Nitrogen management challenges and policy

Global Overview

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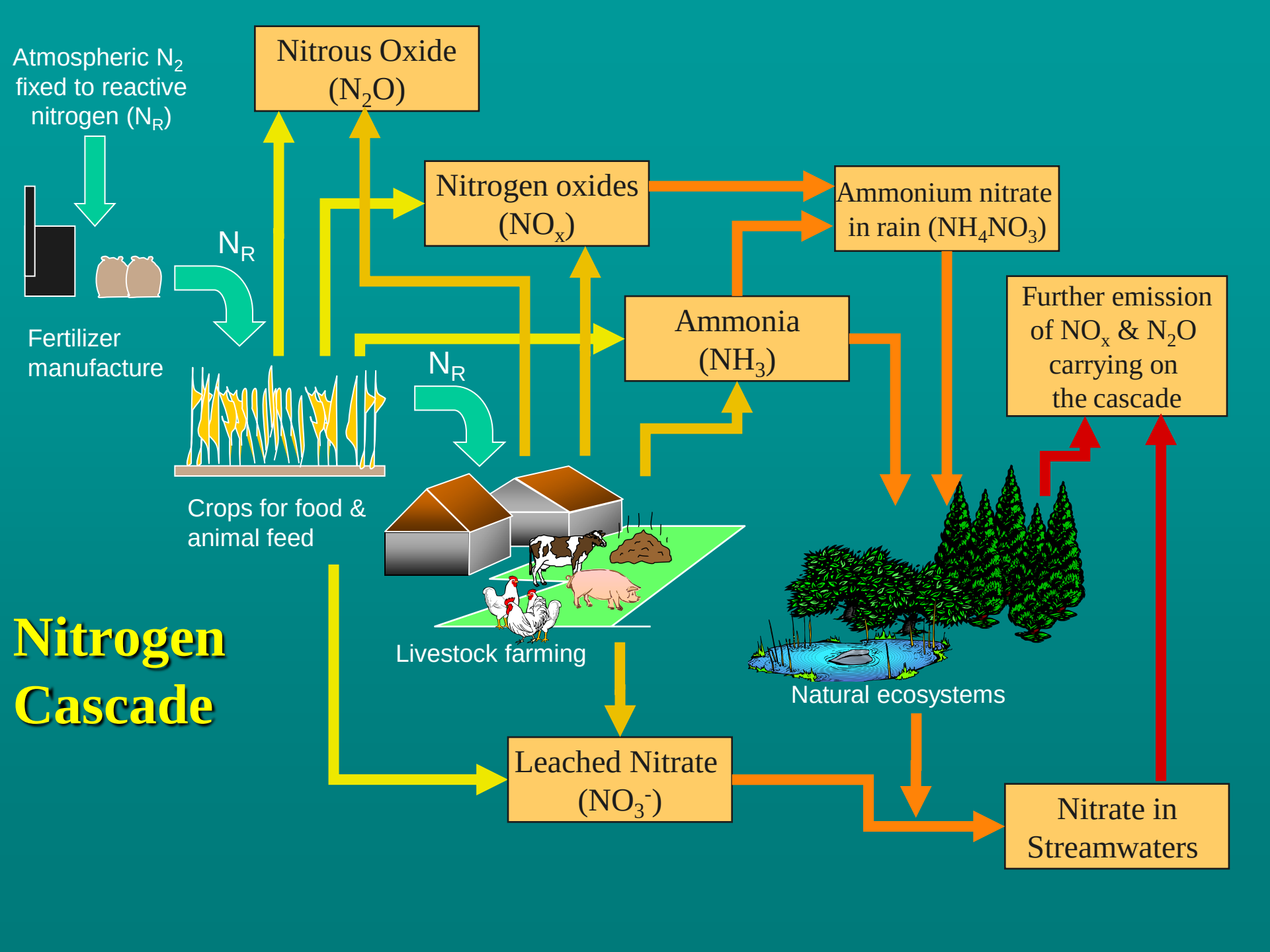
GLOC-2 Montego Bay,

