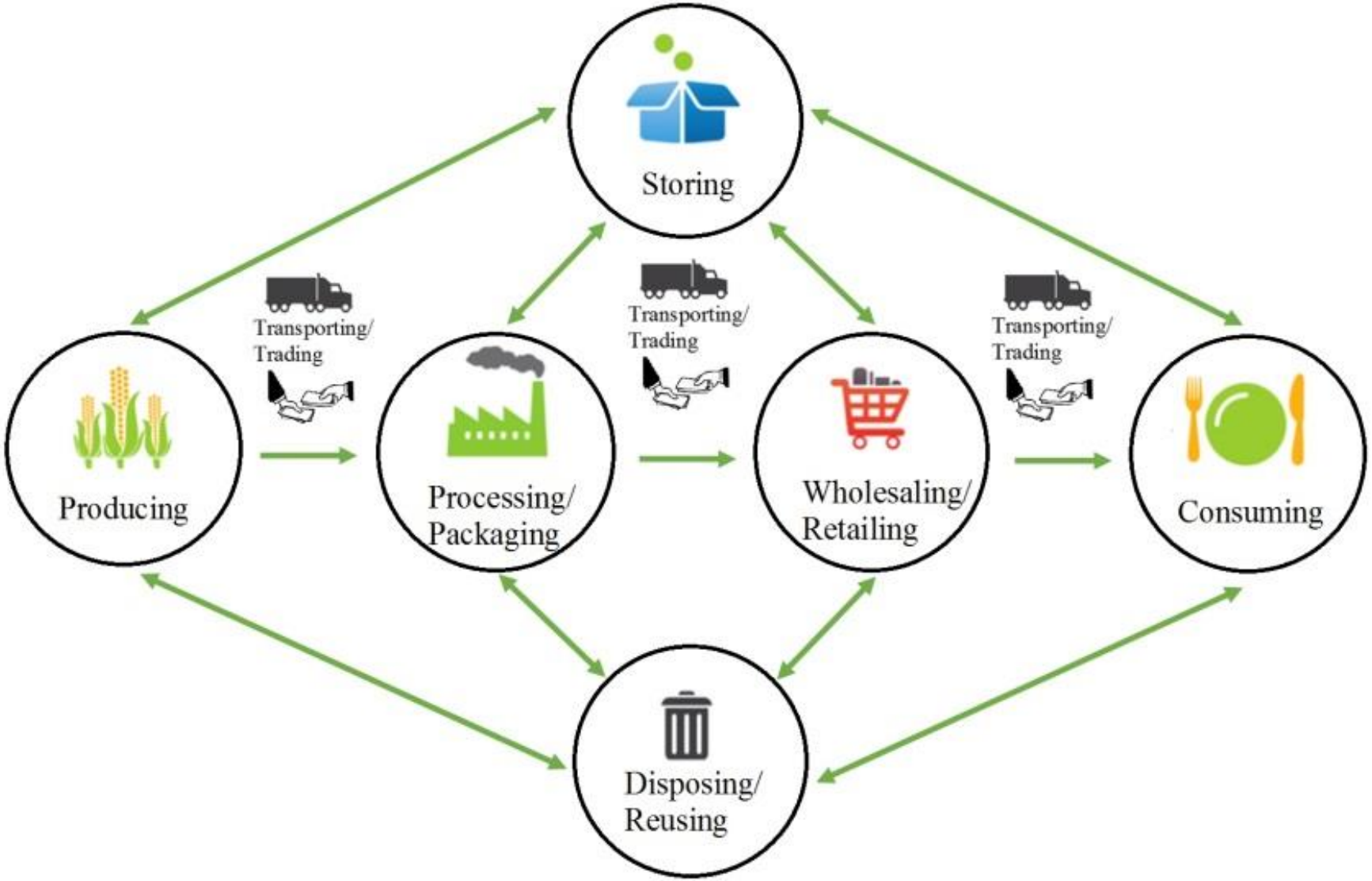
Food security…

… exists when all people, at all times, have **physical, economic and social access** to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

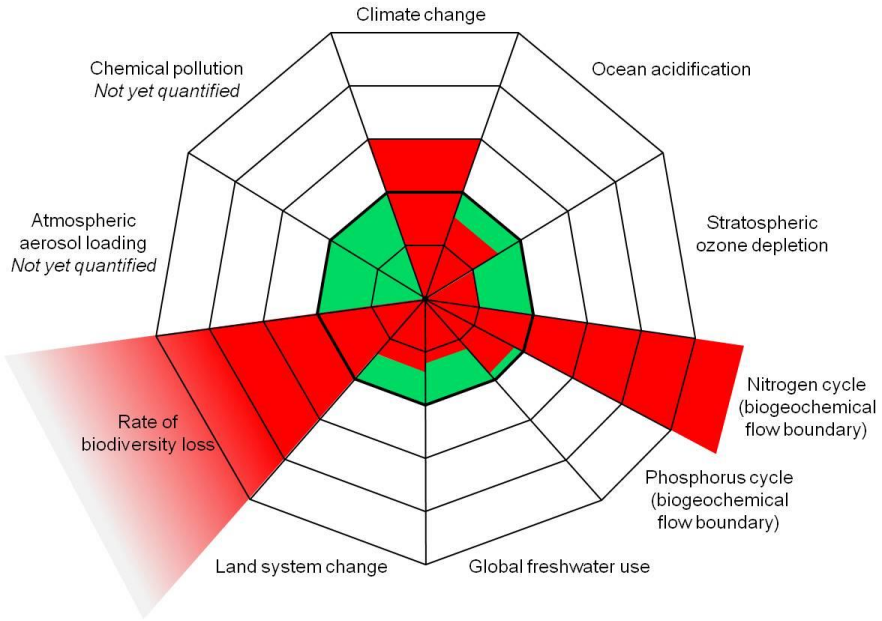
(UN-FAO World Food Summit 1996, 2012)

… is universally applicable
… is more than food production
… is underpinned by food systems

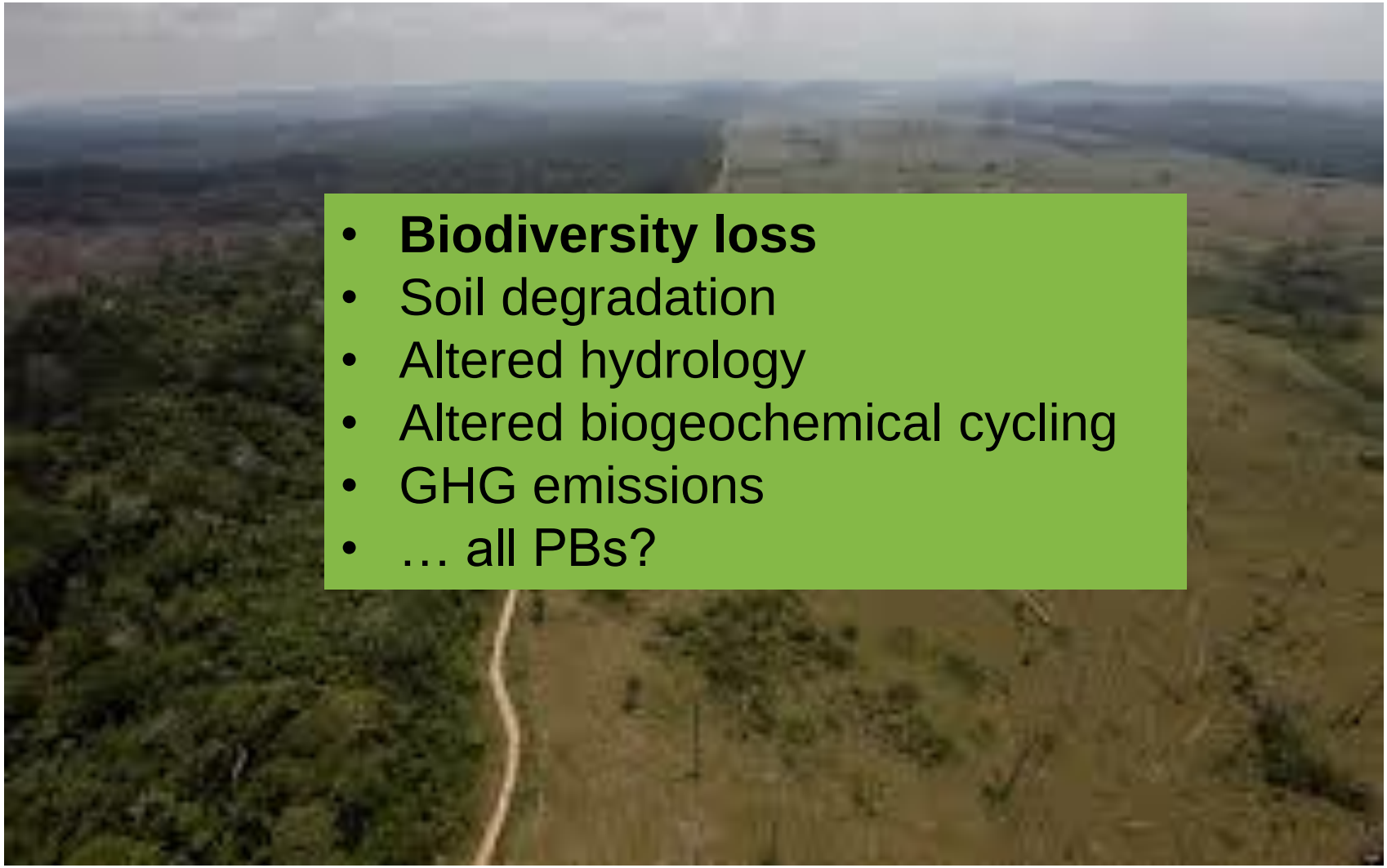
Food Systems include a set of ‘Activities’ …



… all of which contribute to crossing Planetary Boundaries.



