

NITROGEN: TOO MUCH OF A GOOD THING

JAN WILLEM ERISMAN



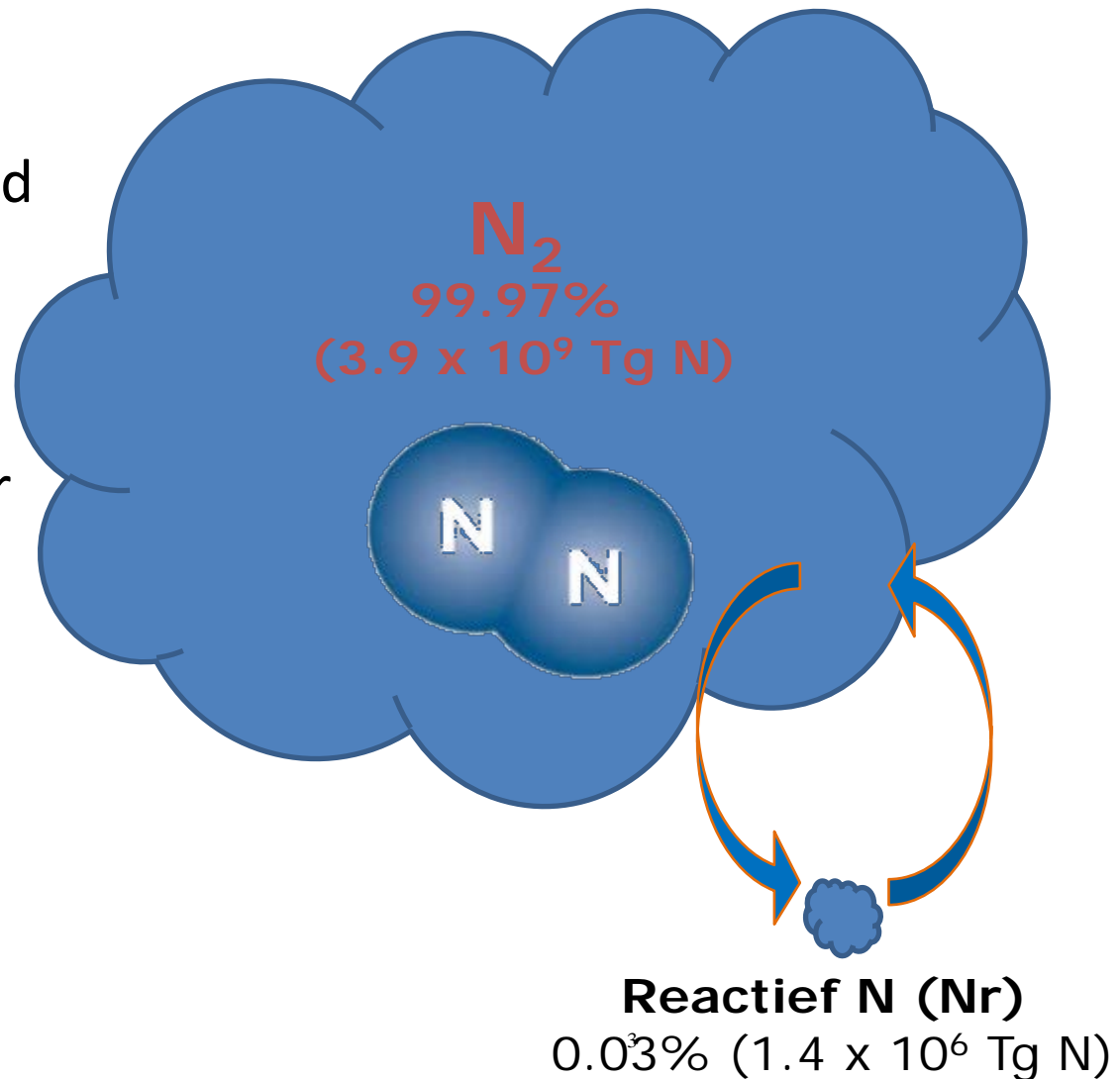
WHY CARE ABOUT NITROGEN?



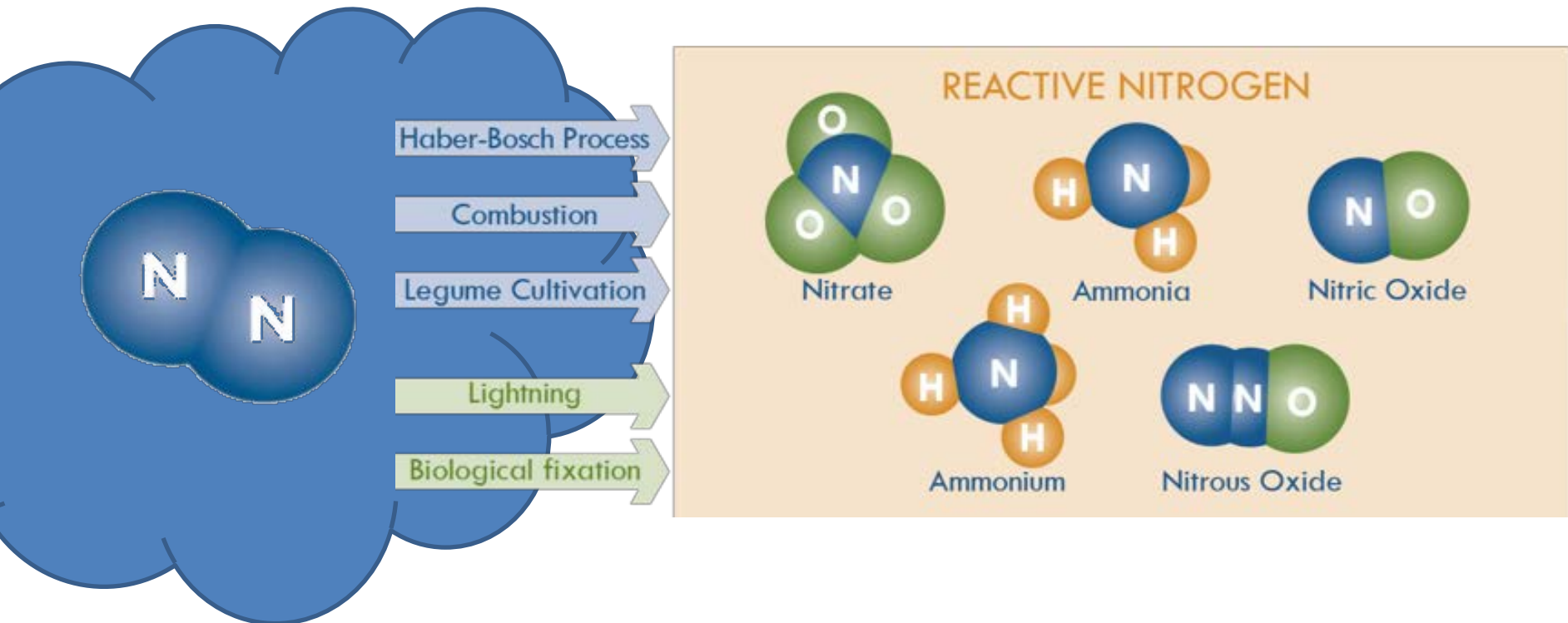
- Nitrogen is necessary for life
- 78% of N on Earth is N_2 and unusable by organisms
- To sustain human life, we convert N_2 to reactive forms
- The Green Revolution is largely due to synthetic N fertilizers
- N_2 is converted into N_r for production of fertilizer, food, feed, fibre, fuel, plastics, explosives, etc.
- Humans depend on internal combustion for transportation and energy
- Yet, N has direct and indirect impacts on the climate system, biodiversity loss, air and water quality, stratospheric ozone destruction, etc.