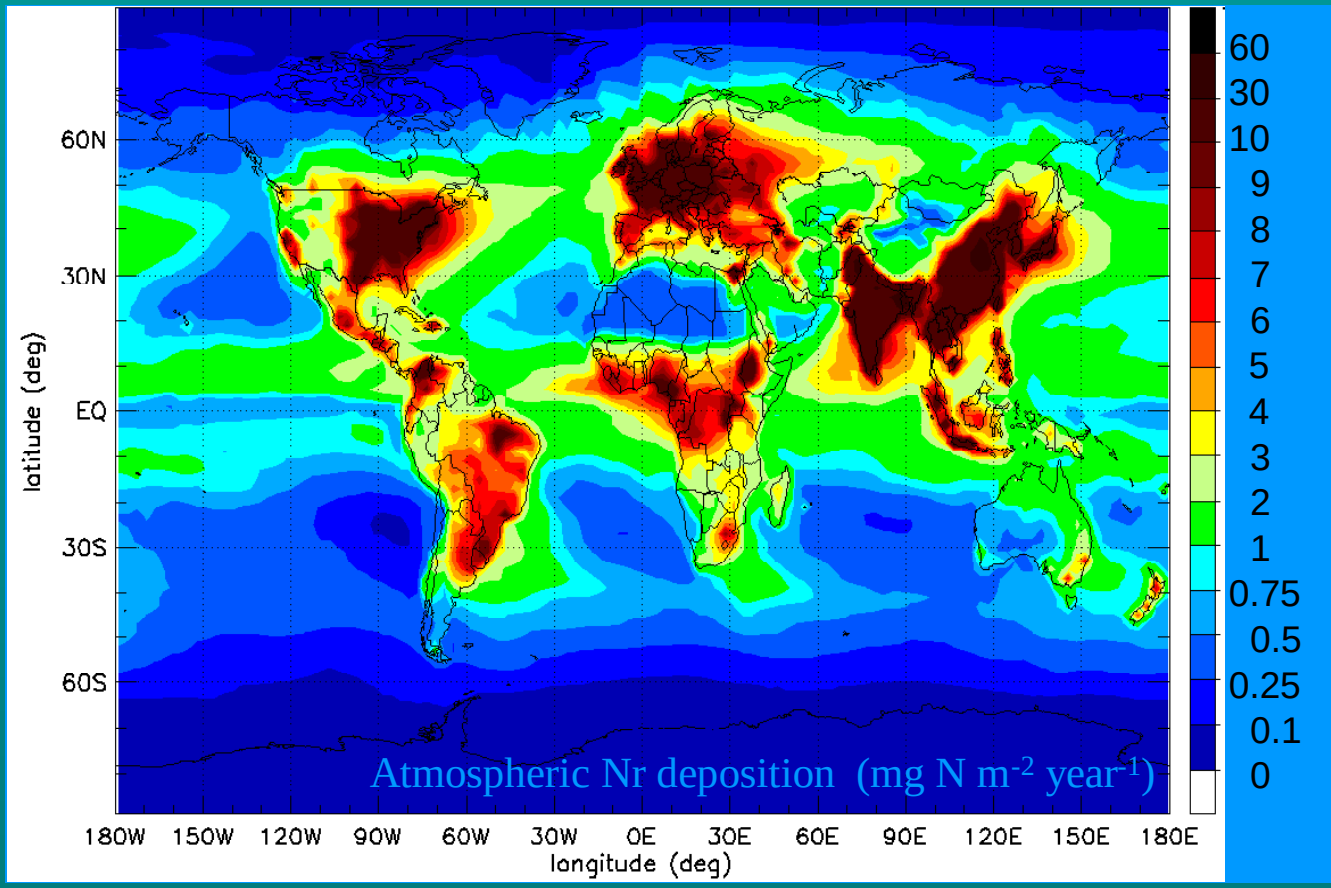
Jamaica, 3 October 2013


Atmospheric N_2 fixed to reactive nitrogen (N_R)
Nitrous Oxide (N_2O)
Nitrogen oxides (NO_x)
Ammonium nitrate in rain (NH_4NO_3)
Further emission of NO_x & N_2O carrying on the cascade
N_R
Fertilizer manufacture
Ammonia (NH_3)
N_R
Crops for food & animal feed
Livestock farming
Natural ecosystems
Leached Nitrate (NO_3^-)
Nitrate in Streamwaters
Nitrogen Cascade

Global N production & dispersion

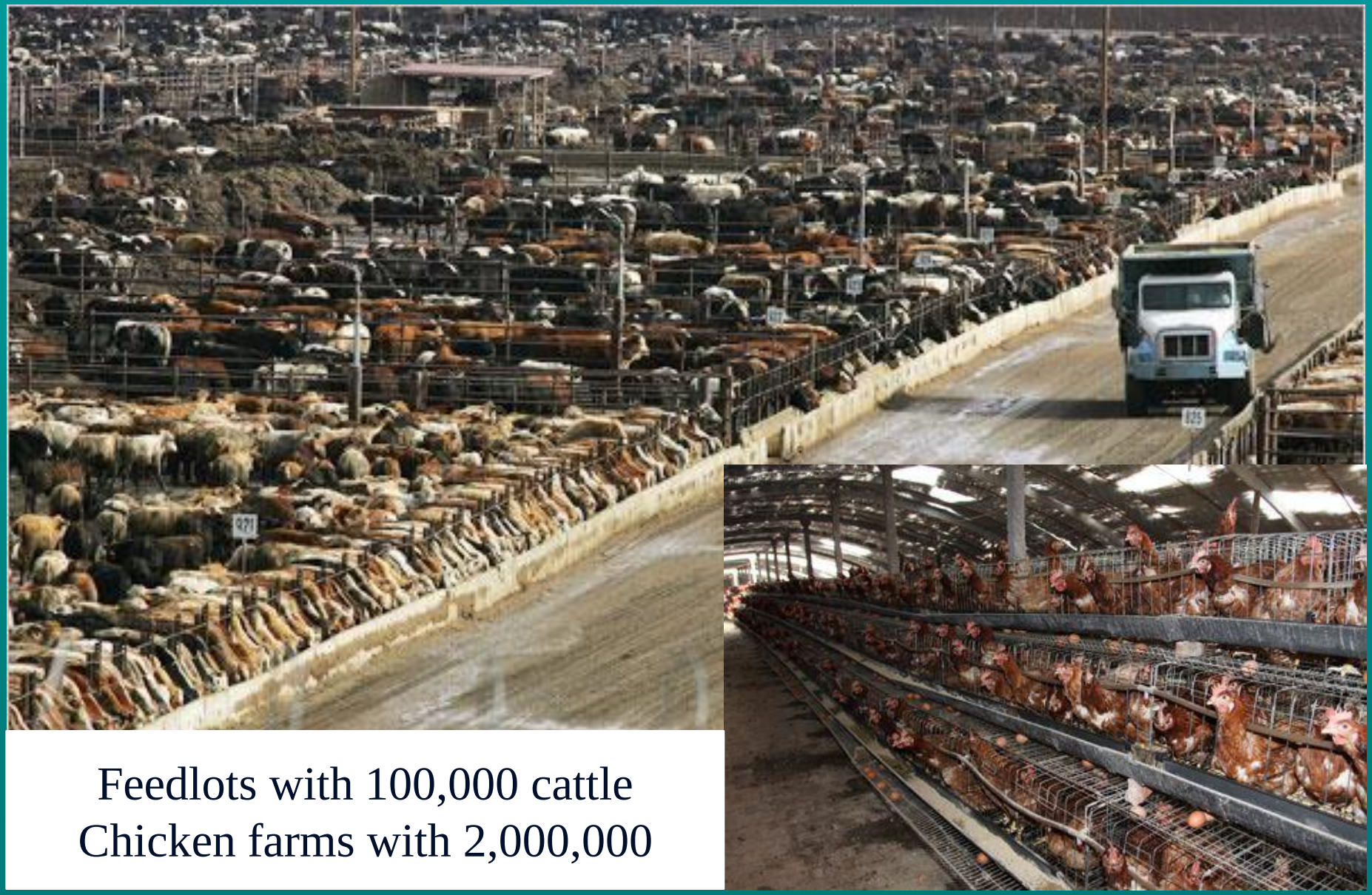
Human Nr Production: ($Tg\ yr^{-1}$)
1860: 15
1995: 156
2005: 191