Agriculture as a driver of Land-cover Change ‘Extensification’



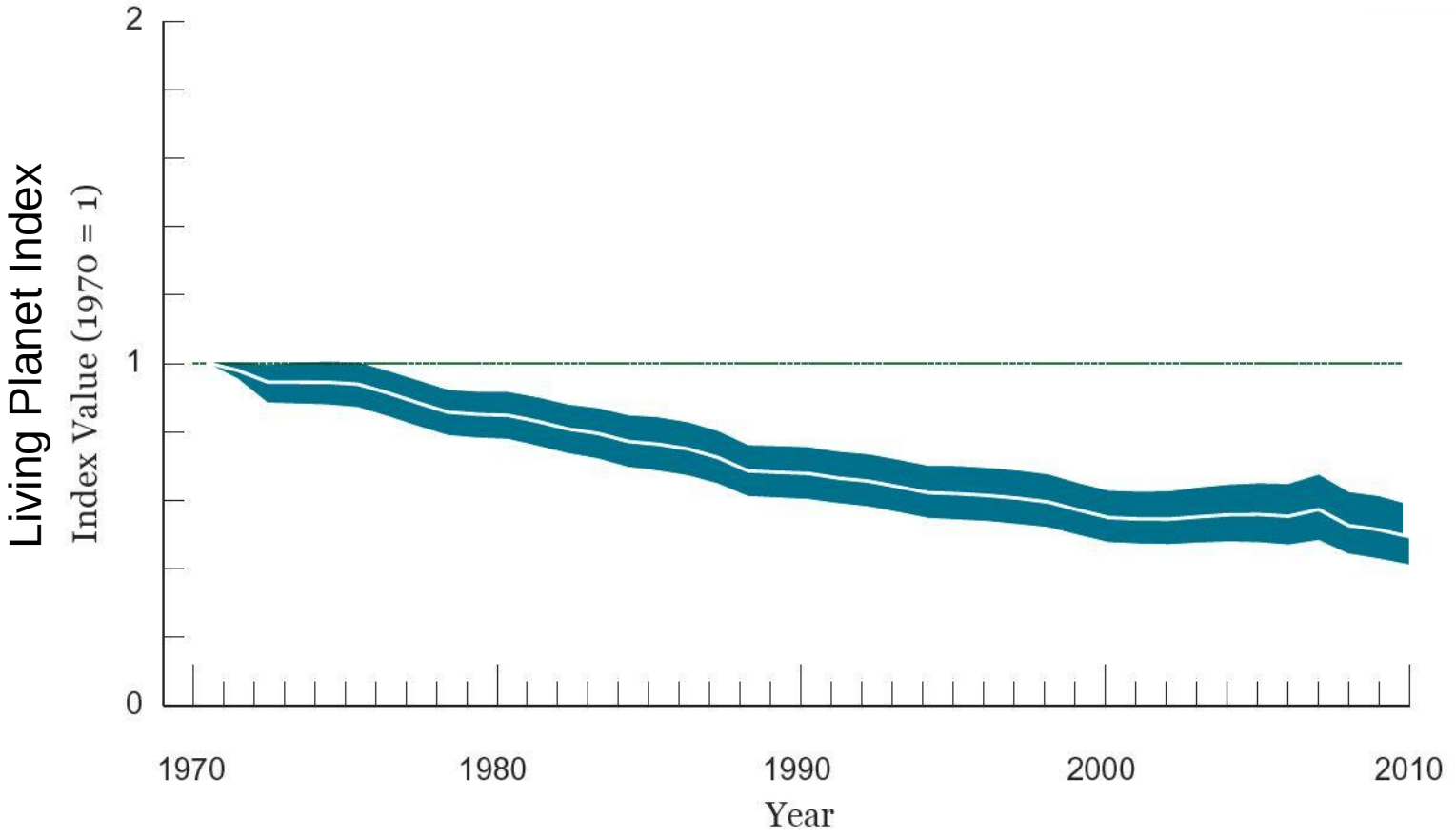
Species' threats attributable to agriculture …

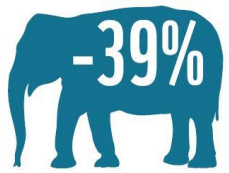
"Among the drivers of habitat loss for mammals, agriculture and pastoralism are the most important, together affecting 40% of terrestrial mammals"

IUCN, Red List of threatened species, 2010

… which is contributing to biodiversity loss.

Declines in 10,000 representative populations of mammals, birds, reptiles, amphibians and fish.