NITROGEN IS ESSENTIAL FOR LIFE, BUT IN REACTIVE FORM

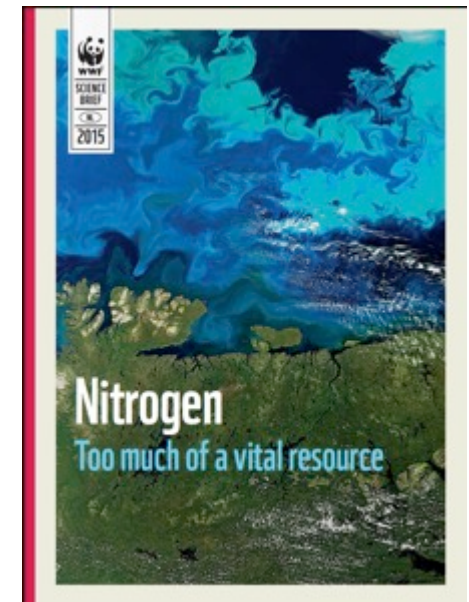
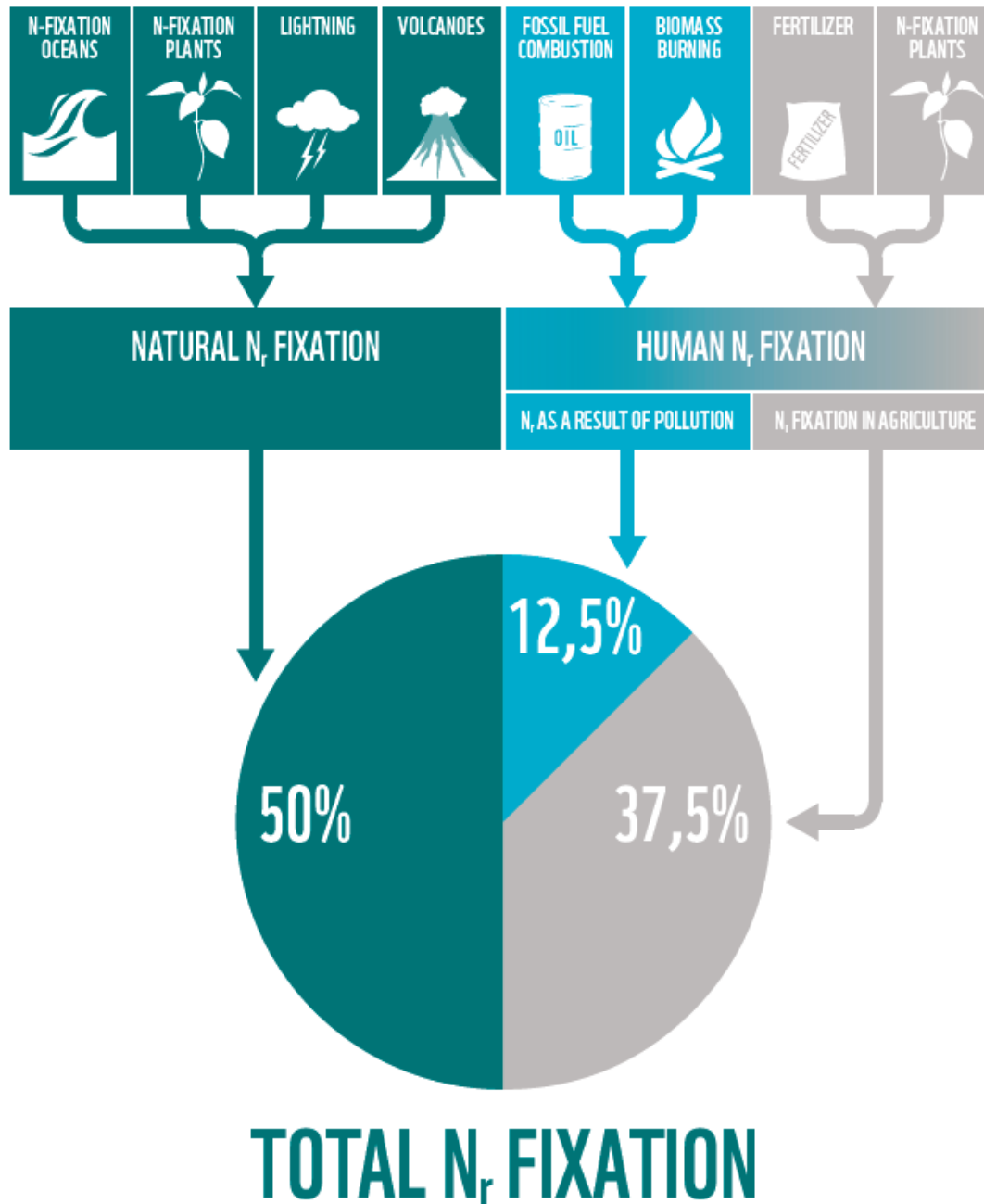
- Only a small amount of reactive N is formed in nature: 99.97% is 'inert' in the atmosphere
- All organisms need Nr (protein, DNA)
- Ecosystems (biodiversity) are based on limited availability



ANTHROPOGENIC AND NATURAL PROCESSES CREATE REACTIVE NITROGEN

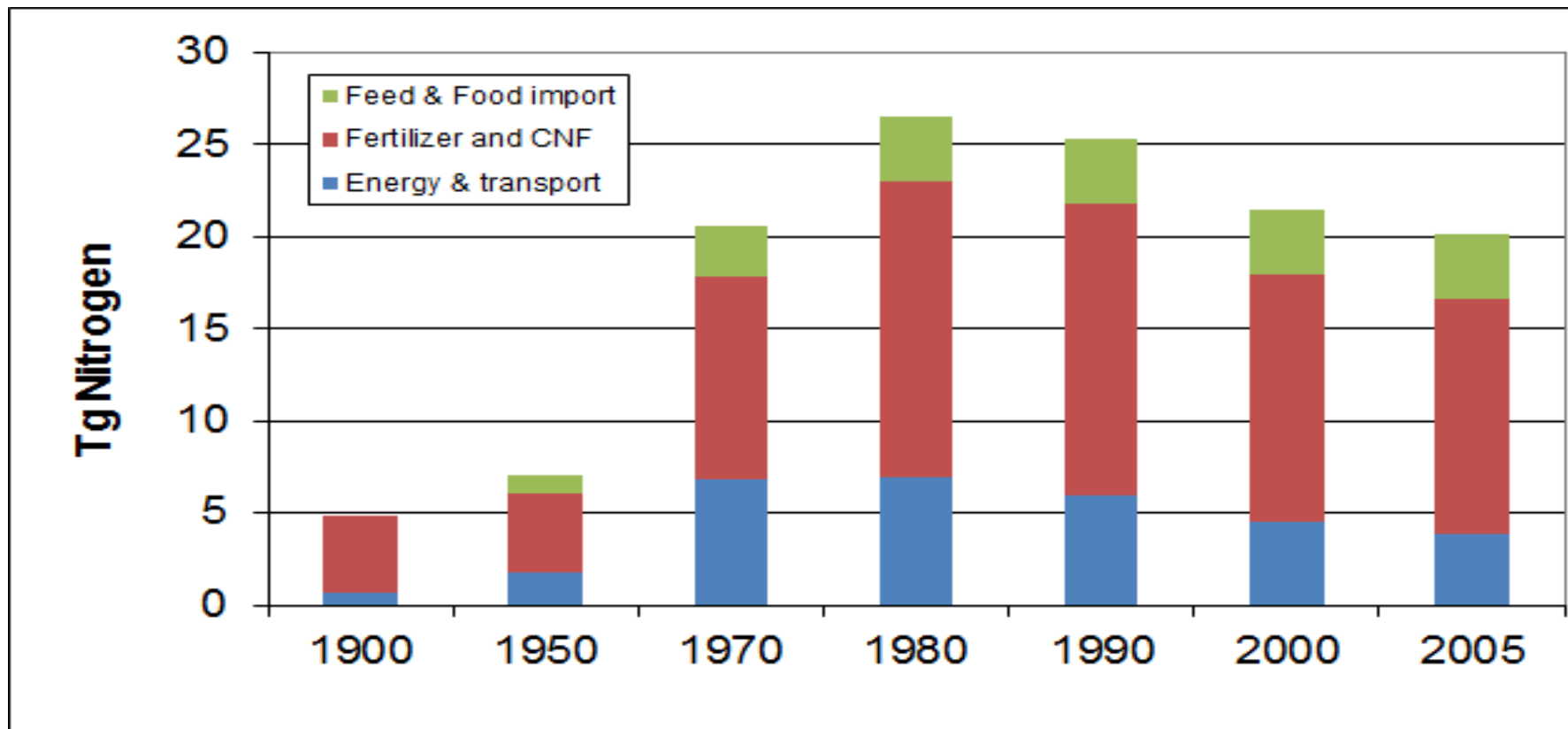


CREATION OF REACTIVE NITROGEN



Erisman et al. (2015)