2005 sources:
Haber Bosch: 121
Biol N fixn: 45
NOx emission: 25



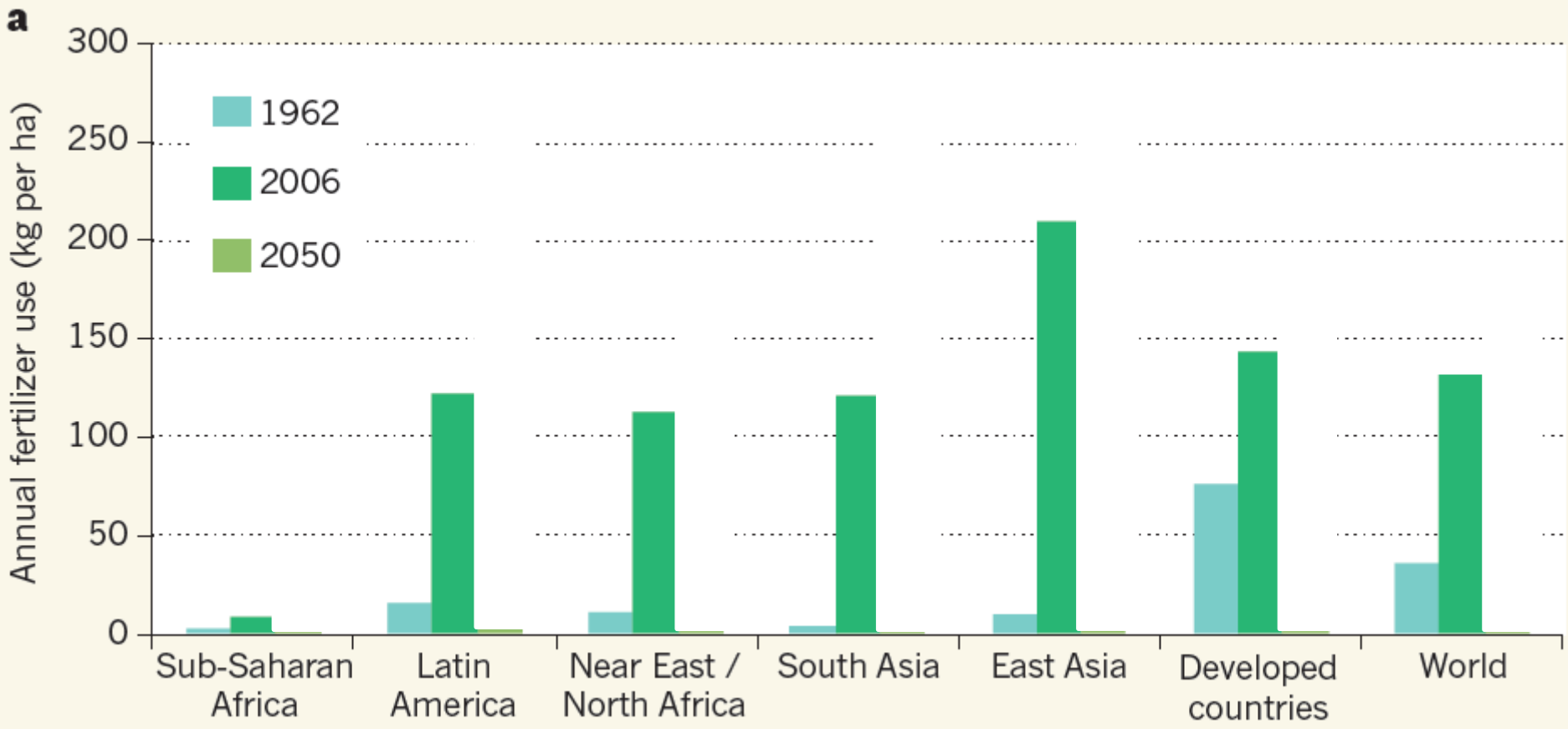
Galloway et al. *Science* (15 May 2008)