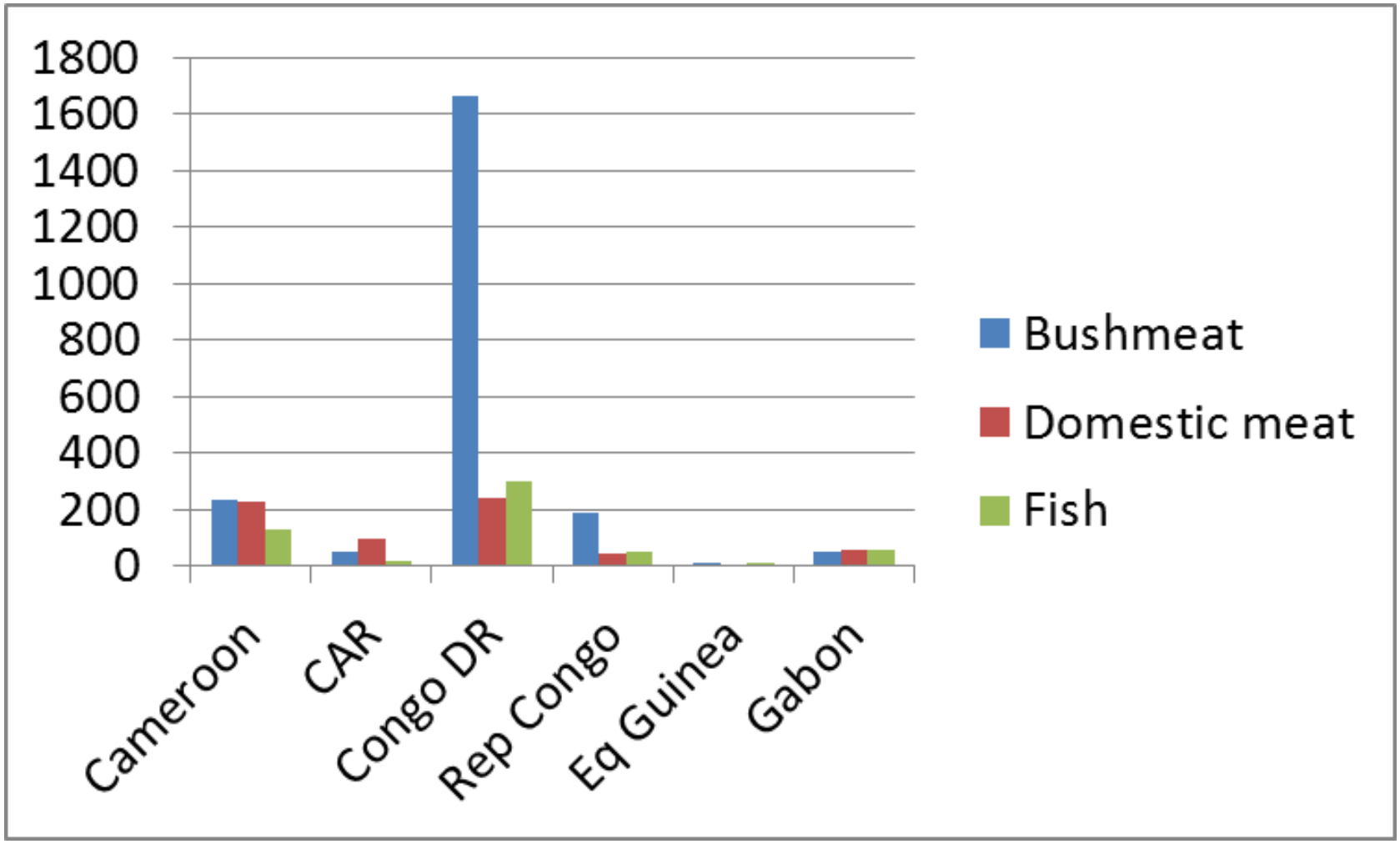
Terrestrial

Fresh water

Marine

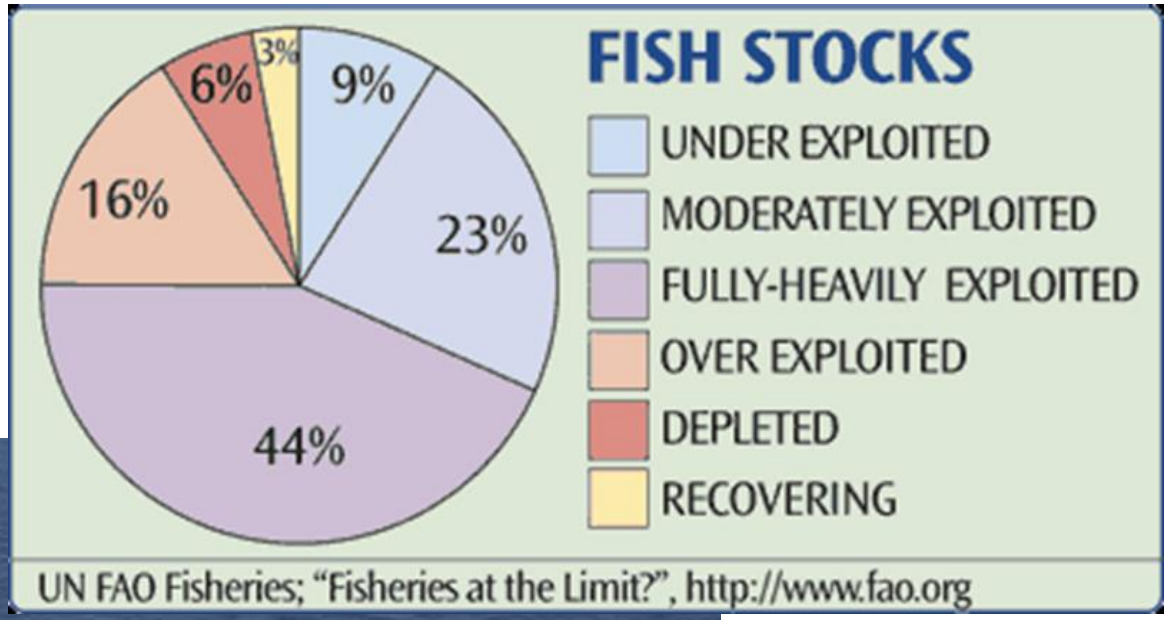
WWF & ZSL, 2014

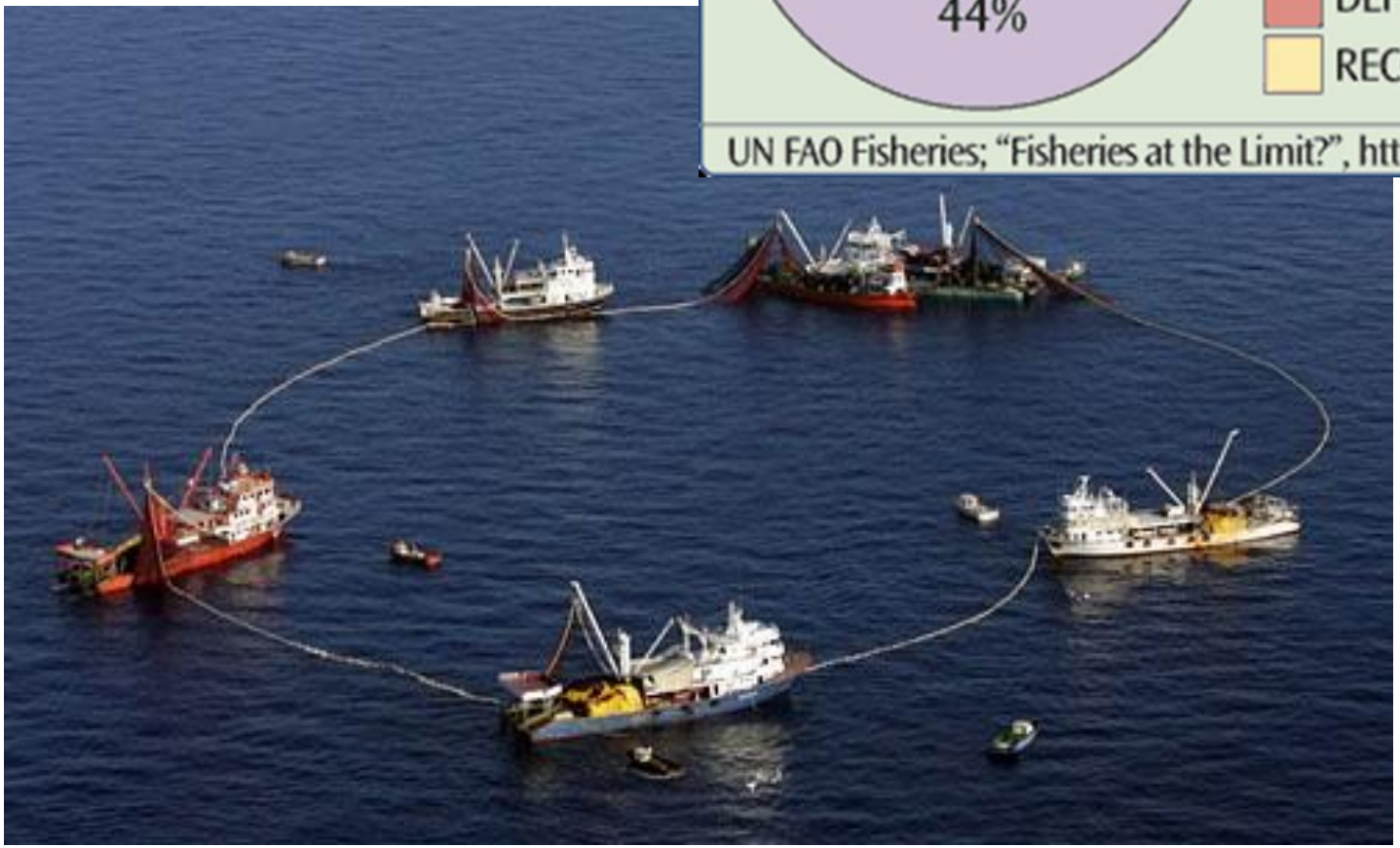
Hunting: importance of fish and bushmeat in West Africa, relative to domestic meat (kt/yr)



Adapted from Watson & Brashares, ODI Briefing 4, 2004

Contribution of capture fisheries to biodiversity loss





But Food Systems involve more than 'agriculture' …

Other environmental issues?

Processing Food: water use and effluent

Other environmental issues?

Processing Food: water use and effluent

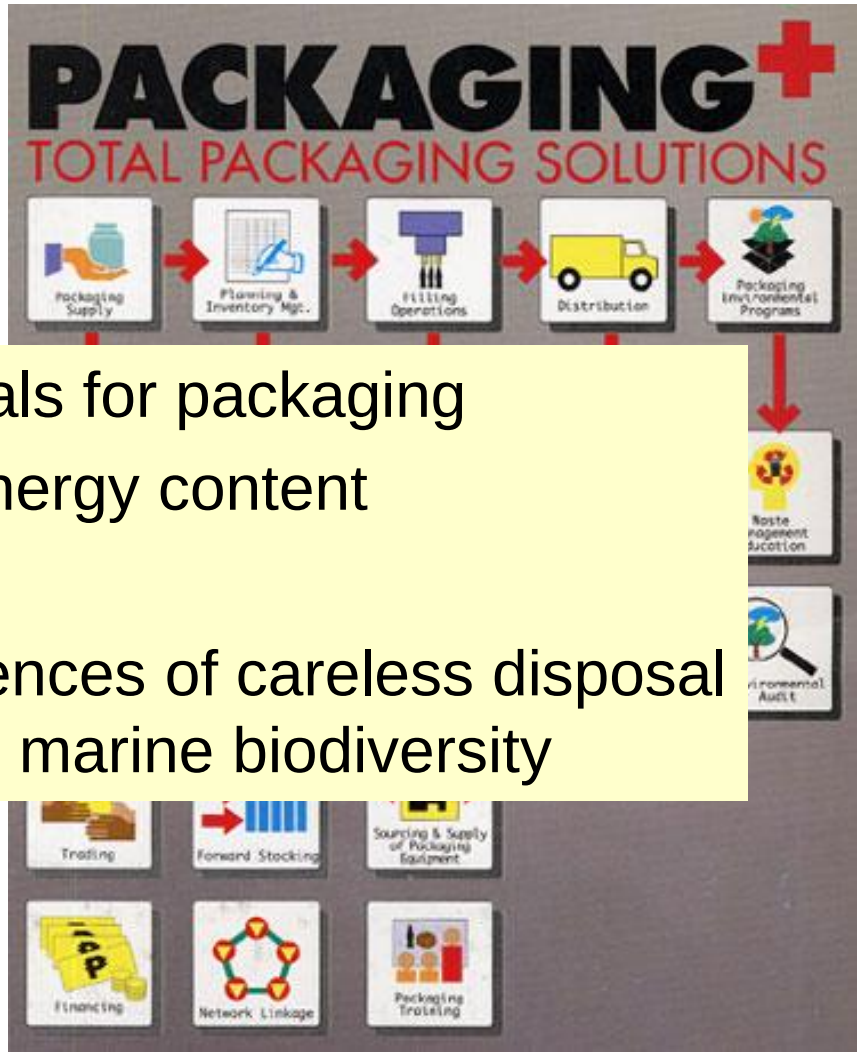
- **5-10% of all industrial use of the public water supply**