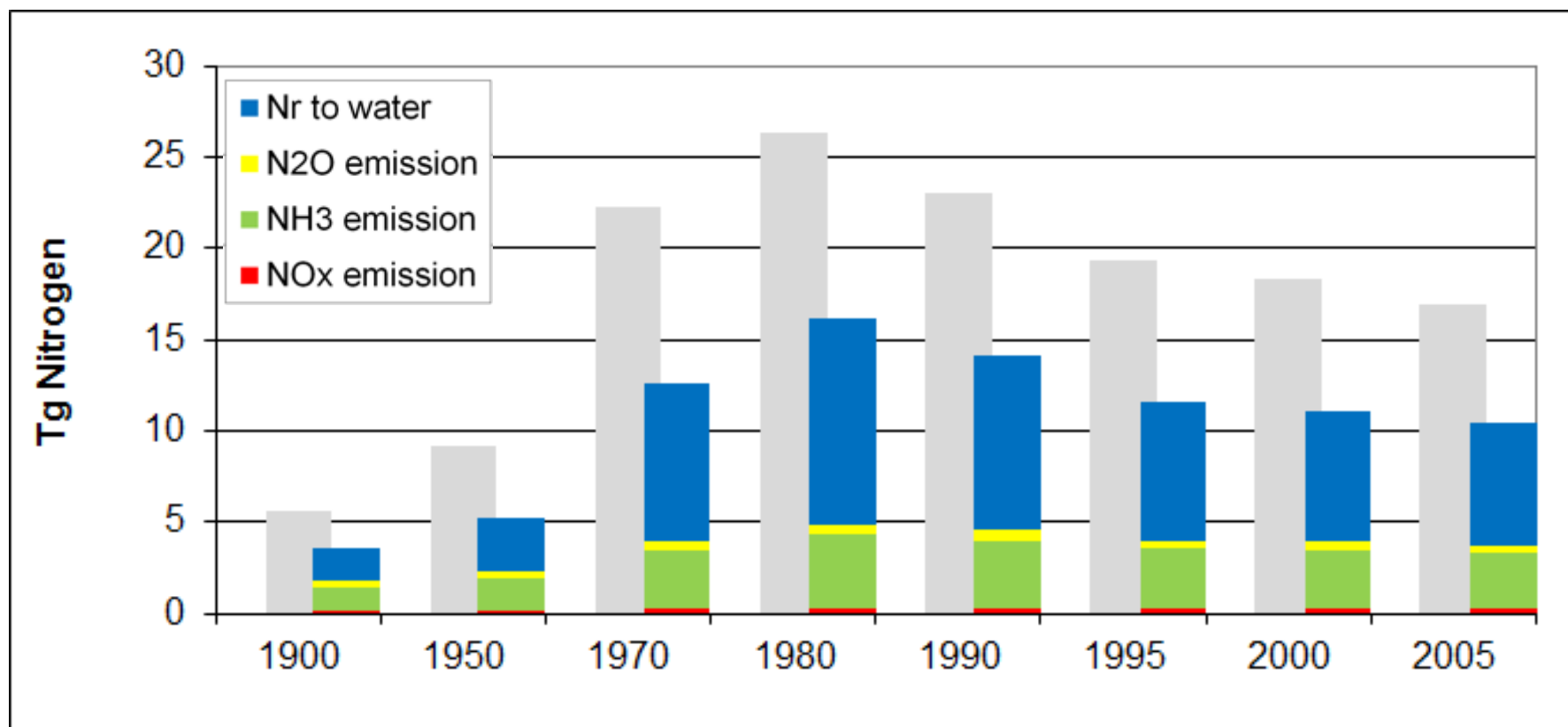
N SOURCES EU27 – SHARE AGRICULTURE 80%



IMAGE, 2012

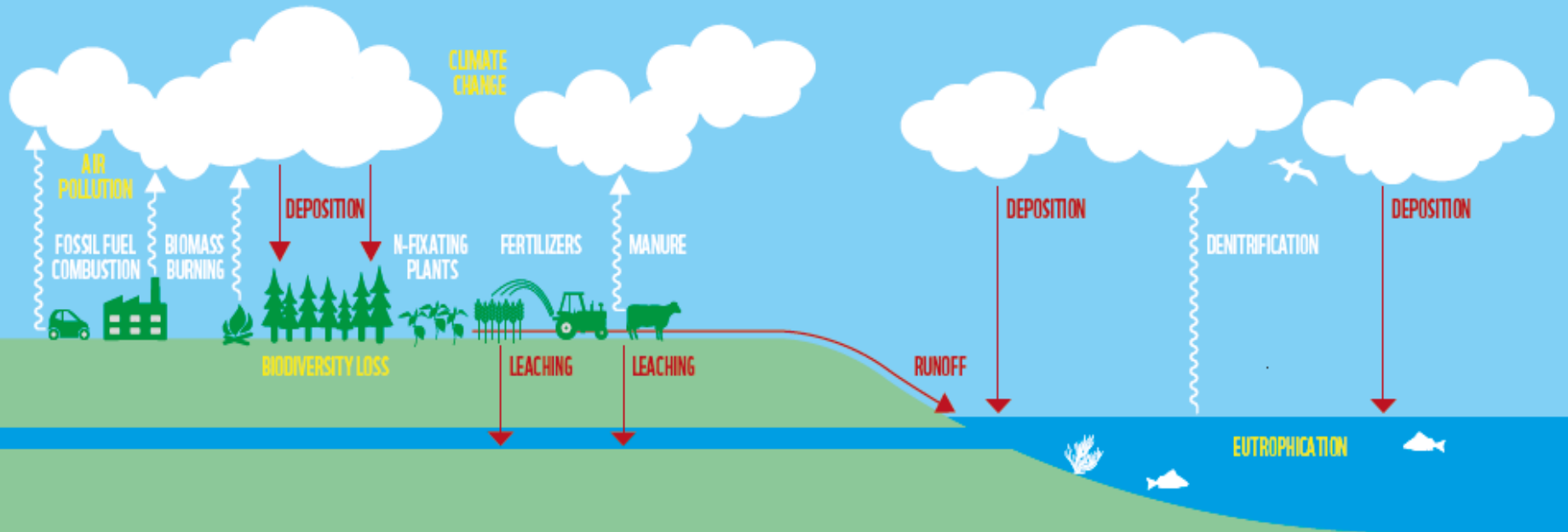
NITROGEN EMISSIONS EU27

≈ 60% agriculture



IMAGE, 2012

THE REACTIVE NITROGEN CYCLE



Agriculture is main N user in EU-27

Nitrogen use efficiency is 35%

Agriculture is main source of N losses in EU-27:

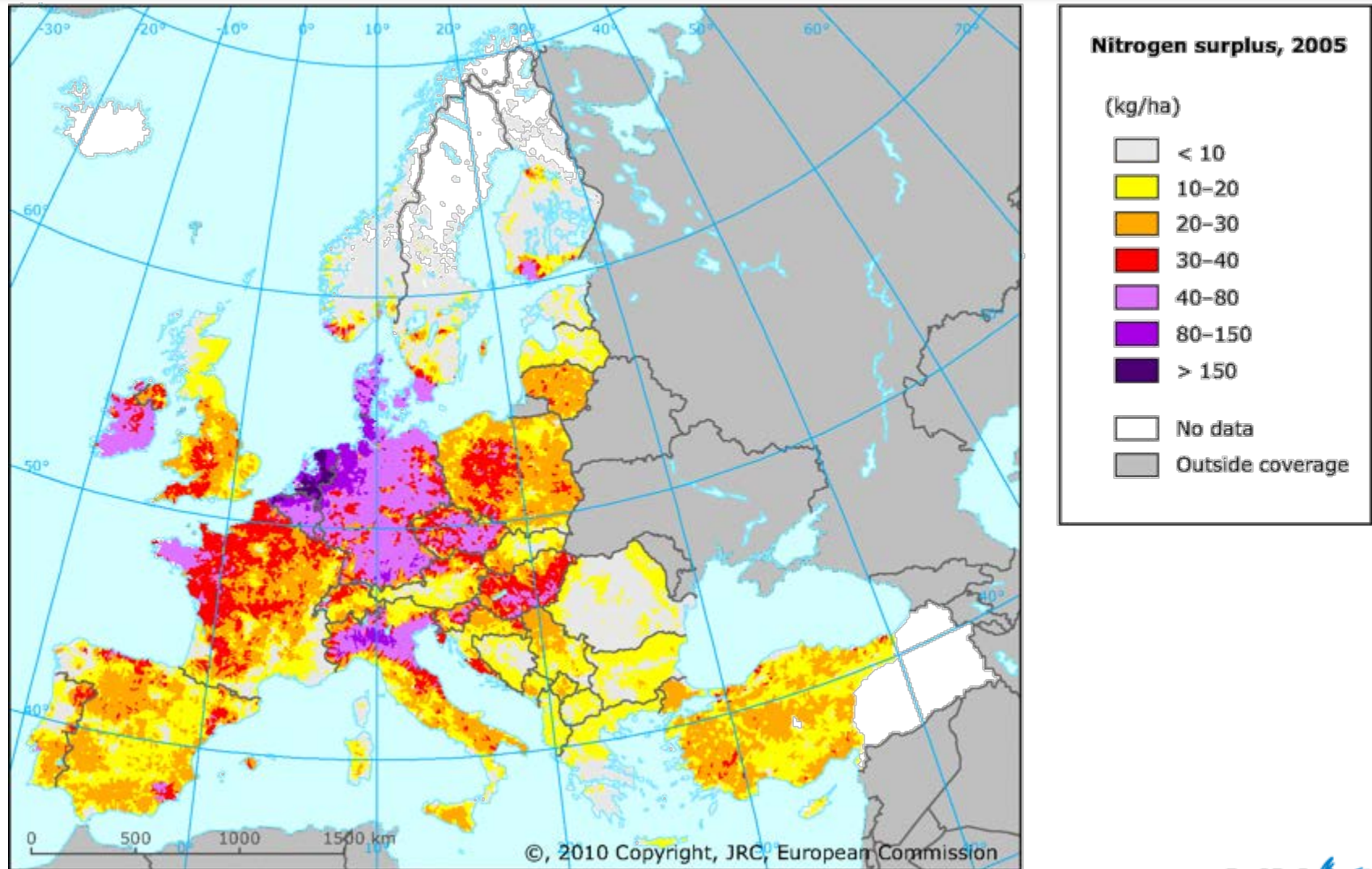
- > NH_3 to air: ~90% of total NH_3 emissions
- > N_2O to air: ~60% of total N_2O emissions