The innocent polluters



Feedlots with 100,000 cattle
Chicken farms with 2,000,000

Past change – future risks
Global fertilizer use



"The shape of nitrogen to come" (*Nature*, 20 Feb 2013)
Based on FAO estimates

The European Nitrogen Assessment

Sources, Effects and Policy Perspectives

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CAMBRIDGE

Vervuiling met stikstof kost miljarden

Nitrogen taint alert

COMMENT

ENVIRONMENT

BIOTECHNOLOGY Biohackers take biology into the garage p.167

ECOLOGY Libyan revolution might protect bluefin tu with trawlers grounde

Meer,

Warning over nitrogen footprint

Pollution à l'azote : une lourde facture pour l'Europe

ecisely than this would be cleaner, reduce odour and emit less ammonia.

Too much of a good thing

Curbing nitrogen emissions is a central environmental challenge for the twenty-first century, argue **Mark Sutton** and his colleagues.

Nature 14 April 2011

Farming

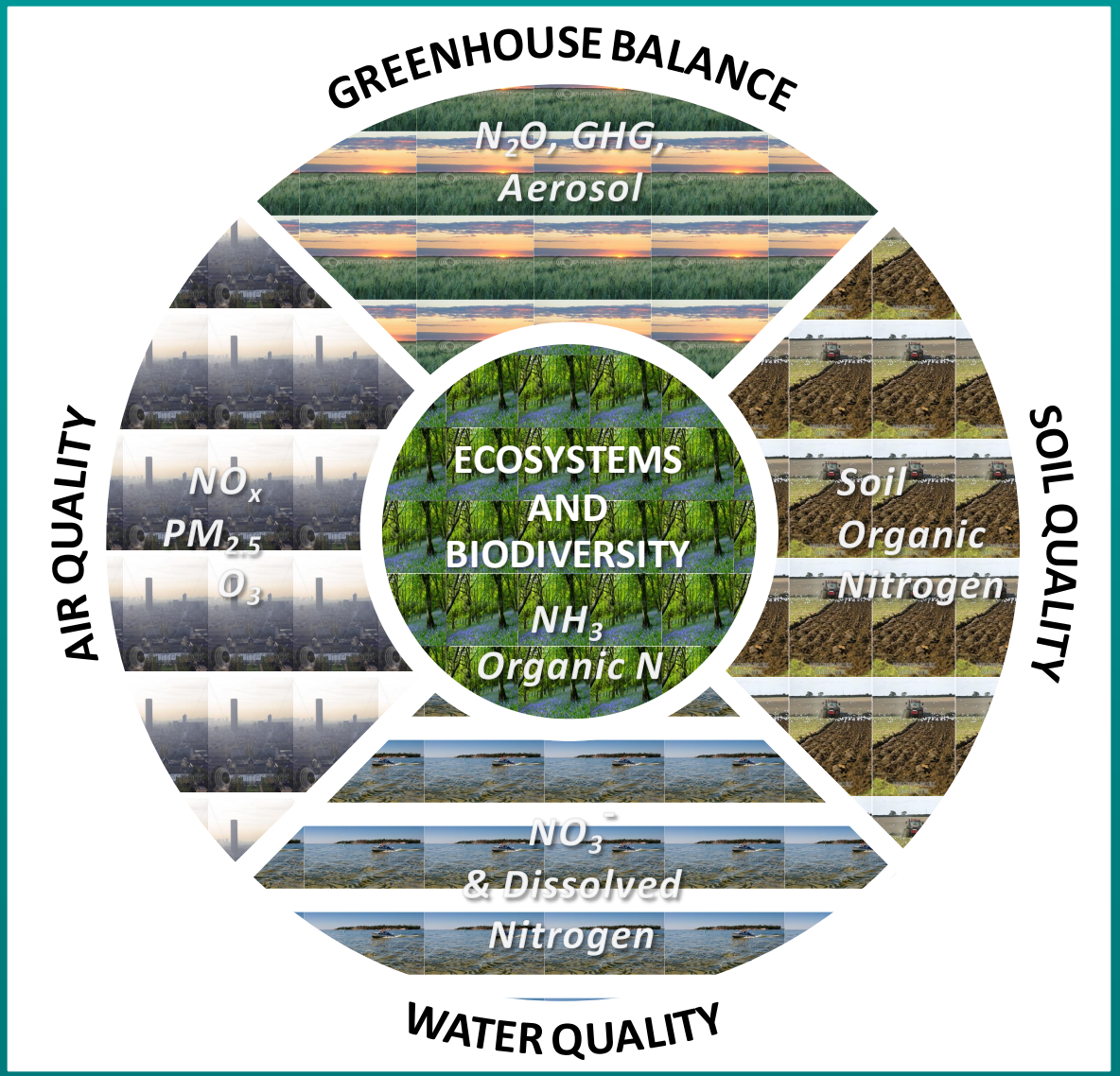
Union defends use of nitrogen in high-octane climate change debate