- **Effluent significantly affects aquatic habitats**
  - large amounts of organic materials such as proteins, carbohydrates, and lipids
  - high biochemical oxygen demand (BOD) and/or chemical oxygen demand (COD)
  - high N and P concentration
  - high suspended oil or grease contents
  - high variations in pH

Defra, 2006; Kroyer, 1995; Prasad et al. 2010

Packaging Food

Packaging Food



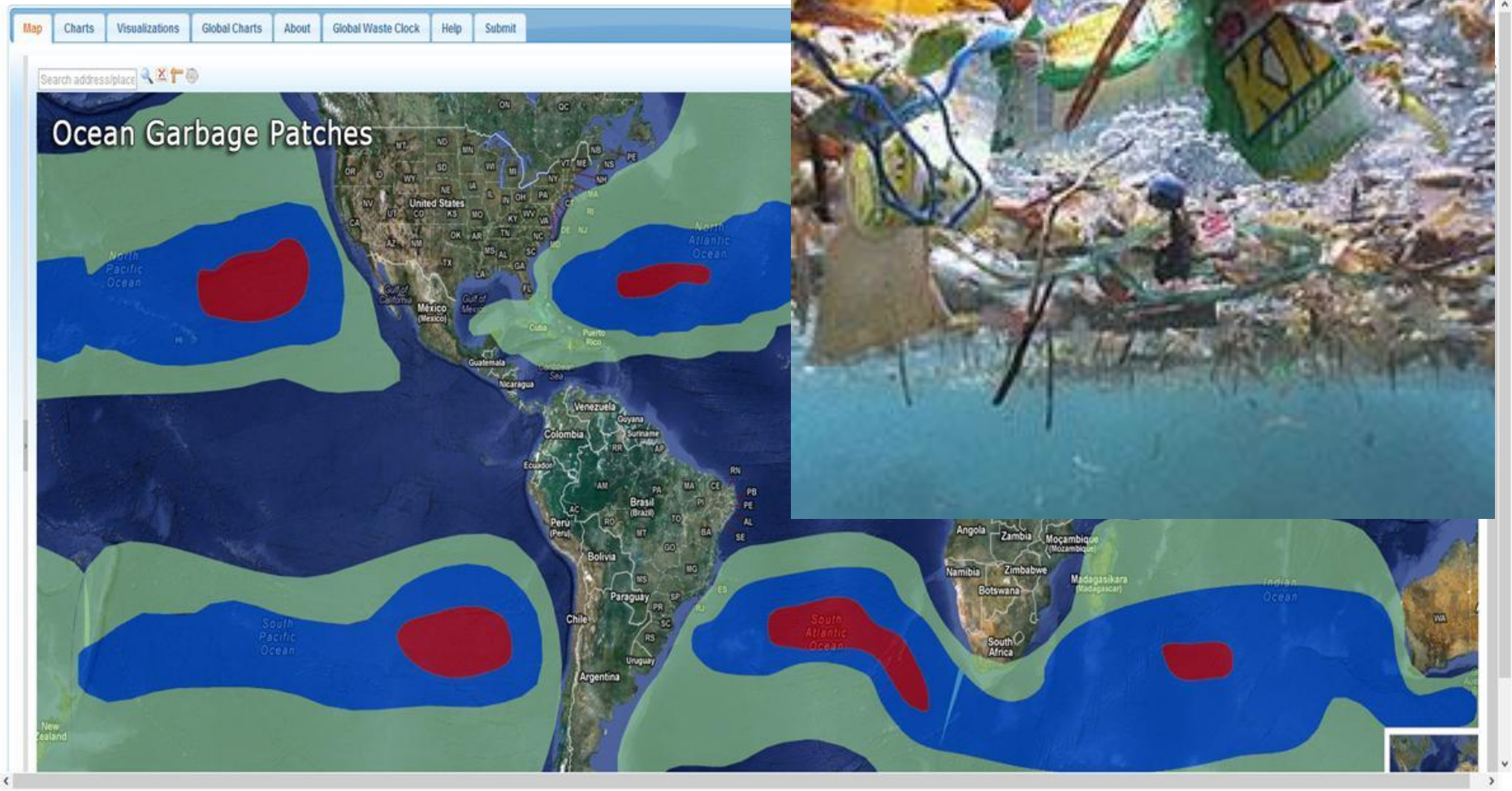
- Use of raw materials for packaging
- Real and virtual energy content
- Litter
- Adverse consequences of careless disposal of packaging, esp. marine biodiversity

Packaging Food

WASTE ATLAS

Partners

ISWA SWEEPNET WIERT SWAPI



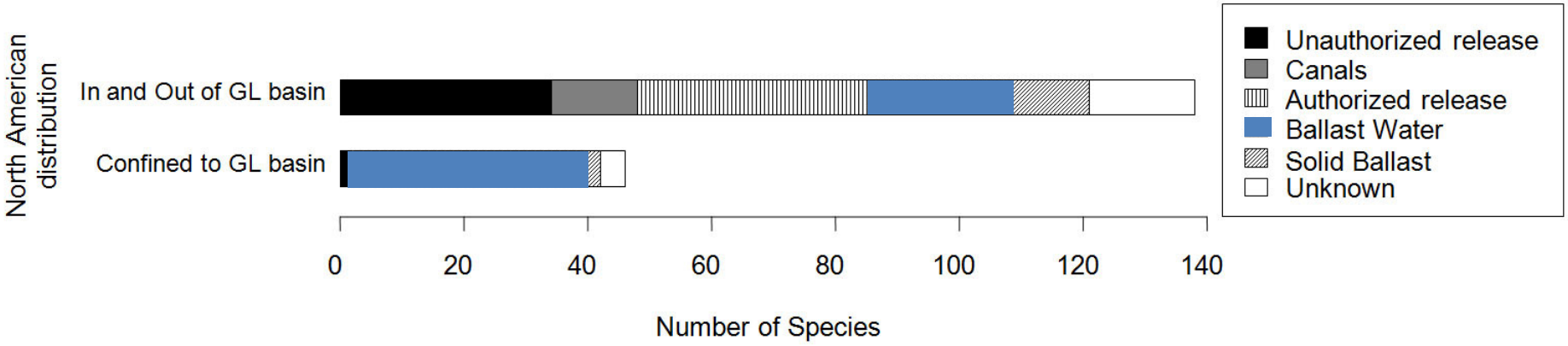
Transporting Food

Ballast water and US grain exports via Great Lakes

Transporting Food

Ballast water and US grain exports via Great Lakes

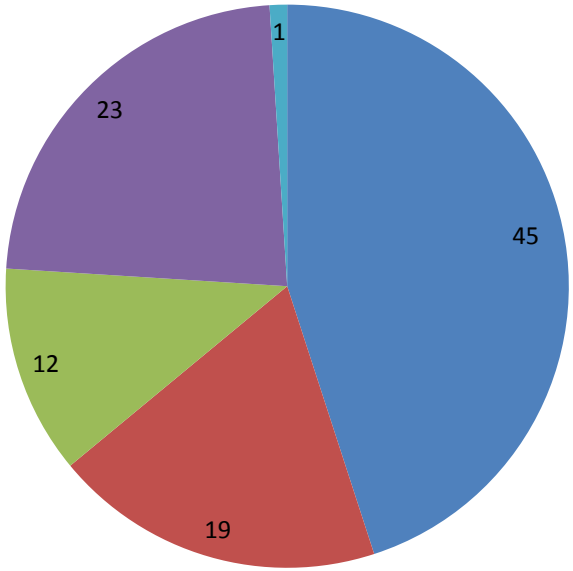
Current North American distribution with respect to the Great Lakes basin of 182 nonindigenous species (NIS).
Shading within each bar shows vector of introduction.