N in surface waters: ~40-60% of total N emissions

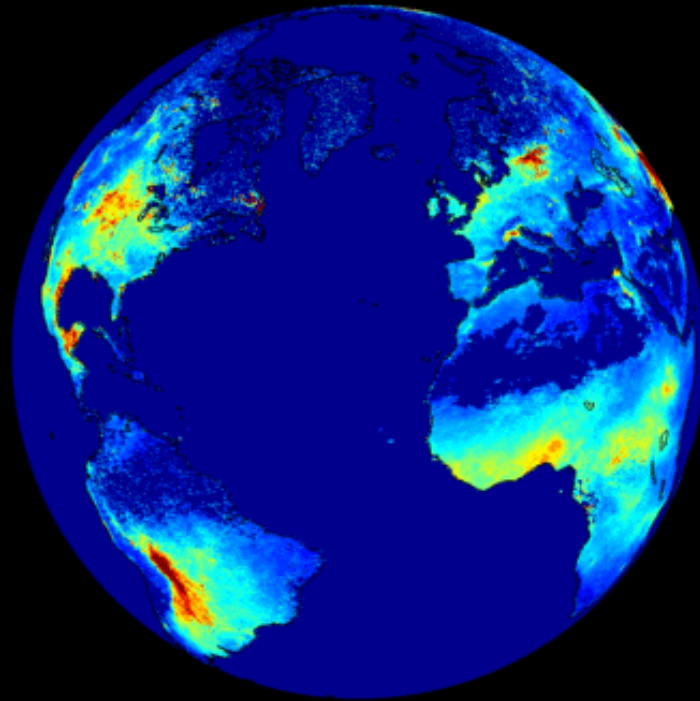
Europe is self sufficient of food apart from heavy import of soya



NITROGEN SURPLUS IN EUROPE



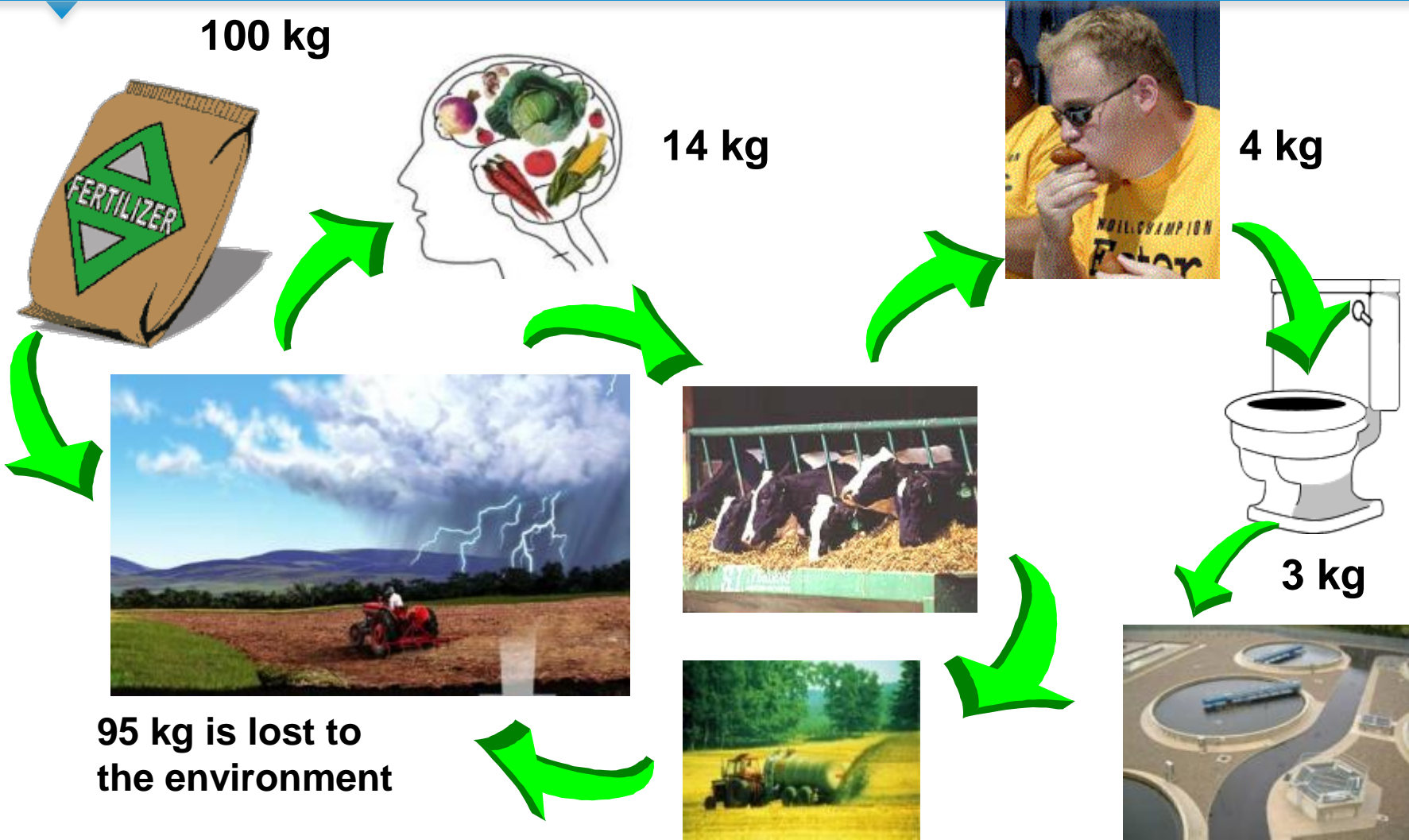
AMMONIA SATELLITE OBSERVATIONS



2011 NH₃ distribution

Van Damme et al. 2014

FERTILIZER EFFICIENCY FOR FOOD



DIFFERENT PROTEIN SOURCES REQUIRE MORE NUTRIENTS (AND LAND)

To produce 1 kg of meat/fish we need:

- 8 kg of feed for beef
- 5 kg of feed for pig meat
- 2,5 kg of feed for chicken
- 5 kg fishmeal for fish (aquaculture)
- 1 kg feed for insects