www.nine-esf.org/ENA

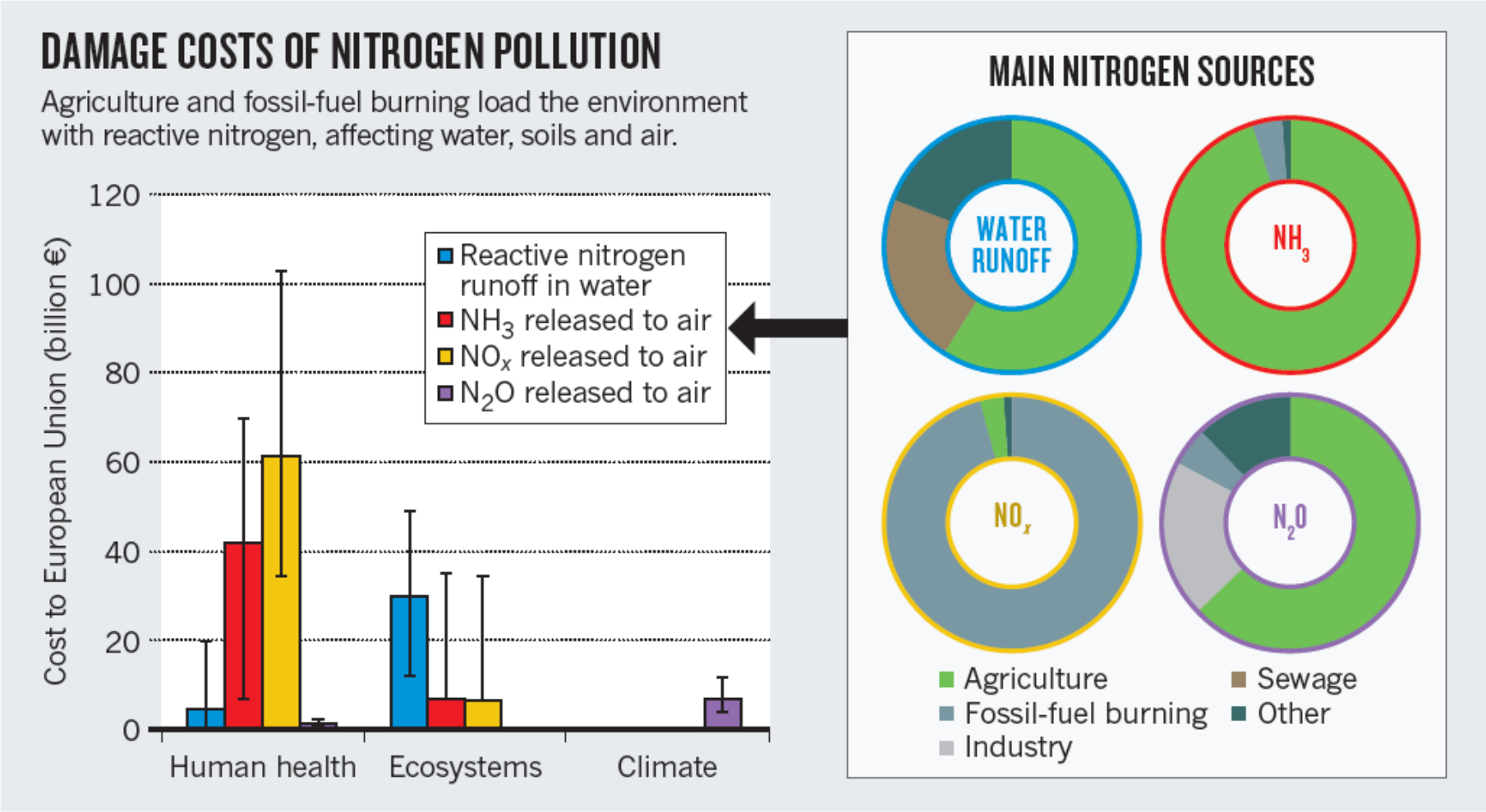
The five key threats of excess Nitrogen

The WAGES of too much nitrogen

Water quality
Air quality
Greenhouse balance
Ecosystems
Soil quality



Nitrogen Damage Costs & Sources



EU Damage cost: 70 - 320 billion € / year

Nature 14 April 2011

Science Policy Support: UNECE Task Force on Reactive Nitrogen

- Scientific input to support revision of UNECE Gothenburg Protocol & long-term strategy:
  - Mitigation of **agricultural nitrogen**.
  - Regional **nitrogen budgets** to support strategy optimization
  - Relationships between **nitrogen and food** choices
  - Knowledge building on **nitrogen in EECCA** countries.
  - Nitrogen options within the **green economy**.

UNECE-CLRTAP –TFRN
5 top priorities for ammonia mitigation

1. Low-emission **land application** of manure & fertilizer:
   a) Application of cattle, pig & poultry slurry & solid manure
   b) Low emission use of urea fertilizer (ban is not proposed)
2. **Animal feeding strategies** to reduce N excretion, from cattle, pig & poultry.
3. Low-emission techniques for all ***new*** **stores** for cattle and pig slurries and poultry manure.
4. Strategies to improve N use efficiencies and reduce N surpluses, with **N balances on *demonstration farms***,
5. Low-emission techniques in new and largely rebuilt pig & poultry **housing**.