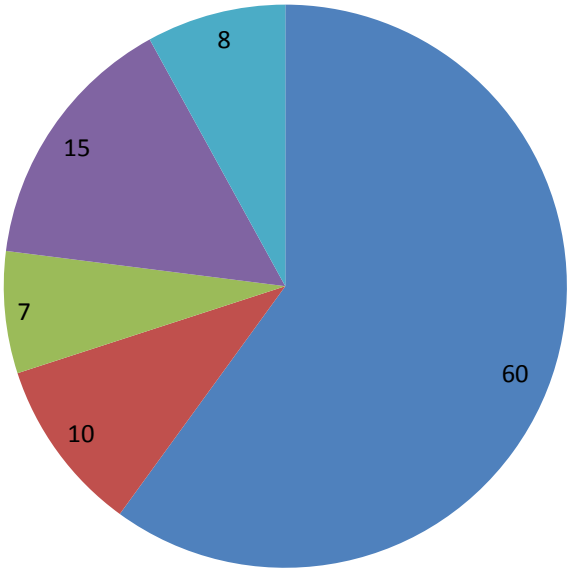
Ballast water release introduces most beachhead nonindigenous species (43 of 65, 66%) in the N Am Great Lakes

Rothlisberger and Lodge, *Aquatic Invasions*, 2013

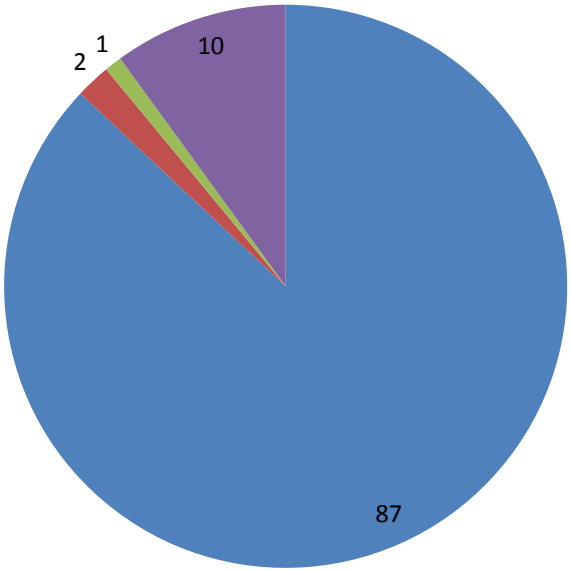
GHG emissions across Food Systems



UK



USA



India

Producing

Distributing

Waste disposing

Processing

Consuming

Garnett, FCRN, 2009

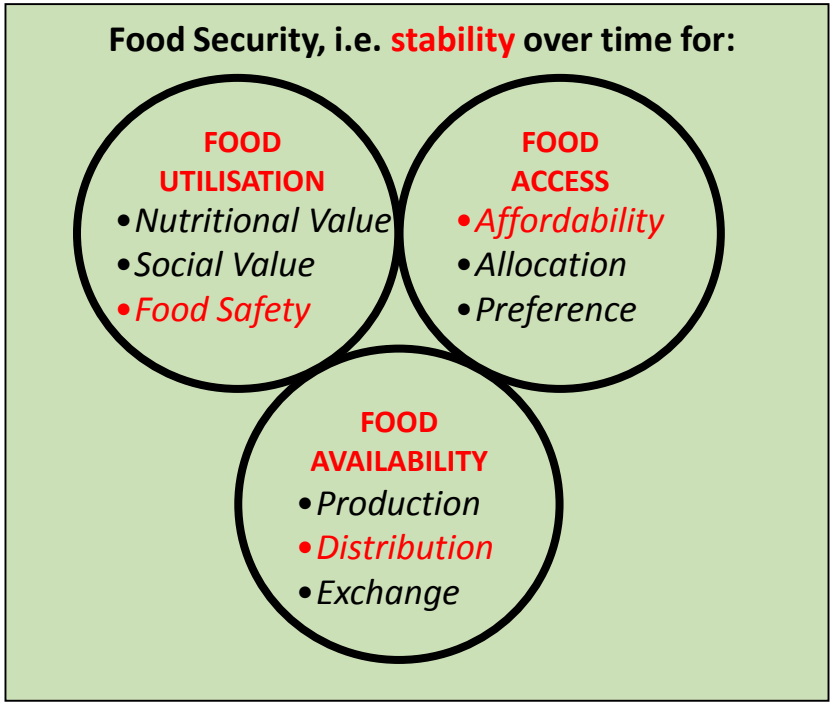
Edwards et al., Inst Agric & Trade Policy, 2009

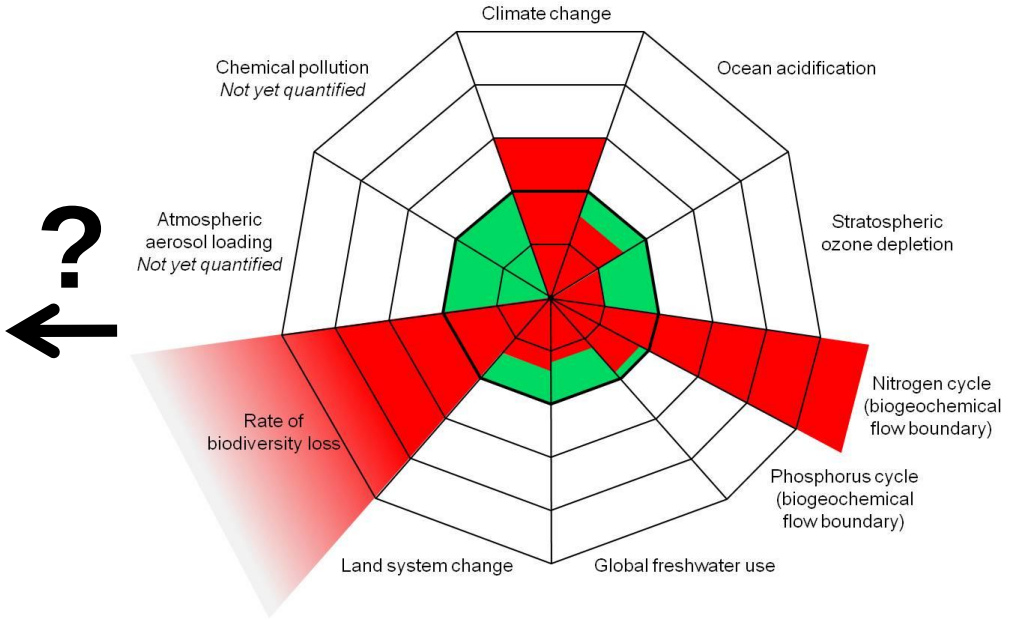
Pathak et al, Ag, Ecosys & Env, 2010

Food System Activities and Planetary Boundaries

Example contributions of FSAs to PBs	Producing food	Processing & Packaging food	Distributing & Retailing food	Consuming food
Climate change	GHGs, albedo	Factory emissions	Emissions from transport and cold chain	GHGs from cooking
N cycle	Eutrophic^{n}, GHGs	Factory effluent	NOx from transport	Waste
P cycle	P reserves	Detergents		Waste
Fresh water use	Irrigation	Washing, heating, cooling	Cleaning food	Cooking, cleaning
Biodiversity loss	Deforestation, soil degrad^{n}, fishing	Paper/card, Al and Fe mining	Invasive spp.	Consumer choices
Atmos. aerosols	Dust		Shipping	Smoke from cooking
Chemical	Pesticides	Factory effluent	Transport	Cooking,

How do Climate Change and drivers of crossing Planetary Boundaries affect Food Security?