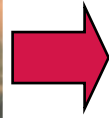


TOO MUCH NITROGEN: IN A CASCADE

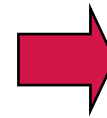
ENVIRONMENT



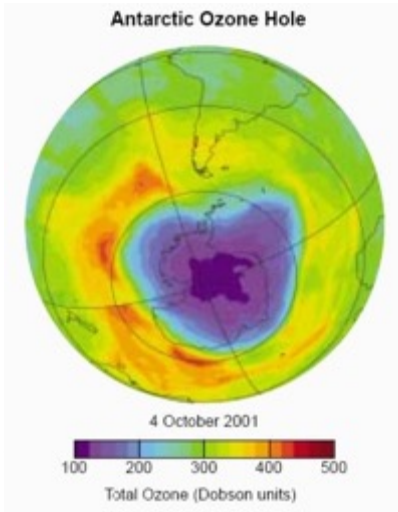
NO_x, O₃, PM



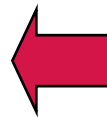
Forest Die-back



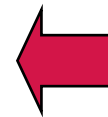
Acidification



Ozone Hole



Global Warming



Eutrophication

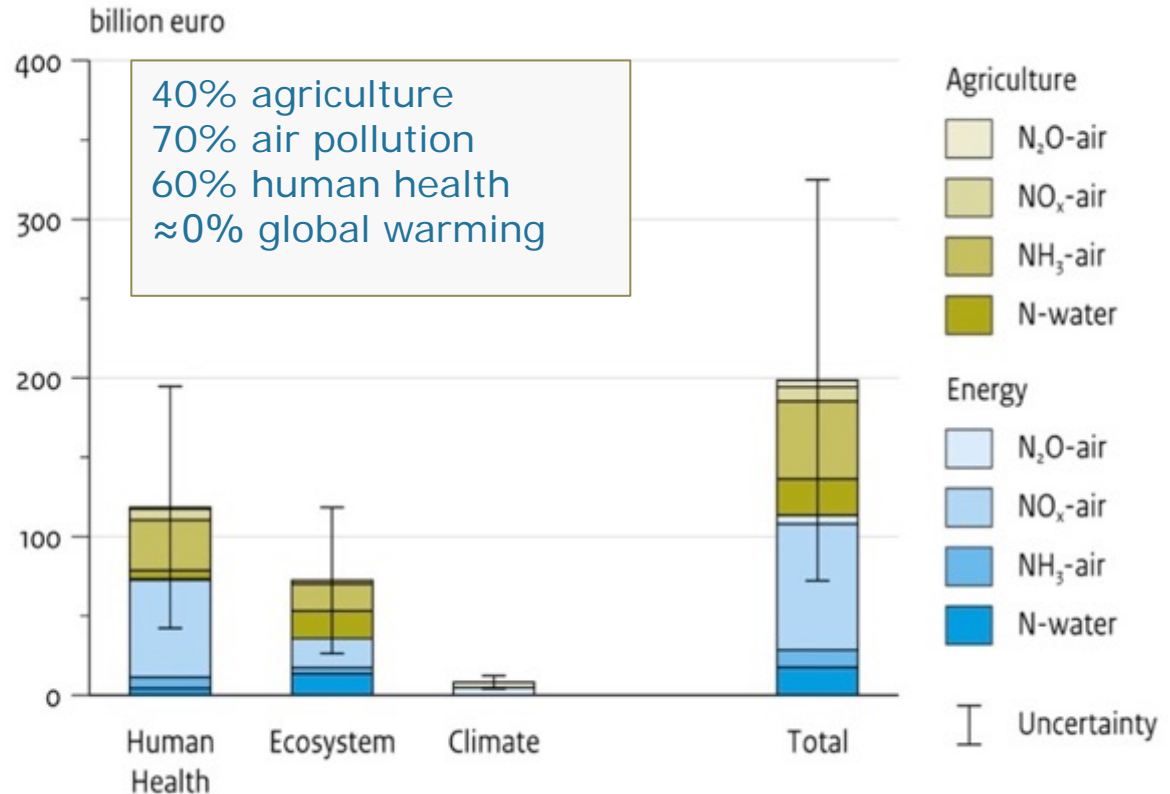
NITROGEN STIMULATES ALL GROWTH



David,
Michelangelo Buonarroti (1475 - 1564)

THE UNINTENDED COSTS OF NITROGEN TO SOCIETY

- Willingness To Pay: to prevent N damage 70-320 bln € (EU, 2000)
- Added value for the primary sector (agriculture) similar to external cost



ENA, 2011

NETHERLANDS

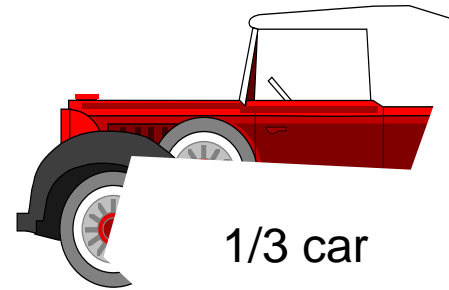
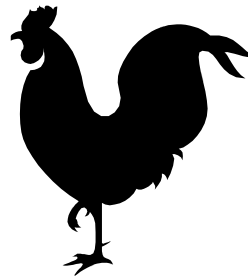
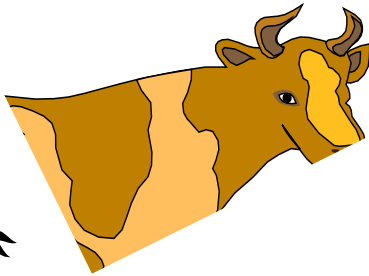


ILLUSTRATION: THE NETHERLANDS

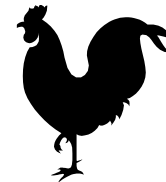
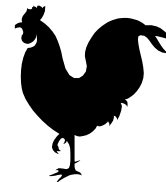
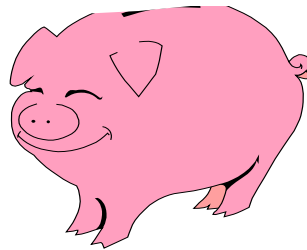
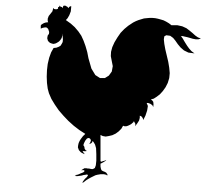


For every random Dutch citizen:

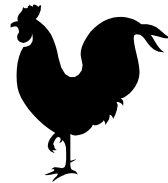
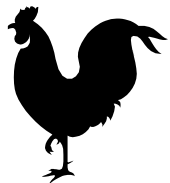
1/4 cow



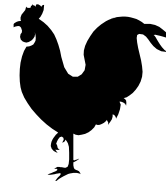
1/3 car



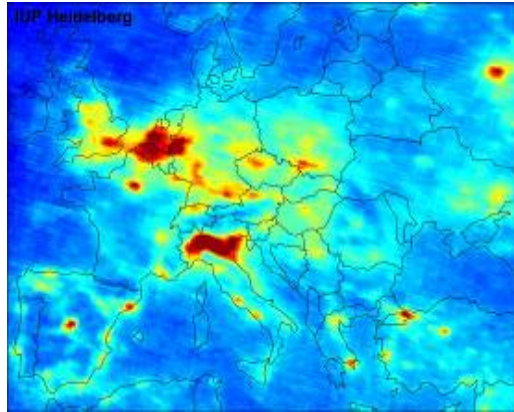
8 chicken



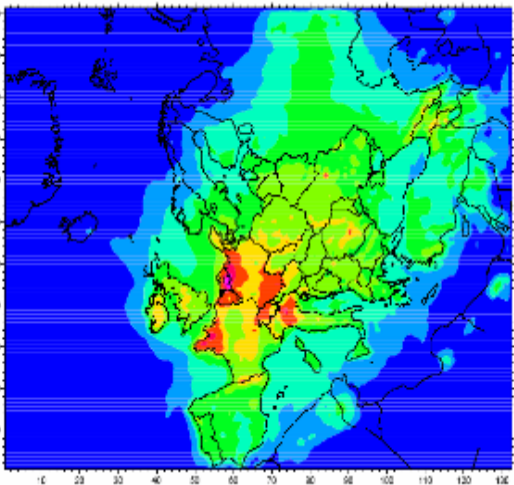
1 pig



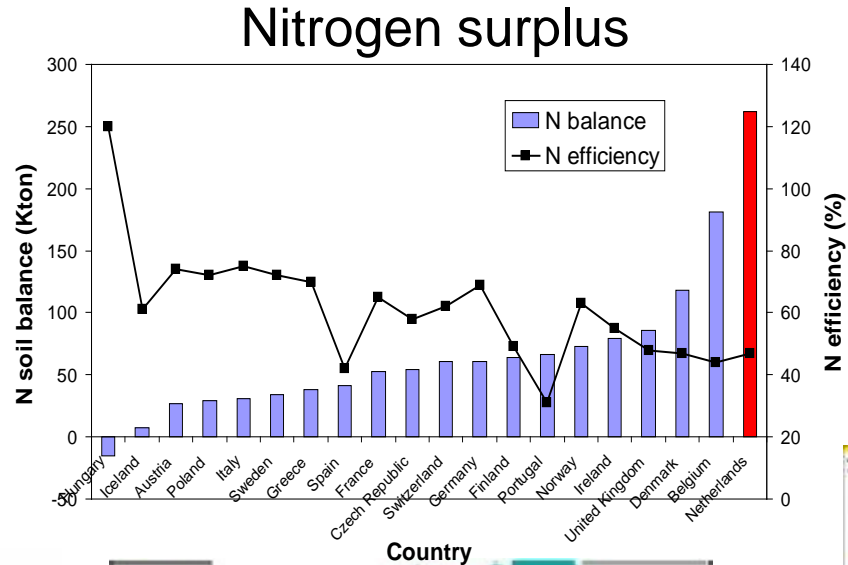
NETHERLANDS THE 'HOT SPOT' OF EUROPE



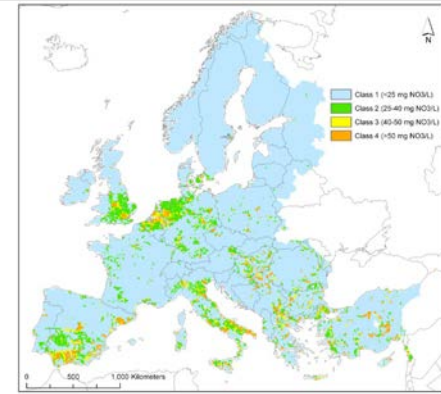
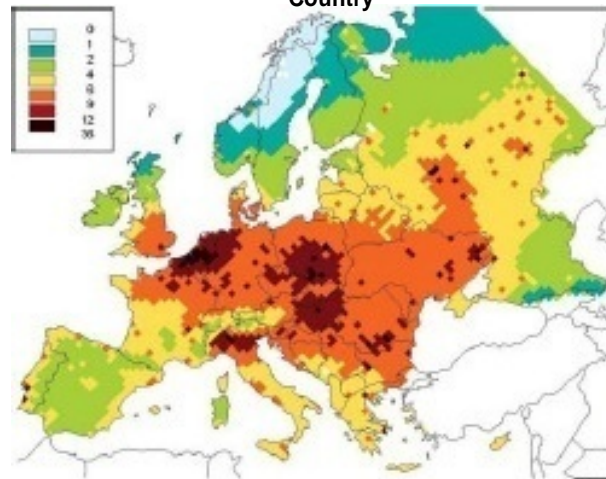
NO₂ concentrations