Slurry spreading:
a wide range of low-emission techniques are available


Splash Plate Spreader
- 1950s technology


Trailing Hose


Trailing Shoe


Slot Injector

The car and the exhaust pipe…

Nitrogen: Food security or food luxury?

- Often said: *"We need N for food security"*
- European Nitrogen Assessment (2011)
  - 85% of N in EU harvests goes to feed livestock
  - The average European eats 70% more protein than needed for a healthy diet
  - Europe is a net *importer* of N in feed & food
- The reality is *Food Luxurity*
  - Society wants "the security of food luxury"
  - The key challenge to optimize (reduce) meat consumption to improve our quality of life

£650-a-year nitrogen pollution 'could be reduced by eating less meat'

Press Comment on the *European Nitrogen Assessment*

***Metro* 10 April 2011:**

Nitrogen and a Demitarian Europe?

Example scenario of 50% consumption reduction

Aspect	Unit	Reference	-50% meat, dairy and eggs
Protein			
Average daily intake	g cap^{-1} day^{-1}	83	75
Proportion of animal origin	%	60%	36%
Red meat			
Average daily intake	g cap^{-1} day^{-1}	88	47
Compared with the RMDI	%	207%	107%

Westhoek and the TFRN-EPNF (under review)

UN says fertiliser crisis is damaging the planet

Scientists urge rich world to halve its meat consumption

The shape of nitrogen to come

An analysis reveals the huge impact of human activity on the nitrogen cycle in China. With global use of Earth's resources rising per head, the findings call for a re-evaluation of the consumption patterns of developed societies.

MARK A. SUTTON & ALBERT BLEEKER

Although Earth's atmosphere consists of nearly 80% dinitrogen (nitrogen

NO_x to the formation of ground-level ozone, which causes crop losses; increased emissions of nitrous oxide (N_2O), a greenhouse gas; and extreme levels of water pollution by nitrates