Extreme weather affects affordability…

Poor people tend to spend relatively more of their income on food, therefore suffer more when food prices go up

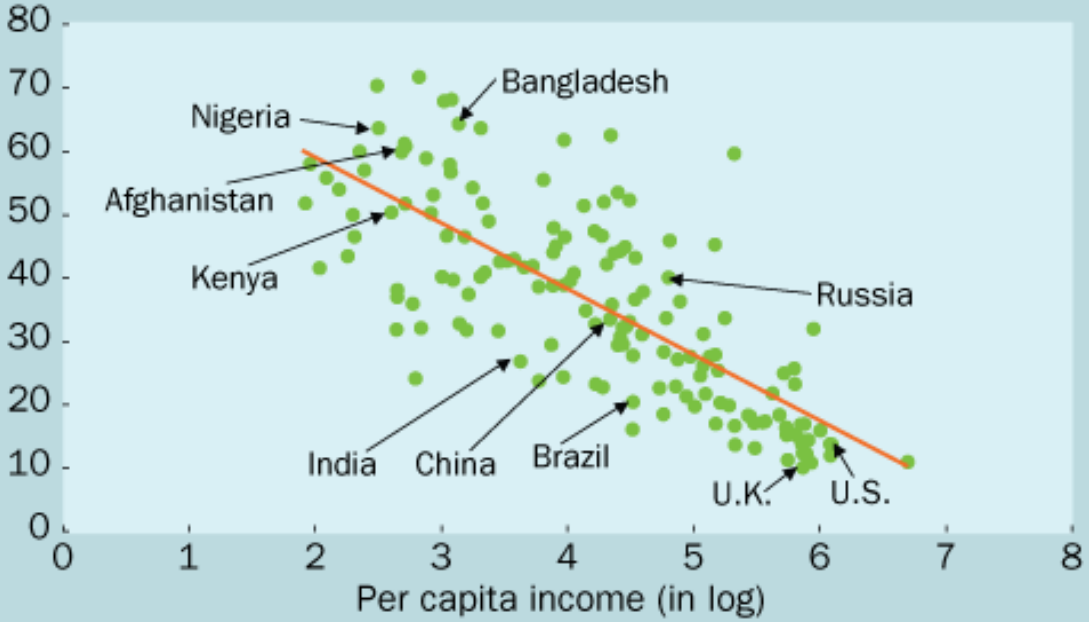
Cost of wheat is 10% of cost of loaf of bread in the US, but 90% cost of chapatti in India

Chart 2

Paying more

Poor people tend to spend relatively more of their income on food, and therefore suffer more when food prices go up.

(food weighting within consumer price index, percent)



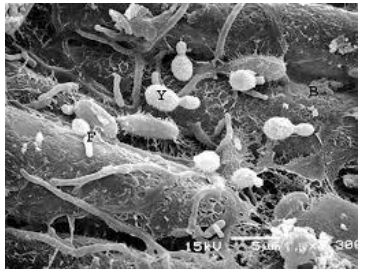
Source: IMF staff calculations.

… and food storage …

… and food distribution …

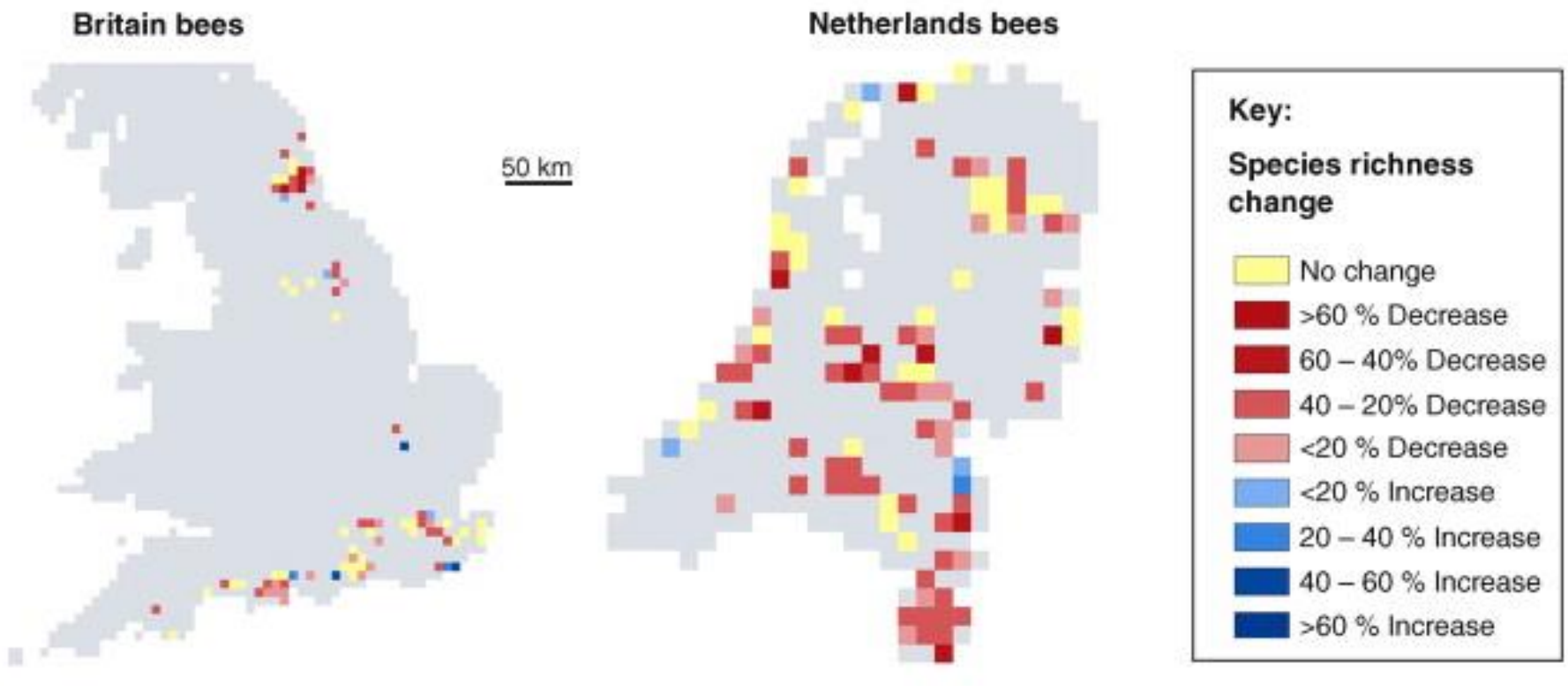
… and biodiversity-related aspects of food safety.

- **Mycotoxins** formed on plant products in the field or during storage
- **Residues of pesticides** in plant products affected by changes in managing increased pest pressure
- **Marine biotoxins** in seafood following production of phycotoxins by harmful algal blooms
- **Pathogenic bacteria** in foods during heat waves.



Miraglia et al., *Food and Chemical Toxicology*, 2009

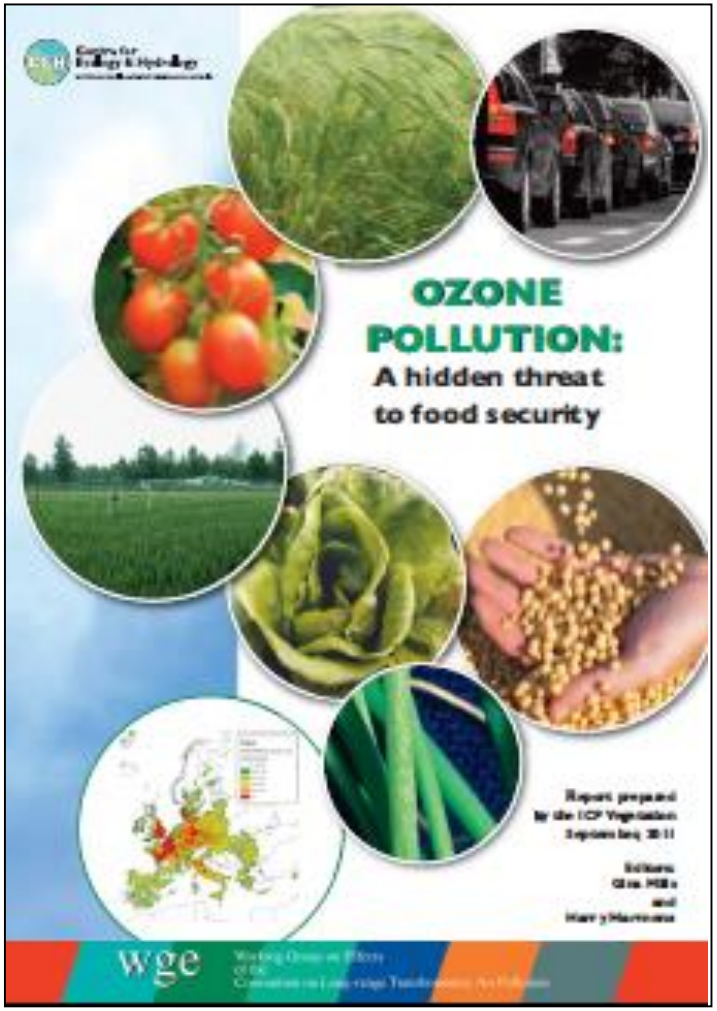
Agricultural intensification leads to declines in pollinators …