N deposition



PM concentrations

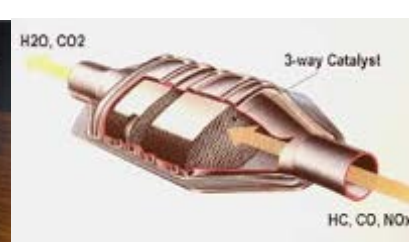
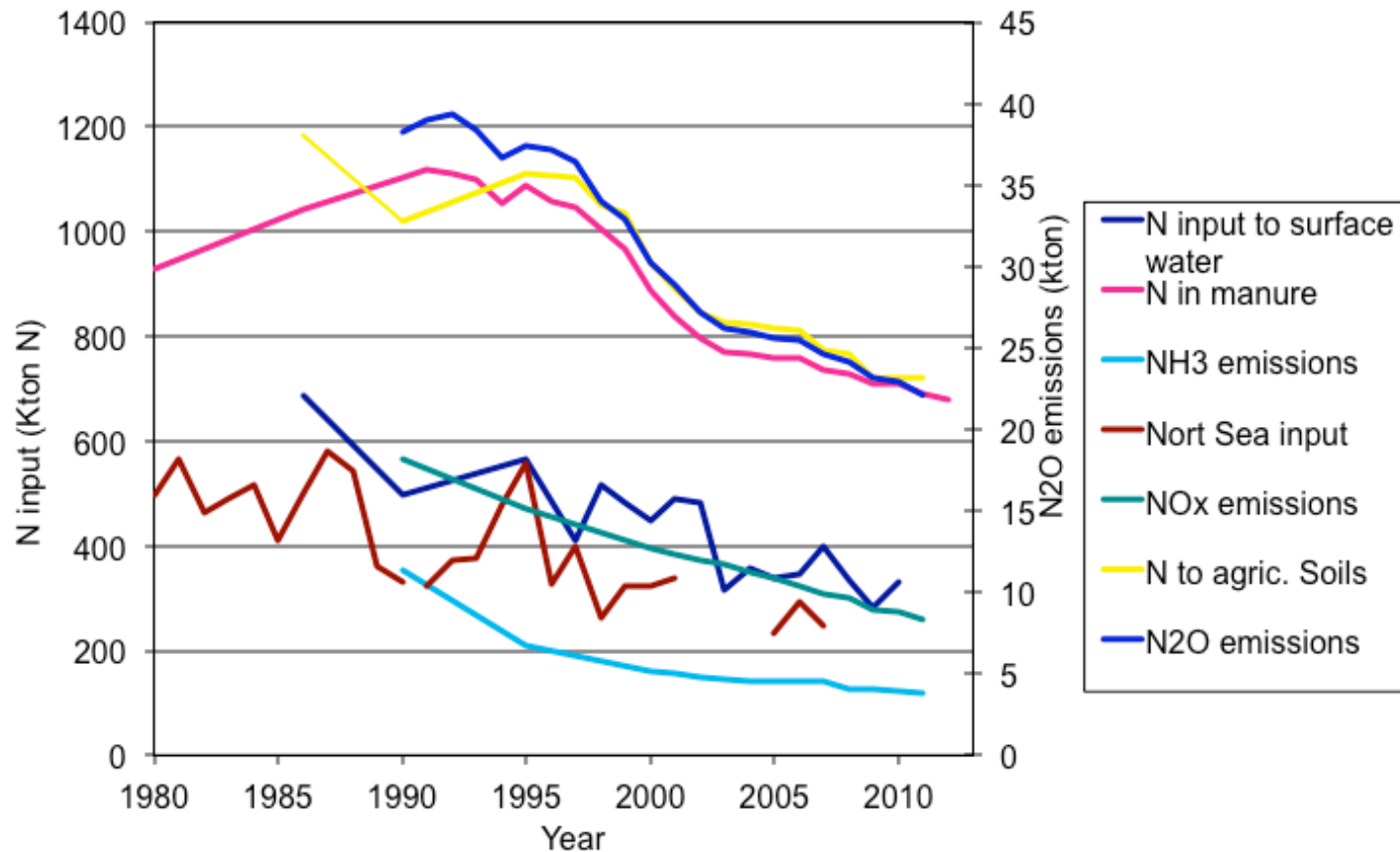


N in groundwater

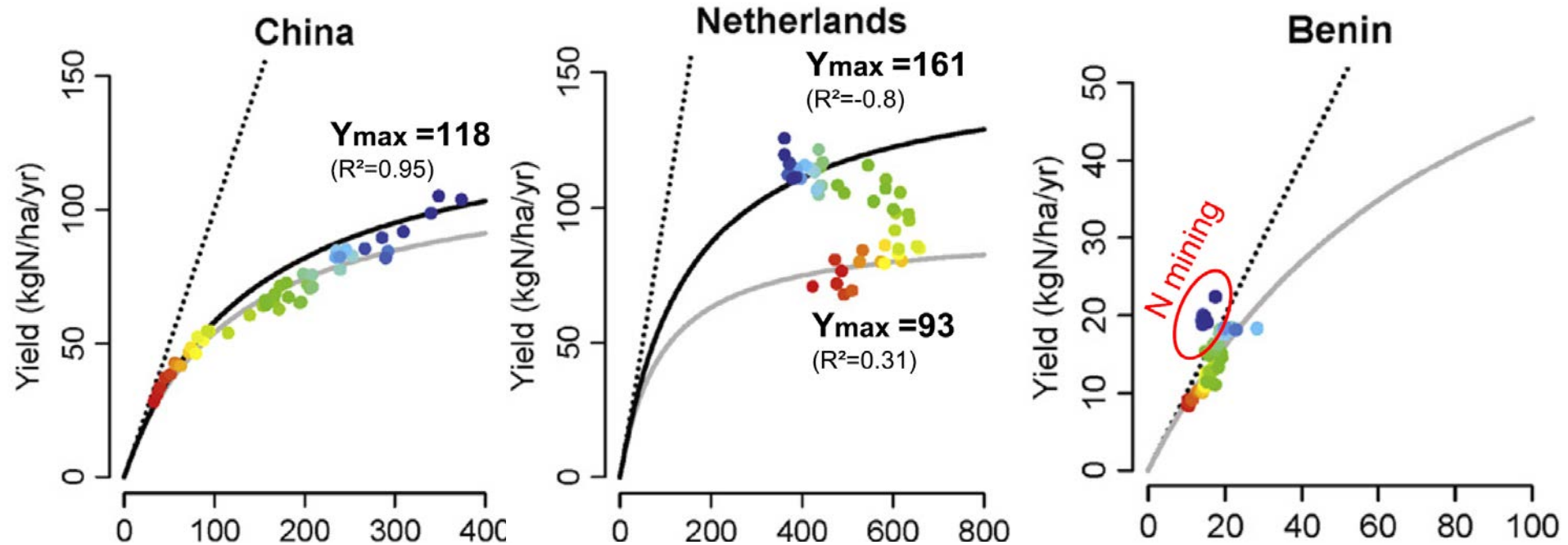


N in riviers

SUCCESSFUL NITROGEN POLICIES IN THE NETHERLANDS



THE NETHERLANDS: YIELD INCREASED WHILE N INPUT DECREASED



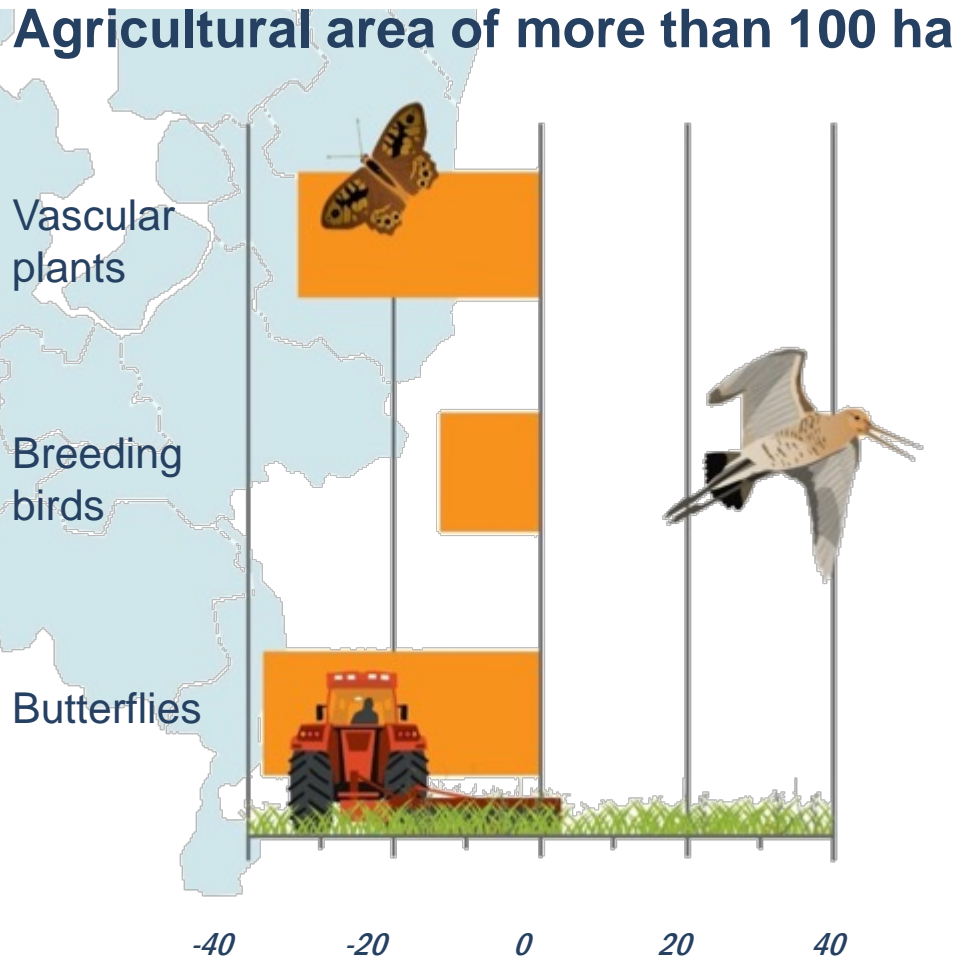
Yield high
Increase slowing
Lowering of NUE