Nature doi:10.1038/nature11954

18 Feb 2013: *Independent* , *Guardian*, *Herald Tribune*, *Times of India* and **300 articles worldwide**

Global Overview on Nutrient Management

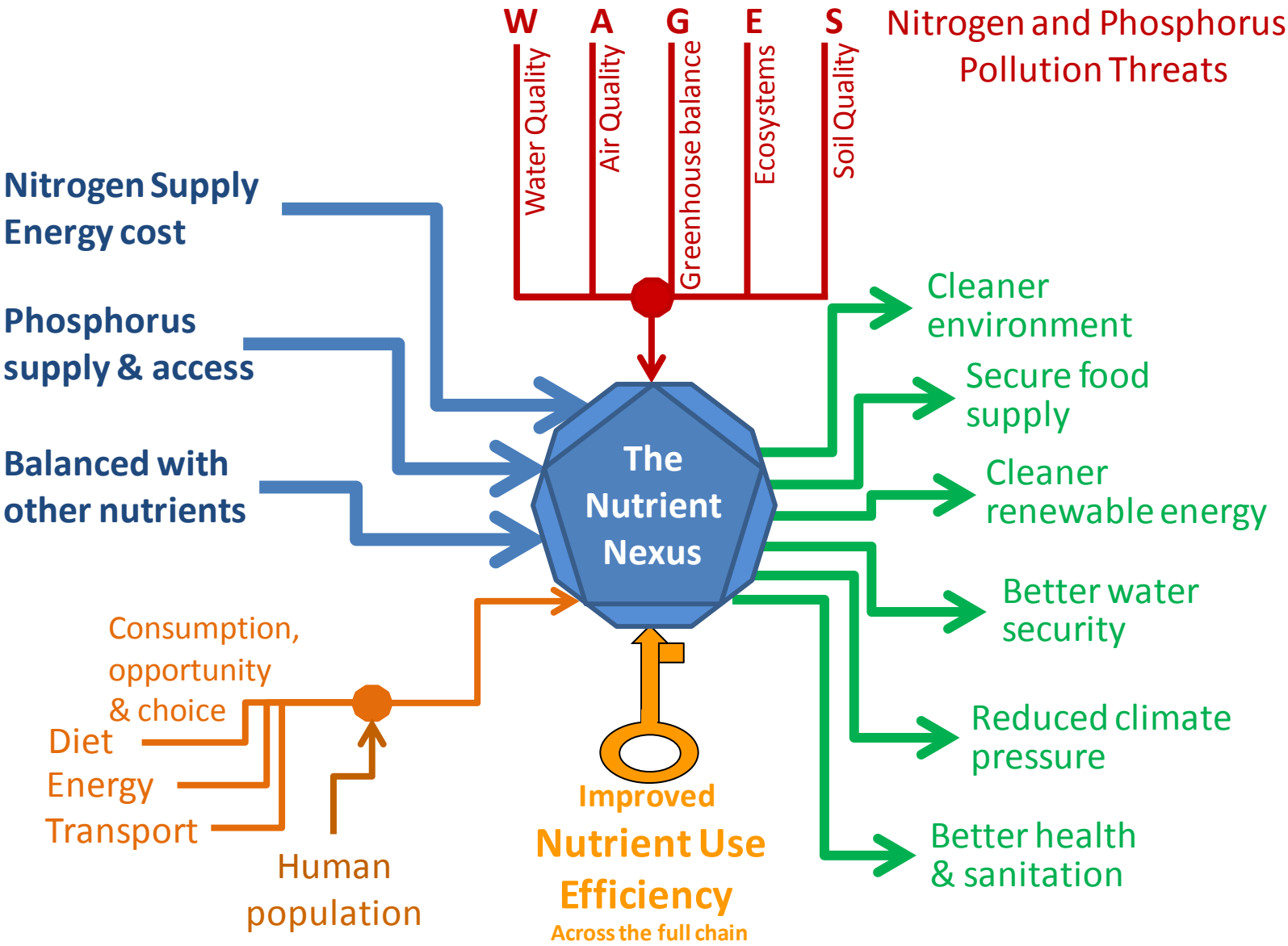
Our Nutrient World

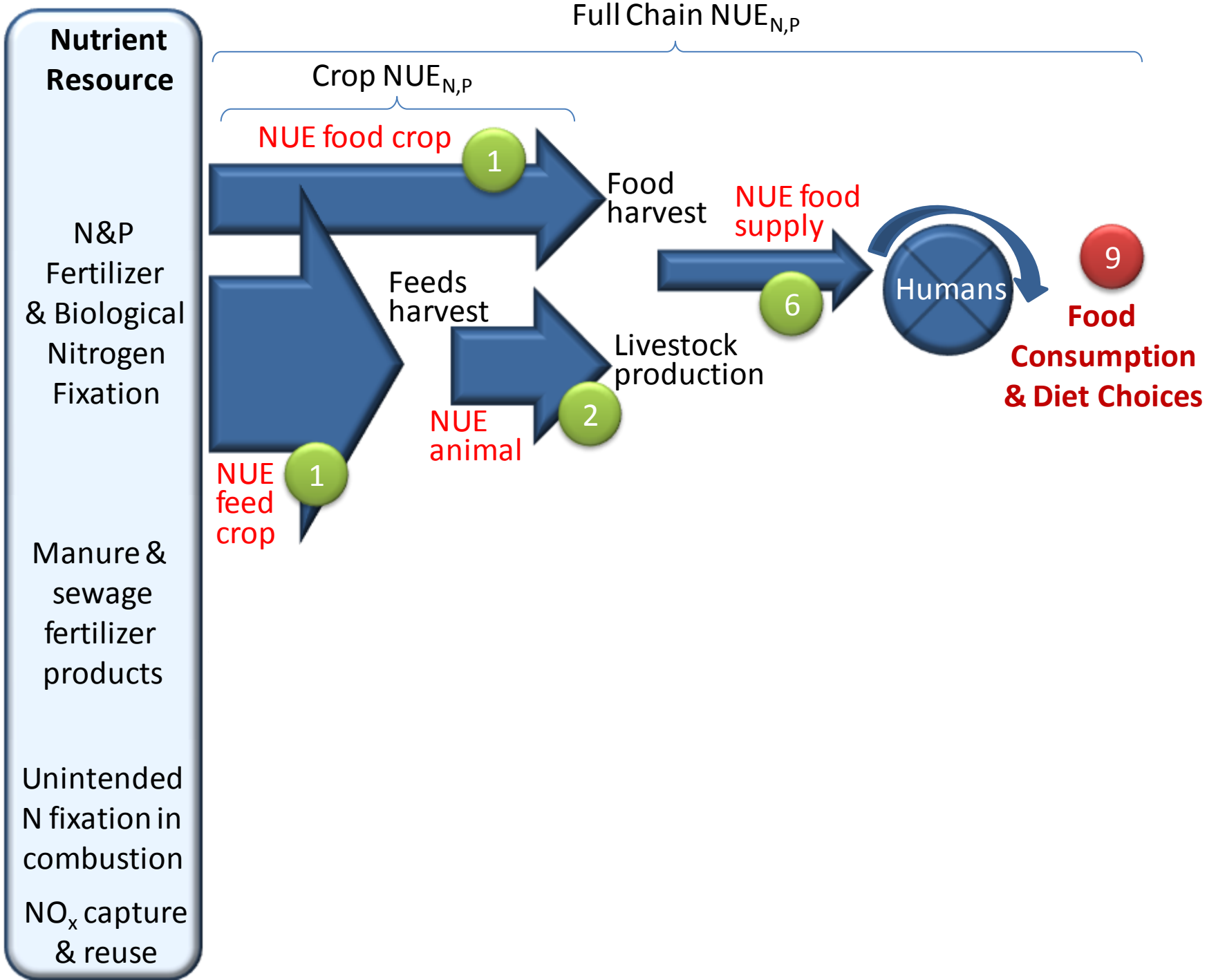
The challenge to produce more food and energy with less pollution

Prepared by the Global Partnership on Nutrient Management in collaboration with the International Nitrogen Initiative

The Nutrient Nexus

a master-key to many global challenges




Nutrient Resource
N&P Fertilizer & Biological Nitrogen Fixation
Manure & sewage fertilizer products
Unintended N fixation in combustion
NO_x capture & reuse
Full Chain $NUE_{N,P}$
Crop $NUE_{N,P}$
NUE food crop
1
Food harvest
NUE food supply
6
Humans
9
Food Consumption & Diet Choices
Feeds harvest
Livestock production
2
NUE animal
NUE feed crop
1

Ten key actions nutrient management

Agriculture

1. Improving nitrogen use efficiency in crop production
2. Improving nitrogen use efficiency in animal production
3. Increasing the fertilizer N equivalence value of animal manure