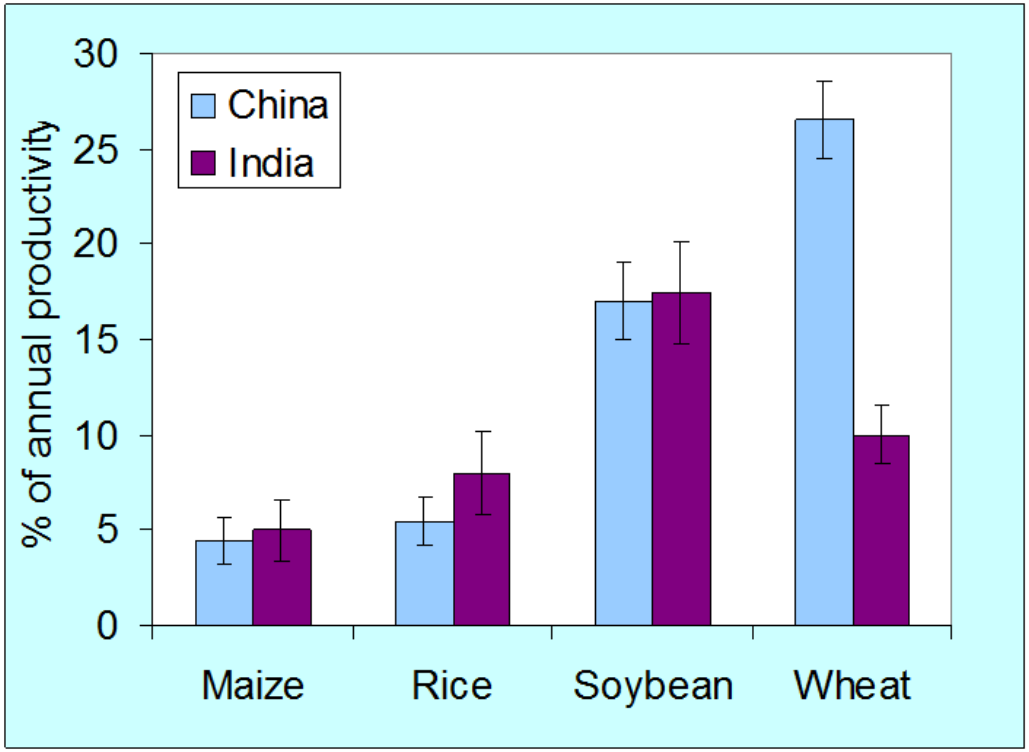


"… a widespread pattern of loss of pollinator richness and abundance as a result of agricultural intensification and habitat loss." [since 1980]

Potts et al., 2010, Trends in Ecol & Evol

… and tropospheric O_3 pollution reduces yields.





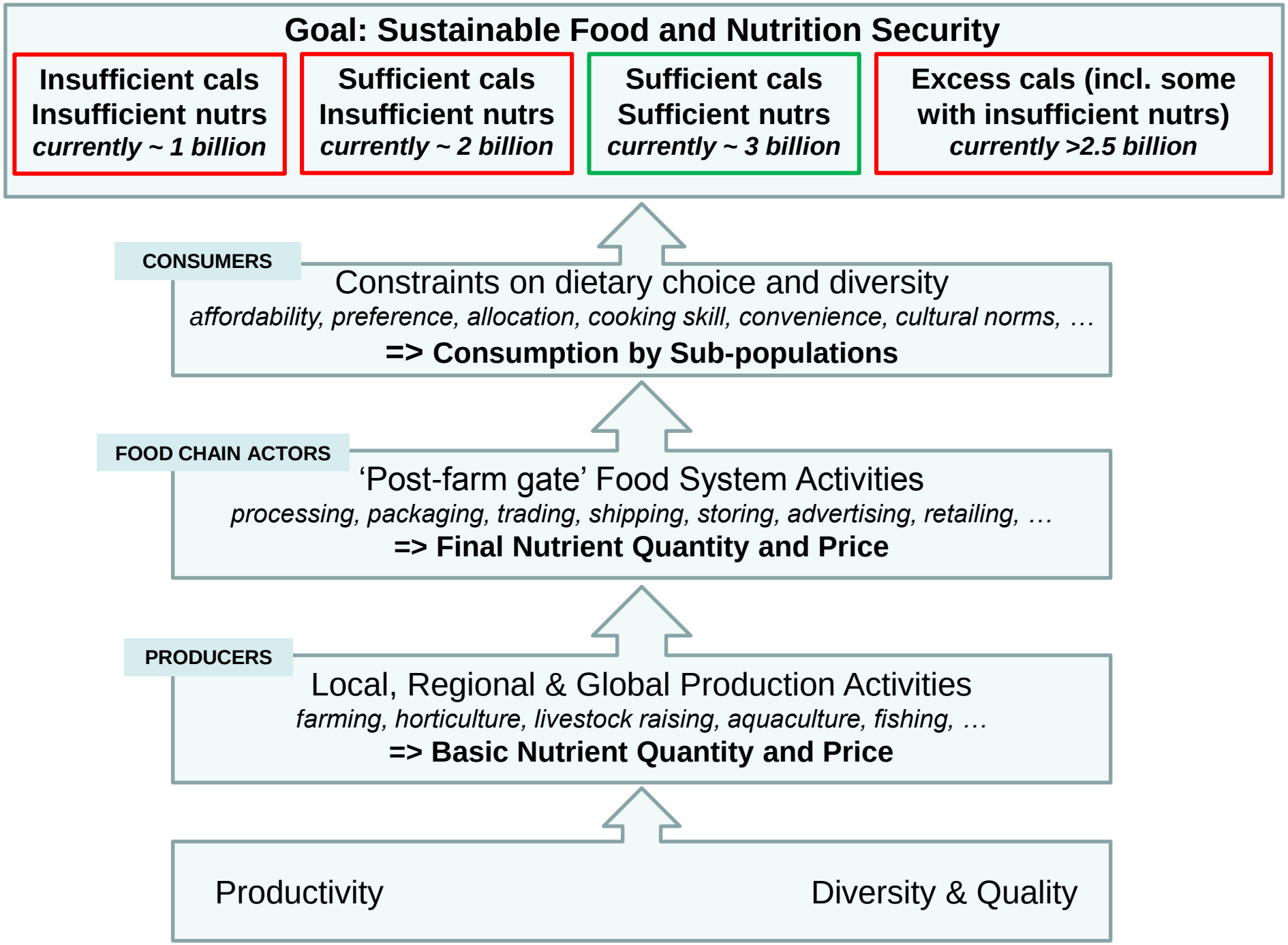
Estimated effects of O_3 on crop productivity, 2000

Mills et al, NERC-CEH, 2011

So why the need to change things?

1. Planetary Boundary concerns are clear
   - *climate change*
   - *biodiversity loss*
   - *other PBs*

2. Food Security also a major concern
   - *~ 1b hungry*
   - *~ 2b insufficient nutrients*
   - *> 2.5b overweight or obese*


Goal: Sustainable Food and Nutrition Security
Insufficient cals
Insufficient nutrs
currently ~ 1 billion
Sufficient cals
Insufficient nutrs
currently ~ 2 billion
Sufficient cals
Sufficient nutrs
currently ~ 3 billion
Excess cals (incl. some with insufficient nutrs)
currently >2.5 billion
CONSUMERS
Constraints on dietary choice and diversity
affordability, preference, allocation, cooking skill, convenience, cultural norms, …
=> Consumption by Sub-populations
FOOD CHAIN ACTORS
'Post-farm gate' Food System Activities
processing, packaging, trading, shipping, storing, advertising, retailing, …
=> Final Nutrient Quantity and Price
PRODUCERS
Local, Regional & Global Production Activities
farming, horticulture, livestock raising, aquaculture, fishing, …
=> Basic Nutrient Quantity and Price
Productivity
Diversity & Quality

So what do we do about it?

- ✓ Adapt to inevitable change
- ✓ Mitigate further change

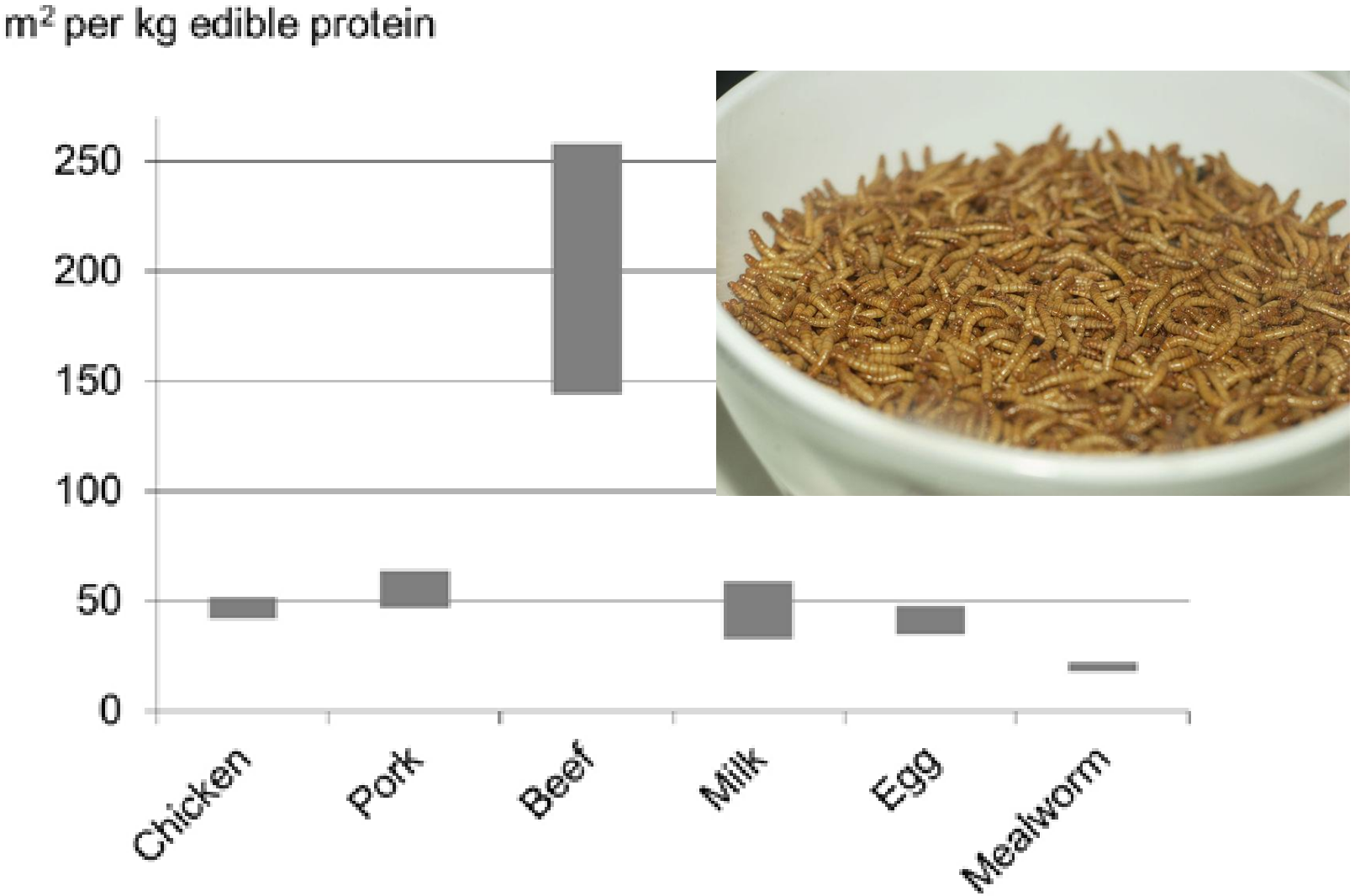
=> Do the “doing things” differently …

Improve agriculture, livestock, horticulture, aquaculture, fisheries, …

- More varied crops
- Stress-tolerant varieties
- Novel food producing systems
- Improve water mgmt
- Insurance for producers
- Wider range of food stuffs

… consider insect protein for better land-use …

Range in land use (m2) per kg of edible protein



De Vries and De Boer 2010; Oonincx and De Boer 2012.

… consider wholly novel foods …

… reduce food losses and waste …

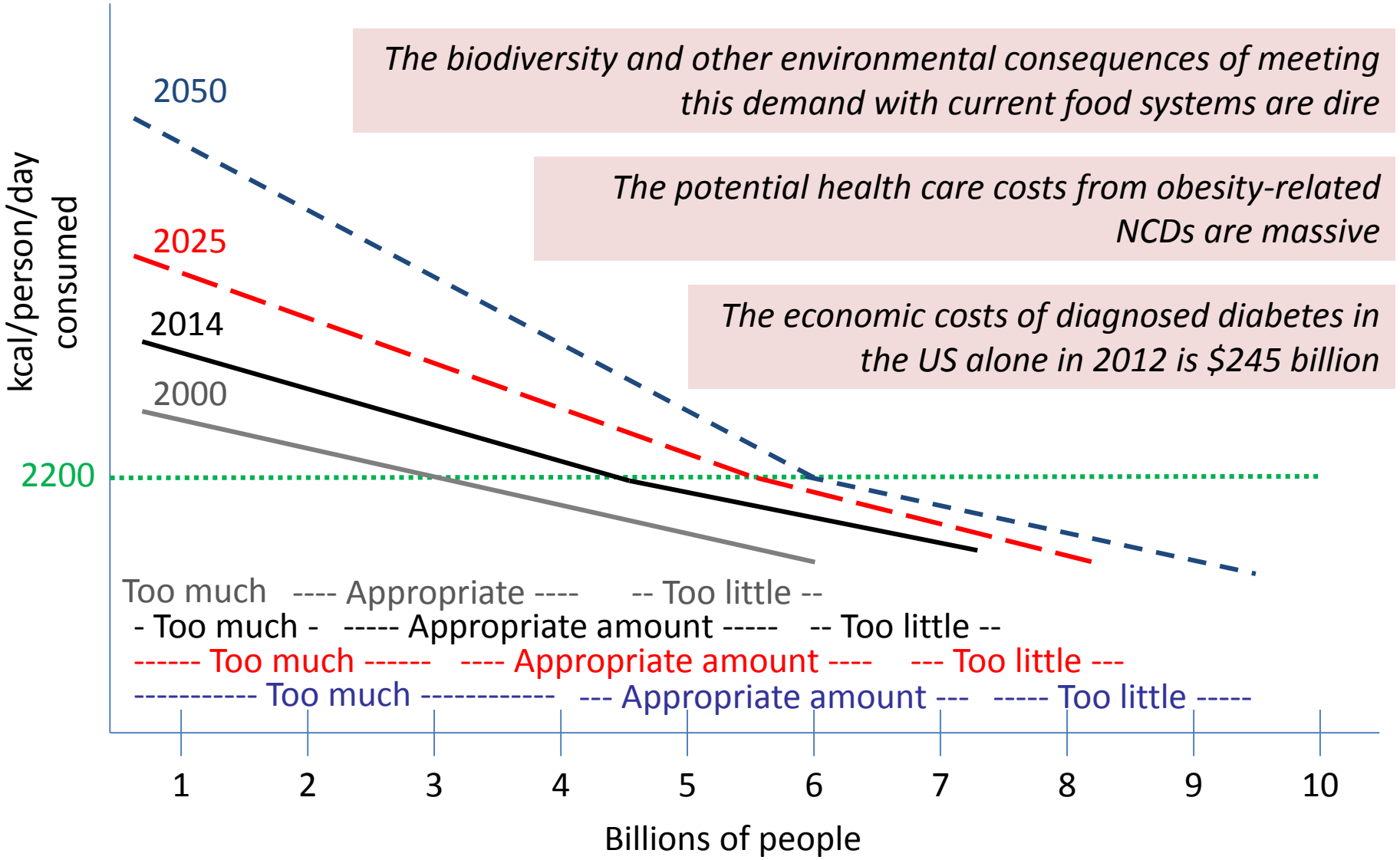
~ 30% worldwide

Figure 3. Part of the initial production lost or wasted, at different FSC stages, for cereals in different regions

FAO, Global Food Losses and Food Waste, 2011

… and reduce over-consumption.

Looking ahead ...



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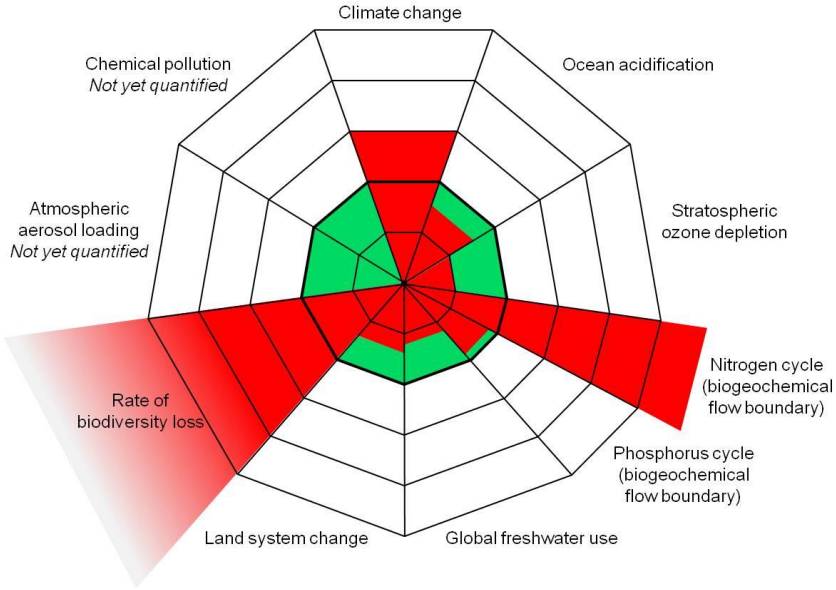
Climate change
Ocean acidification
Stratospheric ozone depletion
Nitrogen cycle (biogeochemical flow boundary)
Phosphorus cycle (biogeochemical flow boundary)
Global freshwater use
Land system change
Rate of biodiversity loss
Atmospheric aerosol loading
Not yet quantified
Chemical pollution
Not yet quantified