Yield increasing
Increase high
Increase of NUE

Yield low
Increase coming
High NUE

CHANGES IN SPECIES IN THE PERIOD 1990-2005 RELATIVE TO 1975-1989

Agricultural area of more than 100 ha



FLORON, SOVON, Van Swaay 2009

THE NITROGEN DILEMMA

Benefits:

- Necessary for life
- Nitrogen fertilizer supports food supply



Drawbacks:

- Excess reactive nitrogen negatively affects environmental and human health



Challenge:

Optimizing the use of nitrogen,
while minimizing the negative impacts

SOLUTION: INTEGRATED APPROACH TO NITROGEN (PAS)

1. Nitrogen deposition has to be decreased through national, provincial and regional measures;
2. Ecological recovery measures will be taken;
3. Nitrogen deposition reductions and ecological recovery measures are compulsory and will be secured;
4. Within the expected decrease of deposition room will be created for economic developments.

The screenshot shows a news article from AD.nl. The navigation bar includes 'NEDERLAND', 'BUITENLAND', 'SPORT', 'SHOW', 'REGIO', and 'MEER AD'. The article title is 'Hogere snelheid op A2 verstikkend voor boer'. The author is Ruud F. Witte, dated 23-4-16 - 08:00. The article features a photo of four men in a barn. Below the photo is a caption: 'CDA-Kamerlid Erik Ronnes, boer Vincent de Groot, zijn vader Joost de Groot en CDA-Kamerlid Jaco Geurts © Peter Franken.' The article text discusses the speed increase on the A2 highway and its impact on farmers. To the right of the article is a sidebar with a 'MEER OVER' section containing 'BAAMBRUGGE' and 'PROVINCIE UTRECHT'. Below the article is a promotional banner for AD.nl offering a 15% discount on all subscriptions for King's Day, with the code 'KONING'.

AD NEDERLAND BUITENLAND SPORT SHOW REGIO MEER AD

NEDERLAND GROENE HART BAAMBRUGGE

'Hogere snelheid op A2 verstikkend voor boer'

Aanbevelen Delen 4 Tweet G+1 0 REAGEER

Ruud F. Witte
23-4-16 - 08:00

BEWAAR ARTIKEL

BAAMBRUGGE PROVINCIE UTRECHT

CDA-Kamerlid Erik Ronnes, boer Vincent de Groot, zijn vader Joost de Groot en CDA-Kamerlid Jaco Geurts © Peter Franken.

De snelheidsverhoging op de A2 van 100 naar 130 km per uur is funest voor uitbreidingswensen van ondernemers. Boeren en bedrijven in de regio kunnen hiervan hinder ondervinden. Veehouders hebben dat gisteren opnieuw benadrukt in een gesprek met CDA-Kamerleden. 'We hadden toch heel heldere afspraken gemaakt?'

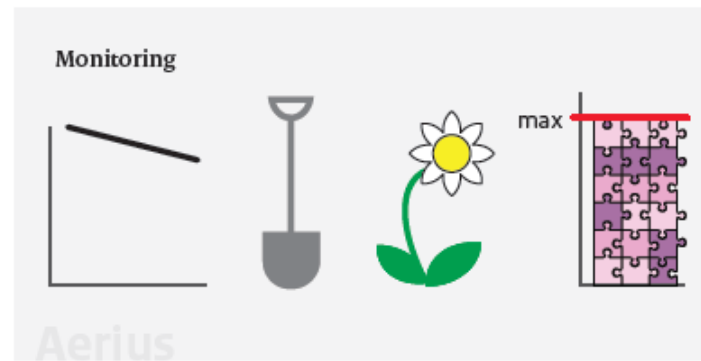
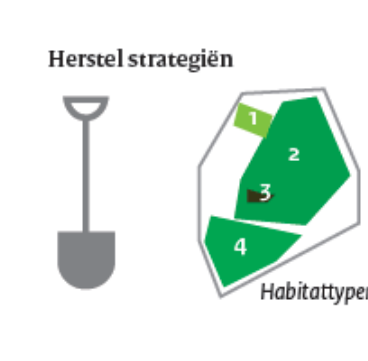
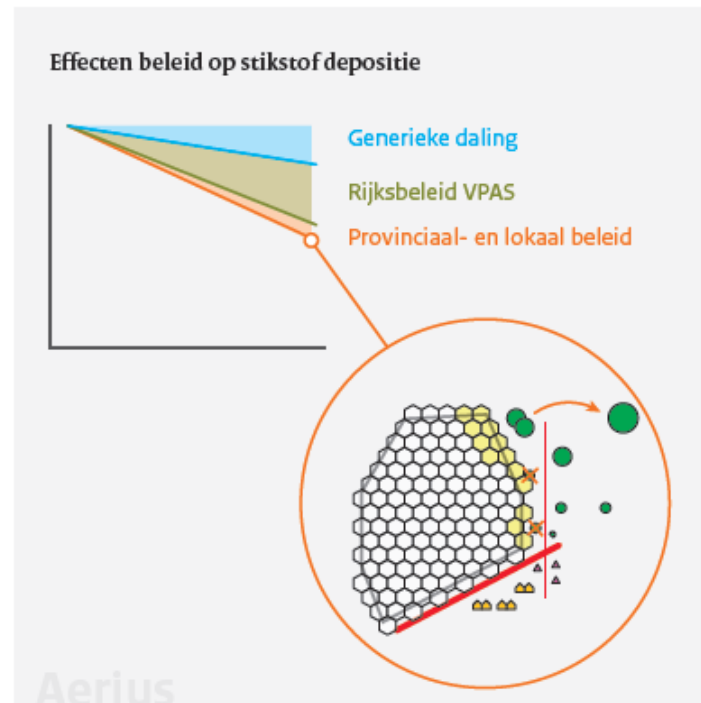
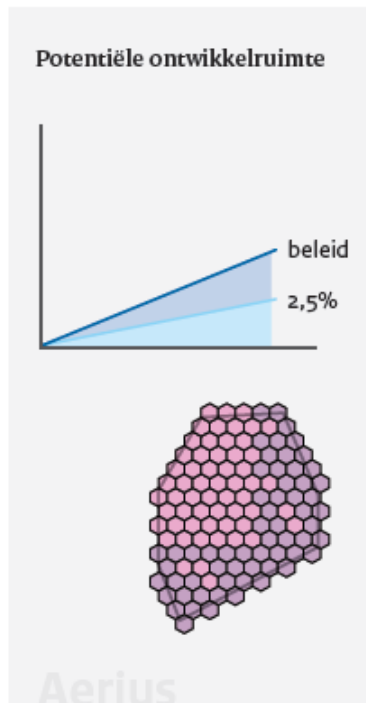
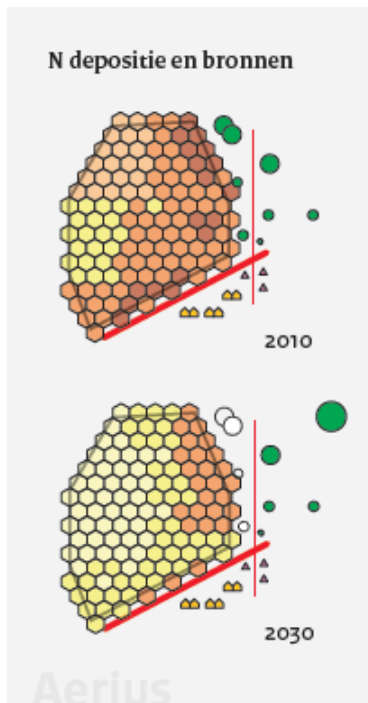
AD
15% KONINGS DAGKORTING
OP ALLE ABONNEMENTEN
NOG 5 DAGEN
GEBRUIK CODE: KONING

Uurtarief van 'n Schilder

Het uurtarief van een Schilder? 101 Schilders op 1 site! Vergelijk ze.