Transport and Industry

4. Low-emission combustion and energy-efficient systems
5. NO_x capture and utilization technology

Waste & Recycling

6. Improving food supply efficiency & reducing food waste
7. Recycling nitrogen (and phosphorus) from waste water systems

Societal consumption patterns

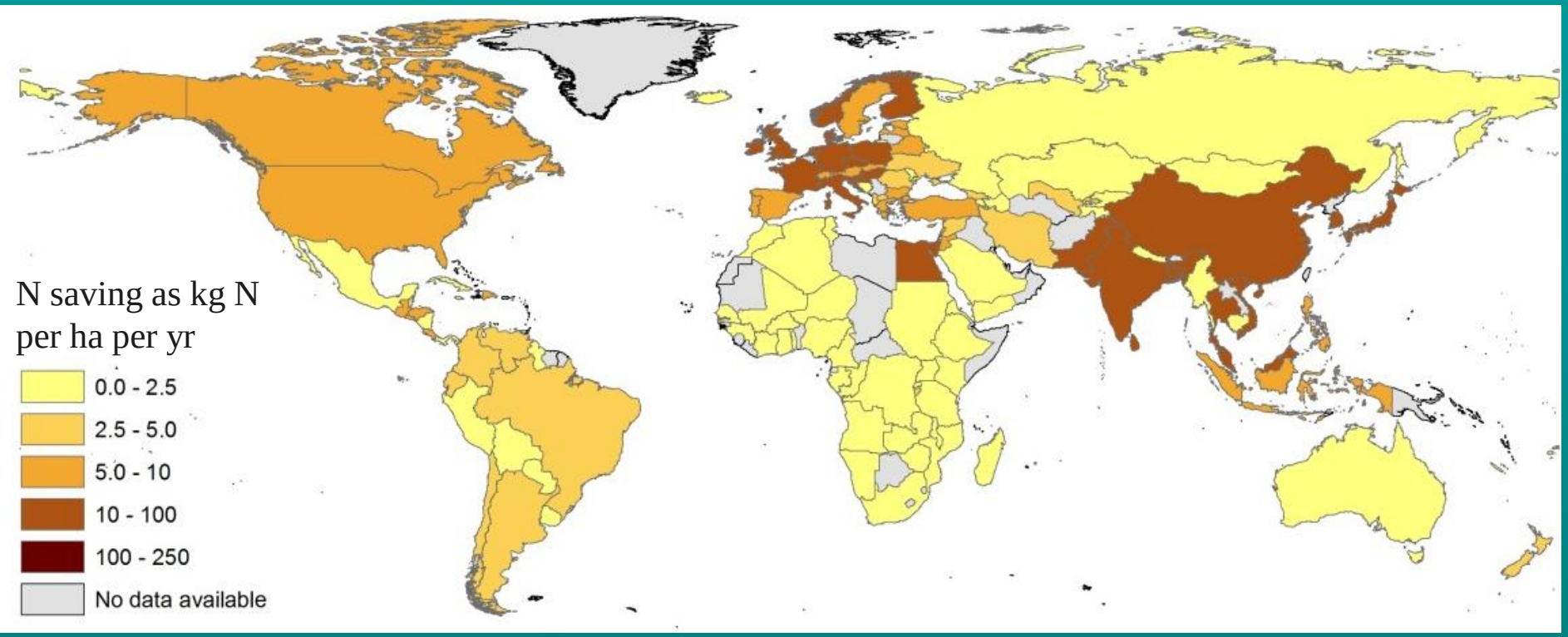
8. Energy and transport saving
9. Lowering the human consumption of animal protein

Integration

10. Spatial optimization and integration

“20:20 for 2020”

20% better NUE: saving 20 Mt N per yr by 2020



Benefits expressed here as equivalent N saving / ha per year from the Full-chain NutUE target

“20:20 for 2020”

20% better NUE: saving 20 Mt N per yr by 2020

Bottom line for the Nutrient Green Economy ($US billion/year)

Fertilizer Saving	23
+Env+Health benefits	160
– Implementation	12
= Net Benefit	170

Our Nutrient World:
A new inter-governmental focus

- There is no global treaty that links the many benefits and threats of altered N & P cycles.

Options

- UN Framework Convention on Climate Change
- UN Convention on Biological Diversity
- To extend and strengthen the mandate of the Global Programme of Action for Protection of the Marine Environment from Land-based Activities (GPA)

Tasks for an inter-governmental process on the global N challenge

- Global assessment of nutrient linkages, benefits threats and Green Economy opportunities
- Investigate practice options, agree indicators and set targets for improved N management
- Address barriers to change, fostering education, stakeholder discourse and public awareness
- Quantify the multiple benefits of meeting the targets: inc. how these support other global treaties
- Monitor time-bound achievement of the targets

Resource outlook: Global Environment Facility

- Global nitrogen cycle, toward an *International Nitrogen Management System (INMS)*
- **Opportunities**
  - Indicator refinement, moving to operational delivery to support countries, inc benchmarking
  - Sharing and development of mitigation and management practices – understanding barriers
  - Regional demonstration on contrasting challenges, inc. East Baltic, Black Sea, Central Asia, N China Plain, Central Asia, SS Africa, S. Asia)
  - Supporting the inter-governmental processes