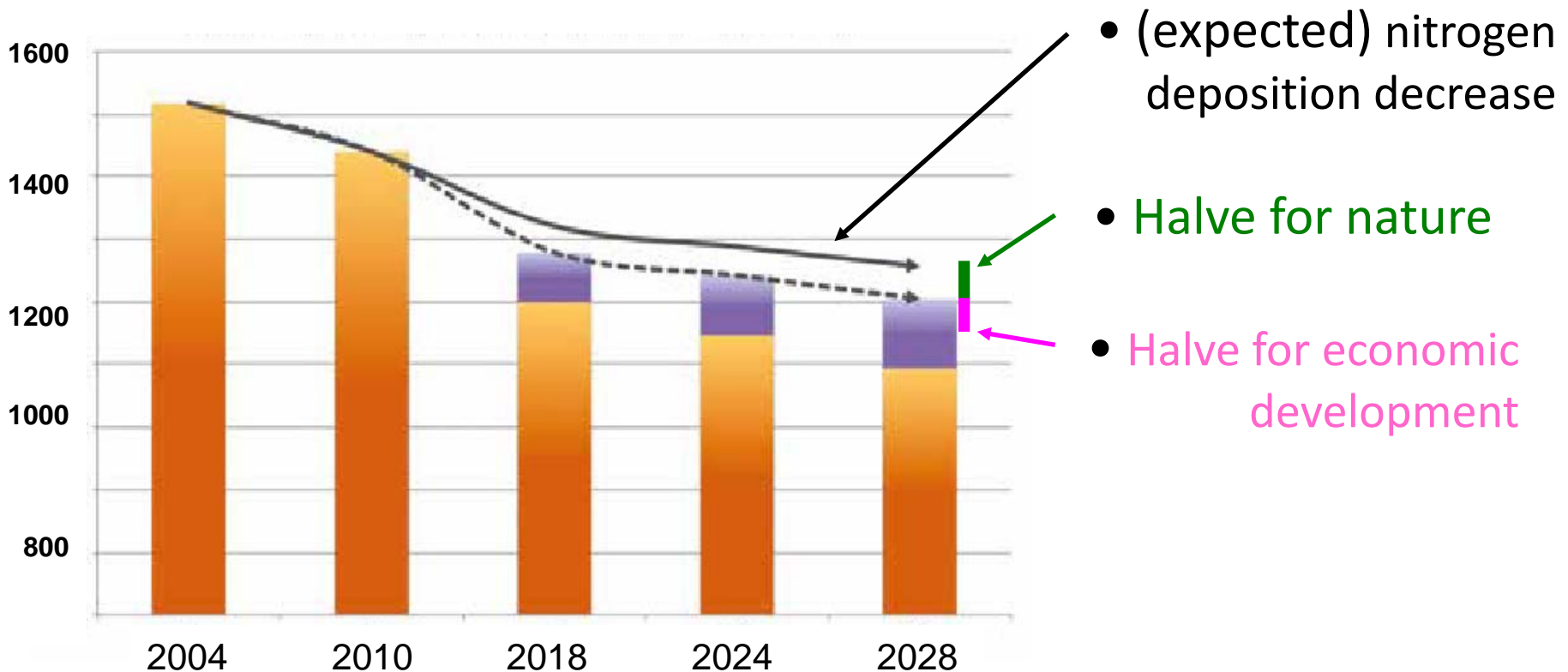


Programmatische aanpak Stikstof



PAS: ROOM FOR (ECONOMIC) DEVELOPMENT

Average nitrogen deposition on all sensitive habitats in the Netherlands



Ministry Economic Affairs

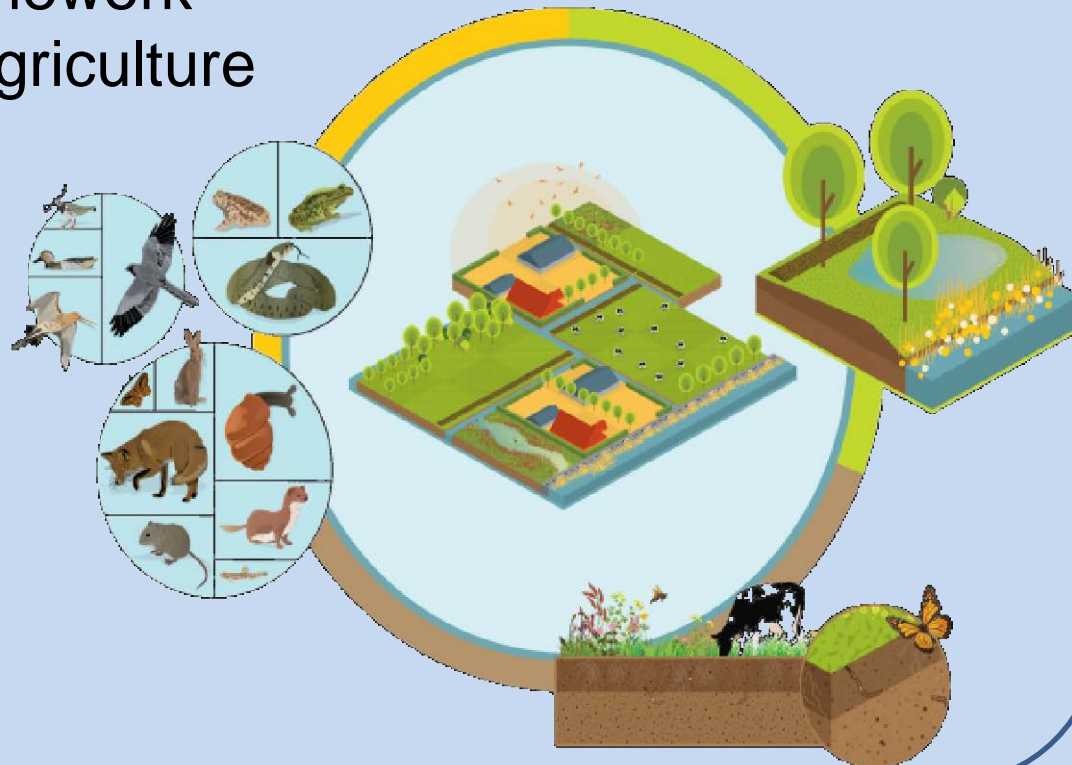
FOUR STRATEGIES TO MORE SUSTAINABILITY FOR N CYCLING RELATED TO FOOD PRODUCTION



Smarter diets

- Healthier diets
- Less animal products
- Less waste

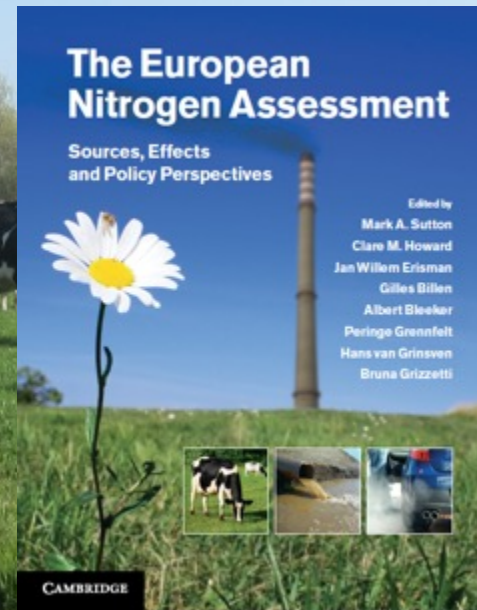
Conceptual framework biodiversity in agriculture



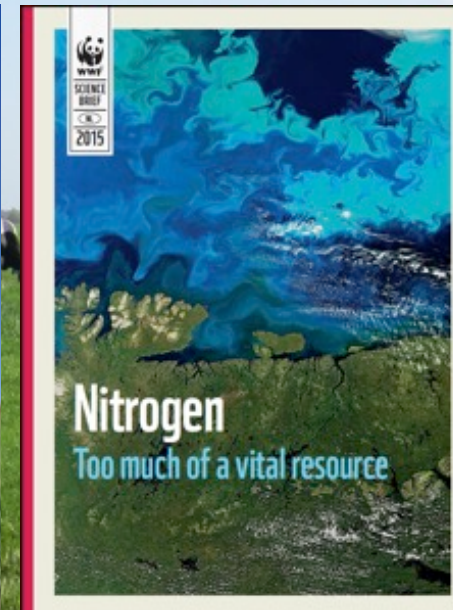
Erisman et al (2014)

THANK YOU FOR YOUR ATTENTION

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www.louisbolk.org



www.nine-esf.org